Document Control Binder

Exxon Valdez Oil Spill
Public Advisory Group

VOLUME TWO

TAB	SUBJECT
I.	*Restoration Framework*
II.	*Restoration Plan*
III.	*Environmental Impact Statement*
IV.	*Annual Work Plans*
V.	*Habitat Protection*

I

Exxon Valdez Oil Spill
Restoration

Restoration Framework Supplement

Prepared by:
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July 1992

State of Alaska: Departments of Fish & Game, Law, and Environmental Conservation
United States: NOAA, Departments of Agriculture and Interior

Dear Reviewer:

The goal of the Habitat Protection and Acquisition option of the Restoration Plan is to identify and protect strategic lands and habitats that will benefit the long term recovery of resources and services injured by the *Exxon Valdez* oil spill. Policy guidance for the Habitat Protection and Acquisition Process is set forth in the Plea Agreement and in the Memorandum of Agreement and Consent Decree.

The purpose of this Supplement to the Restoration Framework is to solicit public review and comments on the proposed Habitat Protection and Acquisition Process for your review and comment. This Supplement contains a narrative description of the process, flow charts that schematically depict the process, and a discussion and summary charts that present alternative threshold criteria.

Figures 6 and 7 (From Chapter VII, pages 50 and 51 in *Volume I, Restoration Framework*) represent alternative approaches for evaluating restoration options including Habitat Protection and Acquisition. Figure 6 depicts a *hierarchical* strategy wherein the Habitat Protection and Acquisition option is not applied unless other direct restoration options are found to be ineffective. Figure 7 depicts a *concurrent* strategy wherein the Habitat Protection and Acquisition option is applied in conjunction with other restoration options. The potential outcome of implementing either a hierarchical or concurrent strategy is significantly different. Both of these strategies require the identification of an injured resource or service whose rate and degree of recovery has been assessed as inadequate.

The relationship of the alternative strategies to the threshold criteria is an exceptionally important part of this process. Regardless of which strategy is chosen, the Trustee Council will approve a proposed project as a *candidate land*, for protection or acquisition, only if it is in full compliance with all adopted threshold criteria. Consequently, the adopted set of threshold criteria must be in concert and consistent with the overall restoration strategy.

We invite your comments on the Habitat Protection and Acquisition Process. We would especially like to solicit your recommendations concerning the adoption of a set of threshold criteria for incorporation into this process. Please send your written comments by August 31, 1992, to:

Exxon Valdez Oil Spill Trustee Council
645 "G" Street
Anchorage, Alaska 99501

Questions concerning this document or its distribution should be directed to the Oil Spill Public Information Center, 645 "G" Street, Anchorage, Alaska 99501, or you may call: (907) 278-8008.

Exxon Valdez Oil Spill
Restoration Framework Supplement
July 1992
Habitat Protection and Acquisition Process

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HABITAT PROTECTION AND ACQUISITION PROCESS

INTRODUCTION

The goal of the Habitat Protection and Acquisition process is to contribute to the restoration of injured resources and services by identifying and, where appropriate, protecting strategic habitats and services. Policy guidance for the Habitat Protection and Acquisition Process is set forth in the Plea Agreement and in the Memorandum of Agreement and Consent Decree.

Habitat Protection and Acquisition is one of the potential restoration alternatives presented in the Restoration Framework document. This alternative: ... *includes changes in management practices on public or private lands and creation of "protected" areas on existing public lands in order to prevent further damage to resources injured by the Exxon Valdez oil spill. Going beyond land management practices, there also are options that involve the acquisition of... habitats or property rights short of title by public agencies to protect strategic wildlife, fisheries habitat or recreation sites.*

Another potential restoration alternative that involves habitat protection and acquisition is the *Acquisition of Equivalent Resources*. The Restoration Framework defines this alternative to mean: ...*compensation for an injured, lost, or destroyed resource by substituting another resource that provides the same or substantially similar services as the injured resource (56 Federal Register 8899 [March 1, 1991]). Restoration approaches, such as the manipulation of resources and habitat protection and acquisition, can be implemented on an equivalent-resource basis.*

The March 1, 1991 Federal Register (56 FR 8903), as part of a description for a lands/ habitat protection restoration project, stated that the objective is ... *to identify and protect strategic wildlife and fisheries habitats and recreation sites and to prevent further potential environmental damages to resources injured by the Exxon Valdez oil spill.*

The purpose of the Evaluation Process and Imminent Threat Protection Process is to provide a conceptual framework and strategy for habitat protection and to serve as a guide to the Trustee Council. Central to this strategy is the requirement that a) the Trustee Council approve a list of candidate lands recommended by the Restoration Team for detailed evaluation, and b) the Trustee Council approve the actual purchases of title or property rights.

In addition, the Trustee Council would review all candidate lands, decide which proposals should receive further evaluation, determine protection tools and boundaries, and establish the ranking of the proposals.

Figures 6 and 7 in the *Restoration Framework* depict alternative approaches to evaluating restoration options, including habitat protection and acquisition options. Figure 6 depicts a hierarchical strategy whereas Figure 7 illustrates one wherein all alternatives would be considered concurrently. The choice of habitat protection and acquisition options as a restoration alternative is compatible with either the hierarchical or concurrent approach.

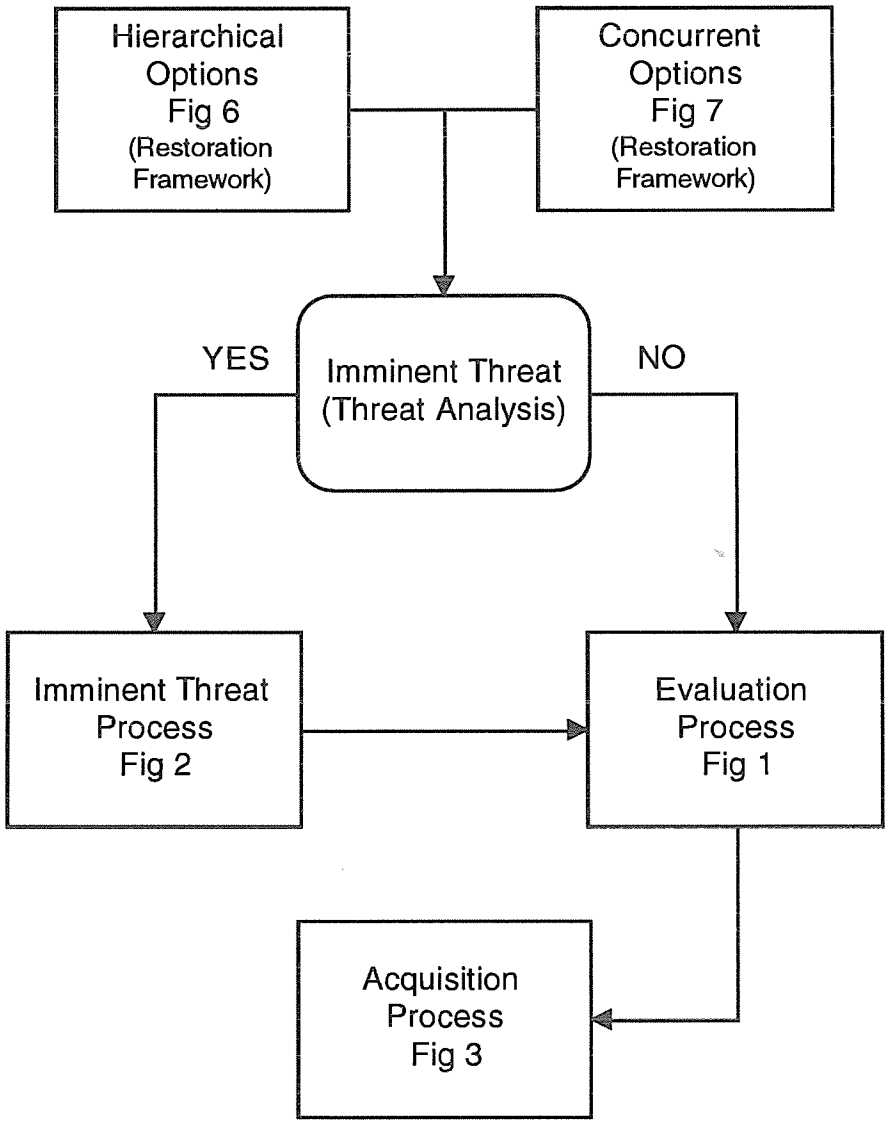
Both of these approaches require the identification of an injured resource or service whose rate and degree of recovery have been assessed as inadequate. Both the Evaluation Process [Figure 1] and Imminent Threat Protection Process [Figure 2] recognize the importance of these two elements. Consequently, they begin with these common elements as prerequisites, as is depicted in the top portions of Figures 1 and 2.

The *Habitat Protection and Acquisition Process* involves the solicitation of proposals of Candidate Lands from land owners, the public, and from State and Federal resource agencies. In order to supplement this basic process, the Imminent Threat Process was developed as an accelerated assessment procedure that recognizes the need to respond to a proposed change in land use that would foreclose habitat protection opportunities that would, if implemented, facilitate recovery of injured resources or services or allow for acquisition of equivalent resources.

The *Habitat Protection and Acquisition Process* will be presented to the public for comment as part of the Draft Restoration Plan and Draft Environmental Impact Statement. All restoration options, including habitat protection and acquisition options along with proposed evaluation criteria are included in Chapter VI of the *Restoration Framework*.

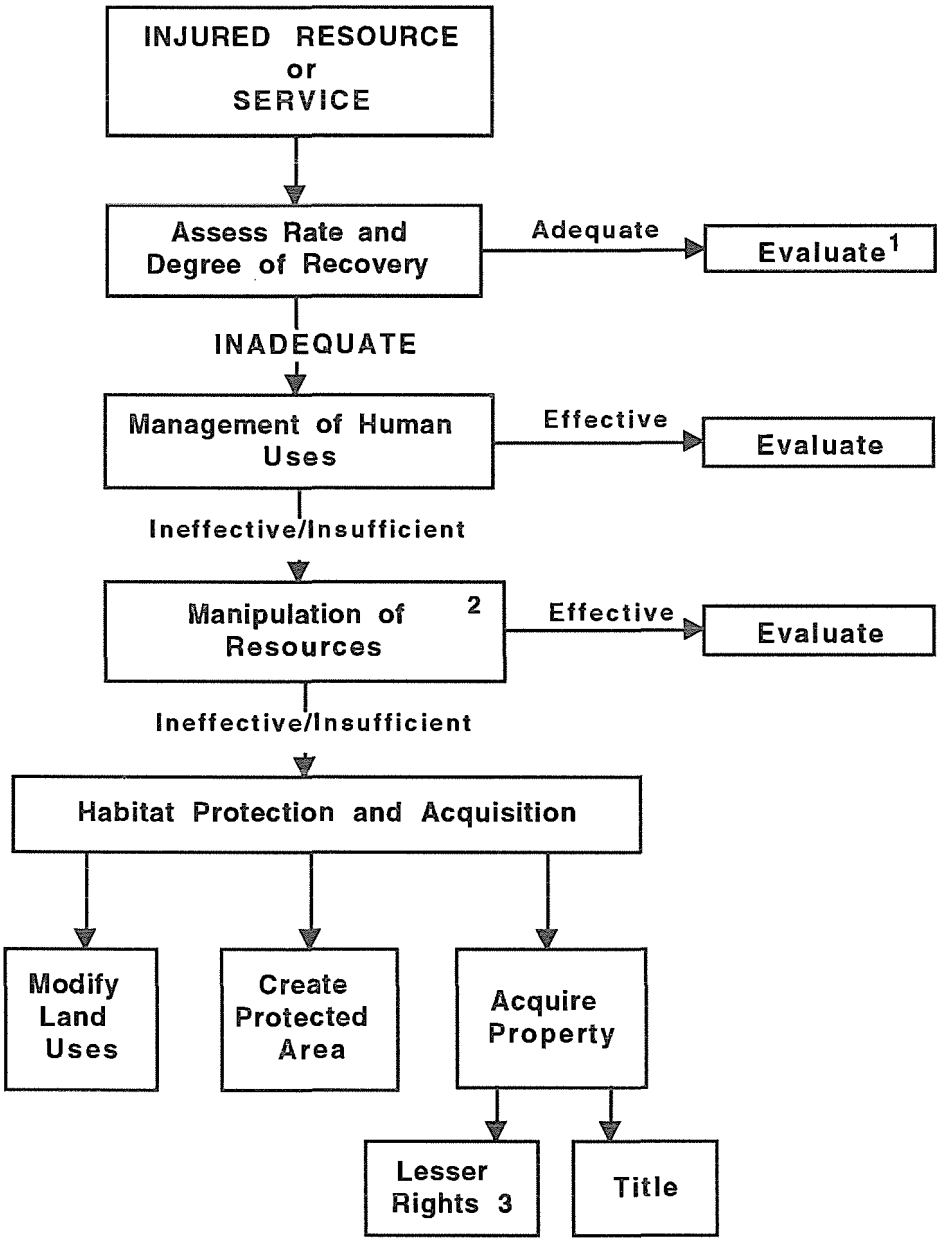
The following discussion describes the two processes by explaining the elements depicted in Figures 1 and 2. Each symbol is numbered and contains *symbol text* that identifies process or structural elements. Text which is outside of all symbols is known as *caption text* and will be defined and discussed along with the appropriate symbol text. Shaded boxes in Figures 1 and 2 represent points in the process where Trustee Council decisions are required.

Flow Chart Guide Diagram



Habitat Protection and Acquisition Process

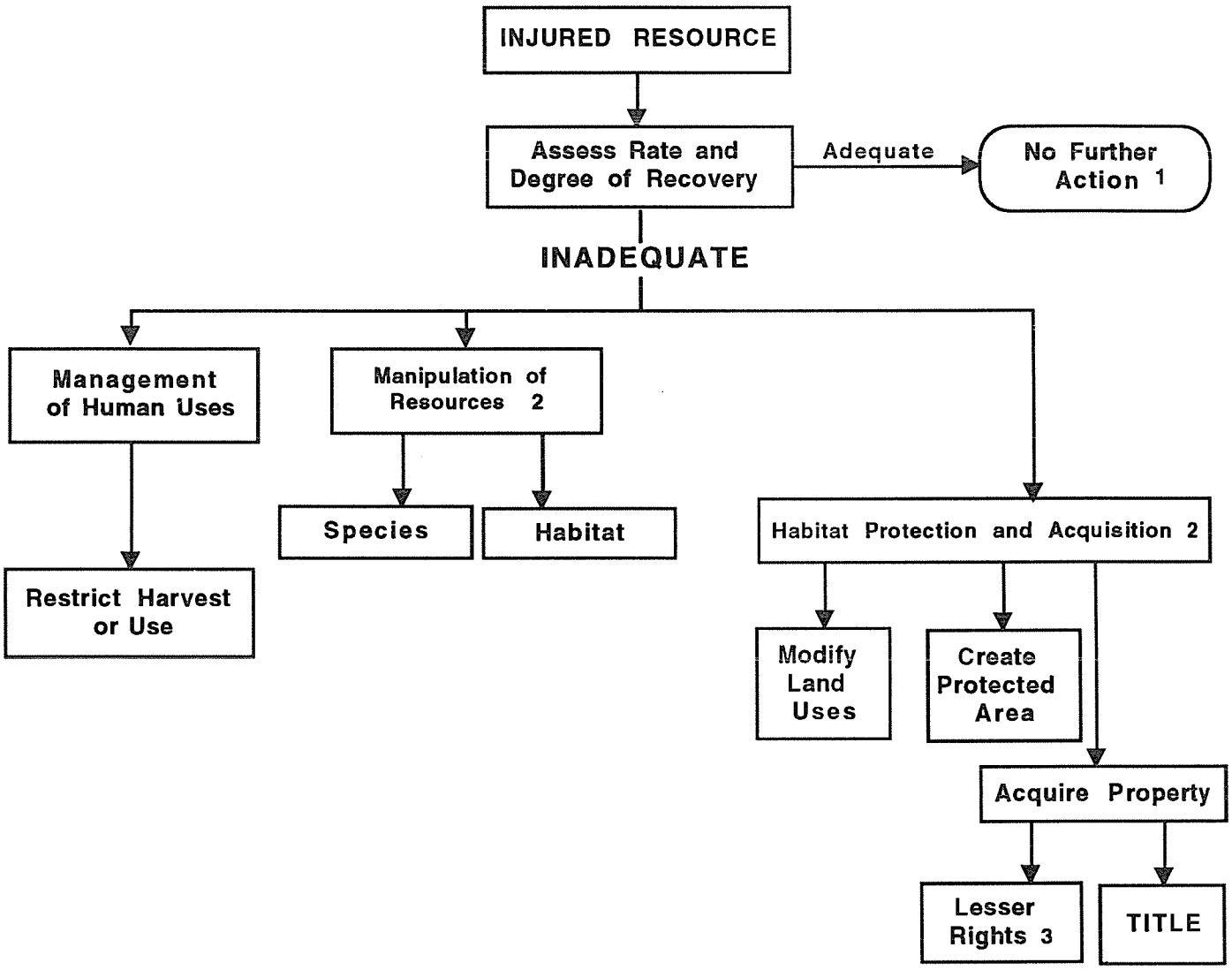
Figure 6. Possible conceptual approach to the analysis of restoration options. This approach considers options in an **hierarchical** fashion. (Framework Document)



1 All restoration actions will be evaluated to assess their effectiveness on the recovery rate of the target injured resource.
2 These approaches can be implemented on a direct-restoration or equivalent-resource basis.
3 Acquisition of full title or lesser rights exclusive of full ownership of title (partial interests), e.g., conservation easement, timber rights, access rights, etc.

Habitat Protection and Acquisition Process

Figure 7. Possible conceptual approach to the analysis of restoration options. This approach does not involve an hierarchical analysis of restoration options.



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2 These approaches can be implemented on a direct-restoration or equivalent-resource basis.
3 Acquisition of full title or lesser rights exclusive of fullownership of title (partial interests), e.g., conservation easement, timber rights, access rights, etc.

Habitat Protection and Acquisition Process

HABITAT PROTECTION AND ACQUISITION PROCESS

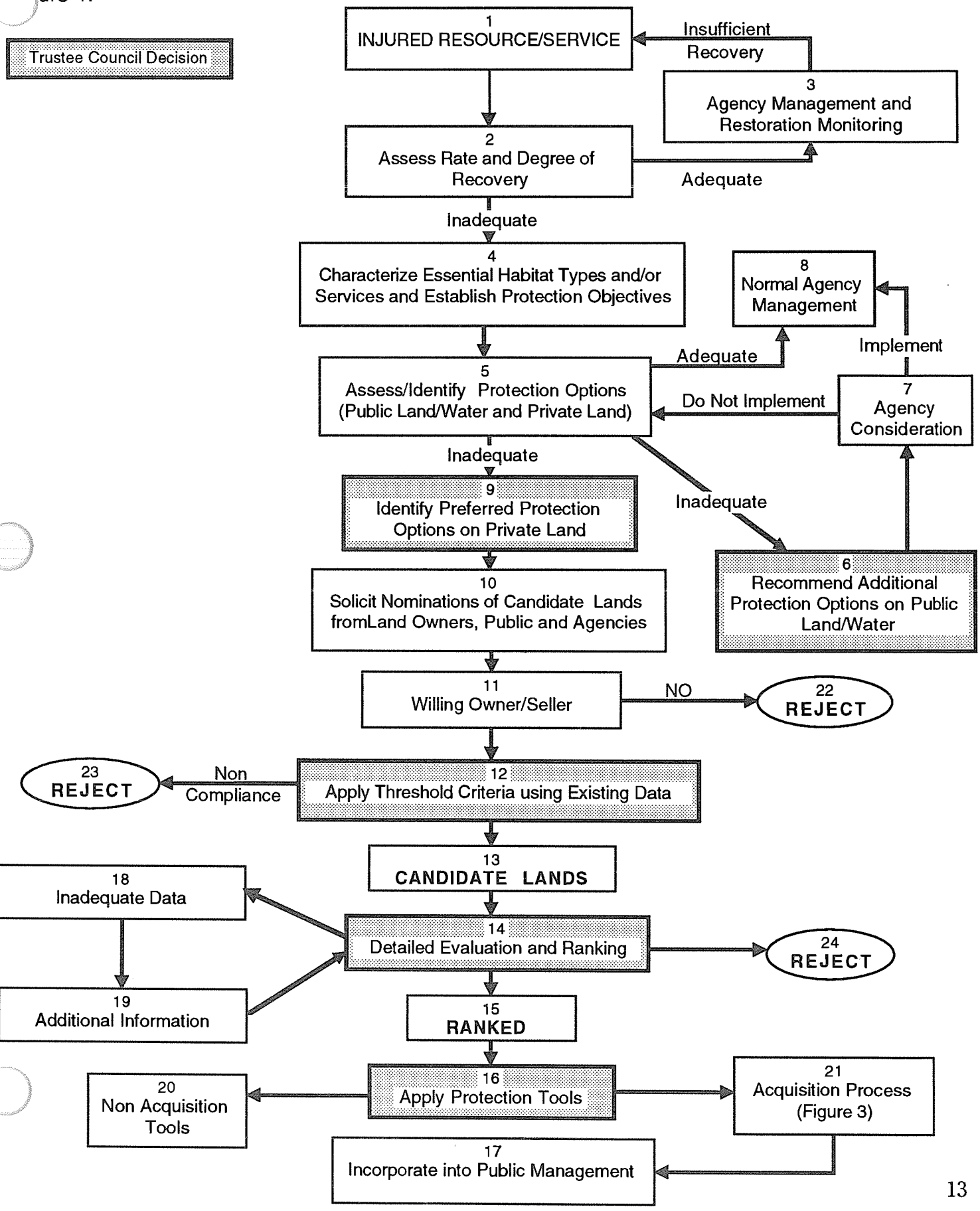
EVALUATION PROCESS

Figure 1. Evaluation Process

Narrative Description

HABITAT PROTECTION AND ACQUISITION OPTIONS EVALUATION PROCESS

ure 1.



#1 Injured Resource/Service

The definition of injury used herein is that found in the *Restoration Framework* document:

A natural resource has experienced "consequential injury" if it has sustained a loss (a) due to exposure to oil spilled by the T/V Exxon Valdez, or (b) which otherwise can be attributed to the oil spill and clean up.

A natural resource service has experienced "consequential injury" if the Exxon Valdez oil spill or clean up:

- has significantly reduced the physical or biological functions performed by natural resources, including loss of human uses; or
- has significantly reduced aesthetic, intrinsic or other indirect uses provided by natural resources; or, in combination with either of these,
- has resulted in the continued presence of oil on lands integral to the use of special-purpose lands.

Chapter IV of the *Restoration Framework, Summary of Injury*, provides a summary of the injuries to organisms, habitat, and other resources and services from the Exxon Valdez oil spill.

#2 Assess Rate and Degree of Recovery

The Restoration Framework states that: *In a scientific sense, full ecological recovery has been achieved when the pre-spill flora and fauna are again present, healthy and productive, and there is a full complement of age classes. A fully recovered ecosystem is one which provides the same functions and services as were provided by the pre-spill, uninjured system.*

Adequacy of the rate and degree of recovery will be estimated from on-going damage assessment and restoration studies, the scientific literature and other sources including the *best professional judgment* of recognized experts.

#3 Agency Management and Restoration Monitoring

Recovered resources and services will be monitored by both the resource agencies that are responsible for the management of the respective resource or service and by specific recovery monitoring studies. These studies will be part of a comprehensive and integrated monitoring program funded and managed by the Trustees.

If resource agency managers and/or results from the recovery monitoring studies indicate that recovery is not proceeding in a sufficient manner, the injured resource or service will be re-introduced into the main stream of the Evaluation Process. Adequacy of the rate and degree of recovery will be estimated from on-going damage assessment and restoration studies, the scientific literature and other sources including the *best professional judgment* of recognized experts.

#4 Characterize Essential Habitat Types and/or Service Components and Establish Protection Objectives

Essential habitat components of critical life history stages, i.e., reproduction, and feeding, of injured resources will be characterized. Habitat components that support injured services, e.g., spawning areas for anadromous fish, will also be defined. Implementation of this step requires the characterization of non-site specific habitat components, e.g., anadromous streams, old growth forests, riparian woodland, cliff ledges on offshore islands, etc. Identification of discrete, geographically-specific sites comes later in the process.

Establishing protection objectives and/or management strategies for these habitat types, that are designed to facilitate the recovery of injured resources or services, will result from reviews of life history literature, on-going studies and other sources, including the best professional judgment of recognized experts.

#5 Assess/Identify Protection Options (Public Land/Water and Private Land)

Federal, State and local regulations and policies will be identified and reviewed to determine whether or not they provide adequate protection for injured resources/ services and their essential habitat components. This review will include both private and public land/water. An assessment will be made of the adequacy of this protection within the Exxon Valdez Oil Spill context, i.e., do these regulations act to facilitate the recovery of resources/services injured by the oil spill. If these regulations are consistent with the requirements for recovery, additional protection options will not be recommended.

#6 Recommend Additional Protection Options on Public Land/Water

If protection options currently in force on public land/water are found to inadequately promote and protect recovery, additional options will be developed and recommended to the appropriate resource agency. For example, more stringent resource development regulations might be recommended, for what is considered to be the recovery period for a specific resource or service.

#7 Agency Consideration

Additional protection options will be submitted to, and reviewed by, the appropriate resource agency. If deemed acceptable, the agency will incorporate the option(s) into normal agency management procedures. If the agency decides to reject the recommended option(s), the options may be re-evaluated and/or new options developed.

#8 Normal Agency Management

Additional protection options accepted by resource agencies will be incorporated into normal agency management procedures and policies for the appropriate duration. Additional recovery monitoring will be part of a comprehensive and integrated monitoring program funded and managed by the Trustees.

#9 Identify Preferred Protection Options on Private Land

If protection options that are in force on private lands are inconsistent or insufficient with the requirements for recovery, additional protection options will be recommended. For example, if the *Alaska Forest Resources and Practices Act (1990)* does not provide for the desired rate of recovery of injured resources/ services in riparian habitats, additional protection options for these habitat types will be identified.

For each injured resource/service for which essential habitat components are considered to be inadequately protected on private lands, a suite of preferred protection options will be identified and approved by the Trustee Council. Most of these protection options have been enumerated and described in *Options for Identifying and Protecting Strategic Fish and Wildlife Habitats and Recreation Sites* (The Nature Conservancy Handbook, 1991).

- Steps 1-9 have accomplished the following tasks:
  - Identification of injured species and services, that are not adequately recovering.
  - Identification of habitat components linked to recovery.
  - Development of protection objectives for each injured resource/service and linked habitat component.
  - Assessment of existing protection options on private and public land/water.
  - Identification of additional protection options needed to be implemented on private and public land/water.
- Each of these steps will be described in both the Draft Restoration Plan and the Draft Environmental Impact Statement.

#10 Solicit Nominations of Candidate Lands from Land Owners, Public and Agencies

A Request for Proposal [RFP] will be issued by the Trustee Council in order to solicit nominations of candidate lands. The RFP will contain information describing, in generic terms, the types of land that the Trustees are interested in evaluating in order to protect injured resources/services. Geographically-specific sites will not be enumerated. The RFP will also contain a list and description of the preferred protection options that will be considered for those nominations that become candidate lands. The RFP will contain language that explicitly states that this is a voluntary program and that condemnation is not contemplated by the Trustees.

#11 Willing Owner/Seller

The first steps in the review of all nominations is the determination of land ownership and willingness, on the part of the owner/seller, to negotiate with the Trustees for rights and/or title to the land. All interests in the land should be identified by the land owner/seller, i.e. surface rights, subsurface rights, other development rights.

#22 Reject

A nomination will be rejected if clear title to the land or other desired interests in the land cannot be demonstrated or if an unambiguous statement of willingness to negotiate is not obtained from the land owner/seller.

#12 Apply Threshold Criteria using Existing Data

Each nomination will be evaluated against a set of threshold criteria designed to determine whether or not a nomination is acceptable for further consideration. Based on existing information, the threshold criteria will eliminate proposals that are inappropriate or unreasonable.

#23 Reject

A nomination will be rejected if it is not in compliance with ALL threshold criteria. Rejected proposals can be recycled back into the process for another review if additional information is made available that could allow for compliance with all threshold criteria.

#13 Candidate Lands

This element is a list of nominated lands approved by the Trustee Council for detailed evaluation.

- At this point in the process there is a list of Candidate Lands that:
  - Contain essential habitat components linked to recovery of injured resources/services.
  - Are not afforded adequate protection by existing law, regulation and/or policy.
  - Are owned by a willing owner/seller.
  - Are in full compliance with all threshold criteria.

#14 Detailed Evaluation and Ranking

Each candidate land will be evaluated and ranked against a set of detailed evaluation criteria designed to determine whether or not a nomination should be prioritized. The Trustee Council will determine the ranking. These criteria will include, but not be limited to, those identified in Chapter VI of the Restoration Framework. The purpose of this component is to conduct a more rigorous analysis of proposals utilizing more specific information than was available for step #12 [Threshold Criteria]. In some cases, it may be necessary to acquire additional information to complete the detailed evaluation. Owners of candidate lands will be provided the results of the detailed evaluation.

#18 Inadequate Data

This step involves characterization of the data gaps and a determination of the most cost-effective and timely method to obtain any necessary information. Funding for the acquisition of any additional data must be approved by the Trustee Council.

#19 Additional Information

Any necessary additional information may be obtained from the studies funded by the Trustee Council. These studies will be subject to review by the appropriate experts and entered into the detailed Evaluation Process.

#24 Reject

Rejection of a candidate land at this step may result from:

- Non-compliance with the detailed evaluation criteria after initial review.
- Non-compliance with the detailed evaluation criteria after additional information was obtained.

#15 Ranked Lands

This element contains proposals that were ranked or prioritized according to the degree of each proposal's conformance with the stated goal of the process [Step #14]. Ranking will also be based upon the outcome of the detailed evaluation.

#16 Apply Protection Tools

The appropriate and most cost-effective protection tool(s) will be matched to each ranked, candidate parcel. This decision will be made by the Trustee Council. In some cases, a single tool will be chosen if it provides adequate protection. In other cases, several protection tools may be deemed necessary; there may even be a mix of non-acquisition and acquisition tools selected.

#20 Non-Acquisition Tools

These could include, but not be restricted to:

- Landowner contact and education
- Voluntary agreements: registration and cooperative management agreements
- Rights of first refusal

These protection tools are discussed in *Options for Identifying and Protecting Strategic Fish and Wildlife Habitats and Recreation Sites* (The Nature Conservancy Handbook, 1991). Agency management and monitoring will be recommended where appropriate.

#21 Acquisition Process

Tools that involve acquisition of property rights or interests could include, but not be restricted to:

- Conservation easements
- Deed restrictions and reverters
- Acquisition of partial interests: timber, mineral and access rights
- Fee acquisitions

These protection tools are discussed in *The Nature Conservancy Handbook*. The process by which acquisition tools should be implemented is depicted in Figure 3 and discussed in the accompanying narrative.

#17 Incorporate into Public Management

Acquired rights or title will be incorporated into existing management plans where appropriate. Management plans for newly acquired parcels will be written where necessary. Each plan's goal will be to manage the parcel or interest in a manner that will benefit the long term recovery of resources and services injured by the Exxon Valdez oil spill. The Trustee Council will decide which agency will manage the land or will create a new management authority.

HABITAT PROTECTION AND ACQUISITION PROCESS

IMMINENT THREAT PROTECTION PROCESS

Figure 2. Imminent Threat Protection Process

Narrative Description

HABITAT PROTECTION AND ACQUISITION OPTIONS
IMMINENT THREAT PROTECTION PROCESS

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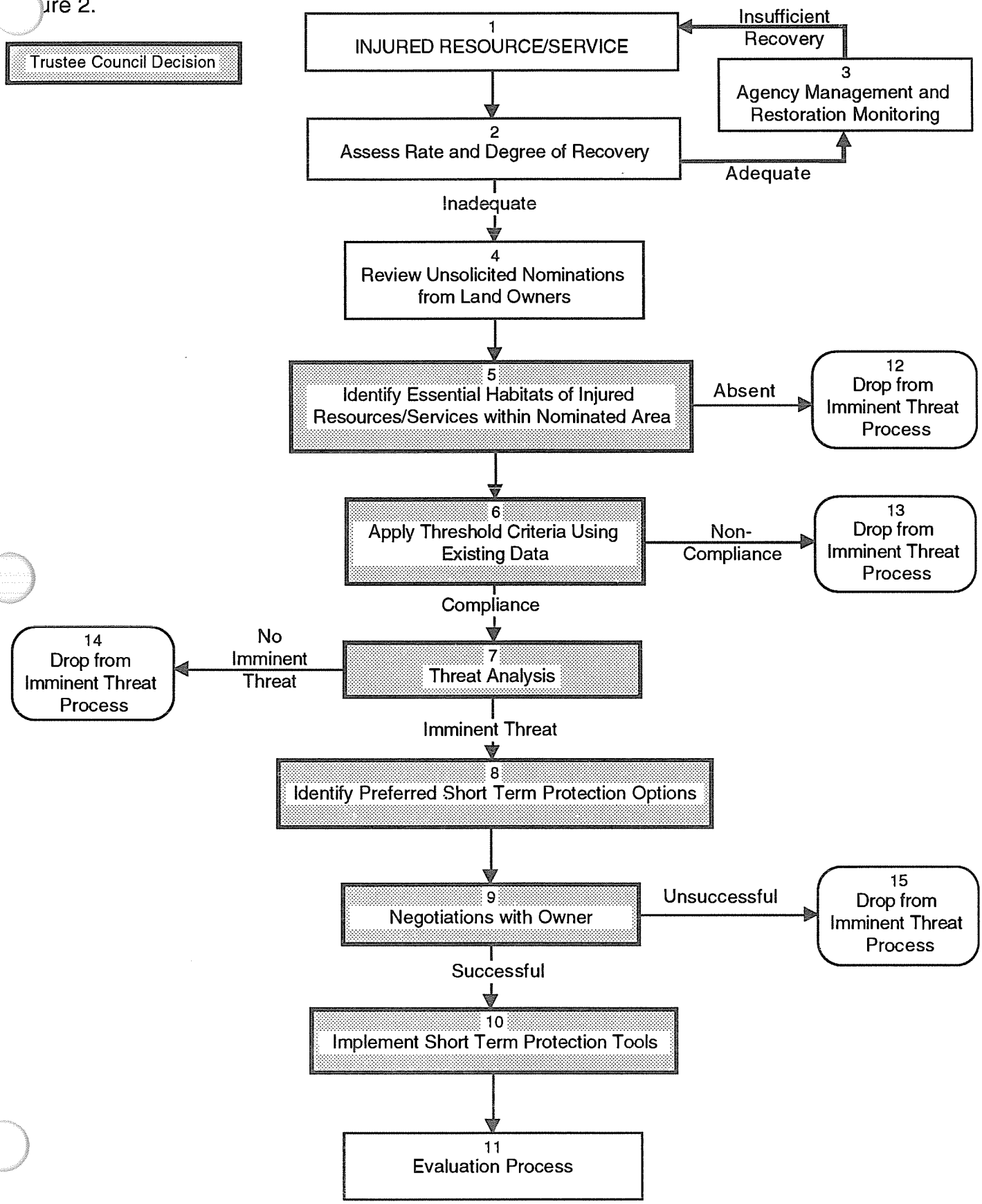

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#2 Assess Rate and Degree of Recovery

The *Restoration Framework* states that: *In a scientific sense, full ecological recovery has been achieved when the pre-spill flora and fauna are again present, healthy and productive, and there is a full complement of age classes. A fully recovered ecosystem is one which provides the same functions and services as were provided by the pre-spill, uninjured system.*

Adequacy of the rate and degree of recovery will be estimated from on-going damage assessment and restoration studies, the scientific literature and other sources including the *best professional judgment* of recognized experts.

#3 Agency Management and Restoration Monitoring

Recovered resources and services will be monitored by both the resource agencies that are responsible for the management of the respective resource or service and by specific recovery monitoring studies. These studies will be part of a comprehensive and integrated monitoring program funded and managed by the Trustees.

If resource agency managers and/or results from the recovery monitoring studies indicate that recovery is not proceeding in a sufficient manner, the injured

resource or service will be re-introduced into the main stream of the Evaluation Process. Adequacy of the rate and degree of recovery will be estimated from on-going damage assessment and restoration studies, the scientific literature and other sources including the *best professional judgment* of recognized experts.

#4 Review Unsolicited Nominations from Land Owners

Nominations that the Trustee Council receive without their solicitation will be reviewed.

#5 Identify Essential Habitats of Injured Resources/Services

Essential habitat components, that were characterized as part of the Evaluation Process [Figure 1], will be identified on the nominated parcels. This site-specific analysis will be conducted utilizing existing information. It is understood that the available information describing the environmental character of these lands is, for the most part, both limited and imprecise.

#12 Drop from Imminent Threat Process

Nominations that do not contain essential habitat components will be dropped from this process. This decision does not prevent the land owner from responding to the RFP solicitation from the Evaluation Process [Figure 1]. Given data limitations that constrain this fast track type of review, it is necessary to allow for the admission of a nomination into the Evaluation Process, after being dropped from the Imminent Threat Process, because more information may become available that could alter the conclusions.

#6 Apply Threshold Criteria using Existing Data

Each nomination will be evaluated against a set of threshold criteria designed to determine whether or not a nomination is acceptable for further consideration. The threshold criteria should:

- Eliminate proposals that will not facilitate recovery of injured resources/services.
- Eliminate proposals that do not represent a reasonable selection for equivalent resource acquisition.

#13 Drop from Imminent Threat Process

A nomination will be rejected if it is not in compliance with ALL threshold criteria. Rejected proposals can be recycled into the Evaluation Process at step #5 (Figure 1) for another review if additional information is made available that conceivably would allow for compliance with all threshold criteria.

#7 Threat Analysis

Nominations in compliance with all threshold criteria will be subjected to a *Threat Analysis*. This is a method for determining the magnitude/validity/reality of a threat to an injured resource/service and the imminence of the threat. Nominations that would be considered on an equivalent-resource basis would also be subject to a threat analysis. The Nature Conservancy defines it as: *...a means of determining whether an accelerated identification, ranking, and protection process is necessary due to immediate threats to recreation resources, activities, or opportunities. Where a short-term threat exists, use of a rapid, or abbreviated assessment will enable decision makers to decide on appropriate actions to buy time or immediately protect significant existing or potential resources. If time can be bought, a comprehensive assessment can proceed. Similarly, in the absence of any short-term threat, a comprehensive assessment would be initiated* [The Nature Conservancy Handbook, 1991].

#14 Drop from Imminent Threat Process

If the threat analysis indicates that there is no imminent threat, the nomination will be considered under the Evaluation Process beginning at step #5 (Figure 1).

#8 Identify Preferred Short-Term Protection Options

If the threat analysis indicates that there is an imminent threat, a suite of short-term protection options will be identified that address the specific situation at hand. Implementation of one or several of these options will provide additional time to allow for the Trustee Council to conduct a detailed evaluation of the proposal. Information needed to carry out this evaluation may require additional field studies. Consequently, the short-term protection option(s) that is selected must provide additional time to collect, analyze and incorporate the additional information into the detailed evaluation. Examples of short-term options are: a) development moratorium, b) lease, and c) management agreement.

#9 Negotiations with Owner

The Trustee Council will negotiate with the land owner utilizing the preferred short-term protection options identified in step #8.

#15 Drop from Imminent Threat Process

Unsuccessful negotiations result in the nomination being dropped from the Imminent Threat Process. The land owner has the option of nominating the proposal for consideration in the Evaluation Process.

#10 Implement Short-Term Protection Options

After successful negotiations with the land owner, the mutually-agreed-upon option(s) will be implemented. During the period that the option(s) is in effect, the required, additional information will be assembled.

#11 Evaluation Process

The proposal will be inserted into the Evaluation Process as a Candidate Land [Step #13, Figure 1] and be subject to the process from that point forward.

HABITAT PROTECTION AND ACQUISITION PROCESS

ALTERNATIVE THRESHOLD CRITERIA

Narrative Description

Chart 1. Comparison of Alternative Threshold Criteria Sets

Chart 2. Summary Analysis of Threshold Criteria

Threshold Criteria

The Habitat Protection and Acquisition Process utilizes *threshold criteria* to initially screen proposals nominated by land-owners, agencies, or the public. The intent of the threshold criteria is to eliminate those proposals which do not contribute to restoration objectives, or are inappropriate or unreasonable. Proposals which successfully meet all of the threshold criteria become *candidate lands* which are then subjected to additional steps in the process leading towards eventual protection/acquisition.

Three alternative sets of threshold criteria (sets A, B, and C) have been developed. One set, or a combination of sets, is to be adopted and incorporated as an integral part of the Habitat Protection and Acquisition Process. Selection of a set of threshold criteria will not preclude criteria in any of these sets from being considered as evaluation criteria.

Table 1 provides a side-by-side comparison of the three sets of threshold criteria. All three sets share two criteria which are dictated by Trustee Council policy and the law; criteria #1, the requirement for a *willing seller*, and criteria #3, the requirement for purchase at *fair market value*. The application of the other threshold criteria differs between each of the sets.

Table 2 provides a summary analysis describing both the objectives and the attributes of each threshold criteria. The application of the threshold criteria in each of the three sets results in significantly different outcomes from the Habitat Protection and Acquisition Process.

Outcome

The following discussion briefly describes the outcome anticipated from applying each set of threshold criteria:

Set A

Set A imposes the least restrictive threshold criteria. In addition to meeting criteria 1 and 3, proposals would need to demonstrate that they are associated either directly with (linked to, replace) or indirectly with (provide equivalent of, substitute for) an injured resource or service. Additionally, the proposed habitat protection/acquisition would need to be shown to benefit an injured or equivalent resource or service. Equivalent resources and services encompass a wide spectrum of species, habitats, and activities in addition to those which were shown to have been injured by the spill.

Set A would allow for a wide scope of habitat protection/acquisition proposals to be considered both within and outside of the spill affected area.

Set B

Set B imposes an intermediate level of threshold criteria. In addition to meeting criteria 1 and 3, and consistent with Set A, proposals would need to demonstrate that they are associated either directly or indirectly with an injured resource or service. Unlike Set A, the *recovery* of an injured resource or service would have to be shown to benefit from each habitat protection/acquisition proposal. The key difference between Set A and Set B is that proposals must benefit the *recovery* of injured resources/services rather than merely providing a benefit to an injured *or equivalent* resource/service.

Set B would allow for a more limited scope of habitat protection/acquisition actions to be considered. A wide range of acquisition/protection proposals could qualify within the spill affected area. Actions outside of the spill affected area would be much more limited than under Set A.

Set C

Set C imposes the most restrictive threshold criteria and follows a strict hierarchical strategy for acquisition/protection. In addition to meeting criteria 1 and 3, proposals would need to demonstrate that they contain habitats that are directly linked to recovery of injured resources/services. A finding would be needed that existing laws, regulations, and other requirements are inadequate to provide the level of protection that a proposed habitat protection/acquisition action would provide. Review of proposals would need to demonstrate that expected land uses (e.g., logging) would threaten resources injured by the spill. Determinations would need to show that: 1) failure to act on a proposal would foreclose meeting restoration objectives, and 2) restoration options other than a protection/acquisition proposal would be inadequate to meet restoration objectives. A proposal would need to demonstrate an incremental benefit to restoration, and be cost-effective relative to other restoration options. Finally, a proposal would have to be reasonably incorporated into public land management systems.

Set C would allow a relatively narrow scope of habitat protection/acquisition actions to be considered. In keeping with the hierarchical strategy, habitat protection/acquisition would only be considered when other direct restoration options were found ineffective. Only habitats of injured resources/services could be protected. Protection of equivalent resources/services would only be an option after consideration of direct or replacement restoration action. A concurrent strategy for the Habitat Protection and Acquisition option could not be followed.

TABLE 1: COMPARISON OF ALTERNATIVE THRESHOLD CRITERIA SETS

#	SET A	SET B	SET C
1	There is a willing seller of the parcel or property right.	There is a willing seller of the parcel or property right.	There is a willing seller of the parcel or property right.
2	The parcel contains key habitats that are linked to, replace, provide the equivalent of, or substitute for injured resources or services based on scientific data or other relevant information.	The parcel contains key habitats that are linked to, replace, provide the equivalent of, or substitute for injured resources or services based on scientific data or other relevant information.	The parcel contains key habitats that are linked to the recovery of injured resources or services by scientific data or other relevant information.
3	The seller acknowledges that the government can only purchase the parcel or property rights at fair market value.	The seller acknowledges that the government can only purchase the parcel or property rights at fair market value.	The seller acknowledges that the government can only purchase the parcel or property rights at fair market value.
4	An injured or equivalent resource or service would benefit from protection in addition to that provided by the owner and applicable laws and regulations.	Recovery of the injured resource or service would benefit from protection in addition to that provided by the owner and applicable laws and regulations.	Protection afforded by existing law, regulations, and other alternatives is inadequate to meet restoration objectives.
5	NOT APPLICABLE	NOT APPLICABLE	The nature and immediacy of expected changes in use will further affect resources injured by the oil spill.

TABLE 1: COMPARISON OF ALTERNATIVE THRESHOLD CRITERIA SETS

#	SET A	SET B	SET C
6	NOT APPLICABLE	NOT APPLICABLE	Failure to act will foreclose meeting restoration objectives.
7	NOT APPLICABLE	NOT APPLICABLE	Restoration strategies other than acquisition of the property right(s) are inadequate to meet restoration objectives.
8	NOT APPLICABLE	NOT APPLICABLE	Acquisition of the property right(s) will result in an identifiable incremental benefit to restoration objectives that is cost-effective relative to other restoration alternatives for the identified resource injuries.
9	NOT APPLICABLE	NOT APPLICABLE	The acquired property rights can reasonably be incorporated into public land management systems.

TABLE 2: SUMMARY ANALYSIS OF THRESHOLD CRITERIA

# Set	Threshold Criteria	Objective	Attributes
1 ABC	There is a willing seller of the parcel or property right.	• To evaluate only proposals amenable to applicable owners. • To avoid perception of condemnation.	•Minimizes unnecessary evaluations. •Facilitates negotiations with owner. •Eliminates consideration of proposals, if owner not interested.
2 AB	The parcel contains key habitats that are linked to, replace, provide the equivalent of, or substitute for injured resources or services based on scientific data or other relevant information.	• To consider a wide range of protection/acquisition proposals for meeting restoration goals. • To reject proposals that are not directly or indirectly linked to injured resources/services.	•Consistent with injury requirement in settlement. •Identifies linkage between acquisition/protection proposal and injured resource/service. •Imposes an objective standard based on scientific documentation. •Makes use of Contingent Valuation studies and other relevant NRDA data and studies. •Allows compensation and/or equivalency *in lieu* of direct recovery of injured resources or services.
2 C	The parcel contains key habitats that are linked to the recovery of injured resources or services by scientific data or other relevant information.	•To consider a narrow range of protection/acquisition proposals for meeting restoration goals. •To reject proposals that are not directly linked to injured resources/ services.	•Imposes strict linkage between acquisition/protection proposal and injured resource/service. •Imposes an objective standard based on scientific documentation. •Limits protection/acquisition option to direct recovery of injured resources/services.

TABLE 2: SUMMARY ANALYSIS OF THRESHOLD CRITERIA

# Set	Threshold Criteria	Objective	Attributes
3 ABC	The seller acknowledges that the government can only purchase the parcel or property rights at fair market value.	•To explicitly comply with the law. •To discourage unrealistic proposals.	•Facilitates cost-control. •Minimizes unnecessary evaluations.
4 A	An injured or equivalent resource or service would benefit from protection in addition to that provided by the owner and applicable laws and regulations.	•To ensure that a proposed protection/acquisition would benefit an injured or equivalent resource or service. •To evaluate adequacy of existing land and resource management regime to protect injured or equivalent resources or services.	•Requires evaluation of regulatory and management capabilities to determine existing level of protection for injured and equivalent resources/services. •Identifies benefit to injured or equivalent resources/services which would accrue from acquisition/protection.
4 B	Recovery of the injured resource or service would benefit from protection in addition to that provided by the owner and applicable laws and regulations.	•To ensure that a proposed protection/acquisition would provide an incremental recovery benefit. •To evaluate adequacy of existing land and resource management regime to achieve recovery.	•Requires evaluation of regulatory and management capabilities to determine existing level of protection for injured resources/services. •Identifies how recovery of injured resources/services would benefit from acquisition/protection.

TABLE 2: SUMMARY ANALYSIS OF THRESHOLD CRITERIA

#	Set	Threshold Criteria	Objective	Attributes
4	C	Protection afforded by existing law, regulations, and other alternatives is inadequate to meet restoration objectives.	•To ensure that a proposed protection/acquisition would provide an incremental recovery benefit. •To evaluate adequacy of existing land and resource management regime to achieve recovery.	•Requires clear linkage to restoration objectives. •Requires evaluation of whether restoration objectives can be accomplished with existing regulatory framework. •Requires consideration of alternatives to protection/acquisition.
5	C	The nature and immediacy of expected changes in use will further affect resources injured by the oil spill.	•To reject proposals that do not address foreseeable threats to recovery. •To identify how changes in land use will affect injured resources/services.	•Precludes evaluation of proposals where there is no direct or foreseeable threat to recovery. •Evaluates proposed changes in land use and their potential effects on recovery. •Gives higher priority to responding to near-term threats.
6	C	Failure to act will foreclose meeting restoration objectives.	•To identify those proposals that are essential to meeting restoration objectives.	•Focuses evaluation on those proposals which threatened restoration options. •Favors short-term planning. •May expedite protection/acquisition actions.

TABLE 2: SUMMARY ANALYSIS OF THRESHOLD CRITERIA

#	Set	Threshold Criteria	Objective	Attributes
7	C	Restoration strategies other than acquisition of the property right(s) are inadequate to meet restoration objectives.	•To ensure that other restoration alternatives are given priority before habitat acquisition is implemented.	•Gives priority to direct restoration alternatives. •Imposes a strict hierarchical restoration strategy. •Alternatives must be judged to be insufficient before acquisition options can be exercised. •May delay acquisition until other alternatives can be evaluated.
8	C	Acquisition of the property right(s) will result in an identifiable incremental benefit to restoration objectives that is cost-effective relative to other restoration alternatives for the identified resource injuries.	•To identify the incremental benefit (either qualitative or quantitative) to be derived from the acquisition. •To compare the incremental benefit of acquisition to that derived from other restoration alternatives.	•Provides for an evaluation of benefit relative to other alternatives. •Provides for an evaluation of cost-effectiveness (which may be subjective) relative to other alternatives. •Data available to evaluate benefits and cost-effectiveness relative to other restoration alternatives may be non- quantitative.
9	C	The acquired property rights can reasonably be incorporated into public land management systems.	•To ensure that a proposed acquisition could be managed appropriately by a government agency.	•Identifies potential agency(s) and restoration strategy for parcel. •Identifies additional management considerations needed to accomplish restoration objectives.

HABITAT PROTECTION AND ACQUISITION PROCESS

FEDERAL / STATE ACQUISITION PROCESS

Figure 3. Federal Acquisition Process

Figure 3a. Federal Acquisition Process Timeline

Narrative Description

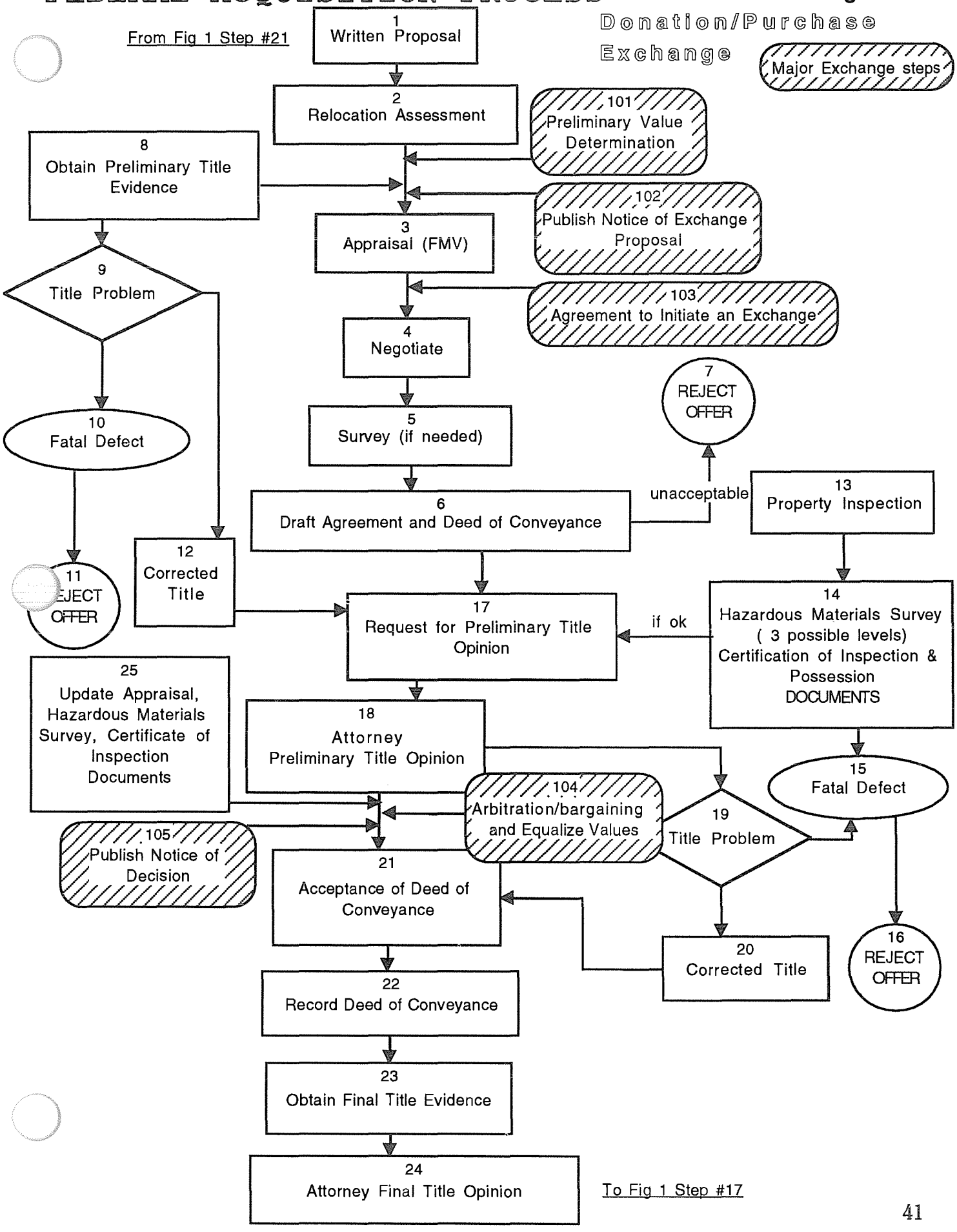
Figure 4. State Land Exchange Process

Figure 4a. State Land Exchange Process Timeline

Narrative Description

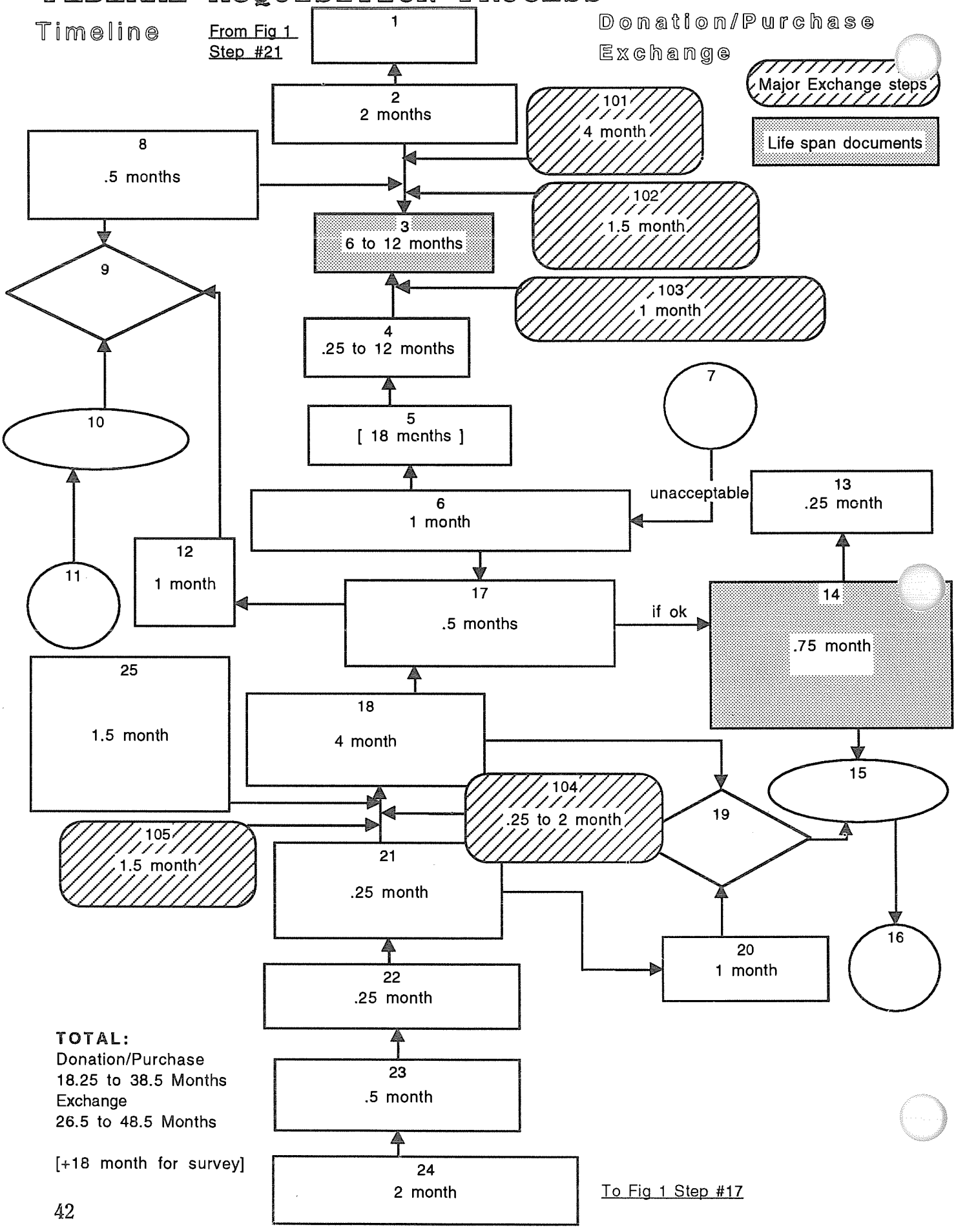
FEDERAL ACQUISITION PROCESS

Figure 3



FEDERAL ACQUISITION PROCESS

Figure 3a



TOTAL:
Donation/Purchase
18.25 to 38.5 Months
Exchange
26.5 to 48.5 Months

[+18 month for survey]

To Fig 1 Step #17

This process outlines the basic acquisition steps used by Federal agencies. It does not reflect all agency specific steps. Each agency has specific authority and requirements that may vary within the context of this outline.

#1 Written Proposal

Each written proposal should include a legal description of the land and maps, and statements indicating that 1)the offeror is the record owner of the land/ interests, 2) the land is free and clear of all encumbrances, 3)there are no persons claiming the land adversely, 4)the status of any unpaid taxes or assessments levied against the land, and 5)the status of any lien assessed which is not due and payable. This written proposal should also include any terms or conditions the offeror is proposing. (Action: land owner)

#2 Relocation Assessment

Use the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970" to assess the need to relocate any displaced people or users. (Action: agency)

#3 Appraisal (Fair Market Value)

Using the "Uniform Appraisal Standards for Federal Land Acquisitions Procedures" (1973) a certified appraiser will complete a written appraisal of the fair market value (FMV) of the real property or interests being considered. If the value and amount being paid is over $250,000 the U.S. Forest Service must provide a 30 day comment period to the House Agriculture Committee on oversite review. If approved, the Secretary of Agriculture will then accept the option. Note: The life span of the appraisal is 6 months in the Department of the Interior (DOI) or 12 months in the U.S. Forest Service (USFS). If the Deed of Conveyance is not accepted within these timeframes, the appraisal will need to be updated before the Department of the Interior Regional Solicitor or the United States Forest Service Office of the General Counsel issues a final title opinion (see Block #25). (Action: agency)

#4 Negotiate

Negotiate terms of the offer. (Action: land owner and agency)

#5 Survey

If needed, the land will be surveyed. In some cases, the lands being offered will be unsurveyed. (For example, lands were conveyed from the Federal government to Native Corporations, pursuant to the Alaska Native Claims Act, without survey). Although not ideal, lands could be conveyed and accepted without survey. (Action: agency)

#6 Draft Agreement and Deed of Conveyance

Draft document that outlines the terms of the donation or purchase. It should include all conditions, reservations, and exceptions, in addition to timeframes, escrow terms (if necessary), and payment procedures. A draft copy of the Deed of Conveyance is completed at this time. (Action: land owner and agency)

#7 Reject Offer

If terms of the draft agreement are not acceptable and consensus cannot be reached, formal rejection of the offer is completed and the acquisition process is terminated. (Action: agency)

#8 Obtain Preliminary Title Evidence

An accepted title company searches title records and prepares a title report listing the recorded land owner, any liens, and exceptions to title and agreements that affect the ownership or use of the land. Title insurance or appropriate title guarantee is obtained to support the title report. This report is reviewed by appropriate Federal agency attorneys (i.e., Regional Solicitor for Department of the Interior and Office of General Counsel for United States Forest Service) in Block #18. (Action: title company)

#9 Title Problem

Recognition that there is a title problem that needs to be corrected before attorney review (see Block #18). (Action: agency)

#10 Fatal Defect

A title problem that cannot be corrected that would make acceptance of title impossible. Final decision rests with appropriate Federal agency attorneys (Regional Solicitor for Department of the Interior and Office of General Counsel for United States Forest Service).

#11 Reject Offer

Formal document to reject the offer and stop the acquisition process.
(Action: agency)

#12 Corrected Title

Process where curable defects are corrected. For example, the title evidence may indicate that the party making the offer is not the land owner of record. All that may be necessary to remedy this problem is for the landowner to record the original deed of conveyance showing they own the land/interest.
(Action: agency and/or land owner)

#13 Property Inspection

On-the-ground inspection to gather information to complete the documents identified in Block #14. Obtain approvals for access to private lands for purposes of inspecting the property. While this work can begin at anytime in the process, it would be best to wait until there is at least confirmation that there is an agreement between all parties. (Action: agency)

#14 Hazardous Materials Survey and Certificate of Inspection & Possession

Prepare two documents that are required for any acquisition of land and/or interests. The Certificate of Inspection & Possession describes the condition of the lands, and identifies any known or physically identifiable conditions that may affect title to the land. The Hazardous Materials Survey and Contaminant (hazardous substances) Survey Checklist describes the condition of the land and identifies any potential or known hazardous materials. If the answer to all questions on the checklist is "no", "none" or "not applicable" a Level I survey is signed by an authorized officer (e.g., Bureau of Land Management = State Director, National Park Service = Regional Director, U.S. Fish & Wildlife Service = Assistant Secretary - Policy, Budget and Administration in the Washington office). A Level II Survey is completed when the answer to any question on the checklist is other than "no", "none" or "not applicable" and the agency wishes to proceed with the acquisition. The Level II Survey is signed by the Assistant Secretary. The Level III Survey requires sampling and further work to determine the extent of contaminants and cost of clean up. Note: These documents have a limited life span and may need to be updated later in the process. (Action: agency)

#15 Fatal Defect

A problem that cannot be corrected that would make acceptance of title not advisable. For example, the property contains a contamination problem that cannot be resolved. Level II survey results might reveal a fatal defect depending on whether the acquisition is for an interest in land or for fee title.

#16 Reject Offer

Formal document to reject the offer and stop the acquisition process. (Action: agency)

#17 Request for Preliminary Title Opinion

Written request for a Preliminary Title Opinion from appropriate Federal agency attorneys (i.e., Regional Solicitor for Department of the Interior and Office of General Counsel for United States Forest Service). The request includes the title company title evidence, legal description, evidence of any clearance actions that have been completed (Block #12), and description of the acquisition proposal. The Certification of Inspection & Possession and the Hazardous Materials Surveys are a part of this request package. (Action: agency)

The Appraisal, Hazardous Materials Survey and Certificate of Inspection & Possession would be updated if too much time had elapsed since their original completion. If values have changed, agency may have to return to Block #4 and negotiate a new agreement/offer. (Action: agency)

Major Exchange Steps

#101 Preliminary Value Determination

Estimated appraisal to determine whether the lands and interests in lands to be exchanged are of equal value. The "Uniform Appraisal Standards for Federal Land Acquisitions" is used for this process.

#102 Publish Notice of Exchange Proposal

A Notice of Realty Action that is published in the Federal Register and once each week for three weeks thereafter in a local newspaper. This document puts all interested parties on notice that an exchange, by the Federal government, is being considered. This document has a 45-day public comment period.

#103 Agreement to Initiate an Exchange

Agreement signed by all exchange parties that: 1)describes the lands or interest in lands being considered for exchange; 2)lists the exchange processing steps; 3)addresses knowledge of hazardous substances on the lands; 4)physical access and Right to Enter; 5)terms of relocation benefits, if any; and 6)closing procedures.

#104 Arbitration/Bargaining and Equalize Value

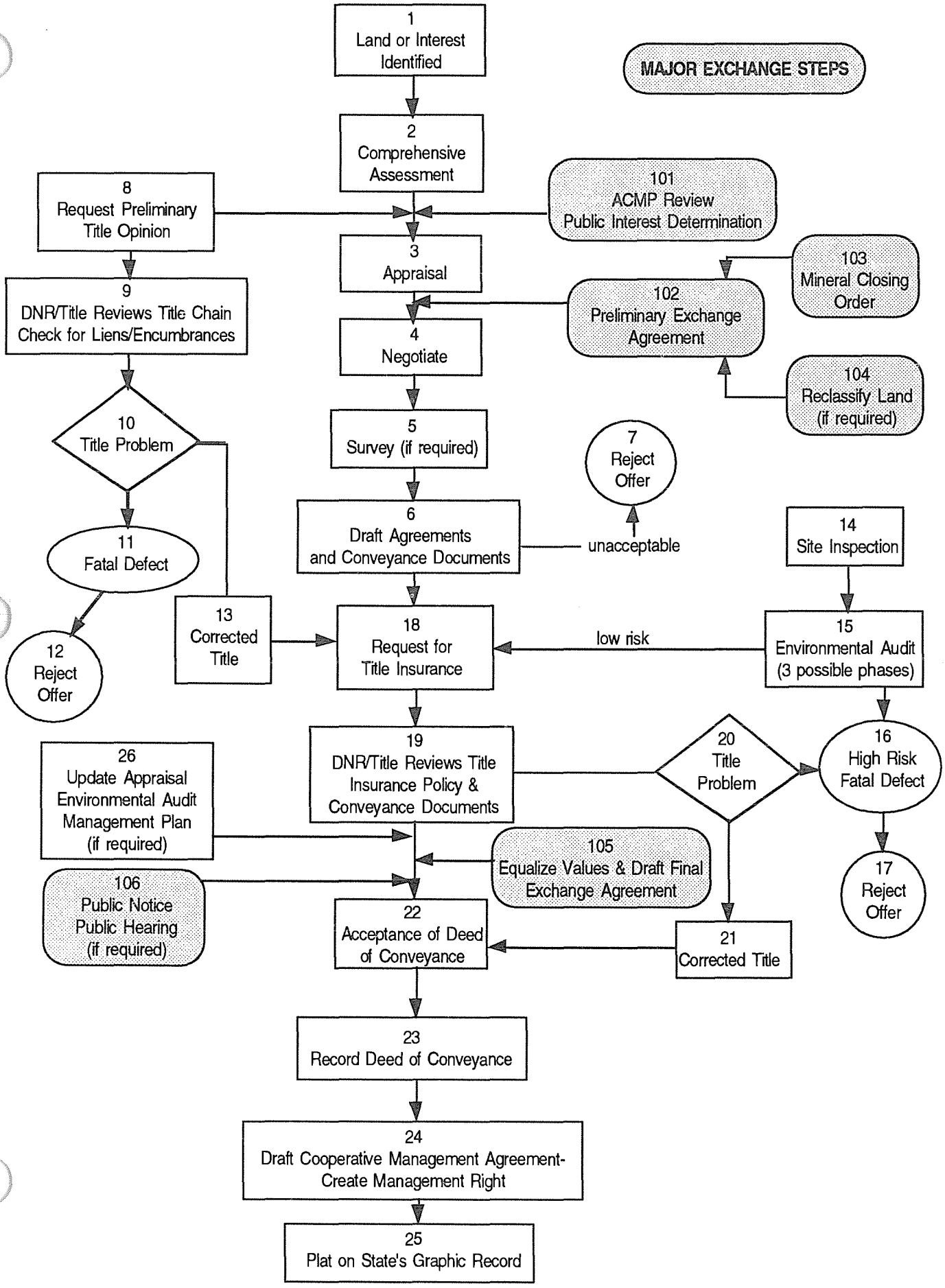
A formal process to resolve disagreements among parties as to appraised value of the lands involved in the exchange. Determination if equalization of value is necessary. A money payment for equalization of value can not exceed 25 percent of the value of the public lands and interests being conveyed.

#105 Publish Notice of Decision

The document identifies all terms of the exchange, describes the lands involved, identities the parties involved, any reservations, terms, covenants and conditions, needs for value equalization, and intended time frames to complete the exchange.

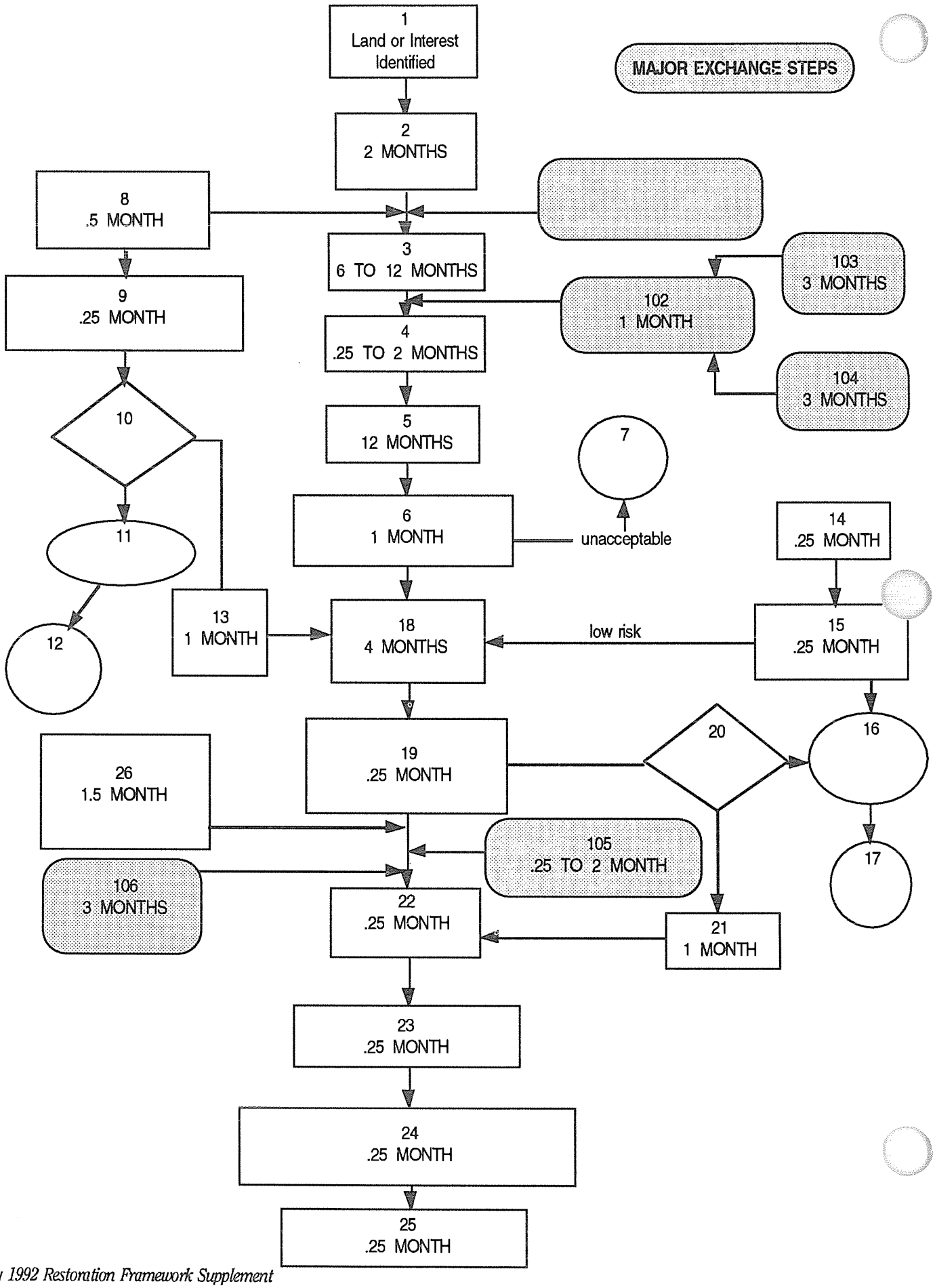
STATE ACQUISITION PROCESS

Donation/Purchase/Exchange
Selection/Judgement



STATE ACQUISITION PROCESS

Donation/Purchase/Exchange
Selection/Judgement



All State agencies with authority to acquire land or dispose of land shall give written notification of the fact of acquisition, lease, disposal, or exchange to the Commissioner of the Department of Natural Resources (Division of Land, Title Administration Unit) within three months after the date they make the acquisition, lease, disposal, or exchange. AS 38.05.030(c). Each State agency has specific authority and requirements that may vary within the context of this basic outline.

#1 Land or Interest Identified

The land or interest to be acquired may be identified by various methods including but not limited to the methods outlined in Figure 1 or by a fax or telephone call citing the land description of the land proposed to be acquired.

#2 Comprehensive Assessment

An assessment of the proposed acquisition, management considerations, opportunities and strategies.

#3 Appraisal (FMV)

Appraisals may be made by employees of the Department of Natural Resources who are qualified to determine the value of land under standards set by the Commissioner. Alaska Statutes 38.05.840. Generally the lifespan of the appraisal is 12 months.

#4 Negotiate

Given the appraisal, negotiate the terms of the offer and what will be accepted.

#5 Draft Agreements and Deed of Conveyance

Draft document that outlines the terms of the donation or purchase. It should include all conditions, reservations, and exceptions. It should also address timeframes, escrow terms (if necessary), payment procedures. A draft copy of the Deed of Conveyance is completed at this time.

#6 Survey

If needed, the land should be surveyed. In most cases the land being offered will be unsurveyed. They were conveyed from the federal government to the private land holder without survey. Department of Natural Resources/Cadastral Survey and Title Administration Unit will determine if the land must be surveyed.

#7 Reject Offer

If terms of the draft agreement are not acceptable, if consensus cannot be reached, then formal rejection of the offer is completed and the acquisition process is terminated.

#8 Obtain Preliminary Title Evidence

An accepted title company searches title records, prepares a title report listing the recorded land owner, any liens, exceptions to title and agreements that affect the ownership or use of the land. If fee title is being acquired, the title company would be asked to provide title insurance to support their title report at a later date.

#9 Review

The Title Administration Unit of Department of Natural Resources reviews all conveyance documents in the title chain from original Federal Patent to the present owner and reviews the chain of title and title opinion from the title company for any outstanding liens or encumbrances. This report is reviewed by the Regional Solicitor in block #18.

#10 Title Problem

Recognition that there is an identified title problem that needs to be corrected and notification of the title company. The problem may be curable or a major problem causing a fatal defect.

#11 Fatal Defect

A title problem that cannot be corrected that would make acceptance of title impossible.

#12 Reject Offer

Formal document to reject the offer and stop the acquisition process.

#13 Title Clearance

Process where curable defects corrected. As an example, the title evidence may indicate that the party making the offer is not the land owner. All that may be necessary to cure this problem is for the owner to record the original deed of conveyance showing they own the land/interest.

#14 Site Inspection

On the ground inspection at anytime in the process with permission for access from the property owners to identify potential management or access problems.

#15 Environmental Audit

On-site investigation to determine what levels of contamination and/or potential liability currently exist. Department of Environmental Conservation has a "Contaminated Sites Database" which should be contacted prior to the on-site audit. The Department of Natural Resources has a Phase I Environmental Audit Review Inspection form and process, which would recommend further environmental audit action to be taken.

#16 Fatal Defect

A problem that cannot be corrected that would make acceptance of title not advisable. As an example, there are contaminants on the property and cleanup cannot be resolved.

#17 Reject Offer

Formal written rejection of offer or cessation of negotiations.

#18 Request for Title Insurance Policy

A policy should generally be equal to the fair market value of the parcel and is only necessary when fee interest is acquired.

#19 DNR/Title Review Title Insurance Policy and Conveyance Documents

The Department of Natural Resources, Title Administration Unit (TAU) reviews Title Insurance Policy and Conveyance Documents to insure the title company has adequately addressed any deficiencies previously identified. The Title Administration Unit also checks the conveyances to insure accuracy especially in the legal description of the land being conveyed. The Department of Natural Resources accepts and secures title to land; therefore, the conveyance should be granted to the State of Alaska, Department of Natural Resources for the managing agency.

#20 Title Problem

Recognition that there is an identified problem that prohibits title acceptance and requires correction or is fatal.

#21 Corrected Title

Process by which curable defects in the title are corrected which may require contacting previous owners in the chain of title to remedy gaps or errors in conveyancing.

#22 Acceptance of Deed and Conveyance

Based on further review in Title Administration Unit of Department of Natural Resources to insure the curing of any previously identified defects and to identify

any previously overlooked errors, the Department of Natural Resources Title Administration Unit accepts the Deed of Conveyance.

#23 Record Deed of Conveyance

Title Administration Unit reviews and then records the executed Deed of Conveyance at the local State Recorder's Office.

#24 Draft Cooperative Management Agreement/Create Management Right

Department of Natural Resources holds the title to the land for the other State agencies, but if another State agency acquired the land or proposes to manage the land, a management right file is created transferring management of the parcel to the managing agency. Alaska Statutes 38.50.027 allows the Department of Natural Resources to enter into cooperative resource management agreements with other agencies.

#25 Plot on State's Graphic Record

Title Administration Unit forwards the title and management information to Status Graphics to be plotted to the State's graphic record.

MAJOR EXCHANGE STEPS

#101 ACMP Review/Public Interest Determination

Alaska Coastal Management Program Review is accomplished. The regional office of Department of Natural Resources conducts agency review, requests a title report from Title Administration Unit and writes a decision indicating whether it is in the best interest of the State to proceed with the exchange.

#102 Draft Preliminary Exchange Agreement

If it is found to be in the best interest of the State to enter into an exchange, the region and the party(ies) will negotiate a preliminary exchange agreement under 11 AAC 67.230, in coordination with other State agencies per Alaska Statutes 38.50.090.

#103 Reclassify Land (if needed)

Reclassify land if necessary.

#104 Mineral Closing Order

Close the State land in the Preliminary Exchange Agreement to mineral entry and location under Alaska Statutes 38.05.185.

#105 Equalize Values and Draft Final Exchange Agreement

Revise Exchange Agreement and equalize values by subtracting or adding land from a pool of land. If Over $5 Million or Unequal Value,
If legislative review under AS 38.50.140 is required under AS 38.50020(a).

#106 Public Notice/Public Hearing (if required)

Upon completion of appraisal, prepare a report and conduct a public notice under AS 38.05.945 and a public hearing if necessary under AS 38.50.120.

Agreement and Consent Decree, filed in United States v. Exxon Corp., No. A 91-082 CIV (D. Alaska) and State of Alaska v. Exxon Corp., No. A91-083 CIV (D. Alaska) and approved on October 8, 1991.

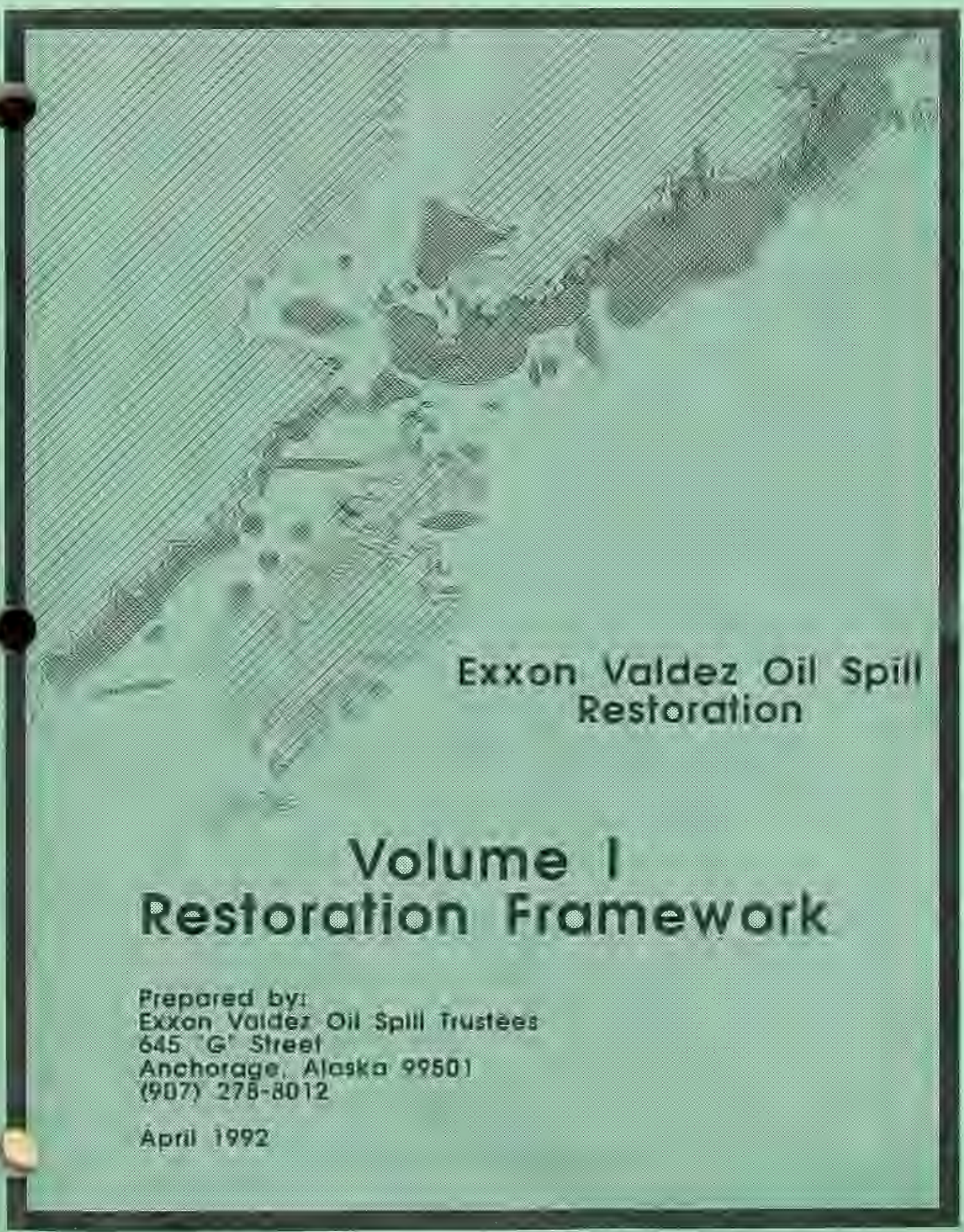
Memorandum of Agreement and Consent Decree, filed in United States v. State of Alaska, No. A91-081 CIV (D. Alaska) and approved on August 28, 1991.

Plea Agreement, filed in United States v. Exxon Corp., No. A90-015 CR (D. Alaska) and approved on October 8, 1991.

The Nature Conservancy, Options for Identifying and Protecting Strategic Fish and Wildlife Habitats and Recreation Site, The Nature Conservancy Handbook, 1991.

Trustee Council, Restoration Framework, Volume I, Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska, April, 1992.

☆ GPO 1992—694-691



Exxon Valdez Oil Spill Restoration

Volume I
Restoration Framework

Prepared by:
Exxon Valdez Oil Spill Trustees
645 'G' Street
Anchorage, Alaska 99501
(907) 278-8012

April 1992

State of Alaska: Departments of Fish & Game, Law, and Environmental Conservation
United States: National Oceanic and Atmospheric Administration, Departments of Agriculture and Interior, in consultation with the Environmental Protection Agency

April 1992

Dear Reviewer:

In the autumn of 1991 the United States and the State of Alaska settled their claims against the Exxon Corporation and Exxon Shipping Company for natural resource damages from the *Exxon Valdez* oil spill. Money provided by the settlement will be used to restore the environment of Prince William Sound, lower Cook Inlet, and the Gulf of Alaska. The undersigned six State and Federal Trustees, in consultation with the public, are responsible for determining how restoration funds are to be spent.

Exxon Valdez Oil Spill Restoration is a key step in shaping the decision-making process. It is divided into two volumes, which are presented for your review and comment. Volume 1: Restoration Framework provides background information and proposes guidelines for the future. The draft Volume II: 1992 Work Plan proposes activities that are important to undertake in 1992 prior to the final development of the Restoration Plan. We expect that a work plan will be developed annually, describing the activities the Trustees intend to conduct in each year.

These documents are intended to elicit comments and suggestions from you and continue the public "scoping" process for environmental analysis under the National Environmental Policy Act. We want to know how you view this process and receive suggestions concerning restoration of the resources and services injured by the oil spill. This planning effort will culminate in the development of the overall Restoration Plan, which will guide the restoration program in the coming years.

We invite your comments on both Volumes I and II of *Exxon Valdez* Oil Spill Restoration. The issues identified on the comment sheets in each document are intended to facilitate but not limit your comments and suggestions. In order to be considered during the development of the final 1992 Work Plan and draft Restoration Plan, written comments must be received by June 4, 1992 at the following address:

Exxon Valdez Oil Spill Trustee Council
645 "G" Street
Anchorage, Alaska 99501

Questions concerning this document or its distribution should be directed to the Oil Spill Public Information Center, 645 "G" Street, Anchorage, Alaska 99501, or you may call (907) 278-8008.

We appreciate your interest and look forward to your participation in this important process.

Sincerely,

Michael A. Barton
Regional Forester
Alaska Region
Forest Service
U.S. Department of Agriculture

Charles E. Cole
Attorney General
State of Alaska

Curtis V. McVee
Special Assistant to the Secretary
Office of the Secretary
U.S. Department of the Interior

Steven Pennoyer
Director
Alaska Region
National Marine Fisheries Service

Carl L. Rosier
Commissioner
Alaska Department of
Fish and Game

John A. Sandor
Commissioner
Alaska Department of
Environmental Conservation

COMMENTS

You are invited to share your ideas and comments with the Trustee Council. Please use this tear sheet to present your views on the Restoration Framework. You may send additional comments by letter or participate in a public meeting on the 1992 Work Plan and Restoration Framework.

If needed, use the space on the back or attach additional sheets. Please fold, staple, and add a postage stamp. Thank you for your interest and participation.

Additional Comments:

----------(fold here)----------

Return Address:

_____

_____

_____

Place
Stamp
Here

Exxon Valdez Oil Spill Trustee Council
645 "G" Street
Anchorage, AK 99501

Attn: Restoration Framework

Restoration Framework
Table of Contents

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EXECUTIVE SUMMARY

In *Exxon Valdez* Oil Spill Restoration, Volume I: Restoration Framework, the Trustees propose a process and structure to guide the restoration of the resources and services injured by the *Exxon Valdez* oil spill. The Restoration Framework also is intended to serve as a "scoping" document as required by the National Environmental Policy Act.

On October 8, 1991 a settlement agreement was approved in United States District Court that required Exxon to pay one billion dollars in criminal restitution and civil damages to the governments. This settlement provides an extraordinary opportunity to address the restoration of injuries resulting from the largest tanker oil spill in United States history.

Post Settlement Administration (Chapter I)

The State and Federal Trustees will receive up to $900 million dollars from Exxon in settlement of the civil claims over the next 10 years. These funds are deposited in the Court Registry Investment Account. Subject to court approval, the Trustees will draw from that fund for restoration.

All decisions about restoration and uses of restoration funds must have the unanimous agreement of six Trustees, three Federal and three State. The Federal Trustees have appointed representatives to an Alaska-based Trustee Council. The State Trustees, unlike their Federal counterparts, serve on the Trustee Council. The Trustee Council has appointed a Restoration Team to administer and manage the restoration process. An Administrative Director will be hired to chair the Restoration Team. The Trustee Council has approved creation of a number of working groups to address specific needs, such as budget, public participation, and habitat evaluation and protection.

Public Participation (Chapter II)

The settlement terms specify that the Trustees shall establish procedures providing for meaningful public participation in the injury assessment and restoration process, which shall include establishment of a public advisory group to advise the Trustees.

The Trustees held a series of public meetings to solicit comments on the role, responsibility and membership of the public advisory group and have approved that group's charter. Public comments are being sought on the Restoration Framework and the draft 1992 Work Plan.

Restoration Planning Before the Settlement (Chapter III)

The Trustees and the Environmental Protection Agency began preliminary restoration planning through the work of the Restoration Planning Work Group from late 1989 until December 1991. This group carried out several scoping activities, including a series of public meetings and consultations with technical experts. The restoration group also developed draft criteria for evaluating restoration options, and began analyzing many restoration options suggested by the public, resource managers and scientists.

Summary of Injury (Chapter IV)

Immediately after the *Exxon Valdez* oil spill, the Trustees began a series of studies--the Natural Resource Damage Assessment--to determine the effects of the oil spill on the environment, both its resources and services (e.g., marine and terrestrial mammals, birds, fish and shellfish, archaeological resources, and subsistence). They provide an assessment of a wide range of injuries, some immediate and acute, some subtle and persistent. Major results of the studies to date are discussed.

Proposed Criteria for Injuries (Chapter V) and Restoration Options (Chapter VI)

The settlement specifies that restoration funds must be spent to restore natural resources and services injured by the *Exxon Valdez* oil spill. The Trustees propose that evidence of consequential injury and the adequacy and rate of natural recovery must be considered in deciding whether it is appropriate to spend restoration dollars on a given resource or service. Once it has been established that a resource or service warrants restoration action, there may be a number of effective restoration options. The Trustees propose criteria to help evaluate such options, including technical feasibility, cost effectiveness, and the potential for additional injury resulting from the proposed restoration option.

Restoration Alternatives and Options (Chapter VII)

The restoration planning process to date has yielded a variety of ideas, which are presented for comment as restoration options in Appendix B. These restoration options, and others identified by the public, will be considered by the Trustee Council in a draft restoration plan.

For purposes of this scoping document, six possible alternative sets of options have been identified. These are:

- no-action;
- management of human uses;
- manipulation of resources;

- habitat protection and acquisition;
- acquisition of equivalent resources; and
- combination.

An analysis of a proposed action and various alternatives will be presented for public comment in a draft restoration plan and draft environmental impact statement.

Appendices A and B

Two appendices are attached: life histories and backgrounds on injured resources and services, and a series of potential restoration options.

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CHAPTER I
INTRODUCTION

The intent of *Exxon Valdez* Oil Spill Restoration, Volume I: Restoration Framework (hereafter referred to as the Restoration Framework) is to propose a process to guide the Trustees and the public in the restoration of the environment injured by the *Exxon Valdez* oil spill. This document contains information on *Exxon Valdez* oil spill restoration activities to date, background information on the legal settlement that provides funding for restoration, and a description of the Trustees' structure for administration of the restoration program. Information is also provided on the injuries to natural resources and services, proposed criteria for determining when injury is sufficient to warrant restoration actions, proposed criteria and procedures for evaluating specific restoration options, and an initial description of possible restoration alternatives. Life history and background on injured natural resources and services are presented in Appendix A. Potential restoration options are presented in Appendix B.

The Restoration Framework also serves the Trustees as a "scoping" document pursuant to the National Environmental Policy Act 42 U.S.C. 4321-4370c. As such, the document presents and discusses the proposed action and the main issues known at this time. The document also invites public comment on these issues and any additional issues related to the proposed action. The Trustees will, as part of a planned draft restoration plan, issue a draft environmental impact statement to ensure that environmental effects are considered as part of restoration planning.

Proposed Action

The Trustees propose to restore natural resources and natural resource services in the areas affected by the *Exxon Valdez* oil spill to their pre-spill condition. This may include the restoration of natural resources injured, lost or destroyed and the services provided by these resources or which replace or substitute for the injured, lost or destroyed resources and affected services. The Trustees will develop a restoration plan considering restoration options described in Appendix B and others identified subsequently. The Restoration Plan will establish management direction in a programmatic manner and guide all activities to restore injured natural resources and services. Specific restoration activities will be developed annually and may be implemented if consistent with the Restoration Plan.

Identification of Issues

The Trustees are addressing a number of issues as they develop the oil spill

restoration program. Among the issues identified in the Restoration Framework are the following:

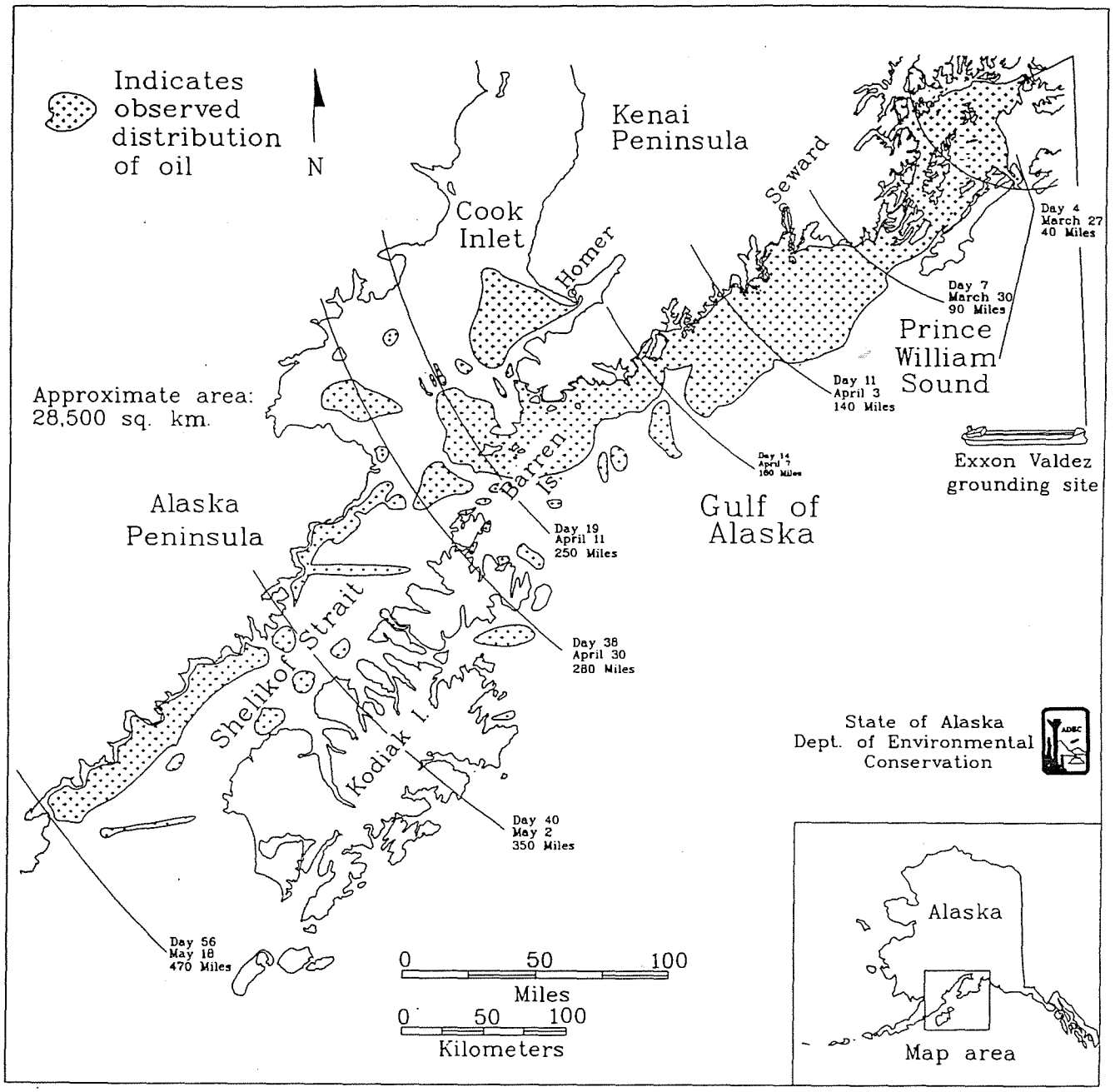
- establishing an administrative structure that enables the maximum amount of settlement funds to be spent on effective restoration (Chapter I);
- providing meaningful public involvement and establishing a public advisory group (Chapter II);
- determining when injuries are sufficient to warrant restoration actions (chapters IV and V);
- evaluating potential restoration options, including the use of objective criteria (Chapter VI); and
- developing a reasonable range of alternatives for restoration options and establishing priorities for use of settlement funds (Chapter VII, Appendix B).

Background

Shortly after midnight on March 24, 1989 the T/V *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound spilling approximately 11 million gallons of North Slope crude oil, making this the largest tanker oil spill in United States history. For the first three days after the spill the weather was calm and the slick lengthened and widened, but stayed in the waters of the Sound and did not go ashore. Even with these favorable conditions for oil recovery, the amount of oil in the water completely overwhelmed the manpower and equipment available to contain and recover the oil. A major windstorm on March 26-27, 1989 pushed the oil in a southwesterly direction and oiled beaches on Smith, Naked and Knight islands. The oil continued to spread, contaminating islands, beaches and bays in Prince William Sound. Six days into the spill, oil entered the Gulf of Alaska. The leading edge of the slick reached the Chiswell Islands off the coast of the Kenai Peninsula on April 2, and the Barren Islands in the Gulf of Alaska on April 11, 19 days after the spill. By May 18, oil had moved some 470 miles and had contaminated shorelines of Prince William Sound, the Kenai Peninsula, lower Cook Inlet, the Kodiak Archipelago, and the Alaska Peninsula. Portions of 1,200 miles of coastline were oiled, including segments of the Chugach National Forest, Alaska Maritime, Kodiak and Alaska Peninsula/Becharof national wildlife refuges, Kenai Fjords National Park, Katmai National Park and Preserve, and Aniakchak National Monument and Preserve. Oil reached shorelines, nearly 600 miles from Bligh Reef (Figure 1).

The magnitude of the efforts of the State and Federal governments, the public and Exxon to contain and clean up the oil, rescue oiled birds and sea otters, and study the effects of the spill was unprecedented. During 1989, efforts focused on containing and cleaning up the spill and rescuing oiled wildlife. Skimmer

Figure 1. Composite overview of oil-spill tracking from March 24, 1989 to June 20, 1989. All degrees of oiling are represented.



ships were sent throughout the spill zone to remove oil from the water. Booms were positioned to keep oil from reaching important commercial salmon hatcheries in Prince William Sound and Kodiak. A fleet of fishing vessels known as the "Mosquito Fleet" played an important role in protecting these hatcheries, in corralling oil to assist the skimmer ships, and in capturing and transporting oiled wildlife to rehabilitation centers. Exxon began a beach cleanup under the direction of the U.S. Coast Guard with input from Federal and State agencies and local communities on the areas that should receive priority for clean up. Several thousand workers cleaned shorelines, using techniques ranging from cleaning rocks by hand to high pressure hot-water washing. Fertilizers were applied to some oiled shorelines to increase the activity of oil-metabolizing bacteria in a procedure known as bioremediation. When the anticipation of deteriorating weather brought an end to clean-up work in the fall of 1989, a large amount of oil remained on the shorelines. Although winter storms proved extremely effective in cleaning many beaches, spring shoreline surveys indicated that much work remained to be done in 1990. Crews operating from boats and helicopters cleaned oiled shorelines in Prince William Sound, along the Kenai and Alaska peninsulas, and on the Kodiak Archipelago. Manual pick up of remaining oil was the principal method used during 1990, but bioremediation and relocation of oiled berms to the active surf zone were also used in some areas. A shoreline survey and limited clean-up work took place during 1991, and another shoreline survey will be conducted in 1992 to determine if further cleanup is needed.

During the first summer after the spill, the State and Federal Trustee agencies planned and mobilized the Natural Resource Damage Assessment (hereafter referred to as damage assessment) field studies to determine the nature and extent of the injuries that were being sustained in the oil-spill area. Even with the rapid deployment of studies, some opportunities to gather injury data were irretrievably lost during the early weeks of the spill due to the complexity and volume of the work at hand and the scarcity of available resources. Shortly after the spill, a legal framework was established and expert peer reviewers were retained to provide independent scientific review of on-going and planned studies and assist with synthesis of results. Most damage assessment field studies were completed during 1991, although some laboratory data analyses are still underway. In the latter part of 1989, the Trustee agencies, with the assistance of the Environmental Protection Agency, initiated restoration planning activities to identify restoration alternatives and procedures and to implement restoration technical and feasibility studies and projects during 1990 and 1991.

Summary of the Settlement

On October 8, 1991 an agreement was approved by the United States District Court that settled the claims of the United States and the State of Alaska against Exxon Corporation and Exxon Shipping Company for various criminal violations and for recovery of civil damages resulting from the oil spill.

Exxon and Exxon Shipping entered guilty pleas to criminal charges filed in the

United States District Court. The companies admitted violating provisions of the Federal Water Pollution Control Act (Clean Water Act), the Migratory Bird Treaty Act and the Rivers and Harbors Act (Refuse Act). The sentences entered by United States District Judge H. Russel Holland included the largest fine ever imposed for an environmental crime--$150 million.

Exxon Corporation and its subsidiary companies also entered into a civil settlement agreement with the United States and the State of Alaska. The governments had filed lawsuits against the Exxon companies, seeking to recover damages for injuries to natural resources and the restoration and replacement of natural resources. The Exxon companies agreed to pay up to $900 million to the State and Federal governments. This was the largest sum ever recovered in the United States in an environmental enforcement civil action.

Thousands of private individuals and other litigants are still pursuing claims in Federal and State courts against the Exxon companies and others, seeking to collect billions of dollars in damages. The litigation in the Alaska Superior Court has been tentatively set for trial during April 1993. No trial date has been set for the litigation in the United States District Court.

Criminal Plea Agreement

Exxon and Exxon Shipping were fined $150 million. Of this amount, the sum of $125 million was remitted (i.e., forgiven) due to their cooperation with the governments during the cleanup, timely payment of many private claims, and environmental precautions taken since the spill. The remaining $25 million was paid as follows:

- $12 million deposited into the North American Wetlands Conservation Fund; and

- $13 million deposited into the Victims of Crime Act Account

The Exxon companies also agreed to pay $100 million as restitution. Fifty million dollars was paid to the United States and $50 million to the State of Alaska. The State and Federal governments will separately manage the $50 million payment that each has received. These criminal restitution funds must, by order of the United States District Court, be used "exclusively for restoration projects, within the State of Alaska, relating to the *Exxon Valdez* oil spill." The court order states that "restoration includes: restoration, replacement, and enhancement of affected resources, acquisition of equivalent resources and services; and long-term environmental monitoring and research programs directed to the prevention, containment, cleanup and amelioration of oil spills."

The Civil Settlement and Restoration Fund

The terms of the civil settlement can be found in the Agreement and Consent Decree. This document details the agreement among the United States, the State

of Alaska, Exxon Corporation, Exxon Shipping Company, Exxon Pipeline Company, and the T/V *Exxon Valdez* that settled the civil claims asserted by the governments. The document was approved in civil actions A91-082 (United States v. Exxon Corp.) and A91-083 (State of Alaska v. Exxon Corp.) by United States District Judge H. Russel Holland on October 8, 1991. The period for consideration of appeals ended on December 9, 1991.

The Exxon companies agreed to pay the United States and the State of Alaska up to $900 million over a period of 10 years, according to the following schedule:

SCHEDULED DATE	AMOUNT
December 1991	$90 Million
December 1992	$150 Million[1]
September 1993	$100 Million
September 1994	$70 Million
September 1995	$70 Million
September 1996	$70 Million
September 1997	$70 Million
September 1998	$70 Million
September 1999	$70 Million
September 2000	$70 Million
September 2001	$70 Million

These monies, less certain allowable reimbursements, will be deposited in the registry account of the United States District Court for the District of Alaska and then transferred to the Federal Court Registry Investment System in Houston. As funds are needed for restoration, the Trustees will apply to the Court for disbursement of these funds. The money deposited in the Houston account will be invested and accrue interest for the restoration fund.

The settlement with Exxon also has a reopener provision, that allows the governments to claim up to an additional $100 million between September 1, 2002 and September 1, 2006 to restore one or more populations, habitats or species that suffered a substantial loss or decline as a result of the spill.

[1]Exxon's cleanup costs for the 1991 and 1992 field season may be deducted from this payment.

Restoration projects funded with this money must have costs that are not grossly disproportionate to the magnitude of the benefits anticipated, and the injury could not reasonably have been known or anticipated from information available at the time of settlement.

The spending guidelines for the civil settlement monies (up to $900 million) are set forth in the Memorandum of Agreement and Consent Decree (hereafter referred to as Memorandum of Agreement), which was filed in the United States District Court for the District of Alaska in civil action A91-081 (United States v. State of Alaska) and approved and entered by United States District Judge H. Russel Holland on August 28, 1991. Through this document the United States and the State of Alaska resolved their claims against each other and agreed to act as co-trustees in the collection and joint use of all natural resource damage recoveries resulting from the *Exxon Valdez* oil spill.

The Memorandum of Agreement provides that the governments shall jointly use such monies for purposes of "restoring, replacing, enhancing, rehabilitating or acquiring the equivalent of natural resources injured as a result of the *Exxon Valdez* oil spill and the reduced or lost services provided by such resources." The Trustees also may use the money to reimburse expenses the governments have incurred due to the oil spill, including costs of litigation, response and damage assessment. The following table summarizes the major points of the Memorandum of Agreement:

MEMORANDUM OF AGREEMENT GUIDELINES

- all decisions shall be made by the unanimous agreement of the six Trustees;
- a joint trust fund will be established;
- within 90 days after the receipt of funds, the Trustees shall agree to an organizational structure for decision making;
- within 90 days after the receipt of funds, the Trustees shall establish procedures for meaningful public participation, which shall include a public advisory group;
- the Trustees "...shall jointly use all natural resource damage recoveries for purposes of restoring, replacing, enhancing, rehabilitating, or acquiring the equivalent of natural resources injured as a result of the Oil Spill and the reduced or lost services provided by such resources..." (except for the reimbursement of certain expenses to the governments); and

- all natural resource damage recoveries will be expended on restoration of natural resources in Alaska unless the Trustees unanimously agree that spending funds outside of the state is necessary for effective restoration.

Organization

The post-settlement organization is largely guided by the Memorandum of Agreement. Under this agreement, the natural resource Trustees are responsible for making all decisions regarding funding, injury assessment and restoration.

The State of Alaska Trustees are:

- Commissioner of the Department of Environmental Conservation;
- Commissioner of the Department of Fish and Game; and
- Alaska Attorney General, Department of Law.

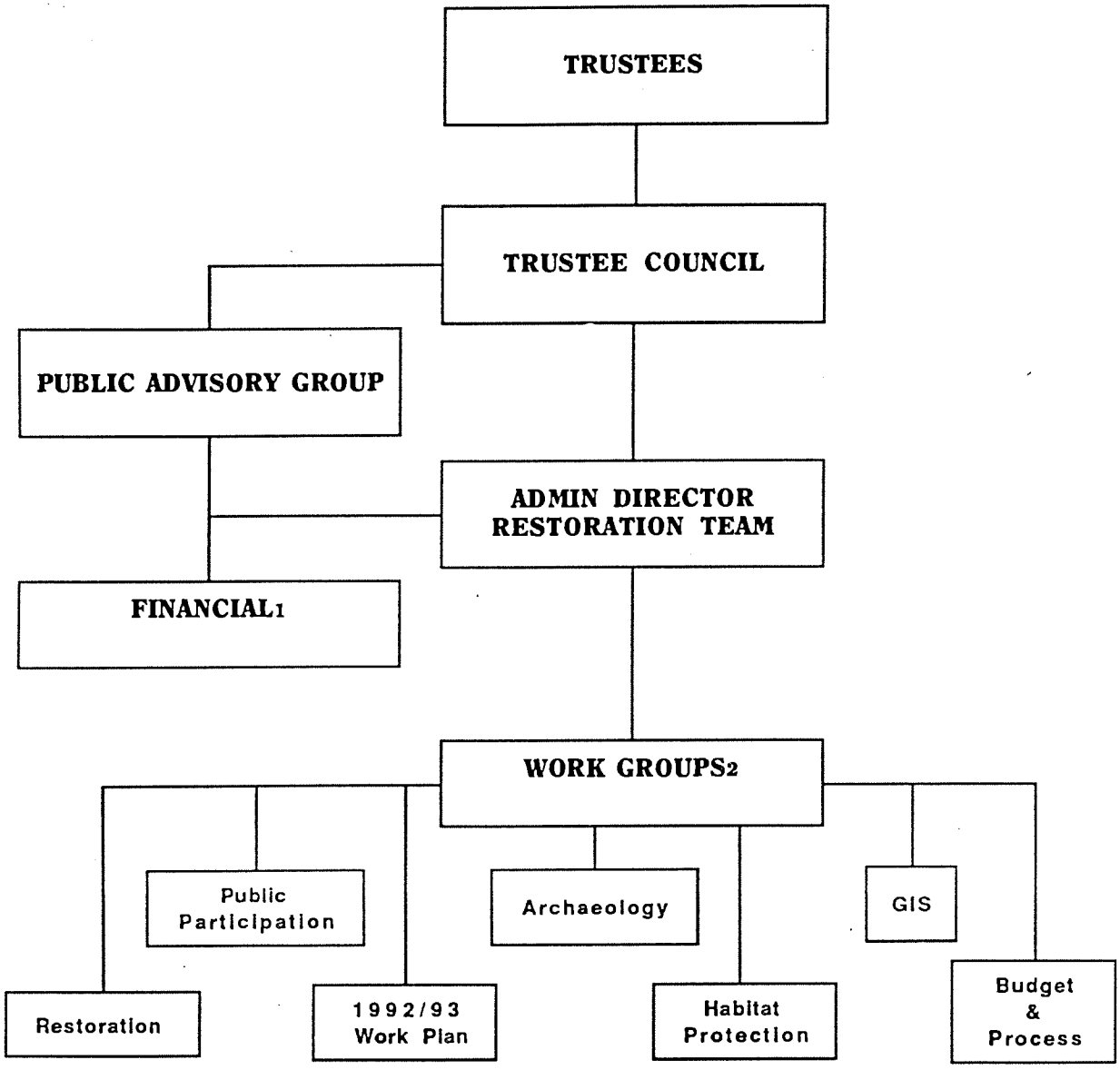
The Federal Trustees are:

- Secretary of the U.S Department of the Interior;
- Secretary of the U.S. Department of Agriculture; and
- Administrator of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

The Federal Trustees have appointed representatives to the Alaska-based Trustee Council. These representatives are the Alaska Regional Forester for the Department of Agriculture, the Special Assistant to the Secretary of the Interior, and the Regional Director for the National Marine Fisheries Service, National Oceanic Atmospheric Administration. The State Trustees, unlike their Federal counterparts, serve on the Trustee Council.

The Trustee Council appointed an interim Administrative Director and a Restoration Team to take on the day-to-day management and administrative functions for implementation of the restoration program. Each Trustee has appointed one representative to the Restoration Team. The Attorney General of Alaska appointed a representative from the Department of Natural Resources. The Trustee Council will approve the hiring of a permanent full-time Administrative Director to chair and support the Restoration Team. The Trustee Council has formed various subgroups from agency staff to work on components of the restoration program, such as finance, public participation, and habitat evaluation and protection. The organization chart approved by the Trustee Council on February 5, 1992 is shown below (Figure 2).

Figure 2. Organization chart approved by the Trustee Council on February 5, 1992.



1 Does not include audit function. A proposal for this function will be developed.
2 Groups will be formed and disband as appropriate.

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CHAPTER II
PUBLIC PARTICIPATION

The importance of public participation in the restoration process was recognized during the Exxon settlement and is an integral part of the agreement between the State and Federal governments. The Memorandum of Agreement (MOA) approved by the court on August 28, 1991 specifies that:

> "... the Trustees shall agree to an organizational structure for decision making under this MOA and shall establish procedures providing for meaningful public participation in the injury assessment and restoration process, which shall include establishment of a public advisory group to advise the Trustees...."

This chapter outlines the goals of the public participation program, the type of information available to the public, and provides a brief description of the public advisory group.

Goals and Objectives

The goals and objectives of the public participation program are as follows:

- invite and encourage public review and comment on the development and implementation of restoration programs;
- provide the public with information and resources to evaluate proposals and programs independently;
- involve relevant constituencies;
- disseminate information to the public concerning the restoration process in a timely manner;
- help identify the issues to be addressed in the draft environmental impact statement and the significant issues related to restoration; and
- ensure that the Trustee Council receives and understands the advice and comments from the public.

Information Availability

Although detailed results of the damage assessment studies are still confidential (as of April 1992), there is significant information available about injuries and restoration. Examples of the types of information currently available to the public are:

- the 1989, 1990 and 1991 Natural Resource Damage Assessment and Restoration plans;
- 1991 restoration study plans;
- restoration reports and bibliographies; and
- settlement documents.

These documents, as well as an extensive collection of other information on the *Exxon Valdez* oil spill, are available at:

Oil Spill Public Information Center
645 "G" Street
Anchorage, Alaska 99501
(907) 278-8008
800-478-SPIL (Inside Alaska)
800-273-SPIL (Outside Alaska)
907-276-7178 (Facsimile)

Information on the restoration program is also available through public meetings and mailings. Mailing lists will be maintained and updated on a regular basis. Mailings to the people and organizations on these lists will be used along with community meetings and the public advisory group as major components of the public participation program. In addition, the following information will be made available routinely to the public:

- meeting agendas;
- transcripts of Trustee Council meetings; and
- planning and other documents (e.g., for studies and implementation projects).

Community Meetings

In December 1991 the Trustee Council directed the Restoration Team to conduct public meetings and solicit written comments on a public participation program. This process began in January 1992 with meetings held in Homer, Seward, Valdez, Cordova, Chenega Bay, Kodiak, Juneau, Anchorage and Fairbanks.

Comments received were evaluated for recommendations to the Trustee Council regarding the role, structure and operating procedures for the public advisory group.

A second series of meetings will provide an opportunity for review and comment on the Restoration Framework. These meetings will be scheduled for April and May 1992, and the public will be notified through newspapers and other means.

Additional meetings will be conducted to provide opportunity for comment on the draft Restoration Plan and draft environmental impact statement. Thereafter, it is anticipated that annual work plans will be developed to implement the Restoration Plan. Each year's draft work plan will be the subject of additional public participation and comment.

Public Advisory Group

As noted above, public meetings were conducted to receive input on the public participation program in general, and the public advisory group in particular. Issues included the role, responsibilities and membership of the public advisory group. The Trustees have identified the following interests and constituencies to be represented on the public advisory group: aquaculture, commercial fishing, commercial tourism, environmental, conservation, forest products, local government, Native landowners, recreation users, sport hunting and fishing, subsistence and scientific/academic. Single seats will be reserved for representatives of local government and Native interests. One representative each of the Alaska House of Representatives and Senate may serve as *ex-officio* members.

The members of the advisory group will be nominated by various organizations and the public and be appointed with unanimous consent of the Trustees. The Trustees will formally solicit nominations for membership on the public advisory group. If you are interested in receiving an announcement, please contact the Administrative Director at 645 "G" Street, Anchorage, Alaska, 99501.

In this first year following settlement the Trustees will develop a draft restoration plan and draft environmental impact statement. The draft plan will present in detail the options and alternative sets of options that will best achieve the restoration of injured resources and services, based on scientific and agency recommendations, public comments, and the judgment of the Trustees.

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CHAPTER III
RESTORATION PLANNING TO DATE

Restoration planning to date has been a process of identifying, evaluating and integrating information about the nature, extent and persistence of injuries to natural resources and services, the rate and adequacy of natural recovery, and the opportunities for restoration. This is a dynamic process which changes as new information is received. The damage assessment studies are the primary sources of information on injuries. Other sources include data gathered during the oil-spill cleanup, public comments and studies conducted outside of the damage assessment program.

Scoping Activities

Public Involvement

Late in 1989 the Trustees and the Environmental Protection Agency established a Restoration Planning Work Group. This group began the process of determining the issues to be addressed in the restoration program.

In March 1990 a public symposium was held in Anchorage, and the proceedings were published in Restoration Following the *Exxon Valdez* Oil Spill, Proceedings of the Public Symposium, July 1990. In April and May public meetings were held in Cordova, Valdez, Whittier, Homer, Kodiak, Seward, Anchorage and Kenai-Soldotna. People were invited to ask questions and put forward their ideas about restoration needs and priorities. In August the work group issued a report, Restoration Planning Following the *Exxon Valdez* Oil Spill: August 1990 Progress Report, that described the planning activities to date, summarized the public comments and presented ideas for restoration. Opportunities for public participation prior to the settlement, however, were limited due to pending litigation with the parties responsible for the oil spill and the need for the results of damage assessment studies to remain confidential.

Technical Workshop

In April 1990 a three-day technical workshop was held in Anchorage, providing the first opportunity for an organized exchange of ideas on restoration among Federal and State resource managers and selected scientists and technical experts under contract to the governments. This workshop was closed to the public because confidential damage assessment information was discussed.

Guided by an overview of preliminary results from the damage assessment studies, a broad range of restoration options were explored to help restore injured resources and services in the oil-spill area. Potential restoration options were identified and evaluated and feasibility studies were suggested. Participants also identified other information required to aid restoration planning.

Issues and Concerns Identified

The restoration planning and scoping process has generated a wide array of issues and concerns regarding the restoration of resources and services in the oil-spill area. The following list summarizes these issues and concerns:

- the use of restoration monies for prevention of future spills;
- determining what clean-up activities should continue to occur;
- the need for continued natural resource damage assessment;
- the need for continued long-term research on injuries;
- the need for long-term monitoring;
- how much reliance should be placed on natural processes to ensure recovery of injured natural resources and services;
- what management practices can be taken by the governments to speed recovery;
- the need to support educational efforts so the general public can understand what happened and what they can do;
- the effect restoration activities have on the local economy of the spill area;
- the need to protect habitat as a direct means of restoration;
- the idea of removing other (not *Exxon Valdez* oil) sources of contamination from the affected area as a means of aiding restoration;
- how to determine the most effective use of restoration monies;
- how to provide for meaningful public involvement; and
- how to establish and operate a public advisory group to the Trustees.

Peer Review

In addition to the technical workshop described above, there have been ongoing consultations with selected nationally recognized scientists and technical experts. Some of these experts continue to provide advice for the restoration planning and damage assessment process, identify information needs and review study proposals.

Review of Recovery Literature

The rate and adequacy of natural recovery may be considered when evaluating restoration measures. In some cases it may be most appropriate to allow natural recovery to proceed without further human intervention.

To supplement damage assessment data on natural recovery, a review and critical synthesis of the scientific literature on the recovery of marine mammals, marine birds, commercially important fish and shellfish, and invertebrates following environmental perturbations, including oil spills, was initiated in 1991. The reviews are being conducted under contract by the Point Reyes Bird Observatory (marine birds), University of Washington Fisheries Research Institute (fish and commercially important shellfish), and Hubbs-Sea World Research Institute and the Pacific Estuarine Research Laboratory at San Diego State University (marine mammals and intertidal and subtidal invertebrate communities). These syntheses will be completed in 1992.

Field Studies

As damage assessment results were reviewed in 1990 and 1991, the restoration planning staff consulted with scientists who were conducting the studies, Federal and State resource managers, and outside experts to identify and evaluate potential restoration options. In some cases lack of information prevented the evaluation or implementation of a restoration option, and field studies were proposed to provide needed information. Thus, the Trustee Council approved a series of small-scale restoration studies in 1990 and 1991.

Three types of studies were conducted:

- feasibility studies, to test the practicality and effectiveness of proposed direct restoration techniques;
- technical support studies, to provide biological or other information necessary to identify, evaluate or conduct potential restoration activities; and
- monitoring studies, to document the extent and rate of natural recovery of an injured resource.

The studies conducted were described in the 1990 and 1991 versions of the State/Federal Natural Resource Damage Assessment and Restoration Plan for the *Exxon Valdez* Oil Spill and in three Federal Register notices (55 Fed. Reg. 8160, [November 19, 1990], 56 Fed. Reg. 8898, [March 1, 1991], and 56 Fed. Reg. 36160, [July 31, 1991]).

Habitat Protection

Resource experts and the public have identified the protection of fish and wildlife habitats and recreation sites as a method of preventing further harm to, and assisting the recovery of, natural resources and services injured by the oil spill. Suggested approaches have included changes in management practices on public lands and land acquisition. Accordingly, the restoration planning staff conducted special projects concerning the protection of marine and upland habitats.

First, a workshop was held in August 1991 to evaluate State and Federal marine habitat protection designations and their potential usefulness in the restoration program. The designations reviewed included national marine sanctuaries, estuarine research reserves and Alaska State marine parks. The workshop participants included managers and administrators of various protected areas who provided first-hand information on the areas for which they are responsible. Each type of designation and specific unit has a different purpose, management approach, historical funding level and track record. Participants suggested that marine habitat protection designations help maintain ecosystem integrity by controlling activities that disrupt ecological processes or that physically damage the environment, thereby minimizing further stress on recovering resources. These designations accommodate conservation objectives as well as other pre-existing uses.

Second, The Nature Conservancy was invited to provide technical assistance in developing methodologies for identifying key upland habitats that are linked to the recovery of injured resources and services and evaluating potential protection strategies. In cooperation with the restoration planning staff, The Nature Conservancy prepared a handbook entitled, Options for Identifying and Protecting Strategic Fish and Wildlife Habitats and Recreation Sites (December 1991). The handbook provides a menu of identification and protection tools, techniques and strategies that may be applicable to restoration planning efforts associated with private lands within the oil-spill area.

CHAPTER IV
SUMMARY OF INJURY

Introduction

The *Exxon Valdez* oil spill occurred just prior to the most biologically active season of the year in southcentral Alaska. During the four-month period after the spill, seaward migrations of salmon fry, major migrations of birds, and the primary reproductive period for most species of birds, mammals, fish, and marine invertebrate species took place. The organisms involved in these critical periods of their life cycles encountered the most concentrated, volatile, and potentially damaging forms of spilled oil. Oil affected different species differently. Resources continue to be exposed to oil remaining in the intertidal zone, as well as to oil transported to the subtidal zone. The following general account summarizes the main results from the Natural Resource Damage Assessment studies carried out after the spill.

Oil spill injuries can be estimated in several ways: Dead animals, such as birds and sea otters, can be counted and used to estimate the total number of each species lost. Where carcasses are not found and counted, injuries to populations can be based either on comparisons before and after a spill, or between oiled and unoiled environments. Measurements of physiological and biochemical changes due to oil exposure provide further evidence that may support changes observed in populations. Because populations fluctuate from year to year and there are natural differences from place to place, the most accurate estimates of injury are those in which the exact population is known just before the spill and then after the injury occurred. Although scientists studying the effects of oil spills may carry out excellent studies under difficult conditions, there are always uncertainties, especially where good pre-spill population data are lacking.

The injuries summarized here may change as the results of additional sampling and data analysis become available. It is also possible that injuries to populations of long-lived species may not be manifested for some time.

Marine Mammals

Introduction

Following the spill, humpback whales, Steller sea lions, sea otters, harbor seals, and killer whales were studied. Field work on Steller sea lions and humpback whales was completed in 1990. Humpback whale studies included photo-identification of individual whales, estimations of reproductive success, and documentation of possible displacement of whales from their preferred habitat

within Prince William Sound. Exposure of this species to oil was not observed, nor were tissues sampled and analyzed for hydrocarbons. The data do not indicate an effect of the spill on mortality or reproduction of humpback whales in Prince William Sound. However, in 1989 humpback whales were not seen in Lower Knight Island Passage, a preferred habitat.

Results from the sea lion study were inconclusive. Several sea lions were observed with oiled pelts, and petroleum hydrocarbons were found in some tissues. Determining if there was an effect of the spill on the sea lion population was complicated by seasonal movements of sea lions in and out of the spill area, an ongoing population decline and a pre-existing problem with premature pupping.

Based on several photo-identification censuses a significant number of killer whales are missing from at least one and possibly two pods in Prince William Sound. Changes also have been observed in killer whale distribution and social structure. Some male whales have drooping dorsal fins. The cause of the mortalities and fin problems is uncertain.

Injuries to harbor seals and sea otters, described below, have been more evident. Studies of these species are continuing.

Sea Otters

The population of sea otters in Prince William Sound before the spill was estimated to have been as high as 10,000. The total sea otter population of the Gulf of Alaska was estimated to have been at least 20,000. Statewide, the sea otter population is estimated at 150,000. As the oil moved through Prince William Sound and the Gulf of Alaska, it covered large areas inhabited by otters. Sea otters were particularly vulnerable to the spill. When sea otters become contaminated by oil, their fur loses its insulating capabilities, leading to death from hypothermia. Sea otters also may have died as a result of oil ingestion and perhaps inhalation of toxic aromatic compounds that evaporated from the slick shortly after the spill. The effects of oil were documented by repeated surveys of populations in the spill area, recovery of beach-cast carcasses, analysis of tissues for petroleum hydrocarbons and indicators of reduced health, tracking sea otters outfitted with radio transmitters (including those released from rehabilitation centers), and estimating total mortality from the number of sea otter carcasses recovered following the oil spill. These studies concentrated on developing an estimate of sea otter mortality in Prince William Sound and along the Kenai Peninsula, the populations believed to have been most affected by the spill. During 1989, 1,011 sea otter carcasses were recovered in the spill area, cataloged and stored in freezers. Of these, 876 otters were recovered dead from the field and 135 died in rehabilitation centers or other facilities. It is estimated that 3,500 to 5,500 sea otters died from acute exposure to the oil in the entire affected area.

Heavy initial and continuing long-term exposure to petroleum hydrocarbons may be resulting in a chronic effect on sea otters. Significantly elevated concentrations of petroleum hydrocarbons have been detected in intertidal and subtidal sediment samples within the spill zone in western Prince William Sound and in intertidal mussels and benthic marine invertebrates and staples of the sea otter diet. Analyses of blood from sea otters in 1990 and 1991 indicated slight but significant differences in several blood measures in exposed animals. For example, higher eosinophil counts, total hemocrits and hemoglobin concentrations occurred in males in western Prince William Sound, the area that was oiled, compared to males in the eastern Prince William Sound, the unoiled area, suggesting systemic hypersensitivity reactions. These changes are not sufficient to indicate that the individuals that were sampled had health problems likely to result in death.

Abnormal patterns of mortality are continuing in sea otters. Based on pre-spill data from Prince William Sound, very few prime-age sea otters (animals between 2 and 8 years old) die each year and most mortality occurs among otters less than two years old. In 1990 and 1991 a high proportion of carcasses of prime-age sea otters were found on beaches, suggesting a chronic effect of the spill on sea otters.

Results of boat surveys indicate continued declines in sea otter abundance within oiled areas in Prince William Sound. Pre-spill estimates of sea otter abundance in Prince William Sound were carried out in 1984 and 1985 using similar survey techniques. Comparisons of pre- and post-spill estimates of sea otter abundance show that sea otter populations in unoiled areas experienced a 13.5 percent increase in abundance, while sea otter populations in oiled areas underwent a 34.6 percent decrease. In addition, the post-spill population in the oiled area is significantly lower than the pre-spill estimate, indicating a real decline of 1,600 sea otters in Prince William Sound in the first year after the spill, and up to 2,200 in the first three years after the spill.

Pupping rates and survival of pups through weaning in 1990 and 1991 were similar in eastern and western Prince William Sound sea otter populations. Weaned sea otter pups with radiotags died at a faster rate in western than in eastern Prince William Sound (Figure 3). In contrast, survival of tagged adult female sea otters was significantly higher in western Prince William Sound than in eastern Prince William Sound.

Sea otters released from rehabilitation centers had higher mortality and significantly lower pupping rates than those measured in the wild population before the spill. Of the 193 sea otters released from rehabilitation centers, 45 were fitted with radio transmitters. As of July 31, 1991, 14 of these animals were still alive, 14 were known to be dead, and 16 were missing. One radio transmitter is known to have failed.

The observed changes in the age distributions of dying sea otters, continued declines in abundance, higher juvenile mortality, and higher mortality and lower

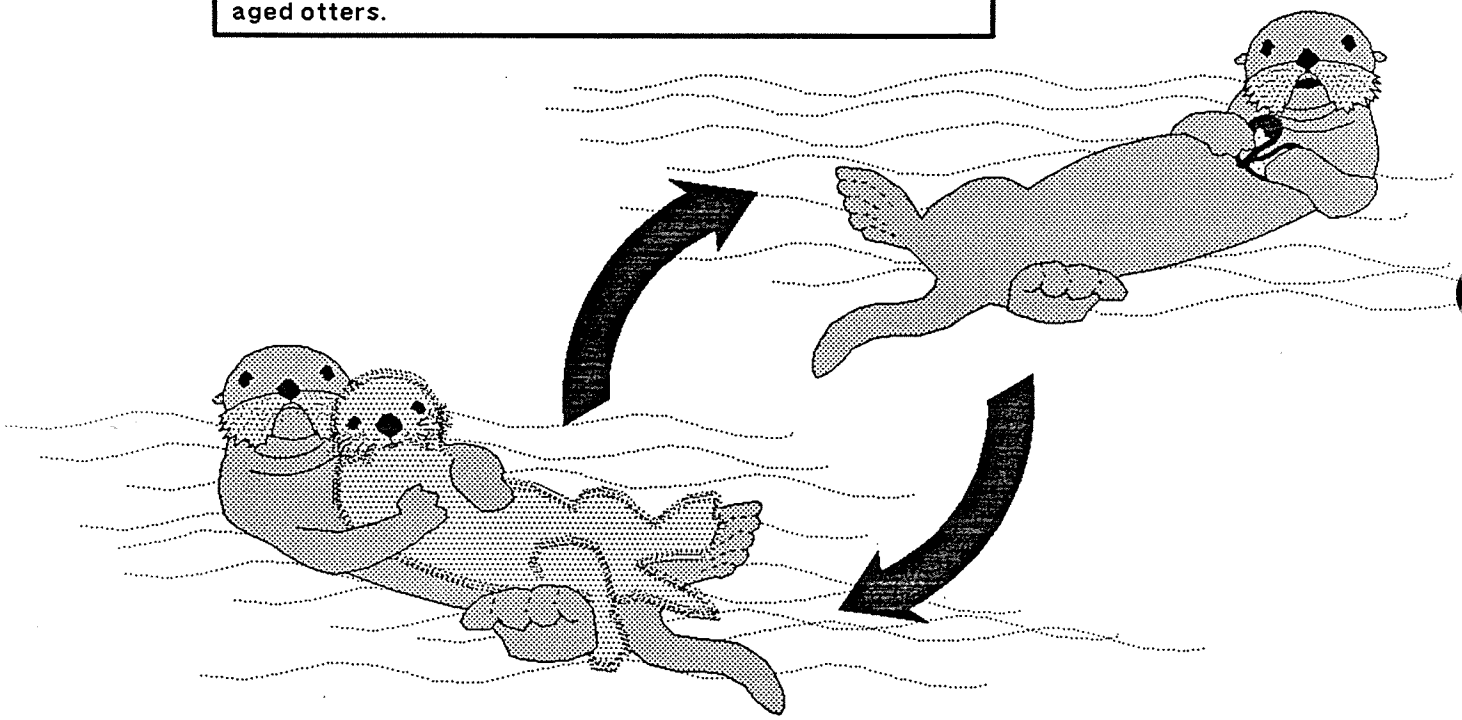
Figure 3. Summary of the major injuries in relation to the life history of sea otters.

Sea Otters

Adults

Sea otters prefer shallow coastal waters with abundant molluscs and crustaceans for prey. Intertidal rocks and exposed beaches are used for haulout sites. Otters become sexually mature in 4 - 7 years. Most otters in Prince William Sound mate from September through October, but they are capable of breeding throughout the year.

INJURY: Heavy direct mortality of all age classes during the Exxon Valdez oil spill; continuing high mortality of prime aged otters.



Pups

Within Prince William Sound, most sea otter pups are born May through June. The single pup is dependent on its mother for 5 - 7 months. High quality, shallow habitats are used by female-pup pairs.

INJURY: High post-weaning mortality within the Exxon Valdez oil spill area.

pupping rates suggest a prolonged, spill-related effect on the western Prince William Sound sea otter population.

Harbor Seals

Two hundred harbor seals are estimated to have been killed by the spill in Prince William Sound. Only 19 seal carcasses were recovered following the spill, since seals sink when they die. Population changes were documented by summer and fall aerial surveys of known haul-out areas. Toxicological and histopathological analyses were conducted to assess petroleum hydrocarbon accumulation and persistence and to determine toxic injuries to tissues. Severe and potentially debilitating lesions were found in the thalamus of the brain of a heavily oiled seal collected in Herring Bay, Prince William Sound, 36 days after the spill. Similar but milder lesions were found in five other seals collected three or more months after the spill. During 1989, oiled harbor seals were abnormally lethargic and unwary. Petroleum hydrocarbon concentrations in bile were 5 to 6 times higher in seals from oiled areas than in seals from unoiled areas one year after the spill. This indicates that seals were still encountering oil in the environment, were mobilizing fat reserves containing petroleum hydrocarbons, or both.

A complete census of harbor seals in Prince William Sound had not been conducted before the spill. However, trend index locations have been intermittently surveyed since the 1970s. Counts at the trend index sites declined by 40 percent between 1984 and 1988, with similar declines in what were subsequently oiled and unoiled areas. From 1988 to 1990, however, the decline at oiled sites, 35 percent, was significantly greater than at unoiled sites (13 percent). Trend surveys conducted in 1991 continue to indicate similar differences between oiled and unoiled areas, although mean numbers of seals in trend counts have increased since the spill. The increases in seals at unoiled sites have been significant, while those at oiled sites have risen only slightly. The first complete survey of Prince William Sound was completed during August 1991, resulting in a count of 2,875 harbor seals.

Killer Whales

Approximately 182 killer whales, forming nine distinct family units or "pods", used Prince William Sound before the spill. These whales were studied intensively before the spill, and their social structure and population dynamics are well known. Damage assessment studies of killer whales involved extensive boat-based surveys in Prince William Sound and adjacent waters. Whales were photographed, and the photographs were compared to the Alaskan killer whale photographic database for the years 1977 to 1989 to determine changes in whale abundance, seasonal distribution, pod integrity and mortality and natality rates.

The AB pod had 36 whales when last sighted before the spill in September 1988. When sighted on March 31, 1989, seven days after the spill, seven individuals were missing. Six additional whales were missing from the AB pod in 1990. Assuming that whales missing for two consecutive years are dead, the

mortality rates for the AB pod were 19.4 percent in 1988-1989 and 20.7 percent in 1990-1991. The average annual mortality in AB pod from 1984 to 1988 was 6.1 percent. An additional whale was missing in 1991, but a calf also was born into the pod. The approximate calving interval of killer whales is four years. Accordingly, some long-term effects may not be obvious for many years.

Several of the missing whales from AB pod were females that left behind calves; such abandonment of calves is unprecedented in killer whales. As a consequence the social structure of AB pod has changed. Calves normally spend time with their mothers, but AB pod calves have been observed swimming with adult bulls. The occurrence of collapsed dorsal fins on two adult bulls after the spill is an indication of possible physiological injury. Very little is understood about the likely mechanisms of death from the spill. Various explanations, including oil exposure and other causes, continue to be explored. During the mid-1980s photographic evidence was obtained of bullet wounds in individuals in the AB pod, though there is no recent evidence of such shootings.

Another Prince William Sound pod, AT pod, is missing 11 whales. A subgroup of four AT pod members was photographed behind the *Exxon Valdez* three days after the grounding on Bligh Reef and three of these animals are among the missing AT pod whales. This is a transient pod and it is possible that the missing whales left the pod.

Terrestrial Mammals

Terrestrial mammals that may have been exposed to oil through foraging in intertidal habitats were studied. These species included brown bear, mink, black bear, Sitka black-tailed deer and river otters.

Brown bears forage seasonally in the intertidal and supratidal areas of the Alaska Peninsula and the Kodiak Archipelago. Preliminary analysis of fecal samples from brown bears in the spill area showed that some bears were exposed to petroleum hydrocarbons. High concentrations of petroleum hydrocarbon metabolites were found in bile from a yearling brown bear found dead in 1989. The normal rate of mortality in yearling cubs is close to 50 percent for the first two years, so it is uncertain if this death was due to oil or other causes.

Black bears also forage in the intertidal zone in the spill area and therefore could have been affected by the spill. No field studies were carried out, however, due to the difficulty of finding, collaring or otherwise investigating these animals in the dense underbrush that is their habitat.

Mink and other small mammals living in coastal areas may feed in and spend part or all of their time in the intertidal zone. When mink are sick or injured, they are known to crawl into inaccessible burrows or the brush. For this reason the effect of the spill on mink populations could not be determined. Also, information on pre-spill populations of mink and other small mammals is

minimal. To determine if mink reproduction may have been affected by oil in their diet, a laboratory exposure study of ranch-bred mink was conducted. The mink were fed food mixed with small, non-lethal amounts of weathered oil. No changes in reproductive rates or success resulted from this exposure. It was found, however, that oil-contaminated food moved through the intestines of the animals at a more rapid rate than did clean food, possibly providing less nutrition to the animals.

Intensive searches of beaches revealed no Sitka black-tailed deer whose deaths could be attributed to the spill. However, deer taken for purposes of testing for human consumption (not part of the damage assessment) were found to have had slightly elevated concentrations of petroleum hydrocarbons in tissues of some individuals that fed on kelp in intertidal areas. It was determined that the deer were safe to eat.

River Otters

A few river otter carcasses were found by clean-up workers. River otters forage in streams and shallow coastal habitats that were contaminated by the spill. Analysis of river otter bile and blood samples indicated that petroleum hydrocarbons were being accumulated by this species. Moderately elevated concentrations of haptoglobin and activities of amino transferase enzymes in the blood of river otters from oiled areas in 1991 indicate a lingering toxic effect of oil on this species. Studies of radio-tagged animals in Prince William Sound showed that home ranges in oiled areas were twice that of unoiled areas, suggesting that in oiled areas otters must forage over a larger area to obtain sufficient food. In 1991, body lengths, body weights and dietary diversity were lower in oiled areas. River otters often feed on mussels, which continue to be contaminated with oil in many areas of Prince William Sound.

Birds

Introduction

Birds were among the most conspicuous victims of the oil spill. Seabirds are particularly vulnerable to oil, as they spend much of their time on the sea surface while foraging. Oiled plumage insulates poorly and loses its buoyancy, and oiled birds often die from hypothermia or drowning. Birds surviving initial acute exposure to oil may ingest oil by preening. About 36,000 dead birds were recovered after the spill; at least 31,000 of these deaths were attributable to oil. In addition to the large number of murres, sea ducks and bald eagles recovered after the spill, carcasses of loons, cormorants, pigeon guillemots, grebes, murrelets and other species were also recovered. The recovered birds represent only a small proportion of the total number of birds killed by the spill. Many oiled birds undoubtedly floated out to sea and sank. Many oiled birds that were washed onto beaches may have been scavenged, hidden in masses of oil buried

under sand and gravel by wave actions, decomposed or simply washed onto a beach that was not searched. In a number of cases carcasses found shortly after the spill were not turned in to receiving stations. The results of analyses using computer models that account for some of these variables suggest that the total number of birds killed by the spill ranged from 300,000 to 645,000, with the best approximation that between 375,000 and 435,000 birds. These estimates reflect only direct mortality occurring in the months immediately following the spill, and do not address chronic effects or loss of reproductive output.

Common and thick-billed Murres

Approximately 1,400,000 murres reside in the Gulf of Alaska region, which stretches from Unimak Pass at the tip of the Alaskan Peninsula to the Canadian border in southeastern Alaska. The total population of murres in Alaska is approximately 12,000,000. The murre colonies on the Chiswell Islands are the colonies most visited by tourists in Alaska. Most of the pre-spill data on murre abundance in the Gulf of Alaska colonies affected by the spill were gathered in the mid-1970s to the early 1980s. In 1989 and 1990 murres were the most heavily affected bird species. As oil moved out of Prince William Sound and along the Kenai Peninsula and the Alaska Peninsula, it encountered major seabird nesting areas, such as the Chiswell and Barren islands, as well as numerous smaller colonies. The oil contaminated these areas in the Gulf of Alaska at the same time that adult murres were congregating on the water near their colonies in anticipation of the nesting season. Approximately 22,000 murre carcasses were recovered following the spill. At the major colonies in the spill area surveys indicated that an estimated minimum of 120,000 to 140,000 breeding adult murres were killed by the spill. Extrapolating this information to other known murre colonies affected by the spill, but not specifically studied, the mortality of breeding adult murres is estimated to have been 172,000 to 198,000 birds. The spill also affected wintering and non-breeding birds and the total area-wide mortality of murres is estimated to be about 300,000. Numbers of breeding murres declined in 1989 from pre-spill counts or estimates at Alaska Peninsula sites (50-60 percent), the Barren Islands (60-70 percent) and the Triplet Islands (35 percent). These decreases persisted in 1990 and 1991. No significant changes in murre numbers were noted for the Semidi Islands and Middleton Island, colonies which are in the Gulf of Alaska, but outside the spill zone. Murres exhibit strong fidelity to traditional breeding sites and infrequently immigrate to new colonies.

Normally, murres breed on cliff faces in densely packed colonies. Each murre colony initiates egg laying almost simultaneously. Synchronized breeding helps repel predators such as gulls and ravens. In oiled areas, murre colonies have fewer breeding individuals than before the spill, breeding is later than normal and breeding synchrony has been disrupted.

These changes in numbers of birds and their behavior have caused complete reproductive failure in several of the large colonies during 1989, 1990 and 1991, and thus lost production of at least 300,000 chicks. There are some indications

that normal breeding occurred in isolated areas of the Barren Island colonies in 1991, but it is uncertain when the whole colony will start to produce significant numbers of viable chicks. Murre colonies in unoiled areas displayed none of these injuries and had normal productivity in the years since the spill.

Bald Eagles

Of the estimated Alaskan bald eagle population of 39,000 birds (27,000 adults and 12,000 fledglings), an estimated 4,000 reside in Prince William Sound, and an estimated 8,000 to 10,000 reside along the northern Gulf of Alaska coast. One hundred fifty-one (151) dead bald eagles were found following the spill. Although there is considerable uncertainty regarding the total mortality of bald eagles, several times this number may have been killed initially by the spill. Seventy-four percent of radio-tagged bald eagles that died of natural causes during subsequent studies ended up in the forest or in other places away from the beaches where they would likely not have been found had they not been tagged. If this pattern of carcass deposition is representative of what happened following the oil spill, then as many as 580 bald eagles may have been killed directly by the spill. However, since eagles dying of acute exposure to oil probably behave differently than those dying naturally and the population trend counts did not indicate a significant decline following the spill, the number of eagles killed is certainly less than this number.

To assess injuries to bald eagles, helicopter and fixed-wing surveys were flown to estimate populations and productivity. Radio transmitters were attached to bald eagles to estimate survival, distribution and exposure to oiled areas. Bald eagles in Prince William Sound were most intensively studied. Productivity surveys in 1989 indicate a failure rate of approximately 85 percent for nests adjacent to moderately or heavily oiled beaches compared to 55 percent on unoiled or lightly oiled beaches. This resulted in a lost production of at least 133 chicks in Prince William Sound in 1989. Nest success and productivity on the Alaska Peninsula were also lower in 1989 than in 1990, but differences between these years for eagles residing in other coastal areas affected by the spill were less apparent. Nest occupancy was lower in oiled areas than in unoiled areas in both 1989 and 1990. Reproduction returned to normal in 1990 and population indices from surveys in 1982, 1989, 1990 and 1991 suggest that the spill has not measurably affected the bald eagle population in Prince William Sound.

Sea Ducks

More than 2,000 sea duck carcasses were recovered after the spill, including more than 200 harlequin ducks. Studies concentrated on harlequins, goldeneyes, and scoters--species that use the intertidal and shallow subtidal habitats most heavily affected by the spill. All of these species feed on invertebrates, such as mussels, which in 1991 continued to show evidence of petroleum hydrocarbon contamination. Harlequin ducks, which feed in the shallowest water of all these species, were most affected. In 1989 and 1990 about 40 percent of the harlequin

ducks sampled had tissues contaminated with petroleum hydrocarbons, and about 33 percent of the harlequins collected in the spill area had poor body condition and reduced body fat. The 1991 survey indicates harlequin population declines and a near total reproductive failure in oiled areas of Prince William Sound (Figure 4). Oil-contaminated mussel beds may be the source of this apparent continuing problem.

Other Birds

Changes in populations of waterbirds in the spill area were assessed with boat surveys, the same technique used in surveys carried out in 1972 and 1973, and then, again in 1984. Changes were assessed on the basis of both the earlier and later pre-spill data. Declines occurred in 16 of the 39 species or groups examined for the entire Prince William Sound area between 1972-1973 and post-spill. Declining species or groups of species include: grebes, cormorants, northern pintail, harlequin duck, old squaw, scoters, goldeneyes, bufflehead, black oystercatcher, Bonaparte's gull, black-legged kittiwake, Arctic tern, pigeon guillemot, *Brachyramphus* (marbled and Kittlitz's) murrelets, and northwestern crow. The following species or group of species declined more in oiled areas than in unoiled areas since the early 1970s: harlequin duck, black oystercatcher, pigeon guillemot, northwest crow, and cormorants. Comparisons of post-spill survey data with 1984 pre-spill data indicate that harlequin duck, black oystercatcher, murres, pigeon guillemot, cormorants, Arctic tern, and tufted puffin populations declined more in oiled areas than in unoiled areas.

Marbled and Kittlitz's murrelet populations declined greatly in Prince William Sound since 1972 and 1973. In 1973, the estimated murrelet population in the Sound was 304,000 birds, while murrelet populations were estimated to be 107,000 in 1989, 81,0000 in 1990, and 106,000 in 1991. The length of time between pre-spill and post-spill surveys makes it difficult to determine the relative contribution of the spill to this decline. However, a high proportion of murrelets present in Prince William Sound were killed by the spill. Also, internal contamination of apparently healthy murrelets by petroleum hydrocarbons in the spill area opens the possibility that there were significant effects on murrelets beyond the initial mortality. Disturbance associated with clean-up activities may have influenced the number of murrelets observed in the spill area in 1989.

Nine black oystercatcher carcasses were found after the spill. This species feeds intertidally and breeds on rocky shores throughout the spill zone. In addition to mortality caused directly by the spill, oiling affected their reproductive success. Egg volume and weight gained by chicks raised on oiled sites were substantially lower than chicks raised on unoiled sites. The difference in weight gain by chicks may have resulted from differences in food supply, as the amount of food delivered to chicks raised on oiled sites was significantly less than that delivered to chicks at unoiled sites. Hatching success, fledging success, and productivity of young birds were not significantly different between oiled and unoiled sites. Direct disturbance by clean-up activities significantly reduced oystercatcher productivity on Green Island during 1990.

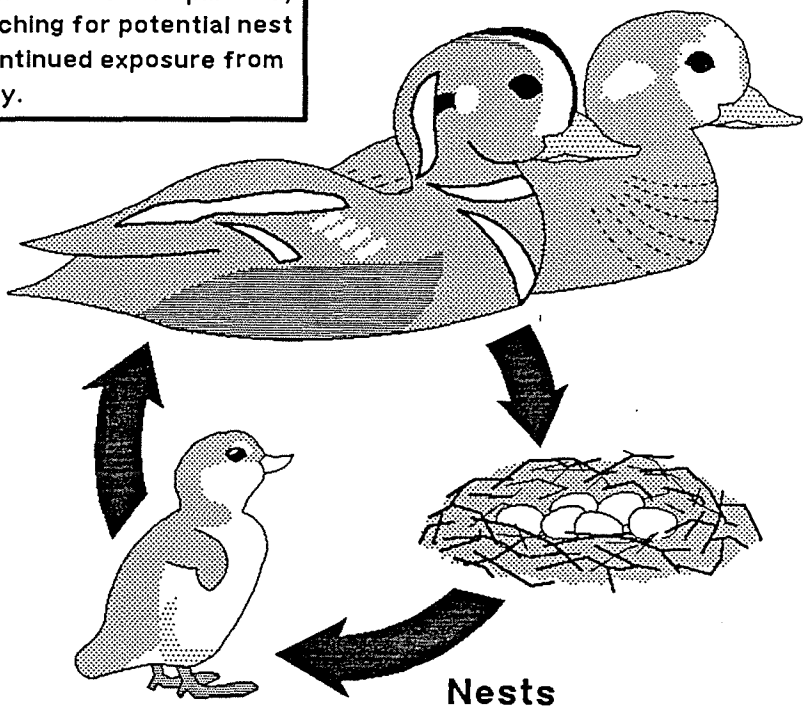
Figure 4. Summary of the major injuries in relation to the life history of harlequin ducks.

Harlequin Ducks

Adults

In early May, paired harlequins congregate at the mouths of anadromous fish streams. The pairs fly upstream to search for suitable nest sites. Wintering harlequins feed on mussels and crustaceans in intertidal waters.

INJURY: Pairs are not congregating at streams in the Exxon Valdez oil spill area, nor are they searching for potential nest sites. Possible continued exposure from contaminated prey.



Broods

Broods hatch in July. They remain on freshwater with the female until August when they return to coastal waters.

INJURY: No broods observed within the Exxon Valdez oil spill area in 1990, and only one brood found in 1991, indicating reproductive failure at nesting and/or poor brood survival.

Nests

Located along shallow and swift rivers and streams. 3 to 7 eggs are laid in May and incubated for 28 - 30 days.

INJURY: No nests discovered in the Exxon Valdez oil spill area.

Pigeon guillemots are nearshore diving seabirds that gather daily on intertidal rocks near their colonies during the breeding season and forage by probing into intertidal and subtidal recesses and kelp. Five hundred sixteen (516) guillemot carcasses were recovered following the spill. Between 1,500 and 3,000 guillemots were estimated to have been killed by the spill, representing as much as 10 percent of the known pigeon guillemot population in the Gulf of Alaska. Boat surveys indicate that in 1973 the Prince William Sound guillemot population was approximately 14,600; while in 1989, 1990 and 1991, the estimated populations were, respectively, 4,000, 3,000 and 6,600. These data indicate that the Prince William Sound guillemot population was declining prior to the spill. The declines were significantly greater, however, in oiled areas. For the four islands of the Naked Island group, post-spill surveys showed a 40 percent decline in guillemots present during peak colony attendance hours compared to pre-spill surveys. Declines corresponded to the degree of shoreline oiling.

The extent of injury to certain species, including loons, cormorants and gulls, will never be known because pre-spill population estimates for these species in the spill area are not available. Although Peale's peregrine falcons did not appear to be directly affected by the oil spill, disturbance from nearshore activities appears to have affected rates of nest occupancy and reduced clutch and brood sizes in 1989. Studies of song birds did not document an injury from the spill.

Fish and Shellfish

Introduction

No massive kills of adult open-water fish were observed following the spill. Adult salmon, for example, were able to migrate as expected to spawning areas after the spill. The early life stages of some fish species and adults of others depend on the intertidal and shallow subtidal areas and the upper layers of the sea where the greatest concentrations of oil occurred. In addition the eggs and larvae of fishes are more sensitive to oil contamination than are adults.

It is not surprising, therefore, that the available evidence from this spill indicates that the greatest damage was to the eggs and larvae of some species of fish, especially those that inhabit and spawn in the intertidal zone (salmon) and shallow subtidal zone (herring) or that forage in shallow water (Dolly Varden and cutthroat trout). Many species of fish produce large numbers of eggs and only a relatively small number reach adulthood. Since natural factors affecting such survival change from year to year it is difficult to estimate or measure the effects of oil on adult fish populations whose early stages were injured. Nevertheless, during 1991, data were gathered that would potentially help clarify the effects on adult fish exposed to oil as eggs or larvae. These data are still being analyzed.

The deaths of some rockfish, a deepwater species, also were attributed to oil. Several species of coastal and offshore fish, including pollock, halibut, sablefish, cod, yellowfin and flathead sole and rockfish, showed evidence of continuing

exposure to petroleum hydrocarbons over a large geographic area, but significant injury has not been documented. Because salmon and other fish species can metabolize petroleum hydrocarbons, these contaminants are unlikely to concentrate in fish tissues. Indicators of exposure in fish include increased concentrations of hydrocarbon metabolites in bile and activities of mono-oxygenates in liver tissue.

Pink Salmon

The full extent of short-term injury to pink salmon cannot be assessed until after the 1991 run returns have been analyzed. As predicted before the spill, the catch of pink salmon in Prince William Sound during 1990 was an all-time record high and the 1991 run was also quite high. These catches were primarily due to strong runs of hatchery-produced salmon. Survival to adulthood of salmon fry released from the Armin F. Koerning hatchery, located in the middle of a heavily oiled area of the spill zone, was half that of Esther Hatchery, located outside the spill area. Wild production of pink salmon did not mirror the record production of hatchery fish.

Seventy-five percent of wild pink salmon in Prince William Sound spawn in the intertidal portion of streams. Wild salmon did not shift spawning habitat following the spill and many salmon deposited their eggs in intertidal areas of oiled streams. In the autumn of 1989 egg mortality in oiled streams averaged about 15 percent, compared to about 9 percent in unoiled streams. Subsequently, egg mortality has generally increased. In 1991 there was a 40 to 50 percent egg mortality in oiled streams, and about an 18 percent mortality in unoiled streams. The relative roles of the spill and other factors, including natural variability, in causing the increased 1991 egg mortality are being analyzed. In general the number of spawning fish in streams of Prince William Sound indicates that the more viable spawn that is produced, the more adults will return to spawn from that year class. If this is true, then it is likely that mortality at the egg stage is additive with other sources of mortality in later stages and that the increased egg mortality observed since the spill is a threat to wild pink salmon in Prince William Sound. Eggs and larvae of wild populations continue to be exposed to oil in intertidal gravel in some areas.

Pink salmon juveniles were exposed to petroleum hydrocarbons from the spill in nearshore marine habitats in oiled portions of Prince William Sound in 1989. The survival of pink salmon to adulthood is directly related to growth rates during the initial marine residency. Growth rates of juvenile pink salmon were lower in oiled locations in 1989, but there was no evidence of continued reduced growth of juvenile salmon in nearshore waters in 1990. Laboratory experiments in 1991 confirmed that ingestion of food contaminated with oil can cause reduced growth and increased mortality of juvenile pink salmon.

Fry growth was decreased in oiled streams as compared to unoiled streams over the winter of 1989-1990 and larvae from some heavily oiled streams showed

gross morphological abnormalities, including club fins and curved vertebral columns. The pink salmon that returned to Prince William Sound in the summer of 1990 were hatched prior to the spill and were exposed to oil as larvae. Although there is great uncertainty, some analyses suggest that the 1990 return of both wild and hatchery pink salmon was 20 to 25 percent lower than expected without the spill, resulting in a return of 15 to 25 million fewer fish. Fish that returned in 1991 were the first that were exposed to oil as eggs. The returns of wild salmon to oiled and unoiled streams in 1991 are still being analyzed.

Sockeye Salmon

Commercial harvest of sockeye salmon was curtailed in portions of Cook Inlet, Chignik, and Kodiak in 1989 because of the spill, resulting in an unusually high number of adults returning to spawn in certain lake systems--for example, Kenai and Skilak lakes, Red and Akalura lakes. The number of adults returning to the spawning areas is referred to as the "escapement." Commercial salmon fisheries are actively managed to maintain high production, and large overescapements resulting in low smolt production are a threat to the maintenance of sustained good production. In this case overescapement has resulted in poor survival to the smolt stage in the Kenai and Skilak lakes system. This overescapement is expected to result in a return of adults in 1993 and 1994 that is less than needed for adequate production. Total closure or severe reduction of the commercial and sport sockeye fisheries may be necessary in those years to enable recovery of this species in the Kenai and Red lakes systems. These fisheries account for up to half the commercial sockeye harvest in the Kodiak and Cook Inlet areas.

Dolly Varden and Cutthroat Trout

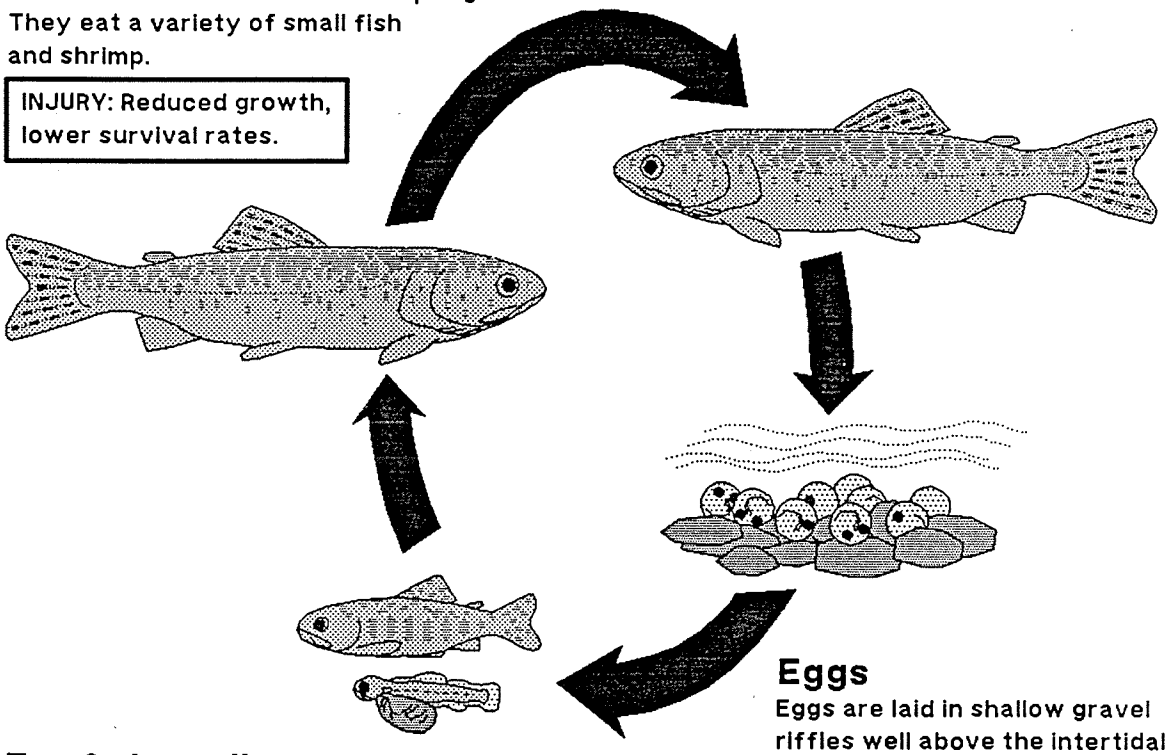
Prince William Sound is the northern extent of the range of cutthroat trout (Figure 5). Both cutthroat trout and Dolly Varden use nearshore and estuarine habitat for feeding throughout their lives, although they overwinter and spawn in freshwater. The highest concentrations of petroleum hydrocarbon metabolites in bile of all fish sampled in 1989 were found in Dolly Varden. Tagging studies demonstrated that the annual mortality of adult Dolly Varden in oiled areas was 32 percent greater than in unoiled areas. The larger cutthroat trout also showed higher levels of mortality in oiled than in unoiled areas. In 1989-1990, there was 57 percent greater mortality, and in 1990-1991, a 65 percent greater mortality, in oiled streams versus unoiled streams. Additionally, cutthroat trout growth rates in oiled areas were 68 percent in 1989-1990 and 71 percent in 1990-1991 of those in unoiled areas. Although concentrations of bile hydrocarbons were greatly reduced in 1990 and 1991, indicating less exposure to oil, it is unclear why differences persist in survival rates between oiled and unoiled streams.

Pacific Herring

Populations of Pacific herring were spawning in shallow eelgrass and algal beds at the time of the spill. The effects of oil on egg survival, hatching success,

Figure 5. Summary of the major injuries in relation to the life history of cutthroat trout.

Cutthroat Trout



Adults in Freshwater

Wild cutthroat mature in 2 - 10 years and may spawn in several consecutive years. Spawning occurs in late fall and winter in small tributaries to coastal streams.

INJURY: None expected.

Adults at Sea

Cutthroat return to estuarine and nearshore marine waters each spring. They eat a variety of small fish and shrimp.

INJURY: Reduced growth, lower survival rates.

Eggs

Eggs are laid in shallow gravel riffles well above the intertidal zone and hatch 28 - 40 days later.

INJURY: None expected.

Fry & Juveniles

Wild cutthroat remain in freshwater until reaching approximately 20 - 25 cm in length. Growth is largely dependent on environmental conditions. Smolt migrate to estuaries between March and July, and return to fresh water in the fall.

INJURY: Unknown or none.

larval development and recruitment to the spawning population were studied. A large percentage of abnormal embryos and larvae were found in samples from oiled areas of Prince William Sound collected during the 1989 reproductive season. Larvae in oiled areas also had a greater incidence of eye tumors. Analysis of histopathological abnormalities in tissues of adult herring reveal the occurrence of some lesions whose presence would be consistent with exposure to oil. Whether the adult population has been affected by these larval injuries and lesions will not be determined until the 1989 and 1990 cohorts return to spawn in 1992 and 1993. It will be difficult, however, to measure a change in the adult population, beyond the bounds of the natural variability.

Evidence of oil contamination in adult herring was found in 1989 and 1990. In 1989, hydrocarbon metabolites occurred in the bile of adult fish. There were significant changes in the incidence of histopathological lesions and in the parasite burden of adults found in oiled as compared to unoiled sites. The parasite burden of adult herring returned to pre-spill incidences in 1991.

Rockfish and Other Fish

A small number of dead rockfish were found after the spill; this was the only type of fish observed dying after the spill. Five rockfish were recovered soon enough after death to establish oil exposure as the probable cause of death. Analyses of rockfish bile indicated exposure to oil in a significant portion of the samples collected from oiled areas in 1989, only one individual in 1990 and none in 1991. Histopathological liver lesions were evaluated in 1990 and two types of lesions (liver lipidosis and liver sinusoidal fibrosis) were found to be significantly elevated in oiled areas. Other species that had measurable amounts of petroleum hydrocarbon metabolites in the bile in 1989 included halibut, pollock, rock sole, yellowfin sole, flathead sole and Pacific cod, and in 1990, Dover sole and sablefish.

Coastal Habitat

Introduction

The coastal tidal zone, commonly known as the "intertidal zone," was the most severely contaminated habitat. Intertidal habitats are highly productive and biologically rich. The intertidal zone is particularly vulnerable to the grounding of oil, its persistence and effects of associated clean-up activities.

Supratidal

The supratidal zone is above the high tide but still within the influence of the ocean from storm surges and wave spray. Results of studies from the Kodiak Island and Alaska Peninsula areas suggest that oil in the supratidal habitat and beach clean-up disturbance decreased the productivity of grasses and other vegetation, including beach rye, a grass that helps stabilize beach berms. In one instance, clean-up activities completely removed the supratidal vegetation.

Increased production of supratidal vegetation was found in Prince William Sound in 1989. Increased production as a result of decreased browsing by terrestrial mammals or a fertilizing effect of the oil are possible causes.

Intertidal

Populations of intertidal organisms were significantly reduced along oiled shorelines in Prince William Sound, on Kodiak Island and Cook Inlet, and along the Alaskan Peninsula. Densities of intertidal algae (*Fucus)*, barnacles, limpets, amphipods, isopods, and marine worms were decreased. Although there were increased densities of mussels in oiled areas, they were significantly smaller than mussels in the unoiled areas, and the total biomass of mussels was significantly lower. Sediment traps collected significant concentrations of petroleum hydrocarbons during the winter of 1990-1991, indicating that oil is continuing to be removed from the beaches by cleaning and natural processes and is being transported subtidally. Intertidal organisms continue to be exposed to petroleum hydrocarbons from subsurface oil in beaches.

In 1991 relatively high concentrations of oil were found in mussels and in the dense underlying mat (byssal substrate) of certain oiled mussel beds. These beds were not cleaned or removed after the spill and are potential sources of fresh oil for harlequin ducks, black oystercatchers, river otters and juvenile sea otters--all of which feed on mussels and show signs of continuing biological injury. The extent and magnitude of oiled mussel beds are unknown and continue to be investigated.

Intertidal fishes were less abundant in oiled areas than in unoiled areas in 1990. No such differences were documented in 1991.

Fucus, the dominant intertidal plant, was severely affected by the oil and subsequent clean-up activities. The percentage of intertidal areas covered by *Fucus* was reduced following the spill, but the coverage of opportunistic plant species that characteristically flourish in disturbed areas was increased. The average size of *Fucus* plants was reduced, the number of reproductive-sized plants greatly decreased, and the remaining plants of reproductive size decreased in reproductive potential due to fewer fertile receptacles per plant. Recruitment of *Fucus* at oiled sites was also reduced.

Subtidal Habitat

Between 1989 and 1991, oil concentrations declined in intertidal sediments sampled at most oiled locations, while the concentration in shallow subtidal sediments at depths of 3-20 meters remained about the same or in some cases, rose slightly. Petroleum hydrocarbon accumulation in filter-feeding mussels experimentally placed in the water column in various oiled areas was significant during the summer of 1989, but decreased in 1990. Patterns of sediment toxicity to marine amphipods and larval bivalve molluscs, used as test organisms,

reflected similar patterns. In 1990 significant toxicity to these organisms was associated only with intertidal sediment samples from heavily oiled sites, but in 1991 toxicity was associated primarily with sediment samples from the shallow subtidal zone. The current evidence from analyses of petroleum hydrocarbons in the bile of bottom-dwelling fishes suggests that animals living on or near the sea floor continue to be exposed to petroleum hydrocarbons. In this connection the analysis of samples of bottom-dwelling organisms at the 100-m depth is continuing to see if there was a detectable effect of oil deep communities.

Clams exposed to oil actively take up hydrocarbons, but metabolize them very slowly. Hydrocarbons are consequently accumulated in high concentrations in clams. Studies of clam growth rates were initiated after the spill and analyses are still being conducted. Contaminated clams and other invertebrates are a potential continuing source of petroleum hydrocarbons for harlequin ducks, river otters, sea otters and other species that forage in the shallow subtidal zone. Samples from pollock, which feed in the water column, taken 500 miles from the T/V *Exxon Valdez* grounding site on Bligh Reef, showed elevated petroleum hydrocarbon metabolite concentrations in their bile. These data indicate that surface oil affected the water column or food supply at great distances from the spill.

No pre-spill data were available to directly determine if the oil spill had altered shallow subtidal communities, so the effects of hydrocarbons were investigated by comparison of oiled and unoiled areas. Data are available for 1990. The greatest differences between oiled and unoiled areas have been observed in the shallow-water eelgrass beds and their associated habitat. Within the oiled eelgrass beds there were lower densities of eelgrass, fewer *Telmessus* crabs and fewer amphipods, but more small mussels and juvenile cod. Even greater differences were observed, however, in the abundance of fauna at depths from 6-20 meters below the oiled eelgrass beds, where there were far fewer individuals in oiled areas. In the shallow subtidal rocky areas (less than 20m) *Laminaria* communities were studied, both in bays and around points on the open coast. In the *Laminaria* habitat fewer differences were noted between oiled and unoiled areas. The most noticeable difference was the greater abundance of young *Laminaria* plants, but fewer large older plants in oiled areas. In shallow-water sandy areas, eelgrass beds and areas around them were studied.

Post-spill populations of spot shrimp were studied in oiled and unoiled areas of Prince William Sound. Some differences were found between populations in these areas. The results of these studies are still being evaluated.

Other Resources and Services

The spill directly impacted archaeological resources, subsistence, recreation, wilderness qualities and aesthetic and other indirect uses. Clean-up activities and the associated significant increases in human activity throughout the spill zone resulted in additional injuries to these resources and services.

Archaeological Resources

Archaeological resources along the shoreline were injured by the spill. Review of spill response data revealed injuries occurred at a minimum of 35 archaeological sites, including burial and home sites. These injured sites are distributed on both Federal and State lands. While injury to these 35 sites was documented during cleanup, a spill-wide assessment of injuries to archaeological resources has yet to be completed. In addition to oil contamination, increased knowledge of the location of archaeological sites puts them at greater risk from looting. Additional injury due to erosion caused by oil-spill response activities was documented.

A study was conducted to determine impacts caused by oil contamination on radiocarbon dating of archaeological resources and to investigate the potential for cleaning artifacts and materials to allow such dating. Results indicate significant injury to the ability to date artifacts and materials by Carbon ^{14} analysis.

Subsistence

Surveys undertaken by State researchers before the spill and in 1990 indicated that subsistence users in the oil-spill area significantly reduced their use of subsistence resources after the spill, primarily because of concern about contamination of these resources. The oil spill disrupted the subsistence lifestyle of some communities that have historically relied upon these resources for a significant portion of their diet. Some communities virtually or entirely ceased subsistence harvests in 1989 and have only gradually begun to resume harvests, while other communities continued some reduced level of subsistence harvest in 1989 and thereafter. Warnings were issued by the State in 1989 for people to avoid consumption of intertidal invertebrates (such as mussels and clams, which accumulate petroleum hydrocarbons) found along shorelines contaminated by oil. After the spill, an oil-spill health task force was formed, including representatives of the State and Federal governments, subsistence users, and Exxon. This group helped oversee studies conducted by the State and others in conjunction with the Food and Drug Administration and National Oceanic Atmospheric Administration in 1989, 1990 and 1991, on subsistence foods, such as seals, deer, salmon, ducks, clams and bottomfish. Based upon the test results these resources, with the exception of clams and mussels in certain oiled areas, such as Windy Bay, were determined to be safe for human consumption.

Recreation

Following the oil spill, recreational use of public lands and waters declined. Recreationists (e.g., sport fishermen, hunters, campers and sea kayakers) avoided oiled areas and many adjacent areas that were affected by clean-up activity. Many users canceled their plans or pursued their activities in other areas within the state. For example, visitor use in the coastal area of the Kenai Fjords National Park dropped by about 50 percent in 1989, compared to 1988. This disruption continued in 1990, because oil remained present in many areas and

some clean-up activity continued. In 1991 oil remained in many areas used by recreationists.

Wilderness and Intrinsic Values

There are designated "wilderness areas" in Kachemak Bay State Wilderness Park, Katmai National Park, and Becharof National Wildlife Refuge. In addition Federal "wilderness study" areas are located in Kenai Fjords National Park and the Chugach National Forest. Portions of these areas were oiled by the *Exxon Valdez* spill. The Wilderness Act of 1964 requires that Federal wilderness areas be "administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired..." Thus, the presence of oil, which was most recently documented by the 1991 May Shoreline Assessment, may be perceived as an injury to these areas. In addition to the injury from the oil, hundreds of workers, motorized machinery and support equipment were used in the wilderness areas during the cleanup. These clean-up activities disrupted uses of the wilderness, such as camping and fishing. These lands and resources may have intrinsic or nonuse values, as well as uses, which also were affected by the oil spill.

CHAPTER V
PROPOSED INJURY CRITERIA

Settlement Guidance

The settlement documents specify that the use of the restoration trust funds must be linked to injuries resulting from the *Exxon Valdez* oil spill. Specifically, the settlement requires that funds recovered for natural resource damages be spent to restore, replace, enhance, rehabilitate or acquire the equivalent "of natural resources injured as a result of the oil spill and the reduced or lost services provided by such resources."

"Natural resources" are defined as the land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to or managed by Federal and State governments. The services provided by natural resources include such activities as subsistence hunting and fishing and recreation.

Proposed Criteria

How do we determine which natural resources and natural resource services warrant further restoration activities? The following criteria are proposed to assist in these determinations:

- evidence of consequential injury, and
- adequacy and rate of natural recovery.

The concepts underlying these criteria are described below.

Injury to Natural Resources

The following definition of injury is proposed to be applied to natural resources in the spill area:

> A natural resource has experienced "consequential injury" if it has sustained a loss (a) due to exposure to oil spilled by the T/V *Exxon Valdez*, or (b) which otherwise can be attributed to the oil spill and clean up. "Loss" includes:
>
> - significant direct mortality;
> - significant declines in populations or productivity;

- significant sublethal and chronic effects to adults or any other life history stages; or

- degradation of habitat, due to alteration or contamination of flora, fauna and physical components of the habitat.

This definition covers a wide range of potential natural resource injuries. Consequential loss is most certain where there was significant direct mortality or if studies revealed a population decline linked to the oil spill. Where only eggs or juvenile life history stages are known to have been harmed, it is more difficult to establish consequential injury. In such cases, however, if the injury is manifested or inferred at the population level, the injury can be considered consequential. This definition also includes injury to the underlying habitats that were oiled (e.g., intertidal zone), some of which were in specially designated areas, such as parks, forests and refuges.

Important archaeological resources, protected by both Federal and State laws, were oiled. Inherent values could be irretrievably lost as oil continues to contaminate additional resources at some sites. Archaeological resources, such as sites and artifacts, are not living, renewable resources and have no capacity to heal themselves. Increased public knowledge of exact archaeological site locations also continues to foster looting and vandalism.

In some cases our knowledge of the degree of injury and linkage to the oil spill are imperfect, due to the difficulty of obtaining the desired documentation or the restricted scope or duration of the damage assessment studies. In these cases, judgments concerning injuries to natural resources as a result of the oil spill will have to be determined by the weight of the evidence or best professional judgment.

Injury to Natural Resource Services

The following definition of injury is proposed to be applied to natural resource services in the spill area:

> A natural resource service has experienced "consequential injury" if the *Exxon Valdez* oil spill or clean up:
>
> - has significantly reduced the physical or biological functions performed by natural resources, including loss of human uses; or
>
> - has significantly reduced aesthetic, intrinsic or other indirect uses provided by natural resources; or, in combination with either of these,

- has resulted in the continued presence of oil on lands integral to the use of special-purpose lands[1].

This definition covers a wide range of potentially injured natural resources services. Examples are commercial fishing, subsistence hunting, fishing and gathering, wildlife viewing, sport fishing, and recreation, which includes a variety of activities, such as kayaking and backcountry camping.

Indirect uses, such as aesthetics or appreciation of wilderness qualities, were also affected by the spill. This is a particular concern for those areas which formally have been designated as wilderness areas by the United States or the State of Alaska.

Recovery Concept

To maximize the benefits of restoration expenditures, the Trustees may consider the effects of natural recovery before investing restoration dollars. In a scientific sense, full ecological recovery has been achieved when the pre-spill flora and fauna are again present, healthy and productive, and there is a full complement of age classes. A fully recovered ecosystem is one which provides the same functions and services as were provided by the pre-spill, uninjured system.

The ability to determine scientifically if recovery has occurred or when it will occur may be limited, due to such problems as the quality and quantity of information on pre-spill, "baseline" conditions. For each injured resource and service, however, an estimation of the rate of natural recovery will be considered based on the best information available from the damage assessment and restoration studies, the scientific literature and other sources. If it appears that recovery will be nearly complete before the benefits of a restoration study or project can be realized, then the Trustees may determine that spending restoration dollars is not justified. On the other hand, if it appears that the time to recovery is prolonged, it may be worth considering technically feasible, cost-effective restoration options.

[1] "Special-purpose" lands have been designated by the State of Alaska or the United States for the protection and conservation of natural resources and services.

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CHAPTER VI
EVALUATION OF RESTORATION OPTIONS

To aid in determining which of the many restoration alternatives and options are appropriate and most beneficial, objective criteria are needed. The following are proposed for public comment (not in order of priority):

- The effects of any other actual or planned response or restoration actions:

  Are there other actions, such as additional clean-up work, that bear on the recovery of a resource targeted by the restoration option?

- Potential to improve the rate or degree of recovery:

  Will implementation of the restoration option make a difference in the recovery of an injured resource or service? What is the prospect for success?

- Technical feasibility:

  Are the technology and management skills available to successfully implement the restoration option in the environment of the oil-spill area?

- Potential effects of the action on human health and safety:

  Are there hazards to or adverse impacts on humans associated with implementation of the restoration option?

- The relationship of the expected costs of the proposed actions to the expected benefits:

  Do benefits equal or exceed costs? (This is not intended to be a straight cost/benefit analysis, but a broad consideration of the direct and indirect costs [including lost uses] and the primary and secondary benefits associated with implementation of the restoration option.)

- Cost effectiveness:

  Does the restoration option achieve the desired objective at the least cost?

- Consistency with applicable Federal and State laws and policies:

  Is the restoration option consistent with the directives and policies with which the Trustee agencies must comply? Potential conflicts must be resolved prior to implementation.

- Potential for additional injury resulting from proposed actions, including long-term and indirect impacts:

  Will implementation of the restoration option result in additional injury to target or nontarget resources or services? Is the project of net environmental benefit?

- Degree to which the proposed action enhances the resource or service:

  Would the restoration option improve on or create additional natural resources or services?

- Degree to which proposed action benefits more than one resource or service:

  Would the restoration option benefit multiple resources and services, both injured target resources and services, as well as secondary resources and services?

- Importance of starting the project within the next year:

  Would delay in the project result in further injury to a resource or service or would we forego a restoration opportunity?

Further Evaluation of Restoration Options

As an example of the preliminary application of these criteria, some potential restoration activities are presented as options in Appendix B. Following public comment on the Restoration Framework, including any suggestions of additional criteria and options, there will be more detailed evaluations of all potential options. The draft Restoration Plan and draft environmental impact statement will present the results of these evaluations, including restoration alternatives, for further public comment.

Information Review and Evaluation

To develop the draft Restoration Plan and draft environmental impact statement, the restoration planning staff will review existing databases for each injured resource or service. Data relevant to this evaluation may be found in the scientific literature, geographic information systems and the reports of damage assessment and restoration studies. Subject areas include:

- the nature and severity of injury;
- the rate of natural recovery;
- life history requirements;
- factors limiting recovery;
- persistence of contaminants;
- opportunities to accelerate the rate of recovery;
- costs and environmental impacts of accelerating recovery; and
- land status and existing management practices.

For some injured resources and services, much of the above information is in hand; in other cases there are substantial deficiencies in the databases that could impede the evaluation and timely implementation of restoration options. To remedy this, additional field work is being recommended to provide the needed information. Detailed study plans for work considered in 1992 are found in the 1992 Work Plan. These study plans were developed in consultation with scientists representing the Trustee agencies, outside peer reviewers and the Chief Scientist.

Evaluation of Options for Identifying and Protecting Marine and Upland Habitats

All restoration options, including habitat protection and acquisition options, will be evaluated using basic criteria such as those outlined in the first section of this chapter (VI). By necessity, however, there are additional steps needed to properly evaluate habitat protection and acquisition options.

In its draft 1991 Restoration Work Plan (56 Fed Reg. 8902-8903, [March 1, 1991]), the Trustees set forth a preliminary sequence of steps for use in identifying and protecting strategic fish and wildlife habitats and recreation sites. While the Trustees are developing a final process for evaluating habitat protection and acquisition options, they again invite public comment on the steps that were published in the March 1, 1991 Federal Register notice:

1. Identification of key upland habitats that are linked to the recovery of injured resources or services by scientific data or other relevant information.

2. Characterization and evaluation of potential impacts from changed land use in relation to their effects on recovery of the ecosystem and its components; comparative evaluation of recovery strategies not involving acquisition of property rights (e.g., redesignation of land use classification), including an assessment of protection afforded by existing law, regulations and other alternatives.

3. Evaluation of cost-effective strategies to achieve restoration objectives for key upland habitats, identified through steps one and two above. This would include evaluation of other restoration alternatives for these resource injuries.

4. Willing seller/buyer negotiations with private landowners for property rights.

5. Incorporation of acquired property rights into public management.

Recovery Monitoring

In 1991 the Restoration Planning Work Group began to develop an integrated long-term monitoring strategy to assess the recovery of injured natural resources in the oil-spill area. Development of a monitoring plan requires the identification of goals and objectives and then technical designs and costs for monitoring target resources and services. If the Trustees implement a program of this type, it would determine if and when injured resources have been restored to their pre-spill baseline conditions. The program also could monitor the effectiveness of restoration activities, detect latent injuries and reveal long-term trends in the environmental health of ecosystems affected by the oil spill. The duration of the monitoring program would depend on the severity and duration of effects resulting from the spill and the time necessary to establish a trend for recovery.

Some limited monitoring studies are proposed to be conducted in the field in 1992 (see draft 1992 Work Plan). At the same time, efforts will continue to develop a comprehensive and integrated monitoring program as part of the draft Restoration Plan.

CHAPTER VII
SCOPE OF POTENTIAL RESTORATION ALTERNATIVES

The restoration-related activities conducted by the Trustees and the Environmental Protection Agency to date have involved the public, technical experts and resource managers from agencies in Alaska (See Chapters I and III). Through these preliminary scoping efforts, a broad array of ideas for restoration activities has been suggested. The ideas listed in Restoration Planning Following the *Exxon Valdez* Oil Spill: 1990 Progress Report (Chapters II and VI) were evaluated by the planning staff using the criteria outlined in Chapter VI of this document. The results of this evaluation, which incorporate what has been learned from the damage assessment and restoration studies, are presented as restoration options in Appendix B.

The draft Restoration Plan and draft environmental impact statement will contain a more detailed presentation of restoration alternatives and options after further technical review and consideration of the public comments received on this framework document. The restoration options presented in Appendix B will be considered by the Trustees in developing restoration alternatives, which will be presented for public comment.

Possible Restoration Alternatives

Paragraphs A-F identify possible conceptual restoration alternatives. These alternatives are provided for discussion purposes only and do not indicate any preference by the Trustees.

A. No Action

A possible alternative that will be addressed in the draft environmental impact statement is for the Trustees to rely upon the natural recovery process to restore the ecosystem. Monitoring would assess whether natural recovery is proceeding as anticipated.

B. Management of Human Uses

This alternative uses Federal and State management authorities (statutes and regulations) to modify human uses of resources or habitats. The goal is to reduce mortality or stress on injured resources and thereby to accelerate their recovery.

Examples:

- restrict or eliminate legal harvests of marine and terrestrial mammals and sea ducks (Option 8, Appendix B); and

- intensify management of fish and shellfish (Option 2).

C. Manipulation of Resources

This alternative includes measures taken directly, usually on-site, to rehabilitate or replace an injured species population, restore a damaged habitat or enhance services provided by a damaged resource.

Examples:

- improve or supplement stream and lake habitats for spawning and rearing of wild salmonids (Option 11); and

- accelerate recovery of upper intertidal *Fucus* zone (Option 14).

D. Habitat Protection and Acquisition

This alternative includes changes in management practices on public or private lands and creation of "protected" areas on existing public lands in order to prevent further damage to resources injured by the *Exxon Valdez* oil spill. Going beyond land management practices, there also are options that involve the acquisition of damaged habitats or property rights short of title by public agencies to protect strategic wildlife, fisheries habitat or recreation sites.

Examples:

- designate protected marine habitats (Option 22); and

- acquire additional marine bird habitats (Option 23).

E. Acquisition of Equivalent Resources.

"Acquisition of equivalent resources means to compensate for an injured, lost, or destroyed resource by substituting another resource that provides the same or substantially similar services as the injured resource" (56 Federal Register 8899 [March 1, 1991]). Restoration approaches, such as the manipulation of resources and habitat protection and acquisition, can be implemented on an equivalent-resource basis.

Another possible alternative, therefore, would be to place primary emphasis upon the acquisition of equivalent resources as opposed to options that attempt to directly restore or rehabilitate specific injured resources or services.

Examples:

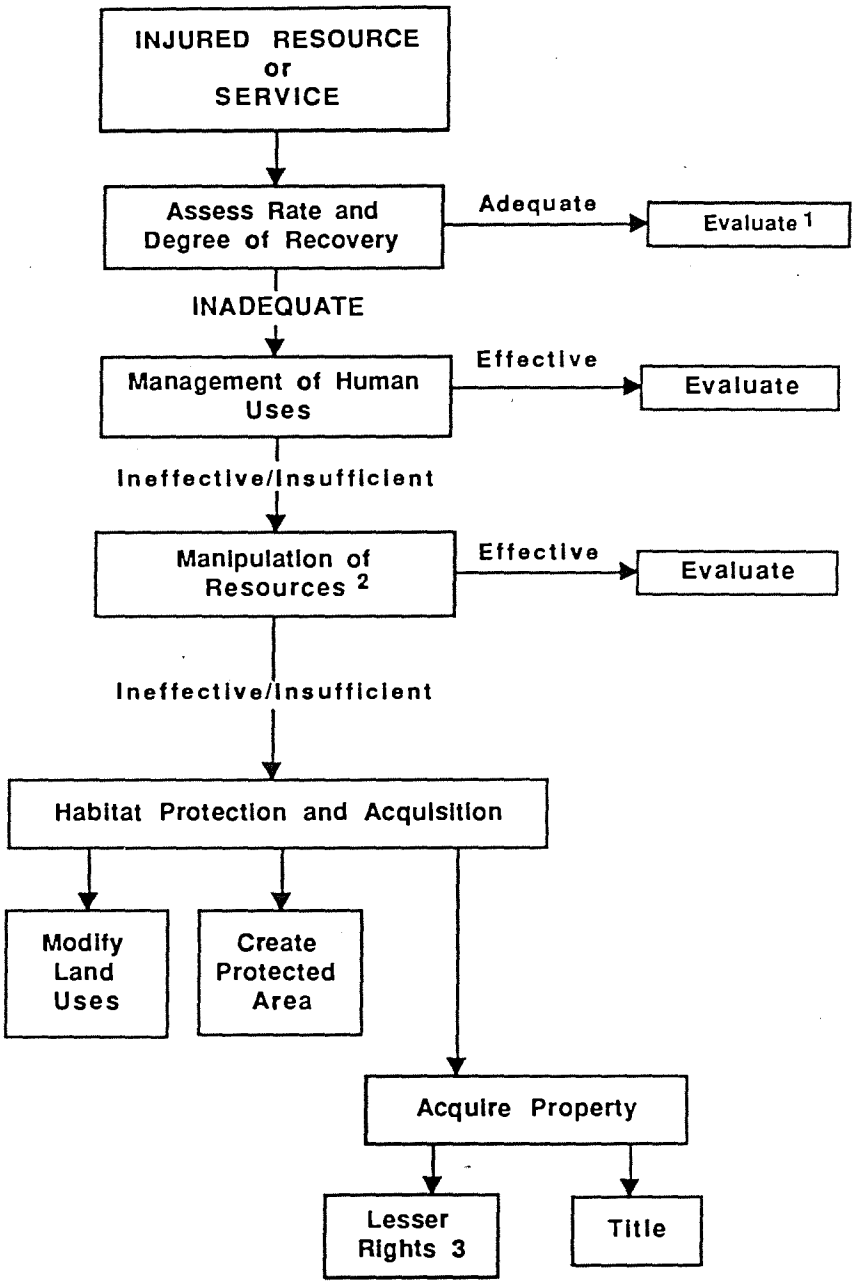
- creation of new recreation facilities (Option 12); and
- acquire tidelands (Option 21).

F. Combination Alternatives

Each of the alternatives above, A-E, may be considered strictly in its own right, or mixed in any number of ways, depending on priorities and methods. For example, Figure 6 depicts a hierarchical analysis, through which the Trustees could consider "habitat protection and acquisition" options only after considering whether options under "management of human uses" and "manipulation of resources" were inadequate. In the analysis illustrated in Figure 7, the Trustees would give equal weight to all approaches, proceeding to those restoration options deemed most desirable based on professional and scientific judgment and public comments.

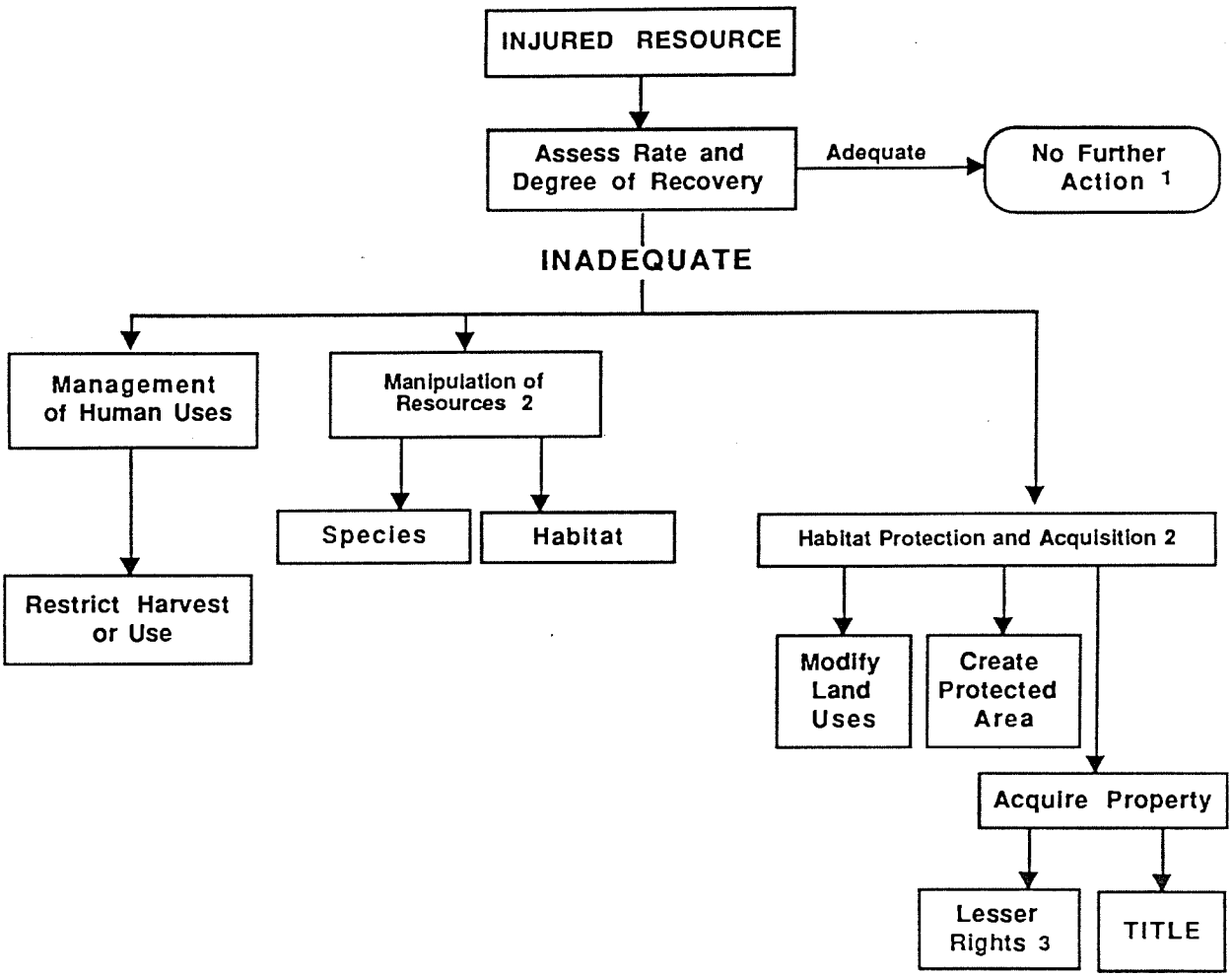
The Trustees seek comment about the likely feasibility and efficacy of these possible restoration alternatives, and any other alternatives and approaches that should be considered in a draft environmental impact statement.

Figure 6. Possible conceptual approach to the analysis of restoration options. This approach considers options in an hierarchical fashion.



1 All restoration actions will be evaluated to assess their effectiveness on the recovery rate of the target injured resource.
2 These approaches can be implemented on a direct-restoration or equivalent-resource basis.
3 Acquisition of full title or lesser rights exclusive of full ownership of title (partial interests), e.g., conservation easement, timber rights, access rights, etc.

Figure 7. Possible conceptual approach to the analysis of restoration options. This approach does not involve an hierarchical analysis of restoration options.



1 All restoration actions will be evaluated to assess their effectiveness on the recovery rate of the target injured resource.
2 These approaches can be implemented on a direct-restoration or equivalent-resource basis.
3 Acquisition of full title or lesser rights exclusive of fullownership of title (partial interests), e.g., conservation easement, timber rights, access rights, etc.

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APPENDIX A

BACKGROUND ON INJURED RESOURCES AND SERVICES

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APPENDIX A
BACKGROUND ON INJURED RESOURCES AND SERVICES

The success of developing and implementing restoration options depends, in large measure, on our understanding of the injured resources and services. This appendix provides a summary of the basic life history traits of the injured species and the characteristics and values of other injured or lost resources and services. This information provides a basis to better understand and evaluate the restoration options and alternatives (Chapter VI and Appendix B).

Life History Summaries

Many of the species affected by the *Exxon Valdez* oil spill have not been extensively studied, especially in subarctic environments. Each species has developed a unique set of characteristics enabling it to survive in its environment. Biologically informed decisions will decrease the chances of causing additional injury and increase the probability of successfully restoring populations. The following life histories are included:

- sea otter
- harbor seal
- brown bear
- river otter
- killer whale
- common murre
- harlequin duck
- black oystercatcher
- marbled murrelet
- pigeon guillemot
- bald eagle
- coastal cutthroat trout
- pink salmon
- sockeye salmon
- pacific herring
- rockfish
- Dolly Varden
- spot shrimp

Sea Otter (*Enhydra lutris*)

Range

Sea otters presently occur in the coastal waters of central California throughout the southern coast of Alaska from Southeast to the Aleutian Islands. The range extends to the Kamchatka Peninsula and south to Japan. Sea otter habitat is found throughout the oil-spill area.

Reproduction

Male sea otters reach sexual maturity at 5-7 years of age; females are capable of breeding at 4-5 years of age and possibly younger. Mating and pupping occur throughout the year, although in Prince William Sound most otters mate in September-October with pups born from May-June. They are capable of reproducing annually, although the reproductive period varies among individuals and areas. Sea otters give birth to a single pup, rarely twins. Pups are generally weaned by mid-November.

Habitat Use and Requirements

Sea otters prefer shallow coastal waters that are generally less than 40 meters deep, with soft substrates as well as rocky substrates. Sea otters will use kelp beds as resting areas, but their geographic distribution is not dependent on kelp. Intertidal rocks, exposed beaches and algal covered rocks are used by some otters for resting. The importance of haul-out sites is poorly understood. They are not considered essential to otter survival in California, but may be very important for otters in northern climates. Males and females tend to segregate except during breeding. Immature and non-breeding males often congregate in large groups. Resident males defend territories during the breeding season. Protected waters on lee shorelines are often used by sea otters during storms.

Food Habits

Sea otters eat a wide variety of prey, and can greatly influence prey availability. They prefer benthic invertebrates, but in some areas they prey heavily on benthic fishes. In Prince William Sound, clams, mussels and crabs are the dominant prey. There is a lot of variation in individual diets. Females with pups tend to forage in shallower areas where smaller mussels and clams are available in short dives from the surface.

Human Interactions

By the late 1800s, sea otters were eliminated from most of their historic range due to excessive fur harvesting by the Russian and American fleets. In 1911, commercial sea otter harvesting was stopped and the remnant populations began to expand. The Marine Mammal Protection Act of 1972 placed a moratorium on harvesting marine mammals, including sea otters. An exemption for Alaska

Natives allows take for subsistence purposes.

References

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Harbor Seal (*Phoca vitulina richardsi*)

Range

Harbor seals are found in coastal waters of the North Pacific Ocean from northern Mexico to Alaska as far north as the Bering Sea. In the western Pacific they occur from Japan to Siberia.

Reproduction

Males and females become sexually mature when they are 3-7 years old. Breeding occurs from late June through July. Harbor seals have a delayed implantation of about 11 weeks, with an actual gestation period of about 225 days. Pups are born between late May and mid-July. Usually a single pup is born. Pups are generally nursed for 3-6 weeks. Sexually mature adults breed annually.

Habitat Use and Requirements

Harbor seals usually occupy coastal waters less than 60 meters deep. Seasonally, they may enter coastal rivers and lakes. They have been recorded as far as 100 kilometers away from the coast. Haul-out areas are especially important for harbor seals. Rocks, isolated beaches with protective cliffs, ice floes, and sand or mud bars are used for resting, pupping and nursing young. Haul-out sites are especially important during the molt, which occurs throughout the summer from June-October, but peaks in late July-September.

Harbor seals have been declining in much of Alaska for unknown reasons since about the mid-1970s.

Food Web Interrelationships

Harbor seals are opportunistic predators and consume a wide variety of fish and invertebrates. Walleye pollock, herring, salmon, eulachon and cephalopods are important prey for seals in the Gulf of Alaska.

Predation - Killer whales, sharks and steller sea lions are known predators. Predation combined with other causes of mortality (disease, starvation, entanglement and hunting) kill about 75 percent of all harbor seals in their first three years of life.

Human Interactions

The Marine Mammal Protection Act of 1972 placed a moratorium on harvesting marine mammals, including harbor seals. An exemption for Alaska Natives allows take for subsistence. Harbor seals are harvested by numerous Alaska villages, but the magnitude of the subsistence harvest is not known. Conflicts with commercial fishermen, competition with humans for food, and disturbance

from haul-out sites pose the greatest threats to harbor seals. Seals are especially vulnerable to disturbance during the molt and during pupping, when a separation may cause the mother-pup bond to weaken resulting in the death of the pup.

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Alaska Department of Fish and Game. 1985. Harbor seal life history and habitat requirements Southwest and Southcentral regions. pages 55-61 *in* Alaska habitat management guide. Life histories and habitat requirements of fish and wildlife. Alaska Dept. Fish Game, Juneau, AK 429 pp.

Pitcher, K.W. 1980. Food of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. Fishery Bulletin 78:544-549.

Brown Bear (*Ursus arctos*)

Range

Brown bears (grizzly bears) once ranged from the Great Plains to northern Alaska. They are still abundant in Alaska and parts of Canada, but they have been eliminated from most of the southern part of their range. They are found throughout Alaska except on some islands in specific regions of the state.

Reproduction

Brown bears reach sexual maturity between 3.5-9.5 years of age. Females typically produce cubs every 3-4 years, but the breeding interval may be longer for some individuals. Mating occurs between May and July, peaking in early June. The gestation period lasts about 6 months and the cubs, usually two, are born in January during hibernation. Survival of cubs to yearlings (1.5 years old) ranges from 45-69 percent, depending on location. Cubs generally remain with their mother for 2.5 years.

Habitat Use

Bears inhabiting coastal habitats in southcentral/southwest Alaska tend to have home ranges of approximately 32 km^2 for females and 170 km^2 for males. These home ranges cover a wide variety of habitat types, supply food throughout the year and provide denning sites in winter. In the spring, the bears often search the coastline for food. In summer, anadromous fish streams provide important food sources for the bears and many bears may be found congregated together at streams with exceptionally large salmon runs (e.g., in Katmai National Park). In late summer and fall, upland sites with abundant berries are used in addition to salmon streams. Dens are generally located on well drained moderately sloping mountain sides, leeward of the prevailing winds. Dens are seldom used in consecutive years. Brown bears enter their dens in late October and November and emerge between early April and late May.

Food Habits

Brown bears are omnivores. They eat a wide variety of plants including roots and berries of some species and eat sedges and grasses in wetlands. During the spring, brown bears often prey upon young moose, deer and caribou. They feed on clams and mussels in the intertidal zone and scavenge the beaches for dead marine mammals. They are capable of killing adult ungulates. Spawning salmon also provide an important component of their diets.

Human Interactions

Brown/grizzly bears are harvested throughout their range on a limited basis. Habitat alterations and human disturbance near food sources can impact local

populations.

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River Otter (*Lutra canadensis*)

Range

Historically, river otters were found throughout North America with the exception of the arid southwest. In Alaska they are found in all areas except the Aleutian Islands, the off-shore islands of the Bering Sea, and the Arctic coast east of Point Lay. Their Alaskan distribution remains unchanged, although they are no longer found in parts of their original range in the contiguous United States.

Reproduction

River otters reach sexual maturity in 2-3 years, although males are usually unsuccessful breeders until they are 5-7 years old. Mating occurs in early spring with adult females breeding shortly after giving birth. Otters have delayed implantation with an actual gestation period of 60-63 days. Most births in Alaska occur in May. Litter size varies from 1-6, but litters of 2 to 3 are most common. Pups remain in the den for about 2 months before accompanying the mother in daily activities. Family groups often include one or more females who help with training the new pups. These females are probably offspring of the mother's previous litters. Male pups probably leave the family group at about 1 year of age. Otters can breed annually once they become mature and they may live to be 20 years old.

Habitat Use

In coastal Alaska, river otters tend to have elongated home ranges which follow the coastline. Rocky shorelines of small inlets and coves are preferred. Ranges of males may overlap with females, but otters generally avoid contact except during the breeding season. Riparian vegetation along the coast and inland by streams and lakes are important areas for otters. These sites provide resting and denning places, as well as protective cover for traveling. Den sites are located in natural cavities in old-growth forests or in rock cavities, or in burrows or lodges of other animals. Latrine sites are established along the shoreline in areas of old growth forest and adjacent to suitable feeding areas. These sites are used as resting areas as otters travel along their home ranges. Home ranges vary with the quality of habitat. Ranges reported for southeastern Alaska varied from 7 to 40 kilometers. Family groups have smaller ranges than adult males.

Food Habits

River otters in coastal Alaska feed primarily in intertidal and shallow subtidal areas, but they also feed in fresh water streams and lakes if fish are available. Boney fish are the most important part of their diet but crusteans and molluscs are also important. In British Columbia, surfperch, sculpin, flounder, rockfish and greenling were the primary prey of coastal otters.

Human Interactions

River otters are trapped for their fur.

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Killer Whale *(Orcinus orca)*

Range

Killer whales have been documented in all the oceans of the world. They appear to be abundant in the coastal waters from Washington through the Gulf of Alaska.

Reproduction

Killer whales are a long-lived species with lifespan estimates ranging from 25-40 years. Females reach sexual maturity when they reach about 5 meters in length (approximately 15 years old). They give birth to a single calf after an estimated gestation period of 17 months. Cows will nurse their calves for 12 months and provide additional care for 2 years or longer. The interval between calves varies among individuals with a mean of about 5 years (range 2-12).

Social Structure and Habitat Use

Killer whales live in social groups called pods. Pods usually consist of less than 40 animals. There are two types of pods. Transient pods do not occupy a defined home range. They move in and out of areas occupied by resident pods and may cover great distances throughout the year. Resident pods have home ranges which may encompass several hundred square miles. In resident pods the whales form matrilineal subgroups. The matrilineal group consists of a female and her offspring. New matrilineal groups may form as a female calf matures and produces her own offspring, but the group remains within the original pod. Matrilineal groups of the same pod interact with each other on a regular basis.

Food Habits

Killer whales are opportunistic predators. Fish are the primary food source for whales in resident pods, but marine mammals and birds are also prey. Salmon, cod, Pacific herring, flatfish, blackcod, squid, pinnipeds and other cetaceans have all been documented as food sources for killer whales. Transient pods may prey on marine mammals more than do whales in resident pods.

Human Interactions

The Marine Mammal Protection Act of 1972 placed a moratorium on harvesting marine mammals, including killer whales. Some whales are still shot, and sometimes killed, by fishermen. Their striking appearance have made them an attraction for tourist industries.

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Common Murre (*Uria aalge inornata*)

Range

The species has a holarctic distribution primarily south of the Arctic Circle. The subspecies *U. a. inornata* is found from Oregon to Point Hope, Alaska.

Migration

Murres winter in offshore waters before returning to their nesting colonies in the spring.

Breeding Chronology

Murres arrive at nesting colonies in April and May. A single egg is laid in June and incubated by both adults for 28-34 days. Hatching occurs between July 10 and early August. Chicks fledge to the ocean in August. Little is known about the behavior of fledged chicks and subadults. Common murres do not breed until they are 5 years old or older, and subadults do not return to visit the colonies until they are 2-3 years old.

Breeding Behavior

The breeding success of common murres is dependent on the physical characteristics of the colony site, which typically is on a cliff face, and the density of murres nesting on each ledge. Since murres do not build nests, the slope of the nesting ledge is important to prevent the eggs from rolling off the cliff. The width of the ledge influences the number of birds that can nest and therefore, their vulnerability to predation. High nesting densities (greater than 10 birds per meter^2) have the greatest breeding success. Higher densities help to synchronize breeding behavior so that eggs are laid over a short period of time and chicks hatch and fledge together. This increases the ability of the murres to protect their young from predators. Most murres return to the same ledge to breed each year.

Food Web Interrelationships

Common murres eat a variety of fish and shrimp. Primary species include capelin, sand lance, walleye pollock and euphausiids.

Predation - Predatory birds, particularly gulls and bald eagles, can have a significant impact on the breeding success of the colonies. Low nesting densities of murres, chicks which hatch and fledge later than their neighbors, and eggs or chicks exposed when the adults are disturbed from the ledges are especially vulnerable.

Human Interaction

Entanglement in fishing nets does not appear to be a problem for murre colonies within the *Exxon Valdez* oil spill area. Fishing and tourism activities which disturb the murres at their nesting ledges can exacerbate predation. Subsistence harvest of the eggs and murres is not common within the oil-spill area.

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Harlequin Duck (*Histrionicus histrionicus*)

Range

In North America, the western population is found from the Seward Peninsula and the Alaska Range, throughout the Aleutian Islands and south to central California and the northern Rocky Mountains.

Migration

In Alaska, harlequin ducks begin arriving on their wintering grounds in the Aleutian Islands and in the Gulf of Alaska in mid to late September. Adults begin congregating at the mouths of suitable breeding streams in May.

Breeding Chronology

Harlequins do not breed until their second year. Egg laying begins between May 20 and June 10. Three to 7 eggs are incubated by the female for 28-30 days. The males leave the females early in the incubation period and begin congregating for the molt. Hatching occurs from early to mid-July. Females with broods remain in freshwater streams until August when they migrate to marine habitats. Adults breed annually after reaching maturity.

Habitat Use

Paired harlequins congregate at the mouths of anadromous fish streams in May. The pairs fly inland to search for nesting sites but return to estuaries to feed. Typically nests are located along shallow rivers and streams with gravel or rocky substrates, and nest sites are located under dense vegetation on steep banks in mature forests. Harlequins may return to the same nest site in consecutive years. Slow stretches on lee sides of stream bends are used by broods for feeding and resting. Turbulent stretches of streams are preferred feeding places for adults in freshwater. Shallow coastal areas and intertidal reaches are used by non-breeders and males during the summer and by molting females in late summer. Wintering harlequins forage in small groups along exposed coasts and in bays.

Food Web Interrelationships

Breeding birds and broods feed mostly on aquatic invertebrates and larvae. When available, salmon roe may be an important food source for harlequins in Alaska. Wintering harlequins feed predominately on molluscs and crustaceans.

Human Interactions

Harlequin ducks can be legally harvested each fall. Disturbance to molting flocks may stress individuals, and both disturbance and loss of nesting habitat can affect populations.

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Black Oystercatcher (*Haematopus bachmani*)

Range

Inhabits coastal areas from the Aleutian Islands to Baja California.

Migration

Black oystercatchers are generally believed to be year-round residents at their breeding areas. Observations from Alaska, however, indicate that some birds may disperse in the winter.

Breeding Chronology

Nest scrapes are built on rock outcroppings and gravel beaches, and are sometimes lined with broken shells. One to 3 eggs are laid and incubated by both adults for 24-29 days. Eggs are laid from mid-May to early July; second clutches may be laid if the first clutch is destroyed. Although the chicks are precocious, they are fed by the adults. Feeding can continue even after the chicks have fledged. Survivorship of chicks to fledging can be very low, less than 20 percent. They are particularly vulnerable to predation in the first week after hatching. Chicks are capable of flying in about 40 days. Oystercatchers might take 2 or 3 years to reach sexual maturity.

Habitat Use

Oystercatchers occupy rocky and gravelly coastal areas. The highest breeding densities occur on low elevation, gravel shorelines, with little wave action. The eggs and young are cryptically colored and rely on camouflage to protect them from predators. Adults feed in the intertidal zone. During the first week after hatching, chicks remain near the nest site and adults bring food from the intertidal zone. After the first week, chicks follow the adults to the intertidal zone at low tide.

Food Web Interrelationships

Black oystercatchers feed primarily on intertidal invertebrates. Mussels and limpets are the primary prey species, but they also eat clams and chitons.

Predation - Flightless chicks are vulnerable to predation, especially in the first week after hatching. During this time the adults brood the chicks and their movements may alert predators to the location of the chicks. Young chicks react by freezing whereas older chicks will run from predators. Gulls, ravens, mink and river otters are known predators.

Human Interactions

Black oystercatchers are not harvested. Destruction of or disturbance at nesting habitats can adversely impact local populations.

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Marbled Murrelet (*Brachyramphus marmoratus*)

Range

North Pacific Coast, from central California to the Aleutian Islands, and from the Kamchatka Peninsula to northern Japan.

Migration

Marbled murrelets return to coastal waters near breeding areas each spring. The dates are variable, usually occurring in Alaska from April to May. The adults and fledged young leave the breeding areas in the fall for unidentified wintering areas. Between 10-25 percent of the summer breeding population of Prince William Sound remain throughout the winter and probably concentrate in protected bays and straits during storms.

Breeding Chronology

Documented evidence of breeding chronology is based primarily on follicle development of collected birds, documented nests and movements of breeding adults. These data suggest that laying can occur as early as late April in the southern part of their range. Egg laying in the Gulf of Alaska probably occurs in late May or June. Marbled murrelets lay a single egg that is incubated by both adults for about 30 days. Fledged chicks begin to appear with the adults on coastal waters from mid-July to early August. Adult survivorship, life span, reproductive period and age at first breeding are unknown.

Habitat Use and Requirements

During the breeding season, marbled murrelets make crepuscular (twilight) flights between inland and coastal areas. Searches for marbled murrelet nests were unsuccessful until 1974. A total of 23 tree nests have been discovered in North America. Current data suggest that most marbled murrelets nest in mature forests. Most of the nests have been located in large conifers, but ground nests also have been recorded. Marbled murrelets are solitary nesters, and have been located as far as 40-50 kilometers from the coast. Marbled murrelets feed in coastal waters, and occasionally in large lakes. They have been known to dive to a depth of 50 meters.

Food Web Interrelationships

Marbled murrelets eat small fishes and crustaceans. Important species within the Gulf of Alaska and Cook Inlet include capelin, cod, sand lance and a variety of shrimp.

Human Interactions

In 1990 marbled murrelets were the most commonly caught seabird in salmon gillnets in the Prince William Sound Copper River flats drift fishery. Although the number caught represent a very small proportion of the population, these incidental catches may have local significance. The loss of nesting habitat due to logging or development of mature forests could also affect murrelet populations. Population declines over the southern portion of their range have caused the species to be considered for listing under the Federal Endangered Species Act as "threatened" in the Pacific Northwest. The species is already listed as "endangered" in California under State law.

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Pigeon Guillemot (*Cepphus columba*)

Range

Pigeon guillemots are found along the north Pacific coast from southern California to the Bering Sea and Aleutian Islands in Alaska. They are also found from the Chukchi Sea to northern Japan.

Migration

Migration patterns are largely unknown in Alaska. They arrive at breeding areas in late April and early May, and depart from Prince William Sound for wintering grounds in late August. Some guillemots remain in the Sound throughout the winter.

Breeding Chronology

In Prince William Sound, pigeon guillemots have been documented on their breeding areas in late April and the peak of egg laying occurs in June. Clutches normally consist of two eggs which are laid 3 days apart. Eggs are incubated for 30-32 days by both adults. Chicks hatch between late June and late July. Fledging occurs approximately 38 days after hatching. Pigeon guillemots probably do not begin breeding until they are 3-5 years of age.

Habitat Use and Requirements

Guillemot nests are usually located in natural cavities beneath boulders at the base of cliffs, in talus slopes, or in rock or soil cavities at the tops of cliffs. They are also known to nest in abandoned puffin burrows, and are probably the only alcid known to regularly use man-made structures (e.g., docks and bridges) for nesting. Guillemots typically nest in small colonies of a few to 50 pairs; some pairs nest solitarily. At some locations adequate nest sites probably determine the breeding bird density, but they do not appear limiting in Prince William Sound. The adults use the supratidal and intertidal areas in front of the nest sites for social activities (e.g., pair-bond maintenance) and feeding throughout the breeding season.

Pigeon guillemots feed in nearshore waters, generally no more than a few kilometers from land. During the breeding season they tend to feed near their colony, and individuals are often site specific. During winter most of the population leaves for unknown waters. In Prince William Sound an estimated 27-43 percent of the summer population were present in March.

Food Habits

This species has a generalist feeding behavior, consuming a variety of fish and shellfish. Capelin, sand lance, Pacific sandfish, sculpin and herring are some of the more important species, as well as shrimp and small crabs. Dietary preference can vary significantly between individuals.

Human Interactions

Because of their nearshore foraging habits and small, stable colonies, pigeon guillemots are considered a good indicator species for the nearshore marine environment.

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Bald Eagle (*Haliaeetus leucocephalus*)

Range

Bald eagles are found from Alaska and Canada to the northern edge of Mexico. Within Alaska, they are most numerous in the southern coastal regions.

Migration

Eagles in coastal Alaska winter near their nesting territories. Interior nesting birds may move to large open rivers or the ocean. Most will wander during the late fall and early winter in search of prey, such as late spawning salmon.

Reproduction

Adults do not overwinter near their nesting sites that return to the same nesting territory each year. Nests are usually used for more than one breeding season. In high density nesting areas, defended territories are approximately 1 linear mile of coastline, but not all nests will be active or successful. Egg laying begins in early April when the female lays 1-3 eggs with two being the most common clutch size. Incubation lasts about 34 days. In late August, or about 75 days after hatching, the fully feathered young are ready to leave the nest. Fifty percent nest failure is not uncommon. Few eagles successfully fledge their young, and even though the adults continue to feed them for several weeks, survival after fledging is low. Bald eagles become sexually mature when they are 6 years old or older.

Habitat Use

Bald eagles in Alaska nest along lakes, rivers and the coast. Along the coast, nests are usually located in the older, larger trees. Coastal areas with more than one nest per mile are considered to be good nesting areas. This high-nest density is associated with undisturbed habitat, a clean environment, abundant food resources and minimal human disturbance. Bald eagles have few predators other than humans.

Food Habits

Fish are the primary prey of bald eagles, but they will also feed on waterfowl, carrion, sea birds and even on garbage at landfills. Winter and spring can be the critical periods for bald eagles. During the late fall and early winter, eagles will often be seen feeding along rivers where they have access to spawning and dead salmon. During spring they feed on eulachon, spawning herring and sand lance.

Human Interaction

A bounty for bald eagles was in effect in Alaska from 1917 to 1953. With statehood in 1959, bald eagles in Alaska received federal protection under the Bald Eagle Protection Act of 1940. This Act prohibits harming or harassment of

eagles. Land management agencies have included additional restrictions on activity near nest sites which has further helped the stability of populations. For example, the Chugach National Forest currently requires a 330 feet buffer zone around any bald eagle nest tree, with an additional 330 feet of restricted activity; the U.S. Fish and Wildlife Service proposes extending restrictions to 990 feet from bald eagle nests.

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Coastal Cutthroat Trout (*Onchorhynchus clarki*)

Range

California to Prince William Sound, Alaska

Migration

Smolts and adults migrate to sea between March and July. The time spent at sea varies from 12 to 150 days. While at sea cutthroat trout travel along shorelines rarely migrating farther than 70 kilometers from their natal streams. Adults return to freshwater lakes to overwinter and then migrate to their natal streams to spawn in the spring.

Reproductive Period

Sexual maturity is reached at 2-3 years for males and between 3-6 years for females.

Spawning/Hatching

Spawning takes place from February to May depending on location; hatching occurs 6 to 7 weeks after spawning.

Survival/Life Span

Cutthroat trout have a relatively high rate of survival for adults. Survival rates between spawning migrations were 39 percent from first to second spawning migrations, 17 percent between second and third, and 11 percent from third to fourth.

Habitat Use and Requirements

Adults - In marine environments cutthroat inhabit inshore areas foraging along gravel beaches, mouths of creeks and in eelgrass beds. Adults return to freshwater lakes to overwinter, and then spawn in small coastal streams or small tributaries to coastal streams and rivers.

Fry and Juveniles - Young-of-the-year cutthroat inhabit low-velocity margins, backwaters and side channels adjacent to main channel pools and riffles. They tend to stay close to where they were spawned. Older juveniles have a greater range of movement within their natal stream.

Food Web Interrelationships

Adults - Adults in marine waters feed on a variety of small fish and shrimp.

Fry and Juveniles - Fry feed primarily on insects and crustaceans. Larger

sized juveniles prey on small sticklebacks and salmon.

Predation - In marine waters cutthroat may be preyed upon by Pacific hake, spiny dogfish, harbor seals and adult salmon.

Human Interactions

Cutthroat trout are not fished commercially in Alaska. They are a highly prized sport fish and are susceptible to overharvest due to small stock sizes. Anadromous cutthroat populations have declined during the past 15-20 years. Reasons cited for these declines include loss of stream habitat due to logging activities and increased urbanization.

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Pink Salmon (*Oncorhynchus gorbuscha*)

Range

Pacific Ocean north of 40° N Latitude.

Migration

Fry emerge from streams from late March through June and rapidly move to feeding areas in nearshore migratory corridors. After about 8 weeks, fry move to offshore waters where they mature for 12-15 months before returning to natal streams to spawn.

Reproductive Period

Mature at 2 years. Adults die after spawning.

Spawning/Hatching

Spawning occurs from June to mid-September; hatching occurs in October - January.

Survival/Life Span

Typical egg to fry survival is 5-10 percent; fry to adult survival is from 2-5 percent. The life cycle is complete in 2 years.

Habitat Use and Requirements

Adults - Migrate to the high seas where they mature. Adult pink salmon return to natal streams to spawn and some travel considerable distances upstream. However, in Prince William Sound as much as 75 percent may spawn in the intertidal zone. Spawning redds (egg nests) are mostly built in riffles with gravelly substrates and water velocity of 35-45 centimeters per second. All adults die after spawning.

Fry and Juveniles - Fry spend very little time in freshwater; they migrate to nearshore marine waters soon after emerging. When they reach approximately 7 centimeters in length, in approximately 8 weeks, they migrate to offshore waters. Virtually all fry in Prince William Sound migrate and feed along the western shore of the sound.

Food Web Interrelationships

Adults - Primary prey include euphausiids, squid and other invertebrates and small fishes.

Fry and Juveniles - In nearshore nursery areas, fry feed on copepods and other

zooplankton. Juveniles eat larger invertebrates and small fishes.

Predation - Eggs, alevins and fry are eaten by cutthroat trout, Dolly Varden, coho salmon, other fishes and aquatic birds. Juvenile and adult salmon in offshore areas are consumed by a variety of predatory birds, marine mammals, and predatory fishes including other salmon. Bears, otters, other mammalian and avian predators eat spawning salmon.

Human Interactions

Wild and hatchery pink salmon are the basis for multi-million dollar fisheries and often occur together in mixed stock harvests. Hatchery runs established to augment natural production and enhance fisheries can sustain a higher harvest rate, and may pose a threat to important wild pink salmon populations if stock-specific management practices are not implemented to protect wild stocks.

References

Alaska Department of Fish and Game. 1985. Pink salmon life history and habitat requirements Southwest and Southcentral, Arctic, Western and Interior regions. pages 519-536 *in* Alaska habitat management guide. Life histories and habitat requirements of fish and wildlife. Alaska Department Fish Game, Juneau, AK 429 pp.

Emmett, R.L., S.L. Stone, S.A. Hinton, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries, Volume II: species life history summaries. ELMR Report No. 8. National Oceanic and Atmospheric Administration/NOS Strategic Environmental Assessments Division, Rockville, MD, 329 pp.

Pauley, G.P., K. Oshima, K.L. Bowers, and G.L. Thomas. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) -- Pink salmon. U.S. Fish and Wildlife Service Biological Report. 82(11.26). U.S. Army Corps of Engineers TR EL-82-4. 18 pp.

Sockeye Salmon (*Oncorhynchus nerka*)

Range

Sockeye salmon occur from northern California to Point Hope, Alaska. They are also found from northeastern Siberia to northern Japan.

Migration

Smolts outmigrate in late spring or early summer, usually after spending 1-2 years in freshwater. For the first few months smolts rear in nearshore marine areas, and by early winter they begin feeding in offshore areas such as the Gulf of Alaska. The fish remain offshore until returning to their natal streams between May and September.

Reproductive Period

They commonly mature in their fifth or sixth year of life, and they die after spawning.

Spawning/Hatching

Spawning typically occurs between July and October. Hatching occurs in mid-winter to early spring with fry emerging from April to June.

Habitat Use and Requirements

Adults - Migrate to offshore waters to feed for 2-3 years before returning to their natal streams to spawn. They spawn on lake shoals and in rivers and streams with lakes or slow moving reaches as part of the system. Spawning occurs over small to medium-sized gravels with good water flow. The adults die after spawning, and their carcasses contribute to the nutrient level of the system.

Juveniles - Soon after emerging from the redds (egg nests), young sockeye migrate to lakes or slow flowing reaches of streams. For the first few weeks they reside in shallow water at the lake edge. They then move to deeper water where they feed in schools in the upper 20 meters of the lake at night. They remain in freshwater for 1-2 years before outmigrating to coastal waters as smolt. For the first 6 months in marine waters, they are found within 50 kilometers of the shoreline.

Food Web Interrelationships

Adults - Euphausiids, amphipods, copepods and young fishes are the primary prey while in the high seas. Adults do not feed once they near freshwater.

Juveniles - In freshwater, young juveniles feed on small insects and insect larvae.

Juveniles in pelagic lake water feed on zooplankton. After migrating to saltwater the smolts feed on a variety of small crustaceans, plankton and fish larvae.

Predation - Predatory fishes and marine mammals prey upon sockeye salmon in saltwater. Bears and gulls are the primary predators of spawning adults. Juveniles are preyed upon by other anadromous fish species including Dolly Varden and rainbow trout. Juveniles are also an important prey species of some bird species.

Human Interaction

Sockeye salmon are recreationally and commercially harvested. They receive the highest market price of any salmon species and support multi-million dollar fisheries in Alaska.

References

Alaska Department of Fish and Game. 1985. Sockeye salmon life history and habitat requirements Southwest and Southcentral, Arctic, Western and Interior regions. pages 537-553 *in* Alaska habitat management guide. Life histories and habitat requirements of fish and wildlife. Alaska Department Fish Game, Juneau, AK. 429 pp.

Emmett, R.L., S.L. Stone, S.A. Hinton, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries, Volume II: species life history summaries. ELMR Report No. 8. National Oceanic and Atmospheric Administration/NOS Strategic Environmental Assessments Division, Rockville, MD, 329 pp.

Pacific Herring (*Clupea pallasi*)

Range

North Pacific Ocean, from Baja California to the Beaufort Sea and to Japan.

Migration

Migrates from offshore coastal areas to nearshore coastal waters near natal spawning areas in early spring.

Reproductive Period

First breeds between 2-4 years old. Spawns annually.

Spawning/Hatching

Spawn in March - early June in Prince William Sound; hatching occurs 14-25 days after laying depending on water temperatures during incubation.

Survival/Life Span

Egg-to-juvenile mortality is probably over 99 percent; lifespan is up to 19 years.

Habitat Use and Requirements

Adults - Little information is available about the offshore distribution of adults. They are found to depths of 150 meters. Adults return to nearshore waters to spawn in early spring where they remain until moving to nearshore rearing areas to feed. In early fall, the herring move offshore to deeper waters where they remain until spring. Herring spawn in intertidal and subtidal areas. Spawning substrates include kelp, eelgrass, prominent rocks or artificial substrates, such as nets and other debris.

Larvae and Juveniles - Larvae are easily dispersed by local currents. Juveniles probably remain in shallow waters, but may follow food sources to deep water, until they migrate to offshore waters in the fall.

Food Web Interrelationships

Adults - Primary prey include planktonic crustaceans, euphausiids and fish larvae.

Larvae and Juveniles - Larvae eat a variety of zooplankton including crustacean, mollusc and insect larvae, as well as copepods and fish eggs. Juveniles primarily feed on crustaceans, mollusc and fish larvae.

Predation - Herring are an important prey base for a large number of species.

The eggs provide food for a variety of shorebirds, diving birds, gulls, invertebrates and some fish. Larvae are eaten primarily by jellyfish, as well as amphipods, fish and others. Adults are food for larger fish, sharks, seals, sea birds and whales.

Human Interactions

Herring are the basis for a multi-million dollar fishery and a long standing subsistence harvest. In addition, they are an important prey of many species of birds, mammals and other fishes.

References

Emmett, R.L., S.L. Stone, S.A. Hinton, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries, Volume II: species life history summaries. ELMR Report No. 8. National Oceanic and Atmospheric Administration/NOS Strategic Environmental Assessments Division, Rockville, MD, 329 pp.

Pauley, G.P., K. Oshima, K.L. Bowers, and G.L. Thomas. 1988. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) -- Pacific herring. U.S. Fish and Wildlife Service Biological Report. 82(11.26). U.S. Army Corps of Engineers TR EL-82-4. 14 pp.

Rockfish (*Sebastes spp.* and *Sebastolobes spp.*)

There are over 50 different species of rockfish with highly variable life history characteristics. These genera are not well studied and specific information is limited. Yelloweye rockfish (*Sebastes ruberrimus*) is a commercially important species in Alaska and has been used here to illustrate the life history characteristics of rockfish.

Range

Yelloweye rockfish range from Baja California to the Cook Inlet in the Gulf of Alaska.

Migration

Movement and migration patterns are unknown for the species. Seasonal migrations may not exist, though some species move long distances throughout their lifetime. Movement to deeper water is common with size and age.

Reproductive Period

Yelloweye rockfish first breed between 14 and 19 years of age. They breed annually after reaching maturity.

Spawning/Hatching

Rockfish do not lay eggs, but release live planktonic larvae. Yelloweye rockfish release larvae from April through June in southeastern Alaska.

Survival/Life Span

Yelloweye males have reached 103 years of age, and females at 114 have been documented. Males tend to be fewer at older ages.

Habitat Use and Requirements

Very little life history information is available.

Adults - Yelloweye rockfish are found around coastal reefs and were abundant over varied rocky bottoms that included ragged, steep pinnacles and boulder fields at 90-100 meter depths of southeastern Alaska. Depths vary by species, age and size, with depths up to 365 meters recorded. Most yelloweyes are caught at depths of 75-135 meters.

Larvae and Juveniles - Very little is known about these life stages which are highly variable between species. Some are pelagic, some drift with kelp, others quickly become demersal. Some juvenile yelloweye were noted in boulder fields at 90-100 meter depths in southeastern Alaska.

Food Web Interrelationships

Yelloweye rockfish are opportunistic predators. They feed on a variety of crabs, shrimp, snails and fish.

Predation - Small rockfish and rockfish larvae are eaten by other fishes, including larger rockfish.

Human Interactions

Rockfish provide an important secondary fishery in the Gulf of Alaska.

References

Carlson, H. R., and R. R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, *Sebastes* spp. in rocky coastal areas of southeastern Alaska. Marine Fisheries Review 43:13-19.

Hart, J. L. 1973. Pacific fishes of Canada. Fisheries Res. Board of Canada Bulletin. 180. 740 pp.

O'Connell, V. M. and F. C. Funk. 1987. Age and growth of yelloweye rockfish (*Sebastes ruberrimus*) landed in southeastern Alaska. Proceedings International Rockfish Symposium, Anchorage, AK. October 1986. Alaska Sea Grant Report 87-2:171-186.

O'Connell, V. M., B. E. Bracken, and D. W. Carlile. 1991. Demersal shelf rockfish. *in* Stock assessment and fishery evaluation report for the 1992 Gulf of Alaska groundfish fishery. Gulf of Alaska Groundfish Plan Team. North Pacific Fisheries Management Council, Section 7. pp. 7-1 to 7-18.

Quast, J. C., and E. L. Hall. 1972. List of fishes of Alaska and adjacent waters with a guide to some of their literature. National Oceanic and Atmospheric Administration Technical Report NMFS SSRF-658, 48 pp.

Dolly Varden (*Salvelinus malma*) - Anadromous populations

Range

Dolly Varden are found from the Arctic coast of Alaska to southern British Columbia.

Migration

Anadromous Dolly Varden spend summers in nearshore marine environments. From October through November they migrate to freshwater streams and lakes to spawn. Dolly Varden overwinter in freshwater until spring, returning to coastal waters following ice-breakup.

Reproductive Period

Maturation age is variable, occurring usually between 4 and 7 years. Although post-spawning mortality is high, some females have survived to spawn four times.

Spawning/Hatching

Spawning activity occurs from September through November for most Dolly Varden populations. Hatching occurs 4-5 months later, with free swimming fry emerging in April or May.

Survival/Life Span

Egg to alevin survival has been estimated to be 40.7 percent; alevin to smolt, 1.1 percent; and smolt to spawning adult, 23.5 percent. Life span can range up to 12 years.

Habitat Use and Requirements

Adults - Outmigration from freshwater to marine environments occurs each spring. Adults stay in estuary and nearshore coastal habitats until returning to freshwater streams to spawn. Immature fish and nonspawning adults return to freshwater later than spawning adults. Spawning occurs in streams with gravel substrates, slow to moderate water velocities, and temperatures between 0.5 and 13°C. Adults overwinter in deep lakes or river pools, and near groundwater spring areas.

Fry and Juveniles - Younger fry rely on logs, undercut stream banks and other debris to provide cover from predators. Juveniles prefer quiet pools near swift currents. They overwinter in deep pools and lakes.

Food Web Interrelationships

Adults - Smelt, herring, juvenile salmon, sandlance and other small fish and invertebrates are eaten while the Dolly Varden are in marine water. Juvenile salmon, sticklebacks and invertebrates are preyed on in freshwater.

Fry and Juveniles - Aquatic invertebrates, larvae and fish eggs are the primary prey. Fry and juveniles feed primarily near the stream and lake bottoms.

Human Interactions

Dolly Varden are an important sport fish.

References

Alaska Department of Fish and Game. 1985. Arctic char life history and habitat requirements Southwest and Southcentral, Arctic, Western and Interior regions. pages 317-338 *in* Alaska habitat management guide. Life histories and habitat requirements of fish and wildlife. Alaska Department Fish Game, Juneau, AK. 429 pp.

Armstrong, R. H. 1974. Migration of anadromous Dolly Varden *Salvelinus malma* in southeastern Alaska. Journal of Fisheries Research Board Canada. 31:435-444.

Armstrong, R. H., and James E. Morrow. 1980. The Dolly Varden char, *Salvelinus malma. in* Charrs: Salmonid fishes of the genus *Salvelinus*. E. K. Balon, Ed., Dr. Junk bv Publishers, Hague, Netherlands. pp. 99-140.

Morrow, J. E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, Alaska. 248 pp.

Spot Shrimp *(Pandalus platyceros)*

Range

North Pacific Ocean, from southern California to the Bering Strait, and to Japan and Korea.

Migration

Long-range movements of spot shrimp are unlikely. However, daily movements bring the shrimp to shallow waters at dusk and to deeper waters during the day.

Life Cycle

Spot shrimp are hermaphroditic. They are juveniles for 1-2 years after hatching, then become functional males until 3-5 years of age. They reach a transitional phase from 6-7 and remain as females until they die between 7-10 years of age.

Reproductive Period

Studies in Prince William Sound indicate that spot shrimp may lay multiple egg clutches before death. Conversely, studies from British Columbia have indicated a shorter life span and a single clutch of eggs per female.

Mating/Hatching

Mating occurs in the fall and females carry the eggs for 5-6 months. The eggs hatch from March-April.

Habitat Use and Requirements

Spot shrimp are found at depths ranging from 4 to 487 meters, but they are most common in shallower marine waters. The adults prefer areas with rocky bottoms and fairly steep slopes. Rock crevices, cracks and small caves are used as hiding places; shrimps will also use vegetation as cover against predators. The larvae are pelagic when they first hatch and become demersal as juveniles. Movements between depths and distance from shore occur daily as adults.

Food Web Interrelationships

Spot shrimp feed on detritus and worms (annelids), and on other crustaceans.

Predation - Spot shrimp are an important prey item for many other species. They are an important component in the diet of fish, e.g. salmon, rockfish, Pacific cod, and octopus as well as diving seabirds.

Human Interactions

Spot shrimp are of commercial and recreational importance. They are primarily caught in traps, but are incidentally caught in trawls. In the late 1980s, the Alaska Department of Fish and Game reduced the allowable harvest in parts of Prince William Sound. This change was due to information from experimental fishery management areas which raised concerns about over-harvest.

References

Donaldson, W. 1991. Prince William Sound management area 1990 shellfish annual management report. Alaska Department of Fish and Game. Regional Informational Report No. 2C91-04. 48 pp.

Holthuis, L. B. 1980. Shrimps and prawns of the world: an annotated catalogue of species of interest to fisheries. Food and Agriculture Organization species catalogue No. 125, Volume 1.

Kruse G. H. and M. C. Murphy. 1989. Review of biology and life history of shrimps. Alaska Department of Fish and Game, Regional Informational Report No. 5J89-05. 34 pp.

The *Exxon Valdez* oil spill affected several resources and services normally provided to the public. These include: archaeological resources, recreation, wilderness and intrinsic values, subsistence and commercial fisheries.

Archaeological Resources

Archaeological resources, including sites and the artifacts, constitute an important part of our national and state heritage. They also have international importance in that they constitute a significant link in our knowledge and understanding of Native peoples who have inhabited Arctic and subarctic regions for many thousands of years. These resources help us understand our ancestors' past and enable greater appreciation for the richly varied cultures found in Alaska. The oil-spill area contains both ancient and more recent archaeological resources.

The U.S. Congress recognized the significance of archaeological resources when it passed the Archaeological Resources Protection Act of 1979. In that act they recognized that:

> "Archaeological resources on public lands and on Indian lands are an accessible and irreplaceable part of the Nation's heritage."

Similarly, the Alaska State Legislature passed the Alaska Historic Preservation Act. That law states:

> "It is the policy of the state to preserve and protect the historic, prehistoric and archaeological resources of Alaska from loss, desecration and destruction so that the scientific, historic and cultural heritage embodied in these resources may pass undiminished to future generations. To this end...historic, prehistoric and archaeological resources of the state are properly the subject of concerted and coordinated efforts exercised on behalf of the general welfare of the public..."

Recreation and Wilderness and Intrinsic Values

Alaska has the most significant assemblage of park, refuge and forest lands in the United States, and much of this land is still wild. Large portions of lands under Federal management in the spill area have been designated wilderness areas by the Congress. Such lands are included within Katmai National Park and the Becharof National Wildlife Refuge, both areas were contaminated with *Exxon Valdez* oil. Areas within the Chugach National Forest and Kenai Fjords National Park are in wilderness study area status. Under state management, the Kachemak Bay State Wilderness Park lies on the outer coast of the Kenai Peninsula and it too, felt the effects of the oil spill.

These designated wilderness lands and thousands more acres of undesignated wildlands and developed lands provide, in part, the basis for Alaska's tourist

economy. A wide range of activities take place on these lands, some by individuals or small groups seeking a personal experience, and others with the aid of businesses that provide a variety of professional services enabling visitors to use and enjoy the wilderness. Recreational activities include: hunting, fishing, hiking, camping, skiing, sightseeing, power boating, kayaking and photography.

Beyond those who actively use these lands, many Americans benefit by knowing that in Alaska large areas of undeveloped lands provide habitat for natural, healthy populations of wildlife.

Subsistence Use

Many people, most notably rural residents of Prince William Sound, the Kenai Peninsula, lower Cook Inlet and the entire Kodiak archipelago use a wide variety of subsistence resources to provide for essential needs. Many communities in the oil-spill area have mixed subsistence-cash economies. Considerable subsistence harvest occurs on State, Native and Federal lands within the spill area. Subsistence resources, such as fish, birds, and marine and terrestrial mammals, provide vital food resources without which people could not live. Many of these same resources provide products that serve important functions in daily life and play a significant role in cultural practices and traditions. Several resources are shared with members of the communities unable to obtain them or are traded for other needed items.

Although no single Federal or State statute defines the full range of subsistence uses or users, both the Alaska Constitution and the Alaska National Interest Lands Conservation Act address the value and importance of subsistence.

The Alaska Constitution, in Article VIII, Section 3 states:

> "Wherever occurring in their natural state, fish, wildlife, and waters are reserved to the people for common use."

In 1980 Congress approved the Alaska National Interest Lands Conservation Act. Title VIII, "Subsistence Management and Use" recognizes two important concepts: the need for continued opportunity for subsistence, and the uniqueness of the Alaska situation. ANILCA Section 801 (1) states:

> "the continuation of the opportunity for subsistence uses by rural residents of Alaska, including both Natives and non-Natives, on the public lands and by Alaska Natives on Native lands is essential to Native physical, economic, traditional, and cultural existence and to non-Native physical, economic, traditional, and social existence."

ANILCA Section 801 (2) states:

> "the situation in Alaska is unique in that, in most cases, no practical alternative means are available to replace the food supplies and other items gathered from fish and wildlife which supply rural residents dependent on subsistence uses."

Commercial Fisheries

The seafood industry is the second largest generator of revenue in the state. The industry provides nearly 70,000 seasonal jobs, which translates to 33,000 direct, indirect and induced year-round jobs. Total current investment by the Alaska seafood industry is estimated at $4 billion.

In Kodiak, one of the major fishing ports impacted by the oil spill, seafood landings ranked third in both cash value and volume in the United States from 1988 to 1990. Kenai landings (Cook Inlet) ranked 23rd in volume, but 8th in value during the same time period. Cordova landings were 14th and 13th in value.

All five species of Pacific salmon, herring, bottomfish, including halibut, cod and several species of sole, and king, tanner and dungeness crab comprise the Kodiak fisheries. Herring support a food and bait and a sac roe fishery. Pink and sockeye salmon are of major ecological as well as economic importance.

In Cook Inlet all five species of Pacific salmon are caught as well as herring and shellfish, especially razor clams. Herring support two sac roe fisheries, the Kamishak and the Outer and Eastern Districts. Sockeye are the most abundant salmon, ecologically and economically.

Pacific herring are the most abundant species of ecological importance in Prince William Sound. These populations support a fall food and bait fishery, a purse seine and gill net sac roe fishery, and a wild and pound spawn-on-kelp fishery. Together they constitute the second largest herring fishery in the state.

The pink salmon fishery, however, constitutes the major volume and value of the annual commercial harvest. Groundfish landings are increasing as that fishery develops. Shellfish, including tanner crab and spot shrimp, are also important fisheries in the Sound.

References

Archaeological Resources Protection Act of 1979, 16 USC 470.

Alaska Historic Preservation Act, Alaska Statute 41.35.010.

1916 Organic Act, 16 USC 1, 39 Stat. 535.

1916 Organic Act legislative history, ARA Leisure Services v U.S., 831 F.2d 193 (9th Cir. 1987).

Wilderness Act, 16 USC 1131.

Kachemak Bay State Park Wilderness Act, Alaska Statute 41.21.140.

Alaska Constitution, Article VIII, Section 3.

Alaska National Interest Lands and Conservation Act (ANILCA), 16 USC 3101.

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APPENDIX B

POTENTIAL RESTORATION OPTIONS

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APPENDIX B
POTENTIAL RESTORATION OPTIONS

NOTE: The following options are presented for the purpose of public comment and are not recommendations by the Trustees.

TABLE OF CONTENTS FOR APPENDIX B

13. eliminate sources of persistent contamination of prey and spawning substrates

14. accelerate recovery of upper intertidal zone

15. supplement intertidal substrates for spawning herring

16. test feasibility of enhancing murre productivity

17. eliminate introduced foxes from islands important to nesting marine birds

18. replace fisheries harvest opportunities by establishing alternative salmon runs

Habitat Protection and Acquisition

19. update and expand the State's Anadromous Fish Stream Catalog

20. establish an *Exxon Valdez* oil spill "special management area"

21. acquire tidelands

22. designate protected marine areas

23. acquire additional marine bird habitats

24. acquire "inholdings" within parks and refuges

25. protect or acquire upland forests and watersheds

26. acquire extended buffer strips adjacent to anadromous fish streams

27. designate and protect "benchmark" monitoring sites

28. acquire access to sport-fishing streams

29. establish or extend buffer zones for nesting birds

Other Options

30. test subsistence foods for hydrocarbon contamination

31. develop comprehensive monitoring program

32. endow a fund to support restoration activities

33. develop integrated public information and education program

34. establish a marine environmental institute

35. replacement of archaeological artifacts

II. Restoration Options Rejected (listed by resource and service categories)

1. sea otters and harbor seals

2. killer whales

3. river otters

4. common murres and marbled murrelets

5. marbled murrelets

6. harlequin ducks

7. harlequin ducks and black oystercatchers

8. bald eagles

9. pink salmon and sockeye salmon

10. rockfish

11. spot shrimp

12. coastal habitat

13. archaeological resources

14. multiple resources

OPTION 1: Archaeological Resource Protection

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Archaeological sites and artifacts

BACKGROUND AND JUSTIFICATION:

Beach clean-up activities resulted in increased public knowledge of exact locations of archaeological sites. Consequently, loss of these resources from vandals has increased. Inherently, archaeological resources injured by the oil spill are not restorable and the remoteness of sites makes enforcement of archaeological protection laws difficult. A site steward program could be developed to establish a corp of local citizens to watch over threatened archaeological sites. Additionally, agency monitoring and public education efforts could be expanded to discourage vandalism. The agencies also could develop cooperative management plans for archaeological resources to better coordinate their activities in the oil-spill area.

ACTION:

- create an archaeological site stewardship program;
- increase number of public contact patrols in the oil-spill area; and
- expand public education efforts.

INFORMATION NEEDED TO IMPLEMENT OPTION:

No further information is needed to accomplish this work.

OPTION 2: Intensify Management of Fish and Shellfish

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Pink and sockeye salmon, Dolly Varden, coastal cutthroat trout, Pacific herring, rockfish, and spot shrimp

BACKGROUND AND JUSTIFICATION:

Managing the human uses of fisheries resources, including both commercial and recreational, is fundamental to the restoration of oil-spill injuries. Intensive fisheries management could temporarily reduce human pressure on injured wild stocks or populations to speed their recovery. As a means of minimizing impacts on the fisheries, existing fisheries could be restricted or redirected to alternative sites. In the case of sockeye salmon, for example, one objective is to relieve pressure on what are anticipated to be small runs in the Kenai River system in the next several years, without shutting down other Upper Cook Inlet fisheries.

ACTION:

- develop and implement program to upgrade and intensify management of injured fisheries resources throughout oil-spill area.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Intensive management of injured fish and shellfish resources will be difficult, especially in mixed-stock (i.e., wild and hatchery) fisheries. Improved population modeling, application of genetic and other techniques to separate stocks, and other research and monitoring studies are needed to support intensified fisheries management.

OPTION 3: Increase Management for Fish and Shellfish that Previously Did Not Require Intensive Management

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Rockfish, spot shrimp

BACKGROUND AND JUSTIFICATION:

Prior to the oil spill, commercial fishing did not require comprehensive management plans for some species. This was true for rockfish (various species) and spot shrimp, both of which were to some degree injured by the oil spill itself. The directed harvest and by-catch of rockfish increased significantly in 1990 and 1991, because fishing efforts were shifted from salmon and herring to groundfish. Rockfish are of particular concern; they are long-lived and slow-growing and overharvest could greatly exacerbate oil-spill injuries. Development and implementation of management plans will aid the recovery of rockfish and spot shrimp by ensuring that human harvests are consistent with the status and productivity of post-oil-spill populations.

ACTION:

- develop and implement a fishery management plan for rockfish and spot shrimp. The management plans should establish harvest levels, times and areas that are appropriate to allow for recovery from oil-spill injuries.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Considerable information is needed to develop management plans, including data on commercial and sport catches to describe age and size composition, natural mortality rates, general seasonal movements, stock abundance and recruitment. Separation of discrete stocks through genetic and other studies are also needed to enable management on a targeted rather than broad-scale basis.

OPTION 4: Reduce Disturbance at Marine Bird Colonies and Marine Mammal Haul-Out Sites and Rubbing Beaches

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Marine birds and marine mammals

BACKGROUND AND JUSTIFICATION:

Human disturbance can adversely affect the fitness or reproductive success of marine birds and mammals. Especially vulnerable are species that gather in large numbers and traditionally make use of small, discrete sites. Examples include colonies of common murres, which typically nest on cliffs, haul-out sites frequented by harbor seals, and rubbing beaches used by killer whales. In the case of common murres, recent reports have indicated specific problems with the shooting of halibut landed by charter-boat operators in the Barren Islands. The sound of the gunshots causes murres to flush in a panic from the nesting cliffs, kicking eggs off the cliffs and leaving eggs and chicks vulnerable to avian predators. Problems such as these can be approached through the education of tour- and charter-boat operators and the fishing industry. Designation of buffer zones around particularly sensitive areas and stricter enforcement of harassment provisions in the Marine Mammal Protection Act and the Migratory Bird Treaty Act also are possibilities.

ACTION:

- educate tour- and charter-boat operators about appropriate behavior near sensitive marine bird and mammal areas;
- increase the field presence of Trustee agencies at such areas;
- consider restrictive measures, such as the designation of buffer zones; and
- consider greater enforcement of Federal and State laws.

INFORMATION NEEDED TO IMPLEMENT OPTION:

There is need to determine the specific areas and times in which birds and mammals are sensitive to disturbance. No additional information is needed to implement the education component of this option.

OPTION 5: Reduce Harvest by Redirecting Sport-Fishing Pressure

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Dolly Varden and cutthroat trout

BACKGROUND AND JUSTIFICATION:

Spill-related injuries to cutthroat trout and Dolly Varden have resulted in a loss of sport fishing opportunities in Prince William Sound. Both of these species are important components of recreational fisheries in this area. Moreover, because the affected population of cutthroat trout is at the extreme northern limit of its geographic range, it is important to protect the genetic integrity of these populations. The proposed option is designed to manage this recreational fishery in a manner that would redirect pressure away from impacted populations, maintain sport fishing opportunities and, at the same time, conserve the unique gene pool of these wild stocks.

ACTION:

- prepare a fisheries management plan that includes some or all of the following alternatives:
  - close oiled streams in Prince William Sound;
  - redirect recreational fishing to non-oiled streams and drainages; and
  - reduce creel limits in the affected area.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Results from recovery monitoring studies will provide timing data for management actions. Results of survey and inventory studies will provide locations for alternative sport-fishing opportunities. Stock status data on Dolly Varden and cutthroat trout populations will aid in the development of the management plan.

OPTION 6: Redesignate a Portion of the Chugach National Forest as a National Recreation Area or Wilderness Area

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Recreation, fish, including salmon, coastal cutthroat trout, and Dolly Varden

BACKGROUND AND JUSTIFICATION:

The waters of Prince William Sound are surrounded by the Chugach National Forest. The area is recognized as biologically rich and it provides a variety of resources, including significant opportunities for private and commercial recreation. The National Forest System contains several national recreation areas and designated wilderness areas. Management of national recreation areas emphasizes recreational values and the habitats needed to sustain recreational opportunities. Management of wilderness areas emphasizes the preservation of pristine qualities and opportunities for nonmechanized recreation. Within the Chugach National Forest, Congress previously designated the Nellie Juan/College Fjords wilderness study area, but has never resolved its permanent status. Changing the designations of all or parts of the Chugach National Forest would alter management directions to favor recreational opportunities and wilderness qualities.

ACTION:

- recommend that the Forest Service integrate consideration of national recreation area and wilderness area designations into its management planning process for the Chugach National Forest; and

- if redesignation is determined to be appropriate, that recommendation must be forwarded to Congress for legislative approval.

INFORMATION NEEDED TO IMPLEMENT OPTION:

The Forest Service must gather some new data on the changes brought about by the oil spill on forest resources.

OPTION 7: Increase Management in Parks and Refuges

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Coastal habitat, wildlife, fisheries and recreation within State and Federal parks and refuges

BACKGROUND AND JUSTIFICATION:

There are many parks and refuges scattered throughout the oil-spill area. Because of the size and location of these areas, managing agencies are limited in their ability to provide an extensive field presence. It may be desirable to increase the staff capability and frequency of patrols to ensure that human use activities are conducted in a manner that safeguards the recovery potential of injured resources.

ACTION:

- hire and train additional staff to patrol and monitor spill-affected public lands; and

- provide interpretive services to educate the public about the spill and explain how they can minimize their chances of impeding resource recovery.

INFORMATION NEEDED TO IMPLEMENT OPTION:

This option needs no additional information to implement.

OPTION 8: Restrict or Eliminate Legal Harvest of Marine and Terrestrial Mammals and Sea Ducks

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Sea otter, harbor seal, brown bear, river otter, and harlequin duck

BACKGROUND AND JUSTIFICATION:

Continued harvest of several species could slow or negate recovery from oil-spill injuries. Legal hunting and trapping of these species represents a controllable source of mortality that can be considered in developing a restoration strategy. Brown bears are taken by sport hunters in the oil-spill area and river otters are trapped for their furs. Under the Marine Mammal Protection Act, subsistence users are allowed to take sea otters and harbor seals. Recently, some subsistence users have voluntarily reduced their take of marine mammals. Harlequin ducks are shot by both sport and subsistence users. In 1991 the Alaska Department of Fish and Game delayed the open season on harlequin ducks in Prince William Sound and along the outer Kenai Coast to protect the small resident breeding population prior to an influx of a much larger number of migrant and wintering ducks.

ACTION:

- if necessary, recommend that the Alaska Department of Fish and Game temporarily restrict or close harvests of brown bear, river otter, and harlequin ducks in the oil-spill area; and

- convey information to subsistence users about the status of injured species of marine mammals and other resources and, if appropriate, encourage voluntary reductions in harvest levels.

INFORMATION NEEDED TO IMPLEMENT THE OPTION:

Monitor population levels of injured species, establish harvest levels in oil-spill area and estimate the influence of annual harvests on the recovery of these species.

OPTION 9: Minimize Incidental Take of Marine Birds by Commercial Fisheries

APPROACH CATEGORY: Management of Human Resources

INJURED RESOURCES AND SERVICES: Marine birds

BACKGROUND AND JUSTIFICATION:

Large numbers of marine birds are susceptible to being tangled and drowned in commercial fishing gillnets. Local, nearshore fisheries can cause the death of significant numbers of marine birds as evidenced with common murres in a halibut/croaker fishery in California and with marbled murrelets in a salmon gillnet fishery in British Columbia. Research on marine bird mortalities due to commercial fisheries in Alaska has been limited. Data from the National Marine Fisheries Service's observer program in 1990 suggested that the annual mortality from Prince William Sound drift gillnets was 836-2100 marine birds, most of which were marbled murrelets. This mortality is not high relative to the overall size of the murrelet population, but on a local basis it could slow recovery from oil-spill related injuries. Management strategies, such as reducing hours of night-time fishing during critical times in discrete areas, may reduce the mortality.

ACTION:

- if necessary, develop and implement strategies to reduce the incidental mortality of marbled murrelets in drift gillnets.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Design and implement a sampling program throughout the spill area to obtain data on the significance, level and distribution of annual driftnet mortalities.

OPTION 10: Preservation of Archaeological Sites and Artifacts

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Archaeological sites and artifacts

BACKGROUND AND JUSTIFICATION:

Important archaeological sites, protected by Federal and State laws, were oiled. At some sites oil continues to degrade artifacts, to spread further within sites and to contaminate additional artifacts. Erosion also may be a problem at some sites. The information within some sites could be totally lost, especially since petroleum residues interfere with Carbon[14] dating techniques. Additionally, increased public knowledge of exact archaeological sites locations is encouraging vandalism. Since these injured archaeological resources are not restorable, excavation may be the best option available to retrieve valuable information from some of the key sites and artifacts before they are rendered useless. It may be necessary to develop cleaning techniques so that standard radiocarbon dating procedures can be used to establish age of artifacts.

ACTION:

- excavate and document (e.g., photographic record) the most threatened and significant archaeology sites.[1]

INFORMATION NEEDED TO IMPLEMENT OPTION:

Completion of damage assessment studies will enable managers to more fully understand the effects of oiling on a site-specific basis. Thereafter, possible excavation sites can be ranked, based upon their value and ability to contribute knowledge.

[1] Artifacts collected during excavations will be curated, or distributed to appropriate institutions, by the responsible agency.

OPTION 11: Improve or Supplement Stream and Lake Habitats for Spawning and Rearing of Wild Salmonids

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Pink and sockeye salmon

BACKGROUND AND JUSTIFICATION:

There are a variety of established techniques for improving or supplementing spawning and rearing habitats to restore and enhance injured wild salmonids. These include construction of spawning channels and fish passes, removal of barriers impeding access to spawning habitats and addition of woody debris. In-stream productivity can be improved by placement of egg boxes and use of net pens for rearing fry. Unlike pink and chum salmon which swim to sea in their first year, young sockeye salmon grow in lakes for 1-3 years before emigrating to sea. One restoration technique for sockeye is to add chemical fertilizers to lakes to temporarily supplement the natural nutrients needed to sustain prey on which the fry feed. Once a run is restored, the decomposition of the carcasses of spawned salmon are a natural source of the nutrients needed to sustain the food chain.

ACTION:

- construct or implement stream and lake improvements for the spawning and rearing of wild salmonids.

INFORMATION NEEDED TO IMPLEMENT THE OPTION:

Although stream and lake enhancement techniques are well established, there is need for site-specific analyses to determine which techniques are appropriate. An overall enhancement plan is needed to ensure an efficient, coordinated approach throughout the oil-spill area.

OPTION 12: Creation of New Recreation Facilities

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Recreation

BACKGROUND AND JUSTIFICATION:

The oil-spill area contains an important assemblage of public lands that provide recreational services to the public. These lands include a national forest, several state and national parks and national wildlife refuges. A full range of private and commercial recreational activity occurs in these areas, supported by facilities like mooring buoys, boat ramps, recreational-use cabins, camping sites, and trails.

ACTION:

- replace or construct new recreational facilities within the oil-spill area.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Identify facilities and sites that have been damaged, destroyed or rendered unusable by the *Exxon Valdez* oil spill or clean up. The agencies then need to identify what actions may be taken to restore, replace or enhance recreation sites and opportunities.

OPTION 13: Eliminate Sources of Persistent Contamination of Prey and Spawning Substrates

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Coastal habitat, blue mussels, harlequin ducks, sea otters, black oystercatchers, river otters, fisheries, subsistence

BACKGROUND AND JUSTIFICATION:

Continued oil contamination in substrate used for spawning may affect fish-egg deposition and survival. Mussel beds throughout the spill area were not cleaned during the oil spill cleanup because of the uncertainty of appropriate cleaning techniques. Mussels are an important food resource for a variety of injured species and the acute, chronic or sublethal effects of this continuing contamination are poorly understood. However, there is potential for movement into higher trophic levels, such as birds and mammals. This may cause chronic, sublethal effects at both the individual and population levels, further affecting the health and survival of injured resources.

ACTION:

- determine and implement, if necessary, the most effective and least destructive method of cleaning mussel beds and other critical oiled areas.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Conduct field surveys and sampling of oiled mussel beds and other areas throughout the spill area and chemical analyses of sediments and mussel tissue to determine the extent of the problem and the toxicity of the oil. Conduct additional field tests to determine the most effective and least destructive method of cleaning oiled mussel beds.

OPTION 14: Accelerate Recovery of Upper Intertidal Zone

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Upper intertidal community of invertebrates and algae, especially the brown alga (*Fucus*)

BACKGROUND AND JUSTIFICATION:

Much of the upper intertidal zone within the oil-spill area was heavily oiled and subjected to intensive cleanup. This zone is dominated by the brown alga *Fucus gardneri* (popweed) which is not recovering rapidly. Moreover, many of the other life forms that use the upper intertidal are dependent upon this alga and associated invertebrate fauna for food and cover. The scientific literature indicates that *Fucus* is slow to recover and that its recovery is very important to the rest of the intertidal community. It is also important to evaluate the long-term effects of the various clean-up techniques that were used in the intertidal zone. Conclusions derived from the assessment of these techniques may have significant bearing on clean-up decisions for future spills.

ACTION:

- implement ways to expedite the recovery of the upper intertidal community, especially *Fucus*; and

- design and implement a monitoring program that will assess the effects of the various methods that were used to remove oil from the intertidal zone.

INFORMATION NEEDED TO IMPLEMENT OPTION:

There is need to conduct feasibility studies to test alternative methods of accelerating recovery of *Fucus* in the field.

OPTION 15: Supplement Intertidal Substrates for Spawning Herring

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Pacific herring

BACKGROUND AND JUSTIFICATION:

Pacific herring spawn on a variety of intertidal and subtidal substrates, including *Fucus* and *Laminaria*. Herring eggs, larvae and spawning substrates were adversely impacted by the spill and cleanup. Attempts to supplement spawning habitat in the United States and abroad with both artificial and cultured macroalgal substrates have successfully increased herring egg survival and populations. In Russia, spawning habitat enhancement has been successful in substantially increasing herring egg survival.

ACTION:

- enhance and replace spawning substrates in areas used by spawning herring.

INFORMATION NEEDED TO IMPLEMENT OPTION:

It will be necessary to test the feasibility of implementing this option on a scale sufficient to benefit the herring population.

OPTION 16: Test Feasibility of Enhancing Murre Productivity

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Common murres

BACKGROUND AND JUSTIFICATION:

Numerically, common murres suffered the greatest direct mortality from the oil spill of any vertebrate species. Although murre populations have been damaged by previous oil spills and other human-related perturbations, there have been no documented attempts at direct restoration of murre colonies. Based on restoration work with related species and an understanding of murre behavior, there are several techniques that hold some promise of increasing murre productivity. Methods that could be considered include enhancing social stimuli (e.g., use of decoys and recorded calls) to encourage nesting activity and improving the physical characteristics of nest sites (e.g., adding sills to ledges) to increase productivity. These techniques are experimental and possibly intrusive, but if effective, have the potential to reduce the recovery time of murres nesting in colonies in such places as the Barren Islands. Without intervention, the time to recovery is now estimated to be in the decades.

ACTION:

- conduct field study to determine the feasibility of techniques to enhance the productivity of common murres.

INFORMATION NEEDED TO IMPLEMENT OPTION:

It will also be important to consider the practicality of implementing successful techniques on a scale sufficient to reduce the recovery time of the murre population.

OPTION 17: Eliminate Introduced Foxes from Islands Important to Nesting Marine Birds

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Marine birds

BACKGROUND AND PURPOSE:

Foxes are not indigenous to many of the islands of the Aleutian chain and Gulf of Alaska. Foxes were introduced on more than 400 islands to be raised and trapped for their furs. Introduced foxes reduced and eliminated populations of surface, burrow and in some cases cliff-nesting birds in a matter of years. More than 50 islands still have introduced foxes, and bird populations on these islands have never recovered. Where foxes have died out naturally or been eliminated through trapping and shooting, recovery of marine bird populations has been dramatic. Elimination of introduced foxes on selected islands may result in increased numbers and diversity of marine birds in Alaska and be viewed as "acquiring" resources equivalent to the estimated several hundred-thousand marine birds lost due to the oil spill. If selected as a restoration option, introduced foxes can be eliminated successfully on smaller islands using traps and guns. Most of the target islands would be in the Aleutian Islands, west of the oil-spill area.

ACTION:

- eradicate red and arctic ("blue") foxes on islands in the western Gulf of Alaska and in the Aleutians where such foxes are not indigenous, and the island is or was important to nesting alcids (murres, puffins, auklets, murrelets), storm-petrels, gulls and terns, and waterfowl, such as eiders and Canada geese.

INFORMATION NEEDED TO IMPLEMENT OPTION:

No additional information is needed to implement this project other than to select target islands where successful, cost-effective programs can be instituted.

OPTION 18: Replace Fisheries Harvest Opportunities by Establishing Alternative Salmon Runs

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Pink and sockeye salmon

BACKGROUND AND JUSTIFICATION:

Establishing alternative salmon runs can relieve pressure on injured wild stocks or replace harvest opportunities curtailed due to the restoration needs of injured wild stocks. For example, pink salmon produced in hatcheries are comprised largely of late-run stocks that return at the same time as most wild stocks of injured pink salmon in Prince William Sound. Harvest of the hatchery stocks in this mixed hatchery-wild stock fishery increases pressure on the wild stocks. Early runs of hatchery salmon could be established to alleviate pressure on the injured wild stocks without reducing harvest opportunities. Another example is to temporarily stock hatchery-reared smolts to replace loss of sockeye fishing opportunities that resulted from overescapement when most Kodiak-area commercial salmon fishing was closed in 1989. This would only be appropriate in situations where injured wild stocks would not be affected by the replacement fishery.

ACTION:

- establish alternative salmon runs as appropriate and necessary to relieve pressure on injured wild stocks or to replace lost harvest opportunities during the recovery of wild stocks.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Establishing early-run hatchery salmon requires identification and development of the appropriate brood stock. In all cases, care must be taken to not further harm or complicate the management of injured wild stocks.

OPTION 19: Update and Expand the State's Anadromous Fish Stream Catalog

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: Anadromous fish, streams and intertidal spawning habitat

BACKGROUND AND JUSTIFICATION:

Numerous anadromous streams were affected by the spill and cleanup. Many of these streams are listed in the Anadromous Waters Catalog and Atlas maintained by the Alaska Department of Fish and Game. Additional streams were identified as part of the response survey effort following the oil spill and were added to the catalog. These new additions, as well as a number of previously identified streams, need to be surveyed as part of their evaluation as anadromous fish habitat. Evaluation of management or protection and acquisition options for restoring anadromous fish and their habitats will need the information acquired as part of these surveys. Under the State Forest Practices Act, streamside buffers are required bordering certain anadromous streams. This may be an important tool in the restoration of any stream-related species.

ACTION:

- survey and catalog anadromous streams located within the affected area.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Field surveys of anadromous streams within the affected area will provide the necessary information for documentation.

OPTION 20: Establish an *Exxon Valdez* Oil Spill "Special Management Area"

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

Restoration of injured resources and services may require special sensitivity or emphasis in making permit decisions on land uses and activities in the spill zone. This may be achieved by requiring that permits for such activities as anadromous stream crossings, log transfer sites, and mariculture projects be subject to a finding of compatibility with the recovery of injured resources and services. The duration of special management would be limited, depending upon the rate of recovery of the injured resources and services. A period of 5 to 15 years might be an appropriate time frame. Amendments to the State of Alaska's program under the Coastal Zone Management Act could be a vehicle for implementation of special management objectives. In all cases it would be essential to consider and minimize impacts on human uses of lands and resources.

ACTION:

- recommend creation of a special management area within the oil-spill area. Activities requiring State permits within the zone will be regulated to assure compatibility with the recovery of injured resources and services.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Identify State and Federal permit decisions bearing directly on the recovery of injured resources and services, and evaluate the adequacy of the existing standards for issuing such permits. If a special management area is warranted, the process for establishing a special management area must be identified and initiated. Implementation would require action by the State legislature.

OPTION 21: Acquire Tidelands

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: Coastal habitat, including intertidal flora, fauna and various species of birds, mammals, fish and shellfish that use the intertidal areas

BACKGROUND AND JUSTIFICATION:

Tidelands and their associated flora and fauna were the habitat most injured by the spill. Most tidelands (below mean high water) are owned by the State or Federal governments. Some are owned privately or by municipalities, have high fish and wildlife values and are heavily used by the public for such activities as clam digging and wildlife viewing. Examples suggested by the public are Mud Bay at Homer and the Duck Flats at Valdez. Acquisition of such areas would preserve ecologically-important habitats and maintain the services such habitats provide for both consumptive and nonconsumptive public users. Services provided to the public could be enhanced by interpreting an area's natural history and providing additional access and viewing opportunities. Acquired areas could be designated as critical habitat areas, wildlife refuges or sanctuaries, or could be managed as part of State-owned, unclassified tidelands.

ACTION:

- acquire one or more tideland properties for public ownership and management to benefit wildlife resources.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Identify tidelands eligible for acquisition and subsequent special designation.

OPTION 22: Designate Protected Marine Areas

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: Coastal habitat, marine birds and mammals, seabirds, fisheries, invertebrates, algae and seagrasses, recreation

BACKGROUND AND JUSTIFICATION:

Virtually all species injured by the oil spill live in or use the nearshore and intertidal marine environment for feeding or reproduction. These marine habitats also provide many recreational and research opportunities. The recovery of injured marine resources and services may require long-term efforts and carefully coordinated management. The Trustees have recognized the importance of the marine environment and the potential value of increased, coordinated management for restoration purposes. In 1991, a two-day work shop exploring the subject was conducted. Possible designations include national marine sanctuaries, estuarine research reserves, marine parks, critical habitat areas, sanctuaries and refuges.

ACTION:

- if appropriate, recommend candidate areas for consideration and designation as marine protected areas by the Trustee agencies, the Alaska State Legislature and Congress.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Candidate areas must be identified and evaluated based on such factors as the habitat requirements of injured species and the type of designation needed to achieve restoration objectives.

OPTION 23: Acquire Additional Marine Bird Habitats

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: Marine birds, sea ducks, sea otters, harbor seals

BACKGROUND AND JUSTIFICATION:

There are a number of sites that are important to the recovery of marine species injured by the oil spill. These include various small rocky islands and cliffs used by colonies of nesting marine birds, riparian habitats used by nesting harlequin ducks and forested areas used by nesting marbled murrelets. Adjacent nearshore waters and tidelands are frequented by harbor seals and sea otters. The Alaska Maritime National Wildlife Refuge specifically was established for the conservation and management of marine birds, marine mammals, and other wildlife and fish. Examples of privately-owned islands with important marine bird and waterfowl habitats within the Maritime refuge are Afognak, East Amatuli and Gull. Protecting key habitats in areas such as these would result in increased management, monitoring and research for the benefit of injured species. Bringing additional areas into public ownership could replace and enhance wildlife viewing services and public education opportunities.

ACTION:

- acquire and incorporate high-value marine bird and waterfowl habitats into public ownership.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Gather additional information on habitats relevant to injured species and integrate into the Trustees' overall effort to evaluate and acquire strategic fish and wildlife habitats.

OPTION 24: Acquire "Inholdings" Within Parks and Refuges

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

Several State and Federal conservation system units exist within the oil-spill area. These areas provide habitats for several injured species and various other resources or services. There have been many suggestions to acquire privately owned "inholdings" within existing conservation system units as a restoration action. For example, the Alaska Native Claims Settlement Act provided for several Native corporations to select lands inside the boundary of the Kenai Fjords National Parks. Those selections have been made (although not conveyed) and now overlay a significant portion of the park's coastline.

ACTION:

- acquire, on a willing seller basis, inholdings within existing parks and refuges to restore and enhance resources and services injured by the oil spill.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Gather additional information on habitats relevant to injured species and integrate into the Trustees' overall effort to evaluate and acquire strategic fish and wildlife habitats.

OPTION 25: Protect or Acquire Upland Forests and Watersheds

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: Harlequin ducks, marbled murrelets, river otters, anadromous fish, bald eagles, brown bears, recreation, wilderness and intrinsic uses

BACKGROUND AND JUSTIFICATION:

Although upland areas were not directly affected by the spill, they provide feeding and reproductive habitat for many of the injured species. Populations of salmonids and harlequin ducks are specifically dependent upon anadromous streams and their adjacent riparian lands. Undisturbed uplands and riparian lands provide important habitats and natural buffers that protect the quality of watersheds, streams and rivers. Uplands in the oil-spill area are also important recreation areas and contribute to the aesthetic experience enjoyed by recreational users throughout the spill area. Both recreation and tourism are dependent upon the pristine nature of these areas. By acquiring easements, property rights or fee-simple title to these strategic areas, injured species can be safeguarded during recovery and various resources and services can be restored and enhanced.

ACTION:

- acquire upland areas adjacent to anadromous streams, that are relied upon by injured species; and

- develop and implement a management plan for acquired or protected lands.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Gather additional information on habitats relevant to injured species and integrate into the Trustees' overall effort to evaluate and acquire strategic fish and wildlife habitats.

OPTION 26: Acquire Extended Buffer Strips Adjacent to Anadromous Streams

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: Anadromous fish, harlequin duck, river otter

BACKGROUND AND JUSTIFICATION:

Undisturbed riparian lands are important natural buffers that protect the water quality of streams and rivers and provide cover and food for wildlife. Injured populations of salmonids and harlequin ducks depend upon anadromous streams as feeding and reproductive habitat. Adverse human impacts to the lands adjacent to this habitat could retard the rate of their recovery. The State Forest Practices Act provides for 66-foot buffer strips along certain anadromous fish streams. One concept is to acquire wider buffer strips, as needed to maintain habitat for injured species.

ACTION:

- acquire title or property rights to riparian lands not currently protected under existing law.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Identify anadromous stream habitats important to injured species and evaluate degree of protection afforded under existing law.

OPTION 27: Designate and Protect "Benchmark" Monitoring Sites

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

A comprehensive monitoring plan has been suggested for consideration by the Trustees [Restoration Option No. 31]. Integral to the comprehensive monitoring plan is the designation of discrete and permanent monitoring sites within the oil-spill area. Permanent monitoring sites will allow for the establishment of a baseline environmental condition to use as a reference standard. These sites could include oiled, representative habitat types and unoiled control sites, set aside untreated sites in 1989, damage assessment study sites, and Exxon study sites. There are several designations appropriate for monitoring sites, including "research natural areas" (U.S. Forest Service) and "estuarine research reserves" (National Oceanic and Atmospheric Administration). The Forest Service presently is considering several research natural areas in Prince William Sound, including one on Green Island. The National Science Foundation's program for long-term ecological research sites is also a possibility.

ACTION:

- recommend designation of permanent study sites and control areas for long-term monitoring of marine, intertidal and upland habitats and selected indicator parameters.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Establishment of monitoring sites should be integrated with development of a comprehensive monitoring plan. Ownership, management and other uses of potential sites must also be considered.

OPTION 28: Acquire Access to Sport Fishing Streams

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: Recreation, anadromous fish

BACKGROUND AND JUSTIFICATION:

Anadromous fish species, such as coastal cutthroat trout, and the recreation services provided by these fish were injured by the oil spill. Although most of the oil-spill area is in public ownership, some areas that provide important sport-fishing opportunities are not. Acquiring access to such areas can replace or enhance the injured services and also relieve pressure on streams with injured fish stocks. Acquisition of access for sport fishing might be achieved by various mechanisms, including fee-simple title, easements or other property rights. Candidate sites can be identified based on the knowledge of resource managers in the agencies, nominations from the public and proposals from interested landowners.

ACTION:

- acquire, on a willing-seller basis, access to strategic areas that provide significant sport-fishing opportunities.

INFORMATION NEEDED TO IMPLEMENT OPTION:

The identification and acquisition of access to such areas must be integrated into the Trustees' overall plan for identifying strategic fish and wildlife habitats and recreation sites. Management plans must be developed for any sites acquired.

OPTION 29: Establish or Extend Buffer Zones for Nesting Birds

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: Marine birds, sea ducks and bald eagles

BACKGROUND AND JUSTIFICATION:

Most bird species have specific nesting requirements. Actions that alter nesting habitat or disturb nesting birds may disrupt nesting birds, thus reducing productivity and slowing the recovery of injured species. Examples of nesting habitats for injured bird species are rocky cliffs and headlands for marine birds, large trees along coastlines or streams for bald eagles, upland stands of large trees for marbled murrelets, and upland wooded streamsides for harlequin ducks. During the period these injured species are recovering from spill injuries, it may be appropriate to adopt special management practices to ensure the integrity of nesting habitats and minimize disruption during breeding and rearing times. Extended buffer zones around nest sites or restrictions on certain activities at critical times could be considered. Implementation of this option is most easily accomplished on lands which are publicly managed, but, through cooperative agreements and other mechanisms, privately owned lands could be included as well.

ACTION:

- recommend implementation of special management practices, including buffer zones and time/area restrictions; and

- explore and negotiate cooperative mechanisms for achieving similar management practices on private lands.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Relate results from restoration studies now underway to current and proposed land uses and management directions on public and private lands.

OPTION 30: Test Subsistence Foods for Hydrocarbon Contamination

APPROACH CATEGORY: Other Options

INJURED RESOURCES AND SERVICES: Finfish, shellfish, sea ducks and marine mammals

BACKGROUND AND JUSTIFICATION:

People living within the oil-spill area use subsistence resources obtained from the intertidal zone and from nearshore waters. Finfish, shellfish, marine mammals, and sea ducks are a substantial part of the diet of these local residents. Damage assessment studies documented the contamination of certain of these resources by petroleum hydrocarbons. For example, mussel and sediment samples collected during the summer of 1991 revealed persistent contamination of mussels and mussel beds. An oil-spill health task force was formed in 1989 to oversee analyses of subsistence food resources. These studies tested for petroleum hydrocarbon contamination in seals, deer, salmon, ducks, clams and bottomfish. This option proposes to monitor subsistence foods for residual petroleum hydrocarbon contamination and to disseminate the results to the public.

ACTION:

- develop a program designed to monitor for the presence of petroleum hydrocarbons in subsistence foods; and

- disseminate the results of the monitoring project to subsistence users.

INFORMATION NEEDED TO IMPLEMENT OPTION:

The design and results of the previous food-testing program must be evaluated.

OPTION 31: Develop Comprehensive Monitoring Program

APPROACH CATEGORY: Other Options

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

Monitoring is necessary in order to assess the adequacy of natural recovery. Resources that are found to be recovering at an unacceptable rate may have to be reconsidered as candidates for restoration action. Likewise, resources which are recovering faster than anticipated may allow for the early completion of a restoration action. Monitoring of physical, chemical and biological parameters will establish a baseline for the affected area. This baseline then can be used as a reference standard to evaluate the effects of future disturbances to the oil-spill area, e.g., earthquakes and oil spills. This standard could also be used to assess the anticipated effects of human development and to guide management programs.

ACTION:

- design and implement a program that will monitor:
  - natural recovery of injured resources;
  - monitor recovery of restored resources; and
  - monitor selected parameters to establish an environmental baseline condition.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Initially, target resources and specific objectives of a monitoring program must be established. A determination must be made on the best and most cost-effective methods to be used for monitoring the selected resources.

OPTION 32: Endow a Fund to Support Restoration Activities

APPROACH CATEGORY: Other Options

INJURED RESOURCES/SERVICES: All

BACKGROUND AND JUSTIFICATION:

Ensuring that the spill-affected area will recover fully from the *Exxon Valdez* oil spill is a complex, long-term task that involves many interests, significant funding and much initial uncertainty. There will be a continuing need to identify, protect and manage key habitat areas in the future. Monitoring of natural recovery and the efficacy of restoration activities will be needed. Restoration activities will be implemented as injury and technical information indicate. Continued research into the effects of the spill will help the development of improved clean-up methods. In making a long-term commitment to the oil spill environment, it is important to recognize the need for continuing financial support. Contributions from Exxon for restoration activities terminate in 2001; the Trustees may consider spending mechanisms that will continue that support after 2001.

ACTION:

- establish a restoration endowment or trust fund using all of the available proceeds from Exxon. There are numerous spending alternatives available such as:

  - spending only the investment income;

  - spending principal at a given level for a number of years and then spending only the investment income after that; and

  - spending principal at a given level through the life of the settlement and reinvesting the balance annually.[2]

INFORMATION NEEDED TO IMPLEMENT OPTION:

Identify the process and institutional structure needed to implement and manage the fund.

[2] One scenario would allow expenditure of approximately $24 million a year for restoration through 2001, reimburse the governments for expenditures to date, and still have an endowment fund principal of approximately $600 million. By the year 2020 approximately $900 million would have been spent on restoration with a remaining endowment fund principle of over $1200 million.

OPTION 33: Develop Integrated Public Information and Education Program

APPROACH CATEGORY: Other Options

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

This project would design and develop information available from the damage assessment and restoration process to inform the public of ways they can help injured resources recover from the effects of the spill and the resulting clean-up efforts. Specifically, the information would explain changes to the ecosystem and how people can lessen their potential for creating additional harmful human disturbance. The information would be delivered through brochures, posters, video, enhancement of school curricula, and other informational media. The materials would be delivered to state and federal visitor centers, state ferries, and cooperating private businesses and organizations throughout the entire spill zone. The project would seek to recognize restoration within the context of the entire ecosystem, rather than through a species-specific approach.

ACTION:

- provide updated summaries of oil-spill injuries and make available to the public;
- produce brochures, posters and other informational products for distribution to local, state and federal visitor facilities throughout the spill zone; and
- consider constructing or supplementing interpretive facilities in oil-spill communities.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Conduct feasibility study in regard to anticipated need, use and sites of any interpretive facilities.

OPTION 34: Establish a Marine Environmental Institute

APPROACH CATEGORY: Other Options

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

Restoration of the oil-spill area will require a long-term commitment by the Trustees. Establishing a marine environmental institute to conduct long-term research and monitoring activities could be a means to foster long-term restoration goals. Any information gained also will serve as an environmental baseline and help guide the use and management of the oil-spill area. The institute could be based in a field station in an oil-spill community. Funding for the institute could come either directly from the joint fund or from an endowment, as described in Restoration Option 32.

ACTION:

- establish and equip a marine environmental science institute.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Evaluation of this option requires consideration of a number of factors. The objectives of such an institute must be established and such questions as funding mechanisms and locations must be reviewed in light of those objectives. The relationships to established academic and research entities must be reviewed thoroughly.

OPTION 35: Replacement of Archaeological Artifacts

APPROACH CATEGORY: Other Options

INJURED RESOURCES AND SERVICES: Archaeological sites and artifacts

BACKGROUND AND JUSTIFICATION:

Important archaeological resources, protected by Federal and State laws, were oiled. At some sites oil continues to degrade the resources, while at other sites increased looting and vandalism are occurring. Since archaeological resources are not inherently restorable, a direct replacement of artifacts may be a logical method to restore the injuries sustained. One method could be to purchase privately-owned artifacts that originated in the region and put them into public collections. Another complementary approach would be to retrieve artifacts removed from the spill zone to public institutions and to actively track down other artifacts that were illegally collected during the spill and subsequent clean-up activity.

ACTION:

- identify institutions and individuals with artifacts from the spill area and offer to purchase specific pieces for public institutions; and

- investigate the incidents of looting and vandalism and strive to regain possession of publicly owned artifacts.

INFORMATION NEEDED TO IMPLEMENT OPTION:

Completion of damage assessment studies will enable managers to more fully understand the effects of looting and vandalism and may help lead to the recovery of illegally taken artifacts.

This section provides a brief description of the rationale for recommending the rejection of some options as follows:

Sea Otters and Harbor Seals:

Option: Supplementing winter foods

The technical feasibility of this option is questionable and the methodology is untested. Prey would have to be distributed over a large area in order to be effective and it would encourage unnatural dependence on the part of the predator. The cost of implementing this option would be extremely high, with only a marginal likelihood of success.

Option: Translocating sea otters or harbor seals to augment injured populations

Although translocating otters and seals is technically feasible, there is a risk of causing further damage to the populations by introducing disease and of impacting the donor population through lost individuals. In addition, there are source populations adjacent to the oil-spill area that will naturally expand as the habitat improves.

Option: Reduce incidental loss through buying back limited-entry gillnet permits

This would be extremely costly and may require legislative permission from the State of Alaska. It is unlikely to result in a population-level increase because the incidental take of sea otters or harbor seals is currently low.

Option: Establish international wildlife rehabilitation/public education center

Rehabilitation of oiled sea otters and harbor seals, while technically feasible, has been relatively ineffective. After heroic efforts to save the hundreds of otters brought to the Valdez rehabilitation center post release survival has been relatively low. There is question in the scientific community whether the additional stress related to capture, transportation and handling may contribute to the mortality in these situations. Costs of rehabilitation are very high, with an upper range of $80,000 per animal. To now create a rehabilitation center would do nothing to restore otter and seal populations impacted by the *Exxon Valdez* oil spill. Although use of restoration funds for education has merit, such efforts do not have to be linked to establishing a wildlife rehabilitation center.

Killer Whales:

Option: Reduce marine debris and expand stranding and entanglement rescue operations

Although this option has been used in other areas to benefit different whale species, it is unlikely to produce noticeable benefits to killer whales in the oil-spill area. Incidents of stranding and entanglement of killer whales in the oil-spill area are rare, and the opportunities to implement rescue operations are limited by the remoteness of the area.

River Otters:

Option: Translocating river otters to augment populations within and outside of the oil spill area

Sufficient source populations exist for natural recolonization to occur. Translocating river otters may result in the introduction of disease into the injured population.

Common Murres and Marbled Murrelets:

Option: Augment natural reproduction through captive breeding, fostering and related techniques

The technical feasibility of this option is unknown because of the difficulty of introducing young murres and murrelets back into the wild. This would have to be done on a very large scale in order to have an effect on the populations. This option would require extensive research, at great cost, in order to determine its effectiveness.

Marbled Murrelets:

Option: Provide artificial nest sites to enhance productivity or redirect nest activities to alternative sites

Marbled murrelets often nest in large trees in old growth forests. If sufficient mature forest remains available, nest sites will not be a limiting factor in recovery.

Harlequin Ducks:

Option: Augment natural reproduction through captive breeding, fostering and related techniques

Although this method has been used effectively for other species of waterfowl, it has not been tested for harlequins. Population problems

within the oil-spill area appear to be contaminant related and cannot be altered by augmenting the population of harlequins.

Harlequin Ducks and Black Oystercatchers:

Option: Mariculture of shellfish to supplement prey base

The cost:benefit ratio of this option is extremely poor. Mariculture operations would have to occur over an extremely large area to be effective, and the birds may still be exposed to oil from other food sources.

Bald Eagles:

Option: Augment natural reproduction through captive breeding, fostering and related techniques

Natural recovery is expected to be adequate when combined with habitat protection measures. Source populations for natural recovery exist near the oil-spill area.

Pink Salmon and Sockeye Salmon:

Option: Control predators on fish eggs and juveniles

This option would be difficult to implement over a large area. It also conflicts with the restoration of other injured species which may rely on salmon for food. Predator reduction may not be consistent with State and Federal laws.

Option: Buy back limited entry fishing permits to reduce pressure on resources

Identical results could be obtained through management practices.

Rockfish:

Option: Construct artificial habitat structures (e.g., artificial reefs)

Habitat does not appear to be a limiting factor in the recovery of rockfish.

Option: Buy back limited entry fishing permits to reduce pressure on resources

Identical results could be obtained through management practices.

Spot Shrimp:

Option: Mariculture and shore/intertidal habitat enhancements

The technical feasibility of this option for supplementing spot shrimp populations has not been demonstrated.

Coastal Habitat:

Option: Erosion control using rip-rap, revegetation and other methods

Shoreline assessment studies and other observations in the field indicate that erosion problems are minimal.

Archaeological (Cultural) Resources:

Option: Inventory beach and upland sites for cultural resources

Potentially injured archaeological resource sites are being surveyed under the damage assessment process.

Option: Encourage oral history and video tape projects concerning regional/local history and traditions

This option is not relevant to the restoration of archaeological resources as specified by the civil settlement.

Multiple Resources:

Option: Assist coastal communities and boat operators with environmentally-sound waste disposal and waste recycling programs

Option: Determine whether old community and military dump sites add to cumulative effects

Option: Reduce chronic oil pollution associated with boats, harbors, and transportation of petroleum

Option: Remove mining and logging debris to minimize cumulative effects of pollution

For any or all of the above options it would be difficult to establish direct linkage to the recovery of injured resources. If such a linkage is established, these options may become appropriate. Meanwhile, public education may be an avenue for addressing chronic pollution problems.

Option: Initiate reforestation programs wherever logging has occurred (e.g. Afognak Island)

The injured species which utilize forested habitats rely primarily on mature forests. For this reason, reforestation practices will not help the near-term restoration of populations injured by the *Exxon Valdez* oil spill.

Option: Establish stronger regulations, improved planning, and better response in order to minimize additional effects from future oil spills

The criminal court settlement provisions allow for expenditures towards planning for, and response to, future oil spills. This option is beyond the scope of the civil settlement. In addition, the Oil Pollution Act of 1990 will require new regulations and contingency planning.

Option: Reduce energy consumption through improved efficiency and conservation

This is beyond the scope of the civil settlement.

Option: Buy back Bristol Bay oil leases

This does not apply to the restoration of resources injured by the *Exxon Valdez* oil spill.

Option: Buy "net operating losses" (NOLs) of timber sales or change laws to disallow NOLs

Legislative action has already disallowed "net operating losses" of timber sales.

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RESTORATION PLANNING
FOLLOWING THE
EXXON VALDEZ OIL SPILL

August 1990 Progress Report

Prepared by the

Restoration Planning Work Group

Alaska Departments of Fish and Game, Natural Resources, and Environmental Conservation;
U.S. Departments of Agriculture, Commerce, and Interior;
and the U.S. Environmental Protection Agency

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CHAPTER I
INTRODUCTION

The March 24, 1989 grounding of the tanker *Exxon Valdez* in Alaska's Prince William Sound caused the largest oil spill in U.S. history. A slick containing about 11 million gallons of North Slope crude oil covered the western portion of the Sound and moved for more than 500 linear miles in Cook Inlet and along the northern Gulf of Alaska. More than 1,000 miles of shoreline were moderately to heavily coated, including state and national forests, refuges and parks. The spill damaged areas extremely rich in natural resources. It injured fish, birds, mammals, intertidal plants and animals and their associated habitats. The area's important historical and archaeological resources also were damaged as a result of oiling, cleanup activities and subsequent incidents of vandalism. The oil also affected recreational opportunities and aesthetic and psychological values.

Soon after the spill occurred, President Bush and Alaska Governor Cowper expressed the desire that the environment and economy of Prince William Sound and the Gulf of Alaska be restored. Full restoration of these natural resources and the services they provide is in turn the responsibility of the federal and state agencies which manage and protect them on behalf of the public. As authorized under federal law, the state and federal governments intend to present claims to the responsible parties for the injuries caused to natural resources and their uses. The funds received from these claims must be used to restore the natural resources and services injured by the spill.

Response, Damage Assessment and Restoration

Federal law provides authority for actions undertaken by federal and state governments following the *Exxon Valdez* oil spill. Section 107(f) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Section 311(f) of the Federal Water Pollution Control Act (Clean Water Act) provide for federal and state officials to act as trustees on behalf of the injured natural resources and to pursue recovery of damages for injury to and loss or destruction of those resources.

CERCLA applies to spills of hazardous substances other than oil, while the Clean Water Act applies to oil spills. Both laws are supplemented by the National Contingency Plan and the Natural Resource Damage Assessment (NRDA) regulations, which set out a suggested, but not mandatory, process for determining proper compensation to the public for injury to natural resources. In combination these laws and regulations provide the structure for the response, damage assessment and restoration activities following the *Exxon Valdez* oil spill.

Restoration is one component of this process. Combined with response and the NRDA, these efforts seek to minimize adverse impacts and compensate the public for natural resource injury and lost use values by restoring the resources and the services they provide.

Response activities include the initial emergency measures to contain the spilled oil and minimize adverse impacts, as well as the subsequent efforts to clean up oil from the spill area. The magnitude of and circumstances surrounding the *Exxon Valdez* oil spill resulted in relatively little of the spilled oil being contained. Consequently, cleanup activity has focused primarily on removing oil from the shoreline areas affected by the spill. At the time of this report, more than one year after the *Exxon Valdez* ran aground, cleanup efforts continue.

State and federal agencies initiated 72 scientific studies after the oil spill to determine the amount of damage. This damage assessment process, which continues in 1990, is designed to quantify the specific resource injuries and determine their corresponding monetary values. This monetary value includes "lost-use" and restoration costs. Claims for these damages will be presented to the responsible parties, and under federal law, the monies received must be used for restoration, replacement or acquisition of equivalent resources.

Definition of Restoration

Restoration follows the spill response and damage assessment process by planning for and, then, implementing activities to help restore the environment. Restoration is specifically defined under the NRDA regulations (43CFR11.14(ll)) as follows:

> "Restoration" or "rehabilitation" means actions undertaken to return an injured resource to its baseline condition, as measured in terms of the injured resource's physical, chemical, or biological properties or the services it previously provided...

Restoration actions fall into three categories - direct restoration, replacement, and acquisition of equivalent resources:

- **Direct restoration** refers to measures taken, usually on-site, to directly rehabilitate an injured resource.
- **Replacement** refers to substituting one resource for an injured resource of the same type.
- **Acquisition of equivalent resources** means the purchase or protection of resources that are the same or substantially similar to the injured resources in terms of ecological values, functions or uses.

In late 1989 an interagency Restoration Planning Work Group (RPWG) was established to develop and coordinate restoration planning activities for the *Exxon Valdez* oil spill.

The goal of the restoration planning effort is to identify appropriate measures that can be taken to restore the ecological health and uses of natural resources affected by the *Exxon Valdez* oil spill. Specific objectives include:

- Identify or develop technically feasible restoration options for natural resources and services potentially affected by the oil spill.
- Incorporate an "ecosystem approach" to restoration (i.e., where appropriate, broadly focus on recovery of ecosystems, rather than on individual components).
- Determine the nature and pace of natural recovery of injured resources, and identify where direct restoration measures may be appropriate.
- Identify the costs associated with implementing restoration measures, in support of the overall natural resource damage assessment process.
- Encourage, provide for and be responsive to public participation and review during the restoration planning process.

RPWG Includes representatives of the following agencies:

Alaska Department of Fish and Game (ADF&G)

Alaska Department of Natural Resources (ADNR)

Alaska Department of Environmental Conservation (ADEC)

U.S. Environmental Protection Agency (EPA)

U.S. Department of Agriculture (DOA)

U.S. Department of Commerce (DOC)

U.S. Department of the Interior (DOI)

(Individual representatives are listed in Appendix A)

Restoration planning leads to implementation of an approved restoration plan. It is important to understand, however, that a full damage assessment is not yet complete. At this time, therefore, RPWG is developing the broadest possible list of potential restoration activities for resources that may have been injured. Once the damage assessment process is complete, appropriate activities will be recommended and incorporated in a detailed restoration plan. Such a plan can be implemented only when restoration funds become available from the responsible parties. The figure on the opposite page gives a generalized overview of the restoration planning process.

This progress report summarizes RPWG activities to date. Public participation programs, the technical workshop, a scientific literature review and the feasibility studies are shown in the figure on the opposite page and described in Chapters II through V. These activities led to development of a preliminary list of potential restoration options that are presented as a series of matrices in Chapter VI. Future restoration planning activities, including the evaluation and selection of restoration options and development of a final restoration plan, are discussed in Chapter VII.

The public is encouraged to comment on this report and to share suggestions for restoration alternatives with RPWG. Additional reports will be prepared later in the process. Address comments and questions to:

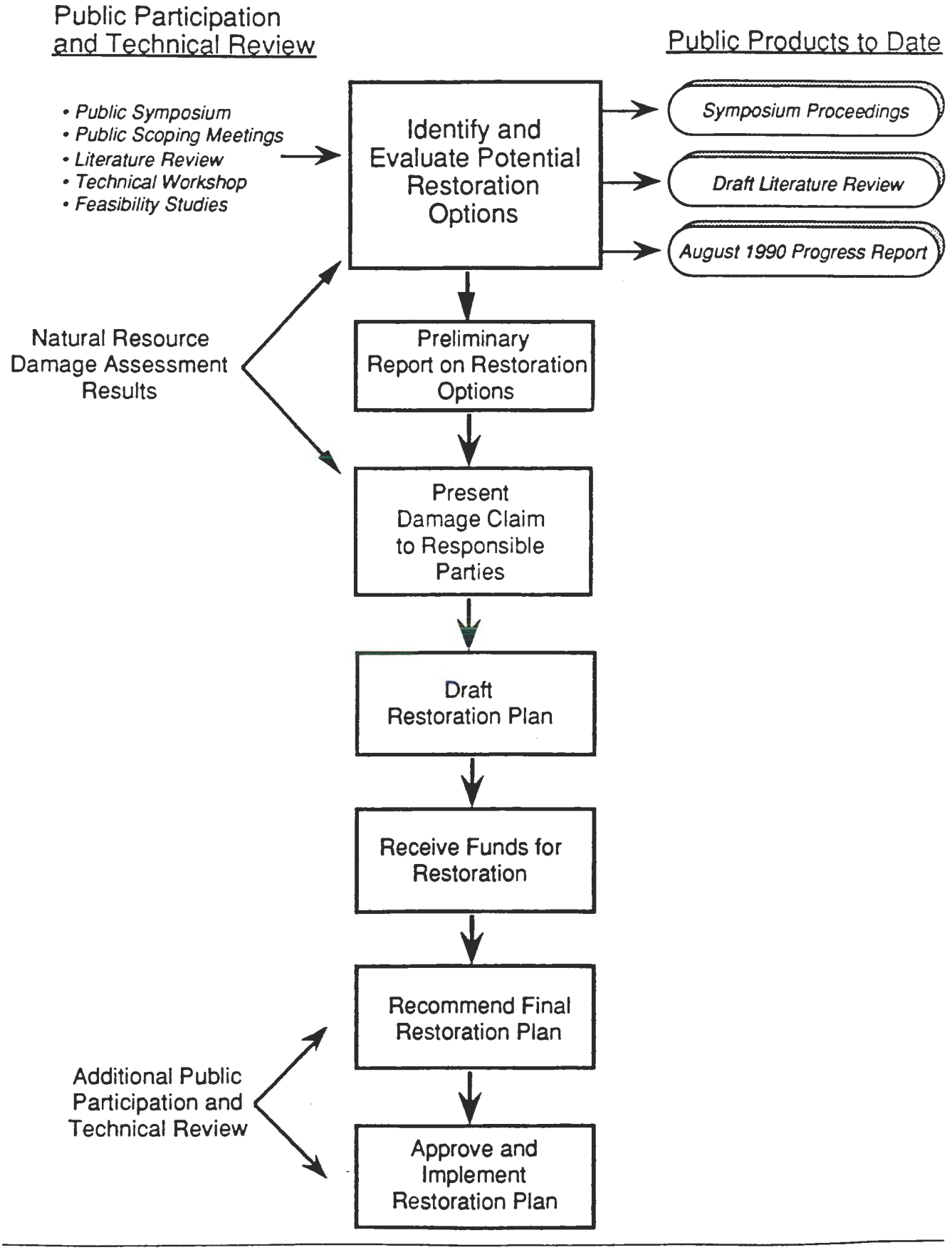
Oil Spill Restoration Planning Work Group

437 E Street, Suite 301

Anchorage, Alaska 99501

(907) 271-2461

THE RESTORATION PLANNING PROCESS



CHAPTER II
PUBLIC PARTICIPATION

The restoration planning process emphasizes public participation. Active public participation provides the greatest potential for long-term benefits in both an environmental and social sense. Just as the spill impacted the social and economic nature of Prince William Sound, Cook Inlet and the Gulf of Alaska, restoration activities also will have social and economic effects. Public involvement throughout the restoration planning process is needed to responsibly balance potentially conflicting biological, social and economic objectives.

Given the importance of public participation, the RPWG began planning a variety of public activities and is continuing to identify ways to incorporate public comments and concerns into the planning process. In March, 1990 a public symposium was organized by RPWG as the first formal opportunity for the public and experts from within and outside of Alaska to express their views about what a restoration plan should entail. The proceedings from the symposium, containing the complete text of speakers' presentations, have been published separately. That report, titled Restoration Following the *Exxon Valdez* Oil Spill: Proceedings of the Public Symposium is available from RPWG.

Soon after the symposium, RPWG initiated public scoping meetings in some of the communities that were directly affected by the *Exxon Valdez* oil spill. The purpose of these meetings was to identify injured resources and restoration options, and to gain a sense of the public's priorities for the restoration program. The communities visited were Cordova, Valdez, Whittier, Homer, Kodiak, Seward, Anchorage, and Kenai-Soldotna. The RPWG is planning to hold additional community scoping meetings in smaller coastal communities, as well as further discussions with individual citizens and interest groups. A limited number of meetings outside of Alaska are also being considered.

The following sections synthesize opinions expressed at the symposium and summarize oral comments from the public scoping meetings and other written comments received to date. These viewpoints should not be construed as representative of the positions or policies of state or federal governments.

The Oil Spill Restoration Symposium was held on March 26-27, 1990 in Anchorage, Alaska. The symposium began with introductory statements by Dennis Kelso, Commissioner of the Alaska Department of Environmental Conservation, and Tom Dunne, Acting Regional Administrator of the U.S. Environmental Protection Agency. These opening remarks described the restoration planning process and its objectives. Three keynote speakers addressed the symposium on legal issues related to the damage assessment and restoration process, experiences with restoration of non-marine ecosystems and public participation in the planning process. A final keynote speaker provided an overview of restoration concepts.

Panel discussions comprised the remainder of the symposium. Sessions addressed direct and indirect restoration of six types of resources: coastal habitats, fisheries, marine and terrestrial mammals, birds, recreational uses and cultural resources. Panelists included experts on restoration in each of these six resource types, as well as representatives from various resource user groups, Alaska Native corporations, public land managers, environmental interest groups and the timber and tourism industries. All panel sessions included opportunities for questions and comments from the public, and an extended public comment session took place at the end of the symposium.

Restoration concepts and ideas discussed at the symposium can be grouped into three categories: broad restoration approaches and philosophies; recommendations for public participation during the restoration planning process; and, ideas addressing restoration of specific resources (i.e., fisheries, mammals, cultural resources, etc.). There was consensus among speakers and attendees that more specific comments on restoration cannot be given without public access to NRDA results. Major points from the symposium discussion are summarized below.

Broad Restoration Approaches and Philosophies

Most speakers called for a holistic, ecosystem approach to restoration. Such an approach will help ensure that the restoration program addresses the integrity of the environment and its many functions, uses and values. Without consideration of the ecosystem as a whole, a variety of impacts could be missed entirely.

Many speakers called for an assessment of the oil spill in terms of cumulative effects, both short- and long-term. They recommended long-term monitoring and research efforts to follow any restoration effort. An environmental trust fund was suggested by many as a way to ensure funding for long-term ongoing research and monitoring activities. A monitoring and research program was seen as critical for detecting subtle or long-term impacts that might not be apparent through the relatively short-term studies being conducted for the NRDA.

Many symposium participants expressed a strong preference for the use of restoration funds within the spill area or, at a minimum, within the state. There were some suggestions, however, that funds be used out of state in order to restore migratory resources harmed within the spill area. In addition, the need to use native fish stocks and species in any rehabilitation efforts was stressed.

One speaker strongly recommended that restoration be limited to the physical removal of oil, and that nothing else should be done so that nature could take its course. This speaker was concerned about the possibility of doing more harm than good through human intervention, and he emphasized the ability of the marine environment to recover naturally.

Many viewed the oil spill and subsequent restoration program as an opportunity to raise public awareness concerning oil spill prevention measures and changes in national energy policies and laws. There was consensus on the need for increased environmental education and natural resource interpretation to encourage better protection of those resources that were damaged by the spill. A specific idea was to establish a public restoration interpretive center. One person stressed that the public needs to be informed about the complexities of ecosystem relationships and the slow processes of recovery, and that this educational effort should be a continual and integral part of the restoration process.

Public Participation and the Planning Process

In general, many people felt that the public participation process needs to be refined based on past experience in the State of Alaska. The process itself should be as simple and flexible as possible, and not become overly bureaucratic. Speakers urged that the restoration process should foster cooperation and trust among scientists, government agencies and the public. In this sense, public participation was seen as an essential aspect of restoration planning, crucial to recognizing differences in social, ecological and cultural values throughout the spill area.

Several people suggested the formation of a citizen advisory committee to oversee public involvement. It was recommended that local input should be encouraged so that residents' knowledge of the affected area is not overlooked. It was also emphasized that Native Alaskans' interests must be met in the public process.

Many speakers expressed frustration that most NRDA information has not been made available to the public. Further, that which has been available has been conflicting and, therefore, counterproductive. Several people explained that the public cannot be expected to get involved without adequate information. It was recommended that the news media be contacted more often to better inform the public about the restoration effort.

Finally, several people commented that the advertising for the symposium was inadequate. One person suggested that such public forums should be held during nonbusiness hours to encourage maximum public involvement. A public meeting in Anchorage following the publication of the symposium proceedings was also suggested.

Specific Restoration Ideas

While one speaker strongly recommended that restoration actions be limited to the physical removal of oil, others supported an active restoration effort and presented ideas regarding specific resources.

Several ideas involved the rehabilitation of habitat. For example, beach rye grass could be reestablished in coastal areas affected by oil and cleanup activity, both to aid habitat recovery and to help prevent erosion. Actions to recover an existing fishery might involve increasing habitat complexity (e.g., addition of spawning channels) or enhancing food supply (e.g., lake fertilization). Active habitat restoration for birds might include enhancing productivity and survivorship through improvement of food sources and manipulation of habitats. One specific recommendation to enhance the island nesting habitat of seabirds was to reduce predators, specifically foxes, that had been introduced in past years as part of the fur trade.

In addition to habitat rehabilitation, efforts to accelerate recolonization may be appropriate for some species. It was stressed that recovery of the habitat must be assessed before species replacement occurs. An example of a recolonization effort is the use of hatchery and aquaculture techniques to help preserve wild populations of fish and shellfish. Reestablishing seabird colonies by reintroducing individuals in affected areas was also suggested. However, relocation of some marine mammal species, particularly seals and sea lions, was not recommended due to past experience showing that these marine mammals often attempt to return to the areas from which they were removed. Some noted that Prince William Sound may be well suited to natural recolonization from nearby populations.

Most speakers agreed that minimizing further disturbance from human activities was important for restoration of all injured resources and uses. This idea applied to bird nesting sites as well as marine mammal rookeries and haulouts. Many people felt that restoration funds should be spent to increase enforcement of existing laws prohibiting human disturbance due to hunting or poaching, violations of buffer distances or illegal fishing practices. Someone questioned whether local resource users will accept any changes in hunting and fishing policies that might result from restoration efforts. Many agreed that promoting nonharmful fishing methods both in Alaska and on a national and international level was important.

Most recreational use of the oil spill area is closely related to natural resources. Therefore, most speakers on the topic of recreation called for active restoration of recreational services through ecological restoration. A common theme was the need for protection of the land and changes in management policies to facilitate recovery. It was stressed that unified promotion was needed for Alaska tourism, since the public is getting mixed signals regarding the nature and extent of damages from the oil spill.

Archaeological sites need protection during cleanup and restoration activities, as well as possible stabilization through traditional archaeological restoration techniques, which should be compatible with the surrounding natural environment. In general, all speakers agreed that sensitive cultural resources should be restored with maximum participation of

Alaskan Native land managers and village representatives. Also, there is a strong need to address subsistence lifestyle issues, including obtaining more information on subsistence as an economy.

Almost all speakers agreed that a good way to help speed recovery for many resources would be through land protection. Most referenced direct acquisition of critical or important habitat, particularly in the case of marine mammals and birds. This included preservation of shoreline buffer strips in timber harvest areas to maintain water quality and protect breeding and other habitats important to wildlife.

Most often land protection was suggested as a way to acquire equivalent resources. For example, one recommendation was to acquire wetlands adjacent to the Kenai River, which is a prime salmon-producing river currently threatened with development. Many alternatives for this type of habitat protection were mentioned including direct acquisition, purchase of timber rights or oil lease options, as well as establishment of new wilderness areas, conservation easements, cooperative land management agreements and habitat conservation tax credits. Establishment of a rotating fund similar to that used by The Nature Conservancy was supported by many participants. Experts in land management stressed that these options may have social and economic impacts, which also must be assessed. Most attendees agreed that land acquisition outside the State of Alaska should be a last resort. The use of some type of endowment fund to support long-term acquisition and enhancement of natural resources was also supported.

Summary of Local Public Scoping Meetings and Written Comments

The public scoping meetings were held in the evenings in the larger communities directly affected by the oil spill (see table below). Presentations were made by members of the RPWG on the legal framework for restoration. Descriptions of the three basic categories of restoration (direct restoration, replacement and acquisition of equivalent resources) were given.

Initial Public Scoping Meetings

Location	Date	Location	Date
Seward	April 16	Cordova	April 17
Kenai/Soldotna	April 17	Homer	April 18
Valdez	April 18	Anchorage	May 17
Kodiak	May 21	Whittier	May 31

Summary of Public Comments

This summary includes comments voiced at the scoping meetings, and written comments received from the public during the period from April through June, 1990. The community(s) from which the comment originated is listed in parentheses after each comment. An asterisk (*) following the community name indicates that it was a written comment.

Prevention

- Use restoration funds for prevention of future oil spills. (all towns)
- Install a satellite communications system for research-response vessels to quickly direct the vessels to remote spills. (Homer)
- Establish a legislative action trust fund. (Kodiak)
- Establish a harbor authority to regulate and monitor vessels. (Anchorage)
- Provide public education for all ages about laws and regulations of oil exploration and transportation so that everyone understands the pitfalls prior to another accident. This will support informed voting and lobbying and thus prevent more oil disasters. (Homer*)

Cleanup

- Conduct special cleanup activities that minimize the impact on the beaches and enhance natural restoration in pristine areas. (Homer)
- Fund local research on cleanup and restoration techniques. (Homer)
- Clean and restore oiled recreation areas that have been scheduled for "no treatment." (Whittier)
- Do not begin restoration until cleanup is completed in accordance with local and Native Alaskan land manager standards. (Whittier)
- Determine effects of oil and effectiveness of different cleanup techniques in different ecosystems as a first step. (Anchorage)
- Discontinue removal of oil-injured sea otters and birds; let them die in peace. (Homer*)
- Stop the use of Inipol fertilizer. (Kodiak, Homer*)
- Use less disruptive cleaning techniques on previously untouched coastlines. (Homer*)
- Continue to clean beaches and areas of impact; however, use research information to identify most efficient and least toxic methods. (Homer*)
- Remove loads of garbage from Exxon and volunteer cleanup sites. (Homer*)
- Thoroughly clean areas; indications that biologists and Exxon officials say that everything is all right are upsetting. (Homer*)

- Clean up all bays that trap and hold oil, such as Herring and Marsha Bays on Knight Island, Nuka Island Passage and Knight Island Passage. Conduct physical removal and replacement of heavily oiled beaches and continue use of bioremediation. (Seward*)

Natural Resource Damage Assessment

- Delay restoration planning until data from the damage assessment studies are available. (Cordova, Homer, Anchorage)
- Provide sufficient government funds to carry out adequate damage assessment. (Cordova)
- Monitor Exxon's damage assessment activities to assure quality. (Cordova)
- Support and implement fishery studies for the Kenai Peninsula that have been cancelled from the NRDA program. (Homer)
- Guarantee that damage assessment and research information be available to the public so that restoration can be planned accordingly. (Homer*)

Research and Monitoring

- Set aside ecosystem research areas, establish long-term research for baseline information, and allow no public use. Fund long-term monitoring and research. (Seward, Cordova, Valdez, Homer, Kodiak)
- Establish a trust fund for long-term restoration, recovery, acquisition and enhancement projects. (Homer, Kodiak, Whittier)
- Involve local people in monitoring to restore public trust. (Whittier)
- Provide in-the-field research and monitoring vessels to combine research, recovery, restoration and prevention. (Homer)
- Study effects of boat distance from eagles and seal haulout and pupping areas, etc.. Then, educate the public. (Valdez)
- Fund research on whales, Dall and harbor porpoises, as well as the impacts of hatchery fish on wild stocks. (Valdez)
- Fund research on impacts of fishing and oil on sea lions. Fund research to identify the cause of sea lion population decline. (Homer)
- Identify subsistence lifestyle impacts and make information about food quality more available. (Kodiak)
- Conduct river otter research for outer coast of Kenai Peninsula and Islands. (Homer*)
- Study salmon internal organs for toxic effects of crude oil. (Homer*)
- Study the ocean floor where dispersants were used. (Homer*)

- Provide useful research and information through regional institutions, such as The Prince William Sound Science Center. (Cordova*)
- Quantify loss of fish rearing habitat to the maximum extent possible and restore areas to their historic fish production levels and environmental state. (Homer*)
- Carry out research and monitoring in backwater marshes and lagoons. (Port William*)
- Continue studies on impacts to sockeye salmon in Cook Inlet so that the damage to fisheries resources will not go unobserved. Both commercial and sport fisheries are the backbone of Alaska's economy and lifestyle. (Soldotna*)

Natural Recovery

- Keep in mind that people may not be able to accept John Teal's comment, at the public symposium, that the best thing we can do to restore coastal habitats is to do nothing. (Cordova)
- Avoid physical restoration; better to leave the Sound alone. Do not establish permanent research stations and boat moorings that will increase public use. (Valdez)
- Be aware that natural processes will be largely responsible for restoration; it will take decades. Do not be deceived into believing that restoration can be accelerated substantially through the expenditure of large amounts of money. (Fairbanks*)
- Need to closely monitor the changes that will be taking place over time. (Fairbanks*)

Management Practices

- Limit human use when and where it competes with wildlife for the reduced number of non-oiled beaches. (Cordova, Anchorage, Valdez)
- Limit use of recreational areas previously used by relatively low numbers of people, such as the outer coast of the Kenai Peninsula. Discourage use through tourism boards. (Homer*)
- Manage increased use of areas of the Sound introduced to many people during cleanup - this increased use could have greater long-term impact than the spill. (Cordova)
- Provide increased protection of archaeological sites. Return artifacts removed by Exxon archaeologists. (Kodiak)
- Be careful not to increase impact with replacement projects, such as building new public-use cabins in non-oiled areas. (Anchorage)
- Support tree planting efforts in areas which have been or will be logged, for example, Afognak Island. (Homer)
- Replant forests to make up for *Exxon Valdez* paperwork. (Whittier)

- Harvest rockweed in non-oiled areas and supply as feed for deer in oiled areas during the winter season. (Whittier)
- Remove introduced predators at seabird nesting colonies to enhance recovery of these colonies. (Homer)
- Manage recreation to reduce human impacts, for example, expand existing facilities rather than construct new facilities. (Homer)
- Change fish and game regulations to curtail human-use impacts on the Sound. (Valdez)
- Shift orientation of the Alaska Department of Fish and Game from consumptive use and harvest; shut down fishing seasons in the Sound for at least two to three years; and, close the river otter and mink trapping season. (Valdez)
- Begin restoration work this year; by the time lawsuits are settled it may be too late to take effective actions. (Anchorage)
- Purchase some limited entry permits to reduce pressure on fishery resources and protect marine mammals and birds. (Anchorage, Cordova)
- Protect humpback and orca "rubbing" beaches on Perry and Knight Island. (Valdez)
- Designate the Sound as a national monument. (Valdez)
- Stop oil exploration and development in the Arctic National Wildlife Refuge. (Homer*)
- Stop offshore and coastal drilling. (Homer*)
- Sacrifice some areas to heavy use so that other areas can be preserved. (Valdez)
- Limit additional commercial development in the Sound; it is already overused. However, must also find some way to provide more economic opportunities for Native Alaskan communities. (Valdez)
- Preserve timbered slopes to protect marbled murrelet nesting areas. (Homer)
- Provide funding to state parks for managing increased numbers of tourists. (Homer*)
- Keep open a National Park Service office to provide information on Katmai. (Kodiak)
- Prohibit state land sales in Iliamna area and create a new wildlife refuge. (Anchorage)
- Restrict logging, mining and fishing in Prince William Sound. (Anchorage)
- Keep areas such as Passage Canal and Port Wells as stocking, natural areas to help repopulate the more damaged adjacent areas. Close or limit drag fishing. (Anchorage).
- Ban hydroelectric development at Nellie Juan. (Whittier)

- Require logging and oil companies to provide restoration plans before conducting their activities. (Whittier)
- View the vast Gulf of Alaska as a limited resource to be protecte (Homer*)
- Discourage mountain bike use in the outer coast of the Kenai Peninsula. (Homer*)
- Discontinue selling lumber to Japan for use as computer paper. (Homer*)
- Discontinue forest destruction for the benefit of few; monopolization of resources should become less profitable. (Homer*)
- Support legislative action for :

  - Statutory state and federal habitat protection for critical habitats, as well as marine and estuarine sanctuary and wilderness designations;

  - Restrictions on development activities that could have a negative impact on the recovery of habitat and wildlife populations in oil-affected areas. (Valdez*)

- Organize agency survey work in small, efficient teams to avoid distress of wildlife. Consult knowledgeable, local residents on safety, operations and damage information advice. (Kodiak*, Port Williams*)
- Provide immediate and complete restoration to fisheries se sites in the Sound, especially Main Bay. Complete restoration bird rookeries in the Sound and the Barren Islands. (Seward*)

Public Information

- Dispel fears of tourists and subsistence users by providing information on contamination or lack of contamination: use direct mail to registered voters, work with state tourism groups and contact journalists outside Alaska. (Kodiak)
- Provide substantial funds for the Seafood Marketing Institute to redevelop damaged markets. (Homer*)
- Mail information flier to all area residents. (Cordova)
- Make the literature review available to local libraries; acquire the most relevant publications. (Valdez)
- Provide information to help restore fish markets devastated by the Exxon spill. (Homer*)
- Keep the public fully informed of what is involved in restoration of the areas affected by the spill. Stress the complexity of ecosystem relationships affected by the spill and the slow processes of recovery. It is important for a public information program to be an integral part of the restoration plan. (Fairbanks*)

- Establish a unified tourism information program; the various tourism groups and chambers of commerce should work together. ADEC and ADFG information has been damaging to tourist perceptions in Shuyak Island area; authenticated information, not rumors, is needed. (Port Williams*, Kodiak*)
- Contact oil-affected area residents concerning food sample analyses. Fear of tainted meat and other foods is rampant and responses have not been received from agencies regarding requests to analyze samples. (Port Williams*, Kodiak*)

Hatchery and Enhancement Programs

- Favor commercial species to help restore economic activities. (Cordova)
- Construct new salmon hatcheries and carry out enhancement programs, such as lake fertilization. (Homer*)
- Expand existing hatcheries to prevent further impacts to wilderness. (Homer)
- Carry out stream enhancement work in areas where salmon fry are dying. Bring closed state hatcheries on line for replacement. (Kodiak)
- Use available wild-stock enhancement techniques where wild stocks have been affected; do not add hatchery stocks. (Homer)
- Direct replacement efforts towards halibut and black cod. (Whittier)
- Reestablish fish and wildlife to affected areas using NRDA information and services of governmental and private conservation groups. (Homer*)
- Continue maintenance and operation of the Fisheries Rehabilitation, Enhancement and Development (FRED) Division projects in outer Kenai Peninsula area. These facilities also can be used for incubation and reintroduction of salmon fry and smolt to areas that have become barren due to oil in the intertidal areas and salmon spawning beds. (Homer*)
- Do not favor hatcheries due to negative impacts to wild fish and cost of hatchery programs. (Cordova, Valdez)
- Fund the Paint River fish ladder and stocking program. (Homer*)
- Fund the Chalatna Lake Stocking Program. (Anchorage*)

Facilities

- Fund underutilized facilities, such as the Institute of Marine Sciences, instead of new facilities, such as the Prince William Sound Science Center. (Seward)
- Enhance existing facilities to further oceanographic research. Enhance or create educational institutions and public ocean information centers. (Homer)

- Establish a local laboratory where subsistence users can bring tissue samples for analysis at affordable prices. (Kodiak)
- Form an international wildlife rehabilitation center in the Gulf of Alaska. (Anchorage*)

Education

- Restore public trust in the oil industry and resource agencies; suggestions were: change resource management practices and use ad campaigns to show the public what is actually happening. (Seward)
- Support public education, such as forums about oil spills, environmental protection and energy conservation programs run by paid volunteer coordinators in spill areas. Hire a contractor to go to schools. (Seward, Homer)
- Fund production of a Prince William Sound Conservation Alliance brochure to educate boaters on environmental protection. (Valdez)
- Expand oil-spill curriculum developed in Cordova to include information on restoration and oil spill prevention. (Valdez)
- Provide library materials. (Kodiak)
- Provide "talking" guides and fliers to tour-boat operators to explain to visitors the importance of maintaining distance from wildlife. This would reduce pressure on captains to take people closer to wildlife. (Valdez)
- Publish a booklet "50 Simple Things You Can Do to Save the Sound." (Valdez)
- Fund the traveling exhibition entitled "Darkened Waters" for display throughout the United States. (Homer*)

Local Economies

- Hire local personnel for restoration projects to increase public trust. (Seward)
- Hire Native Alaskans to clean oil from beaches on or near the culturally significant areas identified by the Chugach Corporation. (Wasilla*)
- Benefit the entire community by proceeding with environmentally-based financial and economic restoration. (Kodiak)

Acquisition

- Acquire development rights along the Kenai River to retain its fisheries productivity and map the Kenai River drainage for baseline management information. (Kenai)
- Acquire timber rights in the Sound and Kodiak; there are willing sellers. Action should be taken soon, before valuable tracts are gone. (Cordova, Kodiak, Anchorage)

- Acquire timber rights: 300+ foot buffer zone around streams and areas visible from the coast; buy inholdings or timber rights that are within the state and national parks; buy net operating losses (NOLs) of timber sales; support a change in the law to prevent further sale of NOLs. (Homer)
- Purchase or buy back permanent logging rights for habitat protection of salmon streams. (Homer*)
- Create an Iliamna wildlife refuge by purchasing conservation easements on private Native land. (Anchorage)
- Protect marbled murrelets by purchasing lands bordering Kachemak Bay that are proposed for logging in the immediate future. (Homer*)
- Purchase wetlands and development rights adjacent to the Kenai River and complete inventory and mapping of wetlands adjacent to the river. (Soldotna*)
- Select acquisition of equivalent resources because that is the most cost-effective option; if oil remains, restoration and replacement activities are likely to be a waste of money. (Cordova)
- Strike a balance between loss of intrinsic values, use and habitat; people are skeptical that there are many direct restoration projects that can be done. (Anchorage)
- Acquire resting and breeding (haulout/rookery) areas for sea lions and seals. (Cordova, Homer)
- Acquire and protect otter and mink denning areas which require more than streamside habitat. (Valdez)
- Research, acquire and protect nesting and roosting habitat for lesser and greater yellowlegs, great blue herons, marbled murrelets and yellow-billed loons. (Valdez)
- Acquire private lands where there are seabird colonies. (Homer)
- Research and acquire migratory bird habitat along the Pacific flyway; become involved in an international effort to protect habitat in South American countries. (Homer)
- Acquire private lands on Middleton Island. (Homer)
- Restore the wilderness experience by acquiring new, unspoiled areas. (Homer)
- Retain upland old-growth forest for deer so further loss of their food base does not occur. (Anchorage)
- Allow a tax write-off in return for a conservation easement; call it a net operating loss. Require the spiller to purchase the easement soon after the spill. (Anchorage)
- Establish national and international protected wetlands for birds. (Homer*)
- Provide major funding for Save the Rainforest International. (Homer*)

- Acquire Gull Island in Kachemak Bay for management by the U.S. Fish and Wildlife Service to protect murres. (Homer*)
- Support habitat acquisition from private land owners. (Valdez*)
- Acquire lands in the Sound to set aside as wildlife refuges, especially bird and sea lion rookeries. Give protection status to Barren Island group, Gore Point, Ruggles Island and Cape Fairfield. (Seward*)

Other Sources of Contamination

- Remove mine tailings and mining and logging debris in and around the Sound. (Cordova)
- Take inventory of and clean up old dump and military sites. (Kodiak)
- Eliminate use of plastics. Clean up plastics. (Cordova, Homer)
- Use restoration funds to educate skippers, provide garbage tenders for at-seas collection, fund municipal recycling programs (especially for oil), set up small local response teams to deal with small spills. There is concern about the gradual decline in environmental quality in the Sound owing to marine pollution such as dumping of oil, fuel and garbage from boats. Several participants felt that prevention of further damage is important so that the natural healing capacity of local ecosystems would be enhanced. (Valdez)
- Provide financial assistance to communities for waste-disposal facilities. (Valdez, Homer, Anchorage, Kodiak)
- Research more efficient ways to use energy. (Valdez)

Funding

- Match restoration funds with agency monies to operate monitoring programs, which would be run in a cooperative format by agencies or through a contractor. (Seward)
- Spend money now and obtain reimbursement from damage claim funds when available. (Anchorage)
- Buy back Bristol Bay oil leases with federal monies received from lease sales rather than from restoration funds. (Anchorage)
- Tax state residents and oil producers to develop a restoration funding source. (Anchorage)
- Use funds in oil-affected areas only. (Kenai)
- Manage trust fund so that money will be available 20-50 years from now when coastal habitats are healthy enough to support restoration activities. (Cordova)
- Guarantee that state lawsuit monies will be applied to restoration. (Anchorage)

- Settle out of court and get on with restoration; litigants will be far apart on monetary value. (Anchorage)
- Set up a fund for mitigation of wetlands in the affected zones. (Kenai)
- Guarantee that the restoration fund is regenerating itself with interest or the money will be gone in six months. (Homer*)
- Restrict expenditures of restoration monies to:

  - Restoration and/or protection in oil-impacted area;

  - Restoration and/or protection outside the of the area for species which depend on oil-impacted area;

  - Assessment and research of resident or migratory species using oil-impacted zone; and,

  - Development of educational displays to inform public about effects of oil on the marine environment and prevention of oil spills. (Valdez*)

- Discourage use of funds for construction or development projects, such as mooring buoys, tent platforms, marine parks facilities, land-based research stations and hatcheries in undeveloped oil-affected areas. (Valdez*)
- Support a restoration endowment fund to assure the long-term availability of monies dedicated to enhancement of the natural environment affected by the spill. (Fairbanks*)

Public Involvement

- Meet to review recommendations with regional planning and advisory groups. (Kenai, Whittier)
- Include different interest groups in local advisory boards; let the groups submit lists of recommended representatives; select carefully, based on references. (Valdez)
- Set up meetings in Native Alaskan villages. It is important to get Native Alaskan viewpoints on restoration and economic diversification. (Anchorage, Whittier)
- Hold more discussions of environmental issues in coastal communities. (Homer*)
- Contact landowners, business operators and residents located in the Sound itself. (Cordova*)
- Mandate citizen and industry advisory process to reduce potential for the restoration process to go awry. (Anchorage*)
- Coordinate oil spill restoration with local people and Alaskan Natives. These people should have as much or more input and decision-making power as the "professionals." (Anchorage*)
- Provide access to the NRDA Trustees. (Kodiak, Homer, Whittier)
- Use science rather than politics to guide decisions. (Anchorage)

CHAPTER III
TECHNICAL WORKSHOP

To gather scientific input for the restoration planning process, a technical workshop was held April 3-5, 1990 in Anchorage, Alaska. The three-day workshop provided the first opportunity for a general exchange of ideas on restoration among scientists and resource managers. This workshop was closed to the public because litigation-related damage assessment information had to be discussed.

Participants in this workshop included members of RPWG, federal and state resource managers, investigators conducting damage assessment studies and technical experts from academic institutions or the private sector. These technical experts were selected based on their experience in restoration of natural resources or their knowledge of a particular resource (e.g., marine mammals). Most participants had direct experience with these resources in Alaska.

Results of Workshop

Workshop participants identified potential restoration projects and discussed these ideas in terms of effectiveness, feasibility and applicability to the spill area. An overview of available damage assessment results helped guide the discussions.

The workshop was divided into six sessions: coastal habitat, fish and shellfish, birds, terrestrial and marine mammals, cultural resources and recreational uses. Each of the sessions discussed restoration alternatives which might be effective in addressing potential injuries to particular resources. The groups were instructed to identify a broad range of restoration options. The matrices in Chapter VI - Development of Restoration Options reflect the potential restoration alternatives discussed at the technical workshop.

To address uncertainties about the effectiveness of specific restoration options, workshop participants developed a list of potential feasibility studies or demonstration projects. These studies were designed to evaluate candidate restoration alternatives for their likely effectiveness, feasibility and applicability to the spill area. Projects which were subsequently initiated during the summer of 1990 are described in Chapter V - Feasibility Studies. In addition, workshop participants identified other information needs that may be helpful to the development of a comprehensive restoration plan.

CHAPTER IV
LITERATURE REVIEW

A review of scientific literature is one of the first steps in any environmental planning effort. Relevant literature supports the planning process by identifying approaches that have potential for success, as well as actions to avoid. Although it is expected that relatively few "off-the-shelf" oil spill restoration techniques will be identified for sub-arctic application, it is recognized that a variety of approaches to restoration have been developed to address different types of environmental disturbances. Some of these may be useful for restoration following the *Exxon Valdez* oil spill.

A preliminary computerized literature search focusing on potential ecological restoration techniques following oil spills was one of the first activities conducted by RPWG. Also a computerized search of literature on restoration of cultural resources and recreational uses is planned. This chapter summarizes our initial literature review. Appendix B lists the most pertinent references identified. A report listing all identified references, with abstracts, will be available from RPWG.

Search Criteria

The initial literature search sorted several computerized databases. Each database contained references from several different publications. Sorting was done by specifying subject identifiers or "keywords". Only references containing the chosen keywords were listed. Those databases searched and the specific keywords used are shown in the following tables.

LITERATURE DATABASES SEARCHED

Databases	Dates of References
Aquatic Science Abstracts	1978-1989
BIOSIS Previews	1969-1990
Environmental Bibliography	1974-1989
ENVIROLINE	1970-1989
Pollution Abstracts	1970-1990
NTIS	1964-1990

INITIAL SUBJECT IDENTIFIERS AND KEYWORDS

- Oil, crude oil, petroleum, fuel oil, gasoline or oil spill
- Restore, establish, reestablish, replant, rehabilitate, create, build, mitigate or construct(ion)
- Recover(y) or succession
- Ecologic effect, ecologic impact, biological impact, aquatic impact, terrestrial impact, environmental impact or environmental effect
- Marine, estuarine, salt marsh, ocean, beach, shore, tidal, subtidal, intertidal or reef
- Reservoir, lake, stream, marsh, river, wetland or freshwater
- Habitat, seagrass, eelgrass, algae or macroalgae

Results

After deleting citations that were not directly relevant, the computerized literature search produced a list of approximately 450 publications. The RPWG then reviewed these titles and abstracts, and identified approximately 200 of the most relevant publications for acquisition and detailed review. Articles were selected based on several information needs, including:

- Techniques potentially applicable to sub-arctic conditions;
- Restoration of the same resources as those that may have been damaged by the *Exxon Valdez* spill;
- Creation of new aquatic habitats (by dredge-and-fill techniques, construction of artificial reefs, etc.);
- Success of organisms grown in or transplanted to oil-contaminated substrates;
- Approaches and techniques for long-term monitoring studies.

The selected documents are listed in Appendix B.

The literature search conducted to date is only a preliminary one, and environmental restoration is a growing field. Consequently, literature review will be a continuing aspect of the restoration planning process. Future efforts will include reviews of accessible government documents and other "grey" literature.

CHAPTER V
FEASIBILITY STUDIES

Feasibility studies are used to evaluate the practicability of restoration techniques in cases for which there is uncertainty of success or benefit, given the particular species and environment within the oil-spill area. Such studies also help determine the cost of implementing full-scale restoration projects and help evaluate associated environmental impacts and benefits.

Many ideas for restoration projects have been suggested—and continue to be suggested—as a result of public participation and technical consultations. Evaluating these ideas will be a long and involved process, and it is important to move quickly to test promising methods for which the technical feasibility is in question.

Five Restoration Feasibility Studies are currently in progress. Factors considered in selecting these studies included:

- Relationship to NRDA studies and injured natural resources;
- Identified public concern;
- Ability to implement the study in time for the 1990 field season;
- Reasonable likelihood of success; and,
- Cost relative to the funds available for feasibility studies.

Of the five Restoration Feasibility Studies, three concern direct restoration of intertidal and supratidal shoreline communities. The remaining two support acquisition of equivalent resources. The 1990 Restoration Feasibility Studies are summarized below and will be described in more detail in the 1990 State/Federal Natural Resources Damage Assessment Plan for the *Exxon Valdez* Oil Spill. It is anticipated that additional feasibility studies will be conducted in 1991; however, implementation of future feasibility studies is subject to the availability of funds. Also, note that feasibility studies are conducted to assess techniques for which there is uncertainty of success. Therefore, feasibility studies alone may not reflect the mix of restoration projects that will be recommended in a restoration plan.

Restoration Feasibility Study Number 1: Reestablishment of *Fucus* in Rocky Intertidal Ecosystems

Species of the marine alga *Fucus* are critical structural components of the intertidal ecosystem on rocky shores in the oil spill area. Qualitative evidence indicates that *Fucus* was damaged by both the spilled oil and cleanup efforts. If the natural recovery of *Fucus* can be enhanced through the dispersal of spores or transplants, it will benefit the associated flora and fauna on intertidal rocky shores. This study will involve field tests to develop and demonstrate the feasibility of a *Fucus* restoration project and will document the natural recovery of *Fucus* under various conditions. The U.S. Environmental Protection Agency is the lead agency.

Restoration Feasibility Study Number 2: Reestablishment of Critical Fauna in Rocky Intertidal Ecosystems

Certain faunal species are key components of intertidal rocky ecosystems. Examples include grazers, such as limpets (e.g., *Diodora*), and predators, such as starfish (e.g., *Leptasterias*). Recolonization rates for these organisms, and for the alga *Fucus*, may limit the natural rates of recovery for entire communities. This feasibility study will compare the rates of recovery in communities with and without such species as limpets, and will evaluate techniques for enhancing recolonization rates. The U.S. Forest Service is the lead agency.

Restoration Feasibility Study Number 3: Identification of Potential Sites for Stabilization and Restoration with Beach Wildrye

Beach wildrye (*Elymus mollis*) was affected by both spilled oil and cleanup activities, and is extremely important in the prevention of erosion in the coastal environment. Erosion can lead to the destabilization and degradation of cultural and recreational sites and wildlife habitats. There are well established techniques for restoring rye grasses on coastal dune systems. This study will identify sites at which damage has occurred and restoration activities appear to be feasible. The Alaska Department of Natural Resources is the lead agency.

Restoration Feasibility Study Number 4: Identification of Upland Habitats Used by Wildlife Affected by the Oil Spill

A variety of marine birds, waterfowl and other bird and mamma lian species were killed by the spill or injured by contamination of their prey and habitats. Many of these species are dependent on

aquatic or intertidal habitats for such activities as feeding and resting, but they also use upland habitats in forests, along streams or above the tree line. Through the public scoping process and technical consultations, many people have suggested that protection of upland habitats from further degradation may be an important way to help wildlife recover from the effects of the oil spill. This study will explore the linkages between wildlife affected by the oil spill and upland habitats, focusing in 1990 on marbled murrelets (*Brachyramphus marmoratus*) and harlequin ducks (*Histrionicus histrionicus*). The U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game are the lead agencies.

Restoration Feasibility Study Number 5: Land Status, Uses, and Management Plans in Relation to Natural Resources and Services

Through the scoping process, members of the public have suggested a wide variety of projects to acquire the equivalent of injured resources. Examples are the acquisition of timber or development rights, conservation easements, recreational and cultural sites, inholdings within state and federal areas and buffer strips along streams and coasts. Habitat protection may also be the best means of providing for the long-term restoration of wildlife populations. To begin identifying and evaluating potential restoration projects of this type, this study will summarize existing information about the current status, uses and management plans of both public and private lands. The Alaska Department of Natural Resources is the lead agency.

1990 Technical Support Projects

Three Restoration Technical Support Projects are also being carried out in 1990. The first project will support development of detailed plans for potential feasibility studies in 1991, including, but not limited to:

- "Natural recovery" monitoring;
- Pink salmon stock identification;
- Herring stock identification/spawning site inventory;
- Artificial habitat construction for fish and shellfish;
- Alternative recreation site/facility identification;
- Historic site/artifact restoration; and,
- Forage fish availability.

A second Restoration Technical Support Project will develop and implement a peer review process. Peer review will improve the scientific quality of feasibility studies and potential restoration projects.

The third and final Restoration Technical Support Project will assess and summarize existing beach segment survey data. This will help to identify sites for future feasibility studies and restoration projects.

CHAPTER VI
DEVELOPMENT OF RESTORATION OPTIONS

Development of a plan to "restore, replace or acquire the equivalent" of the natural resources and services injured by the oil spill requires consideration of a wide range of alternative field projects, management actions and resource acquisitions. The goal of such a plan will be to provide decision-makers with the information necessary to restore injured resources and services to their baseline conditions. This can occur only after a full assessment of damages has been completed.

To date, the restoration planning process has been identifying the widest possible array of alternatives, based on suggestions from the public, technical experts and the literature. Although RPWG will continue to invite ideas about restoration alternatives throughout the planning process, it now can begin to organize the ideas suggested to date and to gather the information necessary to evaluate them.

To that end, RPWG has developed a series of summary tables, or matrices, that portray potential restoration alternatives in relation to categories of potentially injured resources. Although the matrices are broadly inclusive, they do not cover suggestions that are unrelated to the goals of the restoration program (e.g., ideas for legislation pertaining to future oil spills). Also, for convenience, many individual recommendations have been combined into single alternatives; and there is still considerable overlap among the various items and matrices.

The potential restoration alternatives are presented largely without regard to geography, because most options are potentially applicable to more than one site or geographic area. In general, direct restoration projects would be implemented on-site, at one or more localities within the oil-impacted area. In contrast, projects which replace or acquire equivalent resources may take place beyond the spill area.

Matrices are provided for each category of potentially injured resource: mammals, coastal habitats, fish and shellfish, birds, cultural resources and recreational uses. A final matrix includes potential restoration approaches that may apply to multiple resource categories.

The cells of the matrices have been left blank. Future reports may include, within these cells, information necessary to evaluate specific restoration options relative to particular resources. Readers are encouraged to use these matrices to help organize their own thinking about potential restoration alternatives. Suggestions about information to complete these matrices, as well as additional options and other ways to evaluate them are welcome and invited.

Before restoration alternatives can be recommended in the restoration plan, a variety of factors must be evaluated and weighed. A preliminary list of possible considerations is presented in the table below.

Preliminary List of Factors to Consider In Evaluating Potential Restoration Alternatives

- What is the degree and extent of injury to natural resources or services, as determined by the damage assessment?
- What is the degree and rate of natural recovery?
- Is the restoration alternative linked to injured natural resources or services?
- Is the restoration alternative technically feasible?
- Will the restoration alternative result in net environmental benefit?
- What does the restoration alternative cost?

Evaluation of the basic factors presented in this table will yield a universe of potential restoration projects that are responsive to the injuries from the spill, appropriate under the law, feasible and cost effective. Ultimately, however, the alternatives recommended in a restoration plan must also take into account broader considerations. For example, does a potential project benefit single resources or multiple resources and ecosystems? How quickly must a project be implemented to be worthwhile? What are the interests, needs and priorities of the public, and how does a restoration alternative affect people living in or using the affected areas? Finally, the amount of money available for restoration will influence the combination of projects eventually implemented under the restoration plan.

MAMMALS

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources								
	Humpback whales	Killer whales	Steller sea lions	Harbor seals	Sea otters	Sitka black-tailed deer	Bears, brown and black	River otter and mink	Other mammals
a. Natural recovery - no action									
b. Supplement winter-season foods for stressed animals feeding in intertidal habitats (e.g., deer)									
c. Translocations to augment populations within and outside of oil-spill area									
d. Preserve foraging habitats (e.g., mussel beds and eelgrass)									
e. Acquire / protect habitats in uplands (e.g., old-growth forest), and along streamsides and coastal perimeter									
f. Acquire / protect Coastal habitats such as haulout / rookery sites, whale "rubbing" beaches, etc.									
g. Establish new wildlife refuges, sanctuaries, and viewing areas									
h. Reduce marine debris and expand stranding / entanglement rescue operations									
i. Eliminate high-sea gillnet fisheries and the resulting incidental mortality to marine mammals									
j. Reduce incidental loss of marine mammals by buying back limited-entry gillnet permits									
k. Reduce human-use impacts / conflicts through management changes (e.g., fishing and trapping restrictions)									
l. Restrict / eliminate legal harvest of marine / terrestrial mammals									
m. Minimize harassment and illegal shooting of marine mammals through education and law enforcement									
n. Establish international wildlife rehabilitation / public education center									
o. Conduct long-term monitoring / research program on mammal populations and ecology									

FISH AND SHELLFISH

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources								
	Salmon	Herring	Sport fish	Groundfish, including halibut	Rockfish	Other fish	Shrimp and crab	Molluscs	Other invertebrates
a. Natural recovery - no action									
b. Improve productivity in stream / lake habitats by construction of fishways, fertilization, and other means of enhancement									
c. Supplement spawning substrates									
d. Construct artificial habitat structures									
e. Mariculture and shore / intertidal habitat enhancements									
f. Control predators on fish eggs and juveniles									
g. Enhance wild stocks / populations rather than hatchery stocks (e.g., egg boxes, etc.)									
h. Preserve wild gene pools and local populations through hatchery techniques									
i. Construct new hatcheries and / or expand existing hatcheries to provide additional fish for stocking programs									
j. Transplants to augment natural recoveries									
k. Catalog and protect spawning habitats									

FISH AND SHELLFISH

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources								
	Salmon	Herring	Sport fish	Groundfish, including halibut	Rockfish	Other fish	Shrimp and crab	Molluscs	Other invertebrates
l. Protect upland habitats (e.g., timbered slopes) to maintain water quality in streams and nearshore habitats									
m. Map baseline management information and acquire development rights to fisheries habitats in and along rivers									
n. Buy back limited entry fishing permits to reduce pressure on resources									
o. Change management emphases / harvest practices (e.g., focus on "terminal" rather than mixed stock fisheries)									
p. Redirect fisheries efforts to alternative species to encourage recovery of affected species									
q. Restrict high-seas interceptions to provide more control over fish mortality									
r. Close or restrict individual fisheries to speed natural recoveries									
s. Identify and catalog individual stocks to enable more targeted management actions									
t. Improve ecological and harvest data to enable better management decisions									
u. Increase public relations and quality assurance efforts to redevelop damaged markets									
v. Conduct long-term research / monitoring program on populations and ecology									

BIRDS

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources						
	Loons	Grebes	Shearwaters and petrels	Cormorants	Sea ducks	Mergansers	Other waterfowl
a. Natural recovery - no action							
b. Augment natural reproduction through captive breeding (as a source of eggs or young), fostering and related techniques							
c. Stabilize eroded beach / supratidal habitats used by nesting birds							
d. Mariculture of shellfish to supplement prey base							
e. Provide artificial nest sites / substrates to enhance productivity or redirect nest activities to alternative sites							
f. Acquire nesting habitats and colony sites							
g. Protect watershed areas necessary to maintain water quality and habitats that sustain the avian prey base							
h. Restrict logging on timbered slopes, streamsides, and coastal perimeters that serve as nesting / resting habitats							
i. Restrict hunting and reduce illegal "taking" of eggs and adult birds							
j. Eliminate introduced predators (e.g., foxes) from islands that are or were important for ground-nesting birds							
k. Restrict near-shore gillnet fisheries to minimize conflicts with bird populations							
l. Eliminate high-seas gillnet fisheries and the resulting incidental mortality to birds							
m. Acquire stopover / wintering habitats in the Pacific flyway							
n. Protect wetland habitats important to migratory birds, nationally and internationally							
o. Minimize disturbance from tourists, fishermen, researchers, and others through public education and law enforcement							
p. Conduct long-term research / monitoring program on bird populations, ecology, and prey							

BIRDS

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources									
	Bald eagle	Peale's Peregrine falcon	Black oyster-catcher	Other shorebirds	Gulls	Common murre	Puffins	Pigeon guillemot	Murrelets	Other birds
a. (continued)										
b. (continued)										
c. (continued)										
d. (continued)										
e. (continued)										
f. (continued)										
g. (continued)										
h. (continued)										
i. (continued)										
j. (continued)										
k. (continued)										
l. (continued)										
m. (continued)										
n. (continued)										
o. (continued)										
p. (continued)										

COASTAL HABITATS

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources				
	Supratidal Zone				
	Rocky, exposed	*Rocky, sheltered*	*Estuarine, sheltered (incl. marsh)*	*Coarse-textured cobbles / pebbles*	*Fine-textured sand / silt*
a. Natural recovery - no action					
b. Control of erosion by placement of rip-rap, re-establishing vegetation, and other methods					
c. Increase primary productivity in plant communities by fertilizing intertidal / supratidal habitats					
d. Hasten natural recovery of communities and ecosystems by transplanting or "reseeding" flora / fauna					
e. Acquisition / protection of upland areas to protect adjacent coastal habitats from degradation					
f. Establish new marine parks / sanctuaries to provide additional habitat protection					
g. Change management practices at selected sites / habitats (e.g., temporarily restrict access)					
h. Long-term research / monitoring program on such topics as residual oil in the environment, rates of natural recovery, and the character of subsequent ecosystems					

COASTAL HABITATS

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources									
	Intertidal Zone					Subtidal Zone				
	Rocky, exposed	Rocky, sheltered	Estuarine, sheltered (incl. marsh)	Coarse-textured cobbles / pebbles	Fine-textured sand / silt	Silled fiords	Island points	Island bays	Eelgrass	Nereocystis (bulb kelp)
a. (continued)										
b. (continued)										
c. (continued)										
d. (continued)										
e. (continued)										
f. (continued)										
g. (continued)										
h. (continued)										

RECREATIONAL USES

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Diminished Uses						
	Kayaks and canoes	Other pleasure boats	Charters, tour boats, etc.	Marine sport fishing	Freshwater sport fishing	Shellfishing	Trapping
a. Natural recovery - no action							
b. Rehabilitate prime recreation sites and units of the National Wilderness Preservation System							
c. Discourage new use of sites that were poorly known before the spill, or where continued use would slow recovery of oiled sites							
d. Provide alternative destinations (e.g., public-use cabins, camp sites) for recreation users							
e. Purchase private inholdings within public lands (e.g., parks, refuges, forests)							
f. Acquire key public access sites within privately-owned lands and along coasts / rivers							
g. Obtain development rights, easements, etc. (less than fee-simple title) on private lands							
h. Acquire / protect "threatened" wilderness / recreation areas within and outside of Alaska							
i. Establish new parks, refuges, and other protected areas							
j. Revise public-lands management plans to minimize further degradation of recreational resources							
k. Add field personnel / revise regulations in response to increased awareness of recreational opportunities following oil spill publicity and clean up							
l. Develop unified agency-private tourism / public information program							
m. Construct / maintain public interpretive facilities in oil-spill communities, perhaps associated with state or federal conservation units							
n. Publish brochure to educate recreational boaters about environmental protection							

RECREATIONAL USES

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Diminished Uses									
	Hunting, terrestrial mammals	Hunting, waterfowl	Public-use cabins / sites	Low-impact camping	Hiking and climbing	Berry picking, picnicking, etc.	Photography	Nature study	Existence values	Other recreation
a. (continued)										
b. (continued)										
c. (continued)										
d. (continued)										
e. (continued)										
f. (continued)										
g. (continued)										
h. (continued)										
i. (continued)										
j. (continued)										
k. (continued)										
l. (continued)										
m. (continued)										
n. (continued)										

CULTURAL RESOURCES

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources		
	Archaeological / historical sites	Burial sites	Other resources
a. Natural recovery - no action			
b. Inventory beach and upland sites for cultural resources			
c. Protect cultural sites from erosion or other degradation (e.g., stabilize sites by revegetation)			
d. Develop radiocarbon dating techniques for oiled artifacts			
e. Conduct inventory / produce brochure with photographs of artifacts originating from oil-spill area that are now in museum collections			
f. Return artifacts recently removed by archaeologists or clean-up workers			
g. Implement a "site steward" program that employs local residents to watch over cultural sites			
h. Improve enforcement of historic preservation laws			
i. Increase public education / improve law enforcement to reduce vandalism and looting of historical, archaeological, and burial sites			
j. Develop cooperative agreements / management plans for cultural resources involving the state, university, and Alaskan Native communities			
k. Assist in establishing interpretive museums / cultural projects in rural villages			
l. Encourage oral history and video tape projects concerning regional / local history and traditions			
m. Return Alaskan Native artifacts to public collections (e.g., from private collections)			

MULTIPLE RESOURCES AND VALUES

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources and Use Values								
	Coastal habitat	Fish and shellfish	Birds	Mammals	Cultural resources	Subsistence hunting / fishing	Recreational Uses	Intrinsic	Other
a. Natural recovery - no action									
b. Assist coastal communities and boat operators with environmentally-sound waste disposal and waste recycling programs to minimize cumulative effects of pollution									
c. Provide information about status / quality of local food resources (e.g., contaminant levels in shellfish)									
d. Provide local laboratory to which subsistence users can bring samples for contaminants analyses									
e. Buy "net operating losses" (NOLs) of timber sales or change laws to disallow NOLs									
f. Purchase development rights or provide tax incentives for not logging / developing private lands									
g. Preserve buffer strips along streams and the coast									
h. Restrict logging, mining, fishing, hunting, and hydroelectric developments to reduce cumulative effects to the environment									
i. Establish mobile veterinary pathology unit									
j. Require timber, oil, and other industries to provide restoration plans before resource extraction begins									
k. Initiate reforestation programs wherever logging has occurred (e.g., Afognak Island) to minimize cumulative effects of pollution									
l. Determine whether old community and military dump sites add to cumulative effects									

MULTIPLE RESOURCES AND VALUES

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources and Use Values								
	Coastal habitat	Fish and shellfish	Birds	Mammals	Cultural resources	Subsistence hunting / fishing	Recreational Uses	Intrinsic	Other
m. Reduce chronic oil pollution associated with boats, harbors, and the transportation of petroleum to minimize cumulative effects									
n. Eliminate use of plastics and remove plastic debris to protect the marine environment									
o. Remove mining and logging debris to minimize cumulative effects of pollution									
p. Review "glacier ice" industry for possible management changes									
q. Establish fund to support the mitigation of losses of wetland habitats									
r. Review management plans to assess whether land use designations should be changed									
s. Establish stronger regulations, improved planning, and better response in order to minimize additional effects from future spills									
t. Reduce energy consumption through improved efficiency and conservation in order to reduce the potential for future oil spills									
u. Designate Prince William Sound as a national recreation area or national monument									
v. Buy back Bristol Bay oil leases									
w. Establish trust fund to support future needs for land / habitat acquisition									
x. Help develop economic base for rural village residents (including analysis of subsistence economies)									

MULTIPLE RESOURCES AND VALUES

Matrix of Potential Restoration Approaches

Potential Restoration Approaches	Categories of Potentially Injured Resources and Use Values								
	Coastal habitat	Fish and shellfish	Birds	Mammals	Cultural resources	Subsistence hunting / fishing	Recreational Uses	Intrinsic	Other
y. Sponsor symbolic observance of the oil spill (e.g., a public event or monument)									
z. Encourage hands-on public participation in implementing selected restoration projects in the field									
aa. Buy back and redistribute limited entry fishing permits to improve local economies									
bb. Publish booklet with suggestions about what individuals can do to benefit the environment affected by the spill (e.g., recycle marine boat oil)									
cc. Develop education program to foster discussion about oil and the environment (e.g., what are the laws and issues?)									
dd. Develop interpretive / museum programs on the oil spill, the status of the environment, and restoration									
ee. Develop / expand oil-spill curriculum materials for schools to include the restoration program									
ff. Establish trust fund to support restoration from long-term impacts of the oil spill									
gg. Enhance and support facilities / institutions in oil-spill communities that can carry out or provide logistical support for monitoring / research programs									
hh. Establish Long-Term Ecological Research sites (a program sponsored by the National Science Foundation) and provide funds to support research / monitoring at those sites									
ii. Support and equip fleet of marine vessels to conduct research / monitoring activities									
jj. Establish trust fund to support long-term research / monitoring									

CHAPTER VII
FUTURE RESTORATION PLANNING ACTIVITIES

Restoration planning activities will continue to identify potential measures to restore the natural resources and services affected by the *Exxon Valdez* oil spill. The RPWG will evaluate these individual measures, while maintaining a focus on the environment as a whole. To succeed, the process necessarily draws upon the expertise of scientists, economists, local residents, Native Alaskans and other interested and knowledgeable people.

Public Participation

Public participation is fundamental to developing a successful restoration plan. Therefore, RPWG will continue and expand its efforts to involve the public in the planning process. Additional public scoping meetings will be held specifically to encourage the participation of Alaskan Natives. Other possibilities include: creation of public advisory committees, publication of a restoration newsletter, production and distribution of short video tapes explaining the restoration process and additional public meetings inside and outside of Alaska.

Technical Review

Restoration feasibility studies will continue to be an important means of evaluating alternatives identified through the restoration planning process. For example, one of the 1990 Technical Support Projects is designed to identify 1991 Restoration Feasibility Studies. Pending availability of funds, these studies will be conducted during next year's field season. In addition, promising 1990 studies could be continued or expanded. Some projects might be tested more widely, including sites outside of Prince William Sound.

Additional technical workshops with key scientists are being planned. These workshops will help develop and review restoration feasibility projects for 1991. They also will begin to develop an overall monitoring plan to evaluate restoration and recovery. As described in the 1990 Technical Support Projects (Chapter V), a scientific peer review process is being designed and will be integrated into these efforts to ensure effective and efficient progress toward a restoration plan.

Identification and acquisition of pertinent literature will continue. These efforts will expand the ecological search done to date and identify information on cultural resources and recreational uses, as well.

Development of a Final Restoration Plan

All of the activities outlined above lead toward development of a final restoration plan. The final plan will take into account results from the NRDA, other technical input and comments and concerns received from the public. Once restoration funds become available from the responsible parties, the final restoration plan will be implemented. Throughout the process there will be continuing opportunities for public participation.

APPENDICES

APPENDIX A

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APPENDIX B

List of Relevant References from the Initial Literature Review

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Draft Annotated Outline
DRAFT RESTORATION PLAN

10/9/92

i. Cover Letter **(front/back [Trustee signatures]) Editor (1 pg)**

ii. Acknowledgements **(Planning Team) John**

iii. Table of Contents **Editor**

iv. Executive Summary **Editor/John/Bob L.**

I. Introduction

A. Purpose of document

Presents the proposed action (see Restoration Framework, page 1) and explains the function of the Draft Restoration Plan as providing overall direction for the restoration process and guidance for implementation of annual work plans, including all anticipated annual and periodic activities. Explains the relationship among alternatives, options and restoration projects and types of actions to implement them. **John/Bob L. (1 pg)**

B. Background

Summarizes the history of the oil spill, including the cleanup; pre-settlement NRDA program; A summary of Trustee Activity since the settlement, including the role of the U.S. District Court of Alaska; criminal and civil settlements; and the EVOS trustee organization and administration. Presents the number and nature of the public's comments received on the Restoration Framework and how they were used. **Ray/Veronica (5-10 pgs)**

C. Spending guidelines for EVOS settlement

1. Civil settlement

Summarizes guidelines for spending civil settlement money. Includes a description of the decision-making process for expenditures. **Chris (2 pgs)**

2. Criminal settlements (state and federal)

Summarizes state and federal guidelines for spending criminal settlement money. Explains

relationship to civil settlement guidelines. **Chris (2 pgs)**

D. Relationship to Draft Environmental Impact Statement

Following a brief outline of the NEPA process, the relationship of the Draft Environmental Impact Statement (DEIS) to the Draft Restoration Plan will be explained. Explains that the DEIS will be programmatic in nature and the impacts of the preferred restoration alternative will be presented and compared with those of all other restoration alternatives. **Ray (1 pg)**

II. Injured Resources and Services

A. Criteria for selecting injured resources and services

Injury criteria will be listed and briefly explained. Any changes from those in the Restoration Framework will be explained. **Sandy (2-3 pgs)**

B. How criteria are applied

The decision-making process for applying the injury criteria will be explained. **Bob L./Sandy (2-3 pgs)**

C. Conclusions: List of resources and services injured: tables/graphics of resources and services that meet the injury criteria

Presents summary of information on the range of injuries from the ecosystem level to individual resources and services as we now understand it. Injuries will be explained in terms of injured life history stages or user groups, the geography of the injury, and the status and prospects for natural recovery. **Bob Spies/Veronica/Sandy/Bob L. (40-80 pgs)**

III. Restoration Options

A. Explanation of restoration options

Briefly explains restoration options: their origins, the evolution of these public and professional ideas into options and the central importance of them to the plan. Karen (3 pgs)

B. Evaluate restoration options

1. Criteria for evaluating restoration options

Identifies and defines criteria that are used in evaluating and ranking candidate restoration options. Explains any changes from Restoration Framework. **Karen (3 pgs)**

2. How criteria are applied

Describes the process used in ranking options (as high, medium, or low) for each criteria. Includes a description of the process used to generate candidate restoration alternatives. Bob L. (3-5 pgs)

C. Evaluate habitat protection and acquisition options

Describes the evaluation process that will be used in identifying and prioritizing habitat for protection and acquisition, including how protection for services will be approached. Includes description of threshold criteria, habitat types, and the imminent threat analysis for determining whether accelerated protection is required due to immediate threats to restoration potential.

Description of other habitat acquisition issues including 1) land management: which agencies would manage the acquired land; how land management considerations (such as the need for survey, and locatable, contiguous blocks) influence purchases; 2) tools for land acquisition: describes the range of potential tools from development moratoriums to fee-simple purchase; 3) multi-species analysis: describes how the decision to purchase may depend on the benefits provided to more than one resource or service type. Bob L./Art/Veronica (10 pgs)

IV. Restoration Plan Alternatives

Indicates that this section presents a range of restoration alternatives. It explains that while a preferred alternative is presented, clearly no final decision will be made as to the selection of a preferred alternative until the public has had opportunity to comment and the Trustees can take full consideration of the public's opinion. The reason for presenting a preferred alternative at this time is the Trustee's desire to indicate direction at this point in the process and to facilitate compliance with the National Environmental Policy Act of 1969, as amended, i.e., simultaneous publication of the Draft Environmental Impact Statement. **Bob L./Sandy will write up-front (5 pgs)**

A. Description of alternatives

3 - 5 Alternatives will be presented.

1. No action alternative (natural recovery)

   Describes the scope and nature of the no action alternative. Explains reliance on natural processes and the limited activities that would occur. Distinguishes between these and the more active restoration options presented in other alternatives. **Bob L./Carol/Karen/Veronica (? pgs)**

2. Other alternative

   Describes the scope and nature of one of the other alternatives (not including the preferred alternative). Presents a summary of the options included in the alternative and considers the following: responsiveness to recognized injuries and the proposed action, timing of implementation, geographic scope of application, and relative amounts of funding required for option categories presented in the alternative (e.g., management of human uses, habitat protection, etc.). **Bob L./Carol/Karen/Veronica (? pgs)**

3. Preferred alternative

   Describes the scope and nature of the preferred alternative. Presents a summary of the options included and considers the following: responsiveness of the alternative to recognized injuries and the proposed action, timing of implementation, geographic scope of application, and relative amounts of funding required for option categories (e.g., management of human uses, habitat acquisition and protection, etc.). **Bob L./Carol/Karen/Veronica (? pgs)**

4. Other alternative

   See annotation for V.A.2. **Bob L./Carol/Karen/Veronica (? pgs)**

B. Comparison of alternatives

   Describes the significant differences between the alternatives so the public can readily see the choices presented. Sandy/Veronica (3-5 pgs)

V. Implementation Process for Life of the Settlement

A. Development of annual budget and work plans (i.e., selection of projects/studies for a given year legal compliance etc...)

Describes the process and timeline the Trustee Council will follow in prioritizing annual research and restoration needs. **Mark F. (3-5 pgs)**

B. Operations/Administration

How the Trustee Council, staff, etc. will operate the restoration program. This will include an organization chart/flow diagram of how restoration program will operate. **Dave Gibbons (3-5 pgs)**

C. Funding mechanisms

1. Current mechanism

Describes the current funding mechanism (court registry account). Explains how the process functions and its effects on the nature, extent and future of the restoration program. **Mark Brodersen (3-4 pgs)**

2. Endowment

Describes the various approaches to endowments that could be suitable for the restoration program. Explains how endowments could function and affect the nature, extent and future of the restoration program. **Mark Brodersen (3-4 pgs)**

D. Monitoring/Evaluation

Presents elements of an integrated, long-term monitoring program designed to follow the rate of recovery of injured resources and services and to evaluate the effectiveness of restoration activities. Also presents an evaluation process to determine if plans, projects and related activities have been implemented as designed. **John/Mark F. (5-7 pgs)**

E. Public participation/Public education

Describes how the Trustee Council will continue to provide for meaningful public involvement over the life of the settlement. This will include information about the Public Advisory Group (i.e., the process used to establish it and any accomplishments to date) and all other efforts by Trustee Council staff to accomplish this goal.

Explains what actions the Trustee Council will take to provide for an appropriate level of public education about the restoration program. Although this is related to public participation efforts, it differs in that the Trustee Council will generate educational products relating to restoration. Educational efforts may, in part, take the form of annual work plan projects. **Peg/LJ Evans (10-15 pgs)**

F. Amendments to the final Restoration Plan

Describes the process for amending the final plan. **Mark F. (2 pgs)**

Appendices

A. Restoration options

Summarizes all options and suboptions. The descriptions will be more detailed than those in the Restoration Framework. **Various authors (70 pgs)**

B. Charter of the Public Advisory Group

Copy of the Public Advisory Group charter **Editor**

List of PAG principal interests Editor

List of current PAG members and their affiliation Editor

C. List of other publications **Editor**

(i.e., 1990 Progress Report, etc...)

D. Court settlement documents **Editor**

E. Glossary **Editor/Chris**

Brochure

Annotation

The brochure summarizes the draft plan and includes the comment sheet for the plan. It is a stand-alone summary that can be distributed separately from the plan for those who are uninterested in reading the full document. **Bob L./Sandy/Editor/Illustrator (2-4 newspaper size pages)**

d:\sandy\aoutline.tc

Table V-__ shows which resources showed a population decline, and which showed chronic or sublethal injury without a detectable change in population. The table shows the injuries that occurred as of 1989, the spill year and does not take into account recovery.

Table V-__. Degree of Injury

Resources whose populations declined because of the spill.	**Sublethal or Chronic Effects. No Detectable spill-related population decline**
Harbor seals	River otters
Sea otters	Bald eagles*
Common murres	Killer Whales*
Marbled murrelet	Pink salmon*
Pigeon Guillemots	Pacific herring
Harlequin ducks	Rockfish
Black oystercatchers	Dolly Varden*
Sockeye salmon smolts	Cutthroat Trout*
Intertidal organisms	
Subtidal organisms	

* For these species, the Trustees' scientists have considerable disagreement over the conclusions to be drawn from the results of the damage assessment studies.

MEMO to the Exxon Valdez Oil Spill Public Advisory Group

January 8, 1993

From: Brad Phillips, Chair

Subject: January and February Meetings

Attached is a copy of the vote record on the 1993 Work Plan projects from our January 6-7, 1993 meeting. This is being forwarded to the Trustee Council and the Restoration Team for their use at the January 19, 1993 Trustee Council meeting. Since I will be out of state at that time, Vice-chairperson, Donna Fischer, will present our report to the Trustee Council. When the transcript of the meeting is available, it will be forwarded to the Trustee Council so they can see the discussion on each project--a copy will be available in the Oil Spill Information Center library. Just a summary note: the Restoration Team's proposed 1993 Work Plan totalled $37,832,600, plus $4,611,600 in possible projects that were not recommended--the total as a result of the PAG's vote is approximately $44,056,600, excluding our request combine and reduce costs of some projects.

If you plan to attend the Exxon Valdez Oil Spill Symposium on February 2-5, 199[illegible] Anchorage, please make your travel arrangements the same way as done for PAG meetin[illegible] The registration fee can be put on your expense voucher.

The next meeting of the PAG is scheduled for Wednesday, February 10, 1993 at 9:30 a.m. at 645 G Street in Anchorage--an agenda will be sent later.

See you in February!

OK
Brad Phillips

cc: Doug Mutter, Designated Federal Officer
Dave Gibbons, Interim Administrative Director, Restoration Team
Trustee Council
Restoration Team

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt

1 Andrews
2 French

Date: 1-6-93

Issue: 13002

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud	X			
James Diehl				X
Richard Eliason		X		
Donna Fischer		X		
John French	X			
Paul V. Gavora				X
James King		X		
Richard Knecht	X			
Vern C. McCorkle	X			
Gerald McCune				X
John McMullen		X		
Brad Phillips	X			
John Sturgeon	X			
Charles Totemoff	X			
Llewellyn W. Williams Jr.		X		

passed 7 5

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 McCorkle
2 Andrews

Date: 1-6-93

Issue: 93003

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

OK- passed by unanimous consent

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Andrews
2 McMullen

Date: 1-6-93

Issue: 93004

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie				X
James Cloud	X			
James Diehl				X
Richard Eliason	X			
Donna Fischer	X			
John French		X		
Paul V. Gavora				X
James King			X	
Richard Knecht	X			
Vern C. McCorkle			X	
Gerald McCune				X
John McMullen	X			
Brad Phillips		X		
John Sturgeon		X		
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

passed 8 3 2

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
: Andrews
- Fisher

Date: 1-6-93

Issue: 93005 - 93006 - 93007 - 93008 - 93009

combine these - restructure to reduce costs and emphasize use of loc and Alaska people and resou

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud	X			
James Diehl	X			X
Richard Eliason	X			
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed with amendment
by
unanimous
consent

See 13-1

Tabled 1:40
1 - Andrews
2 - Fisher

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Knecht
2 McCorkle

Date: 1-6-93

Issue: 93011

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				X
Pamela Brodie		X		
James Cloud	X			
James Diehl				X
Richard Eliason			X	
Donna Fischer	X			
John French		X		
Paul V. Gavora				X
James King	X			
Richard Knecht	X			
Vern C. McCorkle	X			
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon		X		
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

passed 9 3 1

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 McCorkle
2 Fischer

Date: 1-6-93

Issue: 93012 + 93015
combine with reduced costs

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by unanimous consent
with note above

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Cloud
2 Fischer

Date: 1-6-93

Issue: 43016
add $25,000 for contractual for fish production at hatche

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie			X	
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by
unanimous consent, one abstain
with note above

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 McCorkle
2 Knecht

Date: 1-6-93

Issue: 93017

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				X

try to have affected communities show support of project before getting started. need to communicate clearly project planning.

passed by unanimous consent with note above

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Fiscle
2 Andrews

Date: 1-6-93

Issue: 93018

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				X

passed by unanimous consent

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 McCorkle
2 Fischer

Date: 1-6-93

Issue: 93022

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				X

Failed by unanimous vote with note below.

hope will be dealt with in Restoration Plan

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Andrews
2 Cloud

Date: 1-7-93

Issue: 93024

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				X
Charles Totemoff				
Llewellyn W. Williams Jr.				X

passed by unanimous consent

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 French
2 Fischer

Date: 1-7-93

Issue: 93025

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				X
Charles Totemoff				
Llewellyn W. Williams Jr.				X

passed by unanimous vote

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Andrews
2 Fisher

Date: 1-7-93

Issue: 93028

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie		X		
James Cloud		X		
James Diehl				X
Richard Eliason		X		
Donna Fischer		X		
John French				
Paul V. Gavora				X
James King		X		
Richard Knecht		X		
Vern C. McCorkle				X
Gerald McCune				X
John McMullen		X		
Brad Phillips	X			
John Sturgeon				X
Charles Totemoff	X			
Llewellyn W. Williams Jr.				X

Failed to pass
Minority report from Andrews: voted no because we should encourage the USFS to develop more wildlife habitat.

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move + adopt
1 cloud
2 Fisher

Date: 1-7-93

Issue: 93029

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie		X		
James Cloud	X			
James Diehl				X
Richard Eliason	X			
Donna Fischer		X		
John French			X	
Paul V. Gavora				X
James King		X		
Richard Knecht		X		
Vern C. McCorkle				X
Gerald McCune				X
John McMullen		X		
Brad Phillips	X			
John Sturgeon				X
Charles Totemoff	X			
Llewellyn W. Williams Jr.				X

7 2 .02 5 5

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Cloud
2 French

Date: 1-7-93

Issue: 93030

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				~~X~~
Charles Totemoff				
Llewellyn W. Williams Jr.				~~X~~

Petition for Reconsideration Request

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Cloud
2 Fisher

Date: 1-7-93

Issue: 93031

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud	X			
James Diehl				X
Richard Eliason	X			
Donna Fischer	X			
John French		X		
Paul V. Gavora				X
James King			X	
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon		X	X	
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

Passed 10 2

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Andrews
2 French

Date: 1-7-93

Issue: 43032

Landowners must be consulted prior and approve project ~~to adoption by the [illegible]~~ ~~[illegible]~~

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud		X		
James Diehl				X
Richard Eliason	X			
Donna Fischer	X			
John French	X			
Paul V. Gavora				X
James King	X			
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon	X			
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

passed ~~[illegible]~~ with note above

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Mo. to adopt
1 Fisher
2 Andrews

Date: 1-7-93

Issue: 93033

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French			X	
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by unanimous consent

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Fiske
2 Andrews

Date: 1-7-93

Issue: 93034

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by unanimous consent

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Andrews
2 Fischer

Date: 1-7-93

Issue: 93035

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

Passed [illegible]

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Fischer
2 Cloud

Date: 1-7-93

Issue: 93036

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by [illegible]

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Cloud
2 Fischer

Date: 1-7-93

Issue: 93038

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff			X	
Llewellyn W. Williams Jr.				

[illegible]

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Date: 1-7-93

move to adopt
1 Knecht
2 [illegible]

Issue: 93039
concerned about high costs of this project - reexamine cost

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French			X	
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by unanimous consent
with note about

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Fisher
2 Andrews

Date: 1-7-93

Issue: 930411

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud	X			
James Diehl				X
Richard Eliason	X			
Donna Fischer		X		
John French			X	
Paul V. Gavora				X
James King	X			
Richard Knecht		X		
Vern C. McCorkle				
Gerald McCune				X
John McMullen		X		
Brad Phillips	X			
John Sturgeon		X		
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

passed 5 4

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Fisher
2 Andrews

Date: 1-7-93

Issue: 93042

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by Unanimous consent

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

motion to adopt
1 - Knecht
2 - Fischer

Date: 1-7-93

Issue: 93043

TC consider contracting this project

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud	X			
James Diehl				X
Richard Eliason		X		
Donna Fischer		X		
John French		X		
Paul V. Gavora				X
James King	X			
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen		X		
Brad Phillips	X			
John Sturgeon		X		
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

5 5

passed with next vote

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Fisher
2 Knecht

Date: 1-7-93

Issue: 93046

Put more emphasis on interaction with people living in the area

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff			X	
Llewellyn W. Williams Jr.				

passed with unanimous consent and note above

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Fischer
2 Andrews

Date: 1-7-93

Issue: 93047

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French			X	
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by unanimous consent

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

, move to adopt
1 Fisher
2 Andrews

Date: 1-7-93

Issue: 1305(
Delet channel typing portions of project

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud		X		
James Diehl				X
Richard Eliason		X		
Donna Fischer		X		
John French	X			
Paul V. Gavora				X
James King	X			
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips		X		
John Sturgeon	X			
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

passed with
amendment

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Fidler
2 French

Date: 1-7-93

Issue: 93053

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Fiscley
2 McMullen

Date: 1-7-93

Issue: 93057

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by unanimous consent

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Fisher
2 Totemoff

Date: 1-7-93

Issue: 93061

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud		X		
James Diehl				X
Richard Eliason	X			
Donna Fischer		X		
John French	X			
Paul V. Gavora				X
James King	X			
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon	X			
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

2

pass

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Fisdale
2 French

Date: 1-7-93

Issue: 93062

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed to [illegible] project

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Knecht
2 King

Date: 1-7-93

Issue: 93063

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

please [illegible]

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Andrews
2 Fisher

Date: 1-7-93

Issue: 93064

Ask TC to consult with PAG on individual parcel prop

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud		X		
James Diehl				X
Richard Eliason	X			
Donna Fischer	X			
John French	X			
Paul V. Gavora				X
James King	X			
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon			X	
Charles Totemoff			X	
Llewellyn W. Williams Jr.	X			

5 1 2

passed with note above

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 French
2 Andrews

Date: 1-7-93

Issue: increase PAG budget for 1993 to $225,000 to cover 6 meetings rather than 4.

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie		X		
James Cloud	X			
James Diehl				X
Richard Eliason	X			
Donna Fischer	X			
John French	X			
Paul V. Gavora				X
James King	X			
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon		X		
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

11 2

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Knecht
2 Fischer

Date: 1-7-93

Issue: TC should have an independent reviewer examine administrative costs to ensure there is no double dipping by agencies

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by unanimous consent

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Fischer
2 Knecht+

Date: 1-7-93

Issue: 93010

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews		X		
Pamela Brodie		X		
James Cloud		X		
James Diehl				X
Richard Eliason		X		
Donna Fischer		X		
John French		X		
Paul V. Gavora				X
James King		X		
Richard Knecht		X		
Vern C. McCorkle				X
Gerald McCune				X
John McMullen		X		
Brad Phillips		X		
John Sturgeon		X		
Charles Totemoff		X		
Llewellyn W. Williams Jr.		X		

Failed

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

moved to adopt
1 Cloud
2 Fisher

Date: 1-7-93

Issue: 93014

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews		X		
Pamela Brodie		X		
James Cloud		X		
James Diehl				X
Richard Eliason		X		
Donna Fischer		X		
John French		X		
Paul V. Gavora				X
James King		X		
Richard Knecht		X		
Vern C. McCorkle				X
Gerald McCune				X
John McMullen		X		
Brad Phillips		X		
John Sturgeon		X		
Charles Totemoff		X		
Llewellyn W. Williams Jr.		X		

Failed

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

moved to adopt
1 Fischer
2 Andrews

Date: 1-7-93

Issue: 93019
Make contingent upon favorable legal opinion

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews		X		
Pamela Brodie		X		
James Cloud	X			
James Diehl				X
Richard Eliason				X
Donna Fischer	X			
John French	X			
Paul V. Gavora				X
James King		X		
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon	X			
Charles Totemoff	X			
Llewellyn W. Williams Jr.		X		
	8	4		

passed with note above

~~Tabled by Williams~~

~~Yes II~~

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

moved to adopt
1 Cloud
2 Fisher

Date: 1-7-93

Issue: 93020
make contingent on favorable legal opinion

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				X
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

~~Tabled by Cloud~~

~~yes - 10~~

~~no - 3~~

Passed by unanimous consent with note above

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Moved to adopt
1 F. Sisley
2 Andrews

Date: 1-7-93

Issue: 93 026

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie		X		
James Cloud	X			
James Diehl				X
Richard Eliason	X			
Donna Fischer	X			
John French		X		
Paul V. Gavora				X
James King		X		
Richard Knecht		X		
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon	X			
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

passed 9 4

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

moved to adopt
1 Fisher
2 Andrews

Date: 1-7-93

Issue: 93052

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews		✓		
Pamela Brodie		✓		
James Cloud		✓		
James Diehl				X
Richard Eliason				X
Donna Fischer		✓		
John French	✓			
Paul V. Gavora				X
James King	✓			
Richard Knecht		✓		
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	✓			
Brad Phillips				
John Sturgeon		✓		
Charles Totemoff		✓		
Llewellyn W. Williams Jr.		✓		

Failed

3 yea 8 no

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

moved to adopt
1 McMullen
2 Fischer

Date: 1-7-93

Issue: CRMA proposal & Forward Resolution to TC (attached)

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X	X		
Pamela Brodie		X		
James Cloud		X		
James Diehl				X
Richard Eliason				X
Donna Fischer	X	X		
John French		X		
Paul V. Gavora				X
James King		X		
Richard Knecht		X		
Vern C. McCorkle				X
Gerald McCune				X
John McMullen		X		
Brad Phillips		X		
John Sturgeon			X	
Charles Totemoff			X	
Llewellyn W. Williams Jr.		X		

Failed 1 9 2

EXXON VALDEZ OIL SPILL TRUSTEES
PUBLIC ADVISORY GROUP

RESOLUTION

Whereas:

The Public Advisory Group has been reviewing, commenting on and voting on various projects proposed for inclusion in the 1993 Work Plan;

Proposals not included in the 1993 Draft Work Plan have been presented to the Public Advisory Group for consideration;

The Chugach Resource Management Agency (CRMA) is a new project proposed for 1993 which was not included in the 1993 Draft Work Plan;

The CRMA will identify available project-related resources in the Prince William Sound area for all state and federal agencies involved in oil spill restoration;

The CRMA will involve Prince William Sound area residents in the restoration effort;

The CRMA will reduce the physical impact of the restoration effort by using locally available resources, facilities and equipment and it will coordinate assignment of locally available resources to eliminate or reduce logistics and procurement redundancy;

The CRMA will reduce restoration logistics and resource expenditures by using locally available resources to address spill impacts, creating financial efficiencies;

The CRMA will in some instances submit competitive proposals to perform 1993 Work Plan Projects.

Therefore:

1. The Exxon Valdez Oil Spill Trustees Public Advisory Group endorses the concept of the Chugach Resource Management Agency and encourages the federal and state agencies which support the Trustee Council to fund its resource inventory and project work scope support elements.

2. The Public Advisory Group recommends that federal and state agencies enlist the active participation of the CRMA in development of work scopes for approved projects in order to insure the creation of a relevant inventories.

Move McMullen

2nd Fisher

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

moved to adopt
1
2

Date: 1-7-93

Issue: Idea 920616310
[redacted] Support funding $100,000 for planning for Fisheries

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	X			
James Cloud	X			
James Diehl				X
Richard Eliason				X
Donna Fischer	X			
John French			X	
Paul V. Gavora				X
James King	X			
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips		X		
John Sturgeon		X		
Charles Totemoff		X		
Llewellyn W. Williams Jr.		X		
	7	4	1	

passed

Industrial Tech
center

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 310

Project Source: Kodiak Island Borough & University of Alaska Fairbanks

Project Title: **Near Island Fisheries Research Center**
(expansion of Fishery Industrial Technology Center)

Project Category: Technical Support

Lead Agency: National Oceanographic and Atmospheric Administration

Cooperating Agencies: University of Alaska Fairbanks, School of Fisheries and Ocean Sciences
Alaska Department of Fish and Game
National Parks Service
U.S. Fish and Wildlife Service
National Weather Service

Project Term: March 1, 1993 to September 30, 1993

INTRODUCTION

During the *Exxon Valdez* oil spill many fisheries were closed due to the presence of oil in the water and on the beaches. Major lethal effects on fish were documented for pink and sockeye salmon and herring, chronic and sub-lethal effects were difficult to measure. The planning and design funds for the next phase of the multi-agency fishery technology and research would enable the user agencies to (1) initiate research projects on the efficacy of restoration practices, (2) the enhancement of fishery resources in the effected areas, such as king crab, sea urchins, and molluscan shellfish, (3) the enhanced utilization of replacement fishery resources to those in spill area, such as arrowtooth flounder, and (4) to initiate long term research programs to better understand and ameliorate the effects of oil spills on the fisheries of the western Gulf of Alaska. Seven federal and two State agencies, the University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Kodiak Island Borough, and the City of Kodiak have all participated in the planning for the multi-agency facility.

The seawater system and associated facilities will be designed to enhance research on fish behavior, physiology and perception, marine biology, and aquatic toxicology of normal and stressed fisheries. Stressed conditions could include other human activities, including fish harvesting, in addition to spilled crude oil. In addition the completed multi-agency fishery technology and research facility will provide a variety of analytical testing and monitoring capabilities within Kodiak Island Borough. These capabilities were severely lacking during the oil spill when all samples had to be sent off-island for analysis.

The first phase of the University of Alaska Fairbanks, School of Fisheries and Ocean Sciences (SFOS), Fishery Industrial Technology Center (FITC) has been completed. It is the

first building of the proposed multi-agency fishery technology and research facilities. The FITC Owen Building is being used by the University of Alaska and National Marine Fisheries Service-Utilization Research Division personnel. Co-location of these two groups has resulted in efficient use of facilities and encouraged pooling of expertise to pursue efficient use fishery resources to produce diverse, high quality products, and eliminate waste.

Currently the other agencies interested in co-locating are isolated from each other, the public and the fishing community, and occupy out dated and inadequate facilities. The importance of the fisheries in the western Gulf of Alaska to the State and nation are expanding, and the oil spill emphasized the need for more specific information on these fisheries. Many of the fisheries activities in Kodiak are expanding to meet these needs. The multi-agency fishery technology and research facilities will be necessary to meet the agencies needs and the public's need for better access to information and training in a timely manner.

The City of Kodiak has donated the land for fisheries research facilities on Near island. The City of Kodiak has committed to using its revenue bonding power to fund construction of portions of these facilities to the extent that lease monies are committed by user groups and agencies, if other funding sources are not available. As one of the users of the expanded facilities the National Marine Fisheries Service has been authorized by congress to lease space on Near Island at an annual lease not to exceed $1,000,000 per year and has appropriated $100,000 for planning the federal needs in the facility.

WHAT

The $100,000 in this project will be used to match the federal planning money to initiate planning and design of expanded multi-agency fishery technology and research facilities on Near Island, Kodiak, Alaska following the recommendation of the Kodiak Island Borough an the FITC Policy Council. The University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, in conjunction with NOAA and ADFG, will lead the development. The next phase of this facility which is most critical for restoration, enhancement, enhanced utilization of fishery resources, and better understanding and ameliorating the effects of oil spills in the western Gulf of Alaska will include a gravity fed seawater system, wet and dry marine laboratories, public education facilities and associated systems.

The combined use of state and federal lease monies with funds from the civil EVOS settlement to finish construction of a multi-agency fisheries research center on Near Island in Kodiak will help provide the State of Alaska with state-of-the-art capabilities to undertake critical studies on the restoration, enhancement, and enhanced utilization of fishery resources in the western Gulf of Alaska. These facilities will also provide Alaska's fishing industry with research and technical assistance during the rehabilitation of Alaska's vertebrate and invertebrate fisheries resources. The new facilities will be located in conjunction with existing FITC facilities. These facilities will accommodate NOAA/NMFS and other fisheries research and management groups in addition to the FITC. Land for development of these facilities is being held in trust by the City of Kodiak. Development of these facilities would provide the University of Alaska, State, and Federal agencies resources for evaluating toxicological, physiological, and behavioral effects related to the presence of hydrocarbons.

A principal component of the oil spill related portion of these facilities will be a controlled environment behavior and sensory physiology wet laboratory. This will be the core unit which will be used to investigate physiological and behavioral effects of long term low level exposure to hydrocarbons. Central to this laboratory is a large swimming pool tank which will provide capabilities to assess how adult organisms perceive and react to stimuli produced by their environment in conjunction with the presence of hydrocarbons. The main support facility for this system is a running seawater system with associated mechanical support and filter beds. Additional facilities include food safety, physiology and toxicology laboratories.

These enhancements to the state/university/federal fisheries research complex on Near Island would enhance research and development activities related to the restoration, enhancement, and economic value of fisheries resources of the oil spill effected areas, especially through better understanding of the behavioral, physiological, and toxicological responses of targeted species. Research in this facility would also lead to the development of better tools to monitor aquatic toxic responses and other physiological changes resulting from oil spills and other anthropogenic activity.

The expanded fisheries research center will house the Biotechnology, Fisheries Science, Fish Harvesting Technology, Food Safety, and Toxicology programs of FITC/SFOS in addition to significantly expanding the public education activities of all parts of the center. Alaska Department of Fish and Game research efforts will probably focus on shellfish enhancement and rehabilitation. In addition to management data acquisition National Marine Fisheries Service activities are expected to include marine mammal studies and the observer program.

WHY

Commercial fishing was directly impacted by the salmon closures in 1989. The large number of other fisheries were adversely impacted by the unavailability of fishing vessels under contract to Exxon and Veco. Damage to pink and sockeye salmon stocks has been demonstrated. Herring stocks also appear to have been damaged. In addition studies since the spill have shown that 0-2 year old halibut are primarily found in shallow bays, some of which were heavily oiled (Norcross et al). Since we do not have an accurate juvenile index, we will not have accurate assessment of damage to the halibut resource for eight years until they are recruited into the commercial fishery. Pink salmon escapements in the oil spill area were unexpectedly high in 1991 and very low in 1992. Southeast and western Alaska returns were much more normal over the same period. There may be a second generation teratogenic effect as there is with some hydrocarbons such as diethylstilbesterol or polybrominated biphenyls. Few, if any, of these effects are legally proven but there is certainly enough information to justify further investigation.

Some of the highest tissue hydrocarbon and florescent metabolite levels that were seen during the subsistence foods study came from the Kodiak archipelago. This evidence is also strongly suggestive of much broader exposure of finfish to oil-derived hydrocarbons than is legally recognized. The expanded fisheries research center would have the capabilities to test food samples within the community.

Several food chain related stresses have been identified during the NRDA process. If either these or the previous items result in diminished commercial stocks the efficiency and selectivity of fishing gear will become far more critical. If some stocks drop to critical levels or if some stocks have to be closed to fishing in order to protect, restore or enhance other damaged resources than the development of alternative fishery resources will become critical.

The expanded fisheries research center will also provide the technical capabilities to address both food safety and aquatic toxicology issues within the community of Kodiak, at the cross roads of spilled oil coming out of either Cook Inlet or Prince William Sound.

HOW

The FY93 funding will provide for the following planning and design objectives:

1. A master plan which would address the specific positioning and general configuration of all elements of the proposed facility. It would program phased development and identify requirements of the infrastructure (seawater system, support facilities, roads, parking and utilities).

2. A conceptual design which identifies specific elements and programmatic relationships required to effectively address overall programmatic objectives. Programming all elements of the elements of the facility in sufficient detail to develop realistic project cost estimates. Preliminary facility plans, exterior elevations and specifications will be developed indicating the general configuration and components. This information would be presented in a brochure format which could be used to promote the facility and help secure complete funding.

3. A project construction cost estimate will be prepared which would identify the probable cost of each element based on the anticipated year of construction.

ENVIRONMENTAL COMPLIANCE

Project compliance with the National Environmental Policy Act (NEPA) will be assessed during the planning and design phase. Until project specifications are finalized, specific NEPA requirements cannot be determined. The seawater system will require a Corps of Engineers' permit and compliance with the Alaska Coastal Management Plan will be required. The required State and Federal permits will be identified and incorporated into the planning process.

WHEN

The planning and design will occur during the period 1 March 1993 to 30 September 1993. Final architechure, design and engineering will require an additional $1,000,000 in FY94. The construction project will require approximately 6.5 million dollars above and beyond the funds previously identified. If these funds were available for phased construction during FY95 and FY96, the facilities will be operational by the end of 1996. Careful phasing of the project could make key aspects of the facility operational sooner.

BUDGET ($K)

Personnel	$ 0.0
Travel	0.0
Contractual	93.0
Commodities	0.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 93.0
General Administration	$ 7.0
Project Total	$100.0

Contractual is a subcontract to UAF Facilities Planning and Construction

Name, Address, Telephone of UAF contact:

Kathleen Schedler, Director
UAF Facilities Planning & Construction
Butrovich Building, Suite 211
University of Alaska
Fairbanks, AK 99775

Voice: (907) 474-5026
FAX: (907) 474-7554

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

move to adopt
1 Andrews
2 French

Date: 1-7-93

Issue: Kodiak 92298-17 support Kodiak museum project as modified (attached)

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				
Richard Eliason				
Donna Fischer				
John French				
Paul V. Gavora				
James King				
Richard Knecht				
Vern C. McCorkle				
Gerald McCune				
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by unanimous consent

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL

FORMAT FOR IDEAS FOR RESTORATION PROJECTS

Document ID Number 92061S279

- ☐ A-92 WPWG
- ☑ B-93 WPWG
- ☐ C-RFWG
- ☐ D-PAG
- ☐ E-MISC.

Title of Project: ALUTIIQ MUSEUM AND CULTURE CENTER: PHASE ONE CONSTRUCTION

Justification: (Link to Injured Resource or Service) (SEE PAGE 2)

Description of Project: (e.g. goal(s), objectives, location, rationale, and technical approach)

~~The goal of the project is to provide a regional facility dedicated to the preservation~~ of cultural resources, traditional Native Culture, and Public education.

The research, education programs, and collections now maintained by the Kodiak Area Native Association's Alutiiq Culture Center will be transferred to this facility. Archaeological and ethnographic collections totaling more than ~~35,000~~ 155,000 pieces are already in hand.

A building of ~~6,500~~ 3,000 square feet would house artifact storage facilities, lab space and exhibits. ~~An operations endowment is included in construction costs to insure that the facility can be kept fully functional for the long term.~~

This project has been in the planning process for the past five years. An already urgent race against time; to preserve sites against destruction was e even more crtical by the 1989 spill. A fifty-year lease for 2.5 acres of d for the project has already been granted by the City of Kodiak. A building program and preliminary plans is also in place. We have raised $250,000 in cash to cover initial expenses.

Estimated Duration of Project: One Year construction time.

Estimated Cost per Year: $800,000. for FY 93 ~~$5,000,000. and $4,000,000 for FY 94.~~

Other Comments: This proposal addresses Options 1, 10, and 35 in the Exxon valdez Oil Spill Restoration Framework, Volume I.

Name, Address, Telephone:

KODIAK AREA NATIVE ASSOCIATION
402 CENTER AVENUE
KODIAK AK 99615
ATTN: RICK KNECHT, DIRECTOR,
ALUTIIQ CULTURE CENTER

Oil spill restoration is a public process. Your ideas and suggestions will not be proprietary, and you will not be given any exclusive right or privilege to them.

JUSTIFICATION: The Kodiak Archipelago has the highest archaeological site density of the Exxon-Valdez spill area. Of the 22 sites impacted by vandalism in 1989, 17 were in the Kodiak region. A permanent center would serve as a focal point for archaeological research and survey. Public educational programs are the only effective way to address the problems created by the widespread knowledge of site locations. The museum would also serve as a regional repository for artifacts from the spill area. The cultural center would preserve the traditional lifeways of the Native community, many of which were also disrupted by the oil spill. The project would be a permanent, valued addition to the Native, and non-Native community.

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Move to adopt
1 Williams
2 McMullen

Date: 1-7-93

Issue: PWS Herring Damage Assessment
(Based on the latest findings) (attached)

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews				
Pamela Brodie				
James Cloud				
James Diehl				X
Richard Eliason				X
Donna Fischer				
John French				
Paul V. Gavora				X
James King				
Richard Knecht				
Vern C. McCorkle				X
Gerald McCune				X
John McMullen				
Brad Phillips				
John Sturgeon				
Charles Totemoff				
Llewellyn W. Williams Jr.				

passed by unanimous consent

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number:

Project Source:

Project Title: Injury to Prince William Sound Herring

Project Category: Damage Assessment

Project Type: Fish/Shellfish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies:

Project Term: **Start Date:** Ongoing (March 1, 1993) **Finish Date:** Continuing (Sept 30,1993)

INTRODUCTION:

A. Background on the Resource/Service

Pacific herring *Clupea pallasi* are a major resource in Prince William Sound (PWS) from both ecological and commercial perspectives. Pacific herring provide important forage for many species including humpbacked whales, seals, sea lions, gulls, sea ducks, shorebirds, halibut, salmon, and other fish. It appears that herring may be critical to the reproductive success of certain gull and shorebird species. Several thousand pounds of herring and herring spawn on kelp are harvested annually for subsistence purposes and form an important part of the local native culture. In addition, five commercial herring fisheries in PWS have an average annual combined ex-vessel value of $8.3 million.

B. Summary of Injury

The oil spill coincided with the spring migration of herring to the spawning grounds and adult herring transited oiled waters on their way to nearshore staging areas. Significant histopathological damage was measured in adults collected in oiled areas in both 1989 and 1990 confirming exposure of the fish to toxins. Oiling of over 40% of the spawning areas and of migrating adults caused increased egg mortality, elevated levels of abnormalities and gene breakage in newly hatched larvae, and reduced hatching success of the embryos. Over 90% of the summer rearing and feeding areas of herring were oiled in 1989. Direct mortality was significant on young herring in 1989 and sublethal effects were measurable in larvae and adults in 1989 and 1990. Damages observed in 1989 and 1990 lead researchers to believe that adult and juvenile herring were re-exposed to oil after spawning in both years by persistent sheens leaching from beaches and cleaning operations. Laboratory studies measuring the effect of known doses of oil on newly hatched larvae provided a direct link between estimated doses of oil measured in PWS and the level of injury observed in samples collected from the field.

Although many herring typically spawn for the first time at age 3, herring that hatched in 1989 were noticeably absent as 3-year-olds from the 1992 spawning population. Herring survival varies tremendously under normal conditions, but results to date strongly implicate the oil spill as a major cause for this low 3-year-old recruitment. Herring that hatched in 1988 and that were exposed to oil as 1-year-olds at the time of the spill currently dominate (62% in 1992) the PWS herring spawning population. It was hypothesized that damage to germ tissue caused by exposure to oil would result in non-viable embryos and larvae and a pilot experiment to measure the ability of herring from this age class to produce viable offspring was conducted in 1992. Hatching success of eggs collected

from fish spawning in previously oiled areas was less than half that of eggs collected from fish spawning in pristine areas.

C. Location

Research will be conducted entirely within the confines of PWS and exact locations will depend upon the distribution of spawning herring. Benefits to improved management of the herring resource will be realized by all participants in the commercial and subsistence fisheries throughout the sound, and by all species which utilize herring as forage. Herring have commercial importance to all communities of PWS and are important for subsistence use at Tatitlek and Chenega and to lesser degrees in other communities.

WHAT: The goal of the proposed project is to improve the accuracy of fisheries management of the PWS herring resource. Improved accuracy will allow fishery managers to make fine adjustments to fishing quotas and more effectively result in measurable rehabilitation for PWS herring stocks. Accurate and precise estimation of herring abundance is crucial to the improvement of management accuracy.

Specific objectives to achieve this goal include:

1) Estimate the biomass of spawning herring in PWS using SCUBA diving spawn deposition survey techniques such that the estimate is within $\pm$ 25% of the true value 95% of the time.

2) Estimate the age, weight, length, and sex composition of the spawning herring in PWS such that age composition estimates are within $\pm$ 10% of their true value 95% of the time.

3) Document and estimate the extent of egg retention by spawning females and account for this process in the spawn deposition biomass estimate.

4) Collect and analyze spawning substrate calibration samples for each diver. These samples will be used to estimate diver- and vegetation-specific bias in egg counting to correct the biomass estimate and to provide training for divers in spawn estimation.

WHY: The proposed project will provide a relatively low cost, albeit incomplete, tool for restoration of damaged herring resources through the management of human uses, a major source of herring mortality. Herring spawn deposition surveys will permit more intensive management of the resource by providing more accurate biomass estimation than do standard aerial survey methods. However, it should be cautioned that results from spawn deposition surveys will not provide complete assessment of the injury to herring resources nor permit complete evaluation of restoration success. Additional studies to investigate stock discreetness, stock-specific migration patterns, recruitment processes, and the effects of oil on reproductive success are necessary to construct a comprehensive ecological model quantifying the effects of spilled oil and its passage through the environment.

HOW:

Aerial surveys conducted by area biologists as a regular part of commercial fishery management activities will be used to estimate the extent and distribution of herring spawn and to provide the basis for locating survey transects at nearshore spawning grounds in a two stage sampling design. Trained and calibrated SCUBA divers stationed aboard a research vessel will conduct surveys along the selected transects to estimate the number of herring eggs deposited on vegetation and bottom substrate. Preserved samples of eggs attached to vegetation will be collected and retained for later laboratory analysis. Field estimates by divers of the number of eggs attached to the vegetation will be compared to more rigorous laboratory egg counts to calculate diver-specific and vegetation-specific bias. Samples of adult female herring will be collected immediately following spawning events to estimate the number of females retaining eggs and the quantity of eggs retained to adjust the spawn deposition biomass estimates.

Area research biologists will collect samples representative of spawning herring for determination of age, weight, length, and sex as part of regular ongoing data collection programs. Egg counts adjusted for measured diver and substrate bias will be combined with estimates of the extent of total spawning area and area sampled to estimate the total number of eggs deposited in PWS. The spawning biomass required produce this total will be calculated from total egg deposition combined with average fish size and sex ratio for 1993 and average fecundity at size measured in previous studies. Estimated spawning biomass will be adjusted for natural loss of eggs prior to surveys as measured in previous studies and for egg retention in 1993 measured as part of this proposed project.

Estimates of spawning biomass will be included in ongoing ADF&G investigations of age structured analysis of PWS herring stocks to project the biomass of herring returning to spawn (run biomass) in 1994. The forecast of run biomass will be used directly to set guideline harvests for PWS commercial fisheries. Spawning biomass estimates will also be combined with information from previous herring research studies to continue to evaluate oil spill related damage to the resource and to grossly assess the progress of resource rehabilitation. However, results from the proposed project are likely to have only limited utility to assess resource rehabilitation without additional knowledge of stock structure, mixing, and recruitment processes.

ENVIRONMENTAL COMPLIANCE: The proposed project is not intrusive. It involves collection of data and does not affect fish and wildlife populations or their habitat.

WHEN:	Jan-Feb 1993	Initiate vessel charter bids and contract
		Contact and line up divers (ensure certification requirements met or in progress)
		Complete sample design for egg retention study
		Complete sample design for diver calibration
		Order laboratory supplies and field supplies
	Mar 1993	Complete any necessary diver certifications
		Complete Detailed Study Plan
		Hire technician to finish maintenance and assembly of dive gear
	1-5 Apr 1993	Complete all hiring of field personnel and arrange for arrival of divers
		Complete vessel contract
	early Apr 1993	Diver training/refresher/orientation
		Set up laboratory
	5-15 Apr 1993	Initiate diving/field data collection (at onset of spawning)
	1-12 May 1993	Complete field activities
		Begin lab processing of calibration samples
	30 May 1993	Complete data entry of diver estimates
	May-Jun 1993	Maintain, repair, and store gear
	15 Jun 1993	Complete calibration sample processing
	30 Jun 1993	Data entry of calibration samples
		Initiate data analysis
	1 Sep 1993	Finalize estimate of spawning biomass
	15 Nov 1993	Finalize projection of 1994 run biomass
	Nov/Dec 1993	Complete annual report

Project: Injury to Prince William Sound Herring

Description: SCUBA surveys are conducted to quantify herring spawn in areas of spawn identified through aerial surveys. Estimates of deposited spawn are combined with other biological information (age, sex, size, fecundity, etc.) to estimate the biomass of reproducing herring. Biomass estimates are used to forecast future returns and set harvest allocations.

30-Dec-92

Item	Name	Position	Months Budgeted	Regular Salary	Dive/Sea Duty Premium Pay	01-Feb-93 28-Feb-93	01-Mar-93 30-Jun-93	01-Jul-93 30-Sep-93	TOTAL COST
Personnel Costs	Wilcock	Fisheries Biologist III	3.0	$6,069	$7,876	$6,069	$13,945	$6,069	$26,082
	Brown	Fisheries Biologist II (PI)	10.0	$5,093	$6,707		$27,079	$30,558	$57,636
	Bechtol	Fisheries Bilogist II	1.0	$5,093	$6,707		$11,800		$11,800
	Haley	F&W Technician III	4.5	$3,643	$5,001		$19,575	$1,822	$21,396
	Becker	F&W Technician II	1.5	$3,140	$3,886		$8,596		$8,596
	Miller	F&W Technician II	1.5	$3,140	$3,886		$8,596		$8,596
	Gilman	F&W Technician II	5.0	$3,229			$11,301	$4,843	$16,145
		F&W Technician I	2.0	$2,717			$5,434		$5,434
		Biometrician II	1.0	$5,640			$2,820	$2,820	$5,640
		Research Analyst I	1.0	$4,230				$4,230	$4,230
	TOTAL	FTE =	2.5		$34,063	$6,069	$109,146	$50,341	$165,555
Travel	Bechtol - 2 RT Homer/Cordova						$2,000		$2,000
	Meeting Attendance - 2 RT Anch/Cordova							$800	$800
Contractual	Vessel Charter - 25 days @ $1500/day						$37,500		$37,500
	Fuel for dive skiffs						$1,000		$1,000
	Equipment Maintenance/Repair						$1,500		$1,500
Commodities	Office and Lab Supplies						$1,200		$1,200
	Food and Field Supplies						$1,500		$1,500
Equipment	Dive Gear Replacement							$2,000	$2,000
General Administration	(15% * personnel cost)								$24,833
TOTAL PROJECT COST									$237,889

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

OFFICE OF THE COMMISSIONER

WALTER J. HICKEL, GOVERNOR

P.O. BOX 25526
JUNEAU, ALASKA 99802-5526
PHONE: (907) 465-4100

January 7, 1993

Mr. Mike Barton
Regional Forester
U.S. Forest Service

Mr. Steven Pennoyer
Director
National Marine Fisheries Service

Mr. Curtis McVee
Special Assistant to the Secretary
U.S. Department of the Interior

Mr. Charles Cole
Attorney General
Department of Law

John A. Sandor
Commissioner
Department of Environmental Conservation

I was recently contacted by members of the Public Advisory Group and local commercial fisheries interest groups about the lack of funding for projects dealing with herring. as you know, those projects were not included in the 1993 Work Plan, because at that time, there was less evidence of population level injury to herring and the Restoration Team wanted to wait until the results of the 1992 field season were available. Since that time, information from the 1992 field season has come to my attention that indicates a population level injury has probably occurred to the herring of Prince William Sound (PWS). Pertinent findings include the following.

1. In 1992, the 1989 year class returned as age-3 first time adult spawners at the lowest level age-3s measured since 1967. This year class represents returning offspring of the largest spawning population in PWS since the early 70s.

2. In 1992, adults from the dominant 1988 year class demonstrated significantly different reproductive capabilities (hatching success from unoiled area eggs was 56 percent versus 20 percent in the oiled areas).

In PWS, there are five commercial herring fisheries worth an average annual combined exvessel value of $8.3 million. This fishery is of great economic importance to commercial fishermen in Cordova, Valdez, and the smaller communities of PWS. Without better biological information on age class disappearance and reproductive impairment, the department will likely have to implement more conservative management strategies in 1994 with an associated loss to the herring fishery.

Having reviewed the available data we recommend the following as a minimum to increase the management precision necessitated by the oil spill injuries outlined above.

1. Continue to monitor the reproductive success of the 1988 year class, define differences due to individual variability, location, and timing of spawn.

2. Continue to evaluate the reproductive success of the 1989 year class in 1993.

Because of this new information and the concern from special interest groups and the general public, I submit the enclosed project description for our consideration for inclusion in the 1993 Work Plan.

Sincerely,

C Meacham for

Carl L. Rosier
Commissioner

Enclosure

cc: Restoration Team
Dr. Robert Spies

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Moved to adopt
1 Andrews
2 Fischer

Date: 1-7-93

Issue: PWS pink salmon coded wire tag project (attached)

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	~~X~~	X		
James Cloud	X			
James Diehl				X
Richard Eliason				X
Donna Fischer				X
John French	X			
Paul V. Gavora				X
James King		X		
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon		X		
Charles Totemoff		X		
Llewellyn W. Williams Jr.	X			
	8	3		

passed

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number:

Project Source:

Project Title: Coded wire Tag Recoveries from Commercial Catches, Cost Recovery Catches, and Hatchery Brood Stocks in Prince William Sound Pink Salmon Fisheries

Project Category: Restoration Manipulation and Enhancement

Project Type:

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies:

Project Term: **Start Date: 03/01/92** (day/month/year) **Finish Date:09/30/92** (day/month/year)

INTRODUCTION: Each year approximately one half billion wild pink salmon fry emerge from streams throughout Prince William Sound (PWS) and migrate seaward. Adult returns of wild pink salmon to PWS average from 10 to 15 million fish annually. These huge outmigrations of wild pink salmon and subsequent adult returns play a major role in the PWS ecosystem. Both juveniles and adults are important sources of food for many fish, birds, and mammals. Adults returning from the high seas also convey needed nutrients and minerals from the marine ecosystem to estuaries, freshwater streams, and terrestrial ecosystems. Wild pink salmon also play a major role in the economy of PWS through their contribution to commercial, sport, and subsistence fisheries in the area.

Wild pink salmon stocks in oiled portions of PWS have experienced higher egg mortalities, larval deformities, and lower juvenile growth rates than stocks from unoiled streams and hatcheries. There is evidence that they may also have sustained genetic damage which has resulted in reduced egg survival in generations following the spill. Furthermore, coded wire tag recovery results from NRDA F/S Study 3 indicate that damaged wild salmon streams located on hatchery stock migratory corridors experience a high incidence of genetic interchange as a result of straying from the burgeoning hatchery populations. Ample evidence in the literature suggests that hatchery fish are ill adapted to wild conditions and that genetic interchange between hatchery and wild stocks may lead to reduced fitness of wild stocks. Wilds stocks most impacted by the *Exxon Valdez Oil Spill* (EVOS) are also subject to excessive exploitation in the mixed stock fisheries of western PWS which are targeting on large hatchery returns. The combined effects of oil damage, excessive harvest, and genetic burden may result in an overall reduction in population size, genetic diversity, and fitness of PWS salmon populations.

Presently, the largest single source of wild pink salmon mortality in PWS which can be successfully monitored and manipulated by human intervention is the commercial harvest of returning adults. Depleted and less productive oil impacted wild populations cannot sustain as high an exploitation rate as unimpacted wild and hatchery stocks; consequently, they require special protection if adequate numbers are to escape and spawn. To reduce wild stock harvests and provide this protection, fisheries managers must know time and area abundance trends for both wild and hatchery fish.

This restoration and resource monitoring project will use coded wire tags as a stock identification tool to enable managers to estimate specific contributions to commercial harvests by time and area. These

estimates coupled with estimates of wild stock spawning escapement provided by existing ADF&G programs and another proposed restoration project will be used inseason for adjusting fishing patterns by time and area to protect impacted wild stocks from overexploitation. Almost all project funds will be spent to support PWS field studies and will contribute to the local economy of Cordova. The project may result in altered harve management strategies in PWS fisheries and will contribute to the natural recovery process for PWS pin salmon populations.

WHAT: The goal of this project is to restore PWS wild pink salmon stocks injured by EVOS through more precise, stock specific fisheries management. Although other techniques may be developed, the most effective restoration methods identified at this time is modification of human use of injured stocks. The commercial fishery is a major factor controlling pink salmon population size and reproductive success. Since PWS wild pink salmon stocks are harvested in mixed stock fisheries dominated by hatchery fish, successful restoration efforts must be based on the ability to closely regulate the exploitation of oil impacted wild stocks. Private non-profit aquaculture associations in PWS already apply coded wire tags to fry releases at their own expense. This project is a comprehensive program for recovery of these tags in returning adults and analysis of tag recovery data which will provide inseason estimates of hatchery and wild stock abundance and timing. Results of this project will enable fisheries managers to selectively reduce harvests on injured wild stocks. Timing and abundance data for wild and hatchery stocks can also be used in salmon run reconstruction models which may be valuable tools for managing for depleted stocks far into the future. Tagging information will also provide total return and survival estimates needed to set exploitation rates and assess the success of restoration procedures.

Objectives:

Recovery of coded wire tags from commercial catches to:

a. estimate temporal and spatial contributions of tagged hatchery stocks to PWS commercial and hatchery harvests;
b. provide timely inseason estimates of stock contributions to harvests by time and area to fisheries managers so they can closely regulate exploitation of injured wild stocks;
c. determine total return and overall survival of tagged pink salmon stocks.

WHY: Legal, practical, and philosophical considerations dictate that a significant effort be made to preserve genetic diversity. In the context of this proposal, it is the genetic diversity of populations of wild pink salmon that are of interest.

Wild salmon stocks from oiled streams in southwestern PWS are subjected to extreme fishing pressure in fisheries targeting on hatchery runs. This exploitation may be great enough to drive EVOS damaged stocks to critically low levels and impede the natural recovery process. The ongoing threat of overexploiting wild stocks which has been exacerbated by spill related damages has greatly increased the need for stock identification tools such as the coded wire tag program. Without this project, stock specific timing and distribution data will not be available, and fisheries managers will be unable to control harvests with enough accuracy and precision to protect damaged stocks from overexploitation. Failure to continue this project in 1993 will also prevent continued monitoring of the health of these populations and hinder our understanding of factors limiting their survival and recovery.

HOW: Coded wire tag recoveries from commercial and hatchery harvests will be based on a sampling design stratified by time, area, and processor. For each time and area specific stratum, 15% of the pink salmon catch will be scanned for fish with clipped adipose fins (indicating presence of a tag). Catch sampling be done at processing facilities in Cordova, Valdez, Seward, Anchorage, Kenai, Whittier, Kodiak and floating processors in the PWS area. All deliveries by tenders to these facilities will be monitored by radio and by

daily contact with processing plant dispatchers to ensure the catch deliveries being sampled are from specific fishing periods and districts. In addition to catch sampling at the processing facilities, approximately 15% of the fish in the hatchery cost recovery harvests from terminal areas in front of hatcheries will be scanned for fish with missing adipose fins.

The portion of tagged fish in each hatchery release group must be known to make catch contribution estimates. Although tagged and untagged proportions are estimated when fry are released after tagging, some tags are lost and tagged fish may experience a different mortality rate than untagged fish. To adjusted tag ratios in adult returns for this tag loss and differential mortality, at least 50% of the fish of known origin in hatchery brood stocks will be sampled for tags.

In the catches, terminal cost recovery harvests, and brood stocks the total number of fish with missing adipose fins will be recorded. Heads of fin clipped fish will be removed and tagged with uniquely numbered strap tags which are paired with sampling data. Numbered heads and associated sampling data will be sent to the FRED Division Statewide Coded Wire Tag Laboratory in Juneau where sampling data will be checked for accuracy and completeness, tags will be removed from heads and decoded, and sampling and corresponding tag recovery data will be entered into a statewide database.

A modification of the methods described in an ADF&G technical report by Clark and Bernard (1987) will be used to estimate contribution of each uniquely tagged population to commercial and cost recovery strata. The specific methods, estimators, and confidence interval estimators are described in ADF&G technical reports on two previous studies of pink salmon in PWS: Peltz and Geiger (1988), and Geiger and Sharr (1989). Total hatchery contribution to each catch strata will be the sum of the contributions from each hatchery and the total hatchery return to PWS will be the sum of contributions of all PWS hatcheries to commercial catches, cost recovery harvests, and brood stocks. Survival estimates for each hatchery stock will be estimated using hatchery fry release and adult return data. Wild stock contributions will be estimated as the difference between the total catch and the hatchery contribution. Total wild returns will be the sum of wild contributions in all catch strata and the estimated number of wild fish spawning in PWS streams (escapement).

Inseason catch contribution estimates for wild and hatchery fish will be available within three working days of the date of sampling in fish processing plants. Based on these estimates and wild stock spawning escapement performance fishery managers will adjust fishing time and area to protect oil damaged wild stocks from excessive exploitation, insure adequate wild stock escapement, and optimize the commercial utilization of surplus wild and hatchery fish.

WHEN:

Dates	Activity
June 1 - September 15, 1993	Tag recovery in commercial, cost recovery, and broodstock harvests of pink salmon.
December 30, 1993	Draft Report
February 15, 1994	Final Report

Project Description: This project recovers coded-wire tags from adult pink salmon tagged as fry in streams and at four hatcheries in Prince William Sound. It makes estimates of wild and hatchery catch contributions, total returns, and survival rates. In season catch contribution estimates for hatchery and wild fish permit fisheries managers modify time and area fishing patterns to protect oil damaged wild pink salmon stocks.

Budget Category	Proposed 01-Jan-93 30-Sep-93	FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$650.9	$751.3	$751.3	$751.3	$751.3	$3,005.3
Travel	$5.0	$5.0	$5.0	$5.0	$5.0	$19.9
Contractual	$11.7	$15.6	$15.6	$15.6	$15.6	$62.3
Commodities	$7.5	$10.0	$10.0	$10.0	$10.0	$40.0
Equipment	$0.0	$1.0	$1.0	$1.0	$1.0	$4.0
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Sub-total	$675.1	$782.9	$782.9	$782.9	$782.9	$3,131.4
General Administration	$98.5	$113.8	$113.8	$113.8	$113.8	$455.2
Project Total	$773.6	$896.7	$896.7	$896.7	$896.7	$3,586.6
Full-time Equivalents (FTE)	13.9	15.8	15.8	15.8	15.8	63.3

Budget Year Proposed (FY 93 - 01 Jan thru 30 Sept) Personnel:

Position	Months Budgeted	Cost	Comment
FIELD & CORDOVA OFFICE PERSONNEL			
Fisheries Biologist III (PI)	6.0	$39.0	FY 93 Only
Fisheries Biologist II	7.0	$29.4	FY 93 Only
Fisheries Bilogist I	4.0	$14.8	FY 93 Only
Fisheries Bilogist I	7.0	$25.9	FY 93 Only
Biometrician I	6.0	$26.8	FY 93 Only
Research Analyst I	6.0	$21.0	FY 93 Only
F&W Technician III	7.0	$25.0	FY 93 Only - Includes Overtime
F&W Technician III	4.0	$15.6	FY 93 Only - Includes Overtime
F&W Technician II	42.0	$168.3	FY 93 Only - Includes Overtime
F&W Technician II	16.0	$73.5	FY 93 Only - Includes Overtime
F&W Technician II	12.0	$44.6	FY 93 Only - Includes Overtime
F&W Technician II (short term)	4.0	$16.6	FY 93 Only - Includes Overtime
F&W Technician II (short term)	2.0	$8.3	FY 93 Only - Includes Overtime
Program Managers	7.0	$15.0	FY 93 Only
Analyst Programer IV	0.5	$2.7	FY 93 Only
Analyst Programer II	0.5	$2.1	FY 93 Only
Publication Specialist II	0.5	$2.2	FY 93 Only
FRED DIVISION TAG LAB PERSONNEL			
Analyst Programmer	7.0	$35.8	FY 93 Only
F&W Technician III	7.0	$24.0	FY 93 Only
F&W Technician II (perm season)	15.5	$48.4	FY 93 Only
F&W Technician II (non perm)	6.0	$12.0	FY 93 Only

Exxon Valdez Oil Spill

Public Advisory Group
Voting Record

Moved to adopt
1 Andrews
2 Fischer

Date: 1-7-93

Issue: Coded wire tag project for PWS chum, Sockeye, Coho, Chinook (attached)

Name	YES	NO	ABSTAIN	ABSENT
Rupert Andrews	X			
Pamela Brodie	~~X~~	X		
James Cloud	X			
James Diehl				X
Richard Eliason				X
Donna Fischer	X			
John French				
Paul V. Gavora				X
James King		X		
Richard Knecht	X			
Vern C. McCorkle				X
Gerald McCune				X
John McMullen	X			
Brad Phillips	X			
John Sturgeon	X			
Charles Totemoff	X			
Llewellyn W. Williams Jr.	X			

10 1

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number:

Project Source:

Project Title: Coded-wire Tag Recoveries from Commercial Catches, Cost Recovery Catches, and Hatchery Brood Stocks in Prince William Sound Chum, Sockeye, Coho, and Chinook Salmon Fisheries

Project Category: Restoration Manipulation and Enhancement

Project Type:

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies:

Project Term:	Start Date: 03/01/92 (day/month/year)	Finish Date:09/30/92 (day/month/year)

INTRODUCTION: Each year 40 to 50 million wild chum, sockeye, and coho salmon fry and smolt emerge from lakes and streams throughout Prince William Sound (PWS) and migrate seaward. Adult returns of these wild salmon species to PWS average approximately 700 thousand fish annually. The large outmigrations of wild salmon and subsequent adult returns play a major roles in the Prince William Sound (PWS) ecosystem. Both juveniles and adults are important sources of food for many fish, birds, and mammals and both are also important predators on plankton and other fish. Adults returning from the high seas also convey needed nutrients and minerals from the marine ecosystem to estuaries, freshwater lakes and streams, and terrestrial ecosystems. Wild salmon also play a major role in the economy of PWS because of their contribution to commercial, sport, and subsistence fisheries in the area. Chum, sockeye, and coho salmon are not as numerous as pink salmon but they have a much greater unit value commercial in commercial fisheries. In aggregate these three species account for almost half of ex-vessel value of PWS area salmon fisheries and provide alternate fishing opportunities and income for PWS commercial and sport fishing industries.

Like pink salmon, the majority of PWS chum salmon spend the larval portion of their life in the intertidal portion of streambeds. It is reasonable that chum salmon from oiled streams also experienced many of the oil impacts already demonstrated for pink salmon including higher egg mortalities, larval deformities, and lower juvenile growth rates than stocks from unoiled streams and hatcheries. By similar inference from pink salmon research, chum salmon may also have persistent genetic damage which may have caused reduced egg survival in generations following the spill. Furthermore, coded-wire tag recovery results from NRDA F/S Study 3 indicate that damaged wild pink salmon streams located on hatchery stock migratory corridors in western PWS experience a high incidence of genetic interchange as a result of straying from the burgeoning hatchery populations. Ample evidence in the literature suggests that hatchery fish are ill adapted to wild conditions and that genetic interchange between hatchery and wild stocks may lead to reduced fitness of wild stocks. The extent of straying in chum, sockeye and coho salmon in PWS is unknown but may also be important. Wilds stocks most impacted by the *Exxon Valdez Oil Spill* (EVOS) are also subject to excessive exploitation in mixed stock fisheries of western PWS which are targeting on large hatchery returns. The combined effects of oil damage, excessive harvest, and genetic burden on wild fish may result in an overall reduction in population size, genetic diversity, and fitness of PWS salmon populations.

Presently, the largest single source of mortality to wild salmon stocks in PWS which can be successfully monitored and manipulated by human intervention is the commercial harvest of returning adults. Depleted and less productive oil impacted wild populations cannot sustain as high an exploitation rate as unimpacted

wild and hatchery stocks, consequently they require special protection from commercial fisheries if adequate numbers are to escape and spawn. To reduce harvests on wild stocks and provide this protection, fisheries managers must know time and area abundance trends for both wild and hatchery stocks. The proposed restoration and resource monitoring project will use coded-wire tags as a stock identification tool which enables managers to estimate specific contributions to commercial harvests by time and area. Almost all project funds will be spent to support PWS field studies and will contribute to the local economy of Cordova. The project may result in altered harvest management strategies in PWS fisheries and will contribute to the natural recovery process for PWS salmon populations. The budget attached for this project does not include funding for a project principal investigator or other permanent personnel. It assumes that the tag recovery project for pink salmon will be approved and will fund these full time positions.

WHAT: The goal of this project is to restore PWS salmon stocks which may have been injured by EVOS through more precise, stock specific management of fisheries. Although other techniques may be developed, the most effective restoration methods identified at this time is modification of human use of injured salmon stocks while targeting fisheries on undamaged wild and hatchery stocks. The commercial fishery is a major factor controlling salmon population size and reproductive success. Since PWS wild salmon stocks are harvested in mixed stock fisheries dominated by hatchery fish, successful restoration efforts must be based on the State's ability to closely regulate the exploitation of wild stocks. Private, non-profit aquaculture corporations (PNP's) now fund tagging of hatchery releases of chinook, sockeye, chum, and coho salmon of fry and smolt in PWS. However, NRDA funds were used to apply code-wire tags to hatchery releases of chum, sockeye, coho, and chinook salmon in 1989, 1990, and 1991 and to outmigrating sockeye salmon smolt from three wild streams in 1990 and 1991. Because chum, sockeye and chinook salmon mature at varying ages, fish tagged using NRDA funds will continue to return in significant through 1995. This project is a comprehensive program for recovery of tags from these returning adults. Analysis of tag recovery data will provide inseason estimates of hatchery and wild stock abundance and timing. These results will enable fisheries managers to selectively reduce harvests on wild stocks. Tagging data will also provide total return and survival estimates needed to set exploitation rates and assess the success of restoration procedures.

Objectives:

Recovery of coded-wire tags from commercial catches to:

a. estimate temporal and spatial contributions of tagged hatchery stocks to P W S commercial and hatchery harvests;
b. provide timely inseason estimates of stock contributions to harvests by time and area to fisheries managers so they can closely regulate exploitation of injured wild stocks;
c. determine total return and overall survival of tagged salmon stocks.

WHY: Legal, practical, and philosophical considerations dictate that a significant effort be made to preserve genetic diversity. In the context of this proposal, it is the genetic diversity of populations of wild salmon that are of interest.

Wild salmon stocks from oiled areas of PWS and salmon stocks which passed through oiled areas during their seaward migration are subjected to extreme fishing pressure in fisheries targeting on hatchery runs. This exploitation may be great enough to drive EVOS damaged stocks to critically low levels and impede the natural recovery process. The ongoing threat of overexploiting wild stocks which has been exacerbated by spill related damages has greatly increased the need for stock identification tools such as the CWT program. Without this project, stock specific timing and distribution data will not be available, and fisheries managers will be unable to control harvests with enough accuracy and precision to protect damaged stocks from overexploitation. Failure to continue this project in 1993 will also prevent continued monitoring of the health of these populations and hinder our understanding of factors limiting their survival and recovery.

HOW: Coded-wire tag recoveries from commercial and hatchery harvests will be based on a sampling design stratified by time, area, and processor. For each time and area specific stratum, 25% of the chum, sockeye, coho, and chinook salmon catch will be scanned for fish with clipped adipose fins (indicating presence a tag). Catch sampling will be done at processing facilities in Cordova, Valdez, Seward, Anchorage, Kenai, Whittier, and floating processors in the PWS area. All deliveries by tenders to these facilities will be monitored by radio and by daily contact with processing plant dispatchers to ensure that the catch deliveries being sampled are from specific fishing periods and districts. In addition to catch sampling at the processing facilities, approximately 25% of the fish in the hatchery cost recovery harvests from terminal areas in front of hatcheries will be scanned for fish with missing adipose fins.

The portion of tagged fish in each tagged hatchery release group must be known to make catch contribution estimates for each tagged group. Although tagged and untagged portions are estimated when fry are released after tagging, some tags are lost and tagged fish may experience different mortality than untagged fish. To adjusted tag ratios in adult returns for this tag loss and differential mortality, at least 50% of the fish of known origin in hatchery brood stocks will be sampled for tag rates. In the catches, terminal cost recovery harvests and brood stocks the total number of fish with missing adipose fins will be recorded. Heads of fin clipped fish will be removed and tagged with uniquely numbered strap tags which are paired with sampling data. Numbered heads and associated sampling data will be sent to the FRED Division Statewide Coded-Wire Tag Laboratory in Juneau where sampling data will be checked for accuracy and completeness, tags will be removed from heads and decoded, and sampling and corresponding tag recovery data will be entered into a statewide database.

A modification of the methods described in an ADF&G technical report by Clark and Bernard (1987) will be used to estimate contribution of each uniquely tagged population to commercial and cost recovery strata. The specific methods, estimators, and confidence interval estimators are described in ADF&G technical reports on two previous studies of salmon in PWS: Peltz and Geiger (1988), and Geiger and Sharr (1989). The total hatchery contribution to each catch strata will be the sum of the contributions from each hatchery and the total hatchery return to PWS will be the sum of contributions of all PWS hatcheries to commercial catches, cost recovery harvests, and brood stocks. Survival estimates for each hatchery stock will be estimated using hatchery fry release and adult return data. Wild stock contributions to each catch strata will be estimated as the difference between the total catch and the hatchery contribution. Total wild returns will be the sum of wild contributions in all catch strata and the estimated number of wild fish spawning in PWS streams (escapement). Inseason catch contribution estimates for wild and hatchery fish will be available within three working days of the data of sampling in fish processing plants. Based on these estimates and wild stock spawning escapement performance fishery managers will adjust fishing time and area to protect oil damaged wild stocks from excessive exploitation, injure adequate wild stock escapement, and optimize the commercial utilization of surplus wild and hatchery fish.

WHEN:

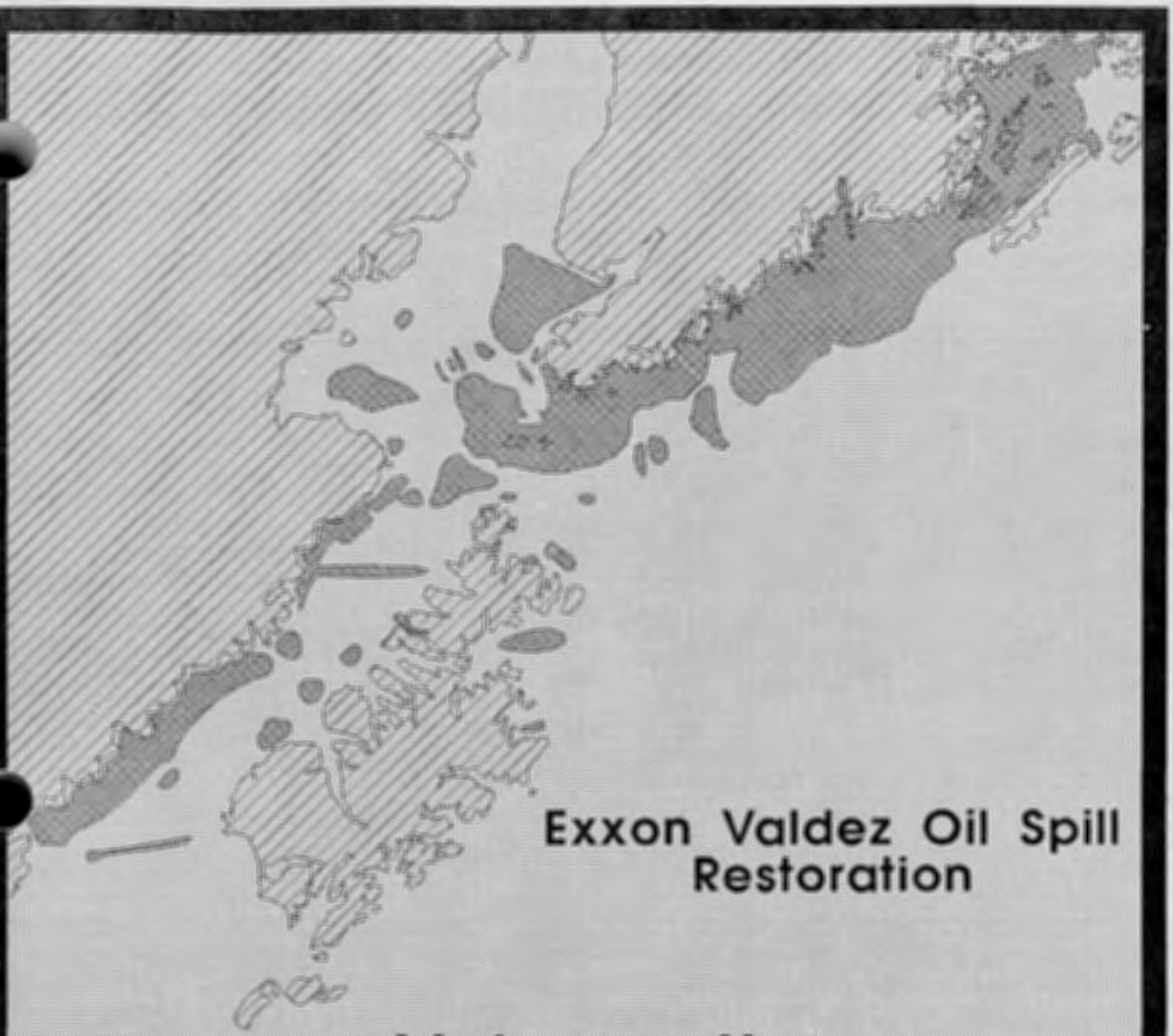
Dates	Activity
June 1 - October 30, 1993	Tag recovery in commercial, cost recovery, and broodstock harvests of salmon.
December 30, 1993	Draft Report
February 15, 1994	Final Report

Project Description: This project recovers coded-wire tags from adult chum, sockeye, coho, and chinook salmon tagged as fry in streams and at hatcheries in Prince William Sound. It makes estimates of wild and hatchery catch contributions, total returns, and survival rates. In season catch contribution estimates for hatchery and wild fish permit fisheries managers to modify time and area fishing patterns to protect depressed wild populations and target effort on large hatchery returns.

Budget Category	Proposed 01-Jan-93 30-Sep-93	FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$208,564	$225,000	$225,000	$225,000	$225,000	$900,000
Travel	$1,000	$1,500	$1,500	$1,500	$1,500	$6,000
Contractual	$6,300	$6,800	$6,800	$6,800	$6,800	$27,200
Commodities	$2,000	$2,500	$2,500	$2,500	$2,500	$10,000
Equipment	$0	$0	$0	$0	$0	$0
Capital Outlay	$0	$0	$0	$0	$0	$0
Sub-total	$217,864	$235,800	$235,800	$235,800	$235,800	$943,200
General Administration	$31,726	$34,226	$34,226	$34,226	$34,226	$136,904
Project Total	$249,590	$270,026	$270,026	$270,026	$270,026	$1,080,104
Full-time Equivalents (FTE)	4.6	15.8	15.8	15.8	15.8	63.3

Budget Year Proposed (FY 93 - 01 Jan thru 30 Sept) Personnel:

Position	Months Budgeted	Cost	Comment
FIELD & CORDOVA OFFICE PERSONNEL			
Fisheries Bilogist I	1.0	$3,706	FY 93 Only
F&W Technician II	47.0	$182,997	FY 93 Only - Includes Overtime
FRED DIVISION TAG LAB PERSONNEL			
Analyst Programmer			FY 93 Only
F&W Technician III			FY 93 Only
F&W Technician II (perm season)	7.0	$21,861	FY 93 Only
F&W Technician II (non perm)			FY 93 Only



Exxon Valdez Oil Spill Restoration

Volume II
1992 Draft Work Plan

Prepared by:
Exxon Valdez Oil Spill Trustees
645 "G" Street
Anchorage, Alaska 99501
(907) 278-8012

April 1992

State of Alaska: Departments of Fish & Game, Law, and Environmental Conservation
United States: National Oceanic and Atmospheric Administration, Departments of Agriculture and Interior in consultation with the Environmental Protection Agency

April 1992

Dear Reviewer:

In the autumn of 1991 the United States and the State of Alaska settled their claims against the Exxon Corporation and Exxon Shipping Company for natural resource damages from the Exxon Valdez oil spill. Money provided by the settlement will be used to restore the environment of Prince William Sound, lower Cook Inlet, and the Gulf of Alaska. The undersigned six State and Federal Trustees, in consultation with the public, are responsible for determining how restoration funds are to be spent.

Exxon Valdez Oil Spill Restoration is a key step in shaping the decision-making process. It is divided into two volumes, which are presented for your review and comment. Volume 1: Restoration Framework provides background information and proposes guidelines for the future. The draft Volume II: 1992 Draft Work Plan proposes activities that are important to undertake in 1992 prior to the final development of the Restoration Plan. We expect that a work plan will be developed annually, describing the activities the Trustees intend to conduct in each year.

These documents are intended to elicit comments and suggestions from you and continue the public "scoping" process for environmental analysis under the National Environmental Policy Act. We want to know how you view this process and receive suggestions concerning restoration of the resources and services injured by the oil spill. This planning effort will culminate in the development of the overall Restoration Plan, which will guide the restoration program in the coming years.

We invite your comments on both Volumes I and II of Exxon Valdez Oil Spill Restoration. The issues identified on the tear sheets in each document are intended to facilitate but not limit your comments and suggestions. In order to be considered during the development of the final 1992 Work Plan and draft Restoration Plan, written comments must be received by **June 4, 1992**, at the following address:

Exxon Valdez Oil Spill Trustee Council
645 G Street
Anchorage, Alaska 99501

Questions concerning this document or its distribution should be directed to the Oil Spill Public Information Center, 645 G Street, Anchorage, Alaska 99501, or you may call (907) 278-8008.

We appreciate your interest and look forward to your participation in this important process.

Sincerely,

Michael A. Barton
Regional Forester
Alaska Region
Forest Service
U.S. Department of Agriculture

Charles E. Cole
Attorney General
State of Alaska

Curtis V. McVee
Special Assistant to the Secretary
Office of the Secretary
U.S. Department of the Interior

Steven Pennoyer
Director
Alaska Region
National Marine Fisheries
Service

Carl L. Rosier
Commissioner
Alaska Department of
Fish and Game

John A. Sandor
Commissioner
Alaska Department of
Environmental Conservation

COMMENTS

You are invited to share your ideas and comments with the Trustees. Please use this tear sheet to present your views on the 1992 Draft Work Plan. You may send additional comments by letter or participate in a public meeting on the 1992 Draft Work Plan and Restoration Framework.

If needed, use the space on the back or attach additional sheets. Please fold, staple, and add a postage stamp. Thank you for your interest and participation.

Additional Comments:

----------(fold here)----------

Return Address:

_____

_____

_____

Place Stamp Here

Exxon Valdez Oil Spill Trustee Council
645 G Street
Anchorage, AK 99501

Attn: 1992 Draft Work Plan

TABLE OF CONTENTS

INTRODUCTION

The March 24, 1989, grounding of the T/V Exxon Valdez in Alaska's Prince William Sound caused the largest oil spill in U.S. history. Approximately 11 million gallons of North Slope crude oil moved through the southwestern portion of the Prince William Sound and along the coast of the western Gulf of Alaska (see map, Fig. 1). The spill injured fish, birds, mammals, and a variety of other forms of marine life, habitats, resources, and the services these resources provide. A summary of the injury documented for these resources is contained in Volume I: Restoration Framework, Chapter 4.

On December 9, 1991, the State and Federal governments and Exxon Corporation agreed to settlement terms of $1.1025 billion for both criminal restitution and civil damage claims. Of these monies the State and Federal Trustees will jointly receive up to $900 million from Exxon over the next 10 years. These monies will be used to restore resources and services injured by the spill. Volume 1: Restoration Framework contains details of the settlement and its terms.

The Exxon Valdez Trustee Council is composed of six members, three Federal and three State of Alaska, representing the following Trustees - the Department of Agriculture, the Department of the Interior, the National Oceanic and Atmospheric Administration, Alaska Department of Fish and Game, Alaska Department of Environmental Conservation, and the Alaska Department of Law.

The initial $90 million payment from Exxon has been received. Of that amount $53.5 million went to reimburse the governments for previous oil spill expenditures, leaving $36.5 million available for restoration and damage assessment work in 1992. The Trustee Council has tentatively approved expenditure of $17.9 million including $13.9 million for the 1992 Draft Work Plan. The remaining $18.6 million has not yet been committed.

This document contains Volume II: 1992 Draft Work Plan approved by the Exxon Valdez Trustee Council on February 28, 1992, for public review and comment. The 1992 Draft Work Plan contains descriptions and budgets of projects that are proposed to be conducted this year.

The proposed 1992 projects fall into two main categories - Damage Assessment and Restoration. Damage assessment projects are those necessary to complete or support the orderly completion of Natural Resources Damage Assessment (NRDA) studies that were begun after the Exxon Valdez oil spill. Although not all these projects were begun in 1989, some have as many as three years of effort behind them. Most of the proposed damage assessment projects will result in completion of final reports in 1992.

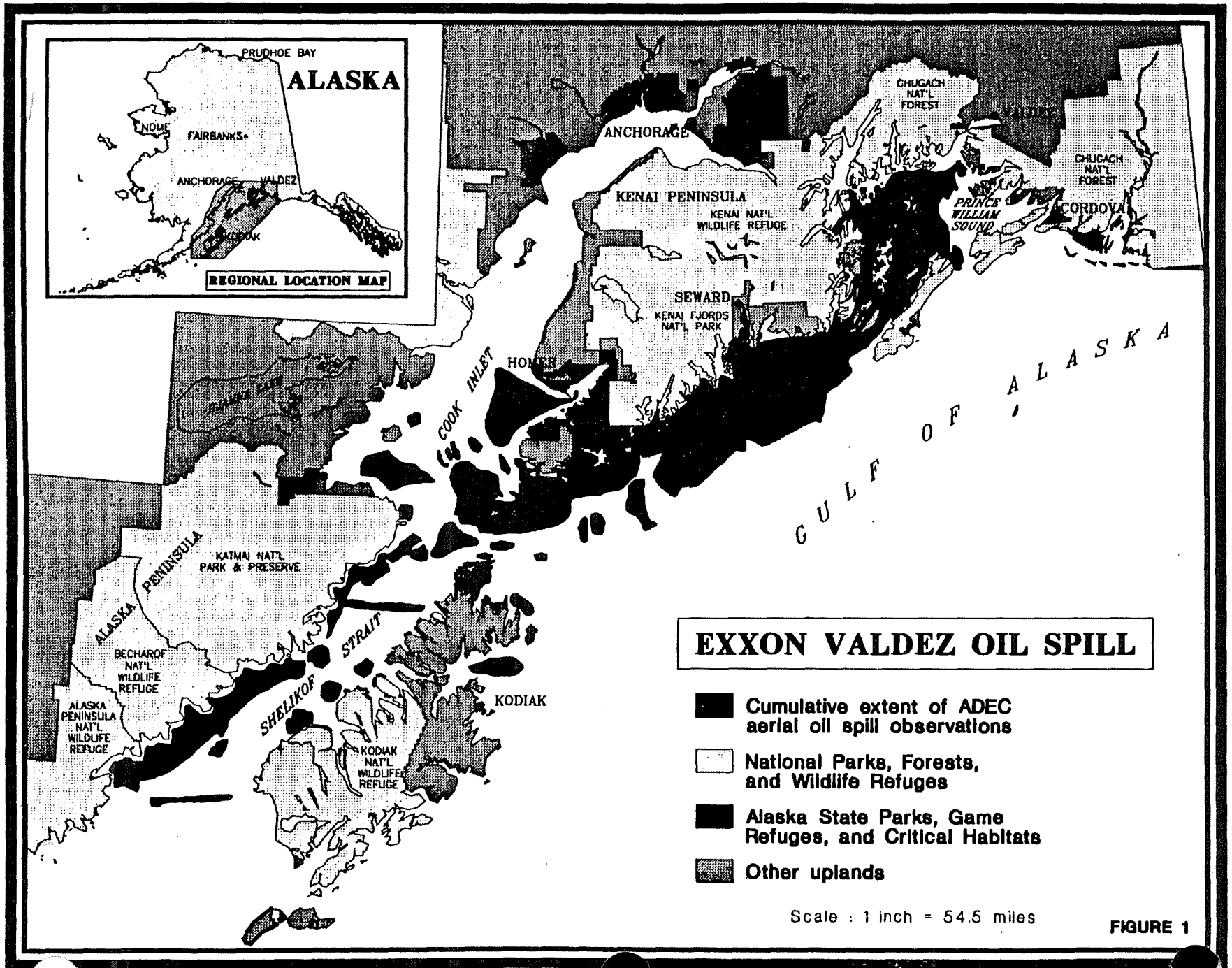

ALASKA
PRUDHOE BAY
NOME
FAIRBANKS
ANCHORAGE
VALDEZ
KODIAK
REGIONAL LOCATION MAP
ANCHORAGE
CHUGACH NAT'L FOREST
VALDEZ
CHUGACH NAT'L FOREST
KENAI PENINSULA
KENAI NAT'L WILDLIFE REFUGE
PRINCE WILLIAM SOUND
CORDOVA
SEWARD
KENAI FJORDS NAT'L PARK
HOMER
COOK INLET
GULF OF ALASKA
KATMAI NAT'L PARK & PRESERVE
ALASKA PENINSULA
BECHAROF NAT'L WILDLIFE REFUGE
ALASKA PENINSULA NAT'L WILDLIFE REFUGE
SHELIKOF STRAIT
KODIAK
KODIAK NAT'L WILDLIFE REFUGE
EXXON VALDEZ OIL SPILL
Cumulative extent of ADEC aerial oil spill observations
National Parks, Forests, and Wildlife Refuges
Alaska State Parks, Game Refuges, and Critical Habitats
Other uplands
Scale : 1 inch = 54.5 miles

FIGURE 1

The Restoration projects will provide timely information necessary to support subsequent decisions about restoration options for injured resources. These projects fall into a number of potential restoration options and restoration implementation categories. The companion document to this work plan, Volume I: Restoration Framework, outlines the process by which restoration options will be developed in the future. Categories of restoration projects described in 1992 Draft Work Plan are Technical Support, Recovery Monitoring, Implementation Planning, Manipulation/Enhancement, Habitat Protection Planning, and Management Actions. The goals or purposes of each of these categories are described more fully in the introduction to each of their respective subsections.

The 1992 Draft Work Plan is the fourth of a series of plans prepared by the State and Federal Trustees for the Exxon Valdez oil spill. Previous plans that were issued were:

- State/Federal Natural Resources Damage Assessment Plan for the Exxon Valdez Oil Spill, August 1989
- The 1990 State/Federal Natural Resource Damage Assessment and Restoration Plan for the Exxon Valdez Oil Spill
- The 1991 State/Federal Natural Resource Damage Assessment and Restoration Plan for the Exxon Valdez Oil Spill

Each of these previous plans contains descriptions of the damage assessment projects that were proposed and conducted in each of those years.

This 1992 Draft Work Plan has received the approval of the Trustee Council to go forward for public review and comment. Many of the proposed projects have elements of work that must be undertaken prior to completion of the public review. However, only interim three-month budgets for the proposed projects have been approved by the Trustee Council, and final decisions on funding will not be made until after the review of public comment on this document.

1. DAMAGE ASSESSMENT

1A. DAMAGE ASSESSMENT INTRODUCTION

Natural Resource Damage Assessment (NRDA) studies began just days after the Exxon Valdez oil spill on March 24, 1989. In the three years of study efforts prior to the settlement agreement, the Trustees conducted the largest damage assessment program in U. S. history. In 1989, the Trustees developed a damage assessment plan incorporating 72 studies in 10 categories. In 1990, 50 studies were undertaken. In 1991, 42 damage assessment studies were conducted. These studies were designed to determine the nature and extent of the injuries, losses or destruction of resources and services, and lost uses of the resources and services. The overall cost of this multi-year effort among the Trustees exceeded $100 million.

Now that a settlement has been achieved, it is possible to undertake restoration of the injured resources and services. Damage assessment information provides the base for developing a restoration plan. Injury information will be essential in the identification of restoration opportunities, and, thorough quantification of injury to a particular resource or service will guide decisions on the choices of restoration options to pursue. In addition, the body of knowledge gained from the damage assessment will greatly advance our understanding of the impacts from oil spills, and it will be invaluable in the planning and implementation of future damage assessment programs.

Most of the damage assessment studies are being brought to a conclusion in 1992 with production of the final reports. These studies are listed as "closeout" studies. A few projects in the damage assessment category require continuation because they either support the closeout efforts or need an additional field effort to complete the documentation of resource or service injury. Both damage assessment closeout studies and continuation studies are described more fully in the following subsections of the 1992 Draft Work Plan.

1B. DAMAGE ASSESSMENT CLOSEOUT

Most of damage assessment studies are recommended for completion in 1992. Completion dates of final reports will be governed chiefly by the number of samples and amount of data remaining to be analyzed for each project. Although in all instances preliminary reports have been prepared, final reports including comprehensive data syntheses and analyses have not yet been completed for most studies. The preparation of final reports will be essential to understanding the spill-related injuries to resources and services.

The preparation and release of final reports on spill injuries will also provide the basis for the first detailed look by the public at the governments' injury assessment. The public's ability to evaluate and suggest restoration measures will be enhanced by the development and release of this information. The timing of the public release of the preliminary and final reports will be determined by ongoing third party litigation.

The following pages provide short project justifications for the damage assessment closeout studies. The more detailed descriptions of objectives and methods of these projects were given in the 1991 NRDA Plan, and are not repeated here.

AIR/WATER STUDY NUMBER 1

Study Title: Geographic Extent and Temporal Persistence of Floating Oil from the Exxon Valdez Oil Spill

Lead Agency: ADEC

JUSTIFICATION

The information from this project will help other studies determine oiling conditions at their study sites. Overflight information on the location of floating oil from several agencies was used each day to produce a map of oil-on-water conditions. Mapping was continued until most of the oil was no longer floating. Some work is needed to finish the maps and prepare a final report.

	BUDGET ($K)
Salaries	$13.5
Travel	0.0
Contractual	0.5
Commodities	1.0
Equipment	0.0
Subtotal	15.0
General Administration	2.0
Total	$17.0

ARCHAEOLOGY STUDY NUMBER 1

Study Title: Archaeological Survey

Lead Agency: DNR

PROJECT JUSTIFICATION

This is the closeout project for the 1991 archaeology injury assessment study. The project will complete the analysis of laboratory test results and artifact collections for the state field injury assessment of direct oiling effects on historic and prehistoric site dating. A synthesis of the data from all of the injury assessment studies will be put together and used to set up the basis for restoration decisions. Future restoration projects may include archaeological site protection through enhanced monitoring and law enforcement, data recovery from excavations, museum exhibits using new artifact collections and information, school curriculum units and educational publications for the general public. Archaeological damage assessment studies were not funded until 1991 and thus conclusion of the assessment lags behind other resource studies.

OBJECTIVES

The project includes the following objectives to arrive at an assessment of injuries to archaeological sites and place them in a context to plan for restoration.

A. Complete analysis of data collected during the State's 1991 field season into a report of scientific findings.

B. Compare results of radiocarbon analysis and sediment oiling analysis with cultural chronology generated from 1991 data.

C. Combine results from the federally contracted damage study by the State University of New York (SUNY), Binghampton, with the State study, and the compilation of injury documentation from existing files.

D. Based on documented injury, formulate a restoration plan for injured sites.

METHODS

The first four months of the project will conclude the analysis of the data collected during the 1991 field season. Radiocarbon dates and results of sediment analysis to detect petroleum in sites will become available for the damage assessment study during March and

April, 1992. The State report of findings will comply with the Secretary of the Interior's Standards for archaeological reporting. Findings of site injury studies need to be synthesized and determination of injuries completed. Establishing more detailed cultural chronologies for the spill area will allow accurate determination of site importance, a process which was not possible prior to the current studies. The process will include defining why each site is important, how the injury affects the importance of each site, and what kind of action is necessary to maintain that value. The process will result in a restoration plan for injured archaeological sites in the spill area.

Findings from the SUNY-Binghampton survey and modeling study will be incorporated into the spill geographic information system database housed within DNR to be used in future assessments and spill responses. The existing Statewide inventory of historic and prehistoric sites will also be updated.

	BUDGET ($K)
Salaries	$ 206.1
Travel	5.1
Contractual	4.5
Supplies	2.2
Equipment	0.0
Subtotal	217.9
General Administration	30.9
Total	$ 248.8

BIRD STUDY NUMBER 2

Study Title: Boat Surveys to Determine Distribution and Abundance of Migratory Birds and Sea Otters in Prince William Sound

Lead Agency: USFWS

PROJECT JUSTIFICATION

Boat-based surveys for migratory birds and marine mammals in the pelagic and nearshore regions of Prince William Sound were conducted following the Exxon Valdez oil spill. Over 120 species of birds and 20 species of mammals have been counted on these surveys. Objectives of the study include: determining distributions, estimating abundances, determining differences in bird and mammal abundances between oiled and un-oiled areas, and determining changes in abundances following the spill.

Preliminary results indicate that bird populations in Prince William Sound declined since pre-spill surveys for 16 species or species groups including grebes, cormorants, northern pintail, harlequin duck, oldsquaw, scoters, goldeneyes, bufflehead, black oystercatcher, Bonaparte's gull, black-legged kittiwake, Arctic tern, pigeon guillemot, murrelets, and northwest crow. More than 30,000 carcasses representing over 90 species of birds were collected from the spill zone in 1989. In addition, both direct and continuing effects of the spill have been demonstrated in NRDA studies on harlequin duck, black oystercatcher, black-legged kittiwake, marbled murrelet, murres, and pigeon guillemot. Intensive studies have also revealed evidence of injury to populations of sea otters.

A preliminary report of results has been prepared for this study but comprehensive data synthesis and analysis have not been completed. The preparation of a final report will be essential for understanding the injuries the spill caused to marine birds and sea otters. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

	BUDGET ($K)
Salaries	$ 42.2
Travel	0.0
Contractual	0.0
Commodities	0.0
Equipment	0.0
Other Non-Contractual	0.0
Subtotal	$ 42.2
General Administration	6.3
Total	$ 48.5

BIRD STUDY NUMBER 3

Study Title: Population Surveys of Seabird Colonies in the Spill Area (Murres)

Lead Agency: USFWS

PROJECT JUSTIFICATION

Following the Exxon Valdez oil spill, seabird colonies in Prince William Sound and other areas westward along the spill trajectory were surveyed to determine the immediate effects of the spill. Cliff-nesting species such as the black-legged kittiwake and common and thick-billed murres were the primary emphasis of the 1989-90 censuses. Timing of egg laying and productivity were also noted for each of these species. In 1990 and 1991, the major effort was placed on replicate counts of murres in those areas that showed the most drastic changes relative to historical data. Study objectives included comparison of pre- and post-spill numbers of breeding colony seabirds within the oiled area and comparison of reproductive chronology and productivity for murres in oiled areas.

As the oil exited Prince William Sound, it passed through areas where large rafts of breeding age murres were congregating around major colonies in preparation for the nesting season. The resulting mortality included an estimated 198,000 adult breeding birds, representing 60 to 70 percent of the total breeding population of certain major colonies. Extrapolating to include mortality of non-breeders, mortality is estimated to be as high as 300,000 murres. This loss resulted in a major disruption of breeding behavior and phenology resulting in reproductive failure for 1989-91. Significant decreases in the number of murres at nesting colonies in the Exxon Valdez oil spill area were noted in 1989-91 surveys. Murres at all sites associated with oil had either low or no success in producing chicks with either very late egg laying or no egg laying at all in 1989-91.

A preliminary report of results has been prepared for this study but comprehensive data synthesis and analysis have not been completed. The preparation of a final report will be essential for understanding the injuries the spill caused to murres, particularly murres breeding in the Exxon Valdez oil spill zone. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

	BUDGET ($K)
Salaries	$ 56.3
Travel	1.6
Contractual	1.0
Commodities	8.3
Equipment	0.0
Other Non-Contractual	0.0
Subtotal	$ 67.2
General Administration	8.5
Total	$ 75.7

BIRD STUDY NUMBER 4

Study Title: Assessing the Effects of Exxon Valdez Oil Spill on Bald Eagles

Lead Agency: USFWS

PROJECT JUSTIFICATION

Surveys were conducted following the oil spill to estimate bald eagle numbers and reproductive success of eagles residing in the Exxon Valdez oil spill area. Eagles were radio-tagged and monitored to determine survival, and document movements and exposure to oiled areas. Toxicological tests were conducted on tissue samples, and addled eggs, prey remains, blood, and feathers were collected and analyzed for evidence of hydrocarbon exposure.

Preliminary results have shown that oil contamination of the intertidal habitats used extensively by breeding, wintering and migrating bald eagles have resulted in impacts to these birds. Conservative estimates of total mortality of bald eagles due to Exxon Valdez oil spill is 553 eagles. Bald eagle nesting surveys revealed a significantly low nest success and productivity in Prince William Sound with approximately 69% of occupied nests failing in 1989 and 43% failing in 1990. A conservative estimate of lost production in 1989 was 133 chicks. Hydrocarbon analysis of addled eggs, prey remains, blood, and feathers in 1989 and 1990 indicated exposure. Two of 3 eggshell samples collected in 1989 on the Alaska Peninsula and Kodiak area were exposed to hydrocarbons. Concentrations of uric acid in blood serum from adult eagles in oiled areas were higher than those from un-oiled areas in 1989. Eggs collected in 1990 in eastern Prince William Sound also indicated exposure to petrogenic hydrocarbons.

A preliminary report of results has been prepared for this study but comprehensive data synthesis and analysis have not been completed. The preparation of a final report will be essential for understanding the injuries the spill caused to bald eagles. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

BUDGET ($K)

Salaries	$ 37.2
Travel	5.0
Contractual	12.0
Commodities	0.0
Equipment	0.0
Other Non-Contractual	0.0
Subtotal	$ 54.2
General Administration	6.4
Total	$ 60.6

BIRD STUDY NUMBER 6

Study Title: Assessment of the Abundance of Marbled Murrelet Sites Along the Kenai Peninsula and Prince William Sound

Lead Agency: USFWS

PROJECT JUSTIFICATION

This study was implemented to assess injury to marbled murrelets from the oil spill. The marbled murrelet population in Prince William Sound has declined from about 300,000 in 1972 to 100,000 in 1989-91. Counts in the Naked Island area in 1989 and 1991 were also lower than counts made from 1978-1980. The length of time between pre-oil surveys and post-oil surveys makes it difficult to determine the contribution of the Exxon Valdez oil spill to this decline.

In Prince William Sound, marbled murrelets comprised 12% of all seabird carcasses retrieved in 1989 following the spill. Based on an 8% chance of carcass recovery, an estimated 9,570 murrelets were killed directly by oil in the Exxon Valdez oil spill zone. In addition, apparently healthy murrelets from oiled areas showed signs of petroleum hydrocarbon exposure, whereas murrelets from unoiled areas in Prince William Sound did not show such signs.

A preliminary report of results has been prepared for this study but comprehensive data synthesis and analysis have not been completed. The preparation of a final report will be essential for understanding the injuries the spill caused to marbled murrelets. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

	BUDGET ($K)
Salaries	$ 21.6
Travel	0.0
Contractual	0.0
Commodities	0.0
Equipment	0.0
Other Non-Contractual	0.0
Subtotal	$ 21.6
General Administration	3.2
Total	$ 24.8

BIRD STUDY NUMBER 7

Title: Assessment of the Effects of Petroleum Hydrocarbons on Reproductive Success of the Fork-tailed Storm-Petrel

Lead Agency: USFWS

PROJECT JUSTIFICATION

Following the oil spill, fork-tailed storm-petrel colonies in the Exxon Valdez oil spill zone were visited to determine reproductive success. The study objectives were to: determine if reproductive success was lower than in pre-spill years; assess the impact of crude-oil exposure on reproduction; count the number of adults contaminated by oil; and determine persistence of crude oil in the marine environment by comparing hydrocarbon contamination of petrel stomach oils with pre-spill data on hydrocarbon contamination of petrel stomach oils collected at the same site.

Preliminary results suggest that there was no measurable change in the storm-petrel reproductive success following the spill. However, it is difficult to conclude that the storm-petrels have not been impacted by the oil spill until the stomach oil samples have been analyzed. Previous studies established that petrels dosed with oil showed significant decreases in hatching success and chick survival.

A preliminary report of results has been prepared for this study but comprehensive data synthesis and analysis have not been completed. The preparation of a final report will be essential for understanding the injuries the spill caused to fork-tailed storm-petrels. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

	BUDGET ($K)
Salaries	$ 6.5
Travel	0.0
Contractual	0.0
Commodities	0.0
Equipment	0.0
Other Non-Contractual	0.0
Subtotal	$ 6.5
General Administration	1.0
Total	$ 7.5

BIRD STUDY NUMBER 8

Study Title: Assessment of Injuries to Reproductive Success of Black-legged Kittiwakes in Prince William Sound

Lead Agency: USFWS

PROJECT JUSTIFICATION

Black-legged kittiwakes are the most abundant colonial nesting seabird in Prince William Sound. The objectives of this study were to: test for changes in reproductive success of kittiwakes nesting in oiled areas; determine if adult kittiwakes were contaminated by oil; test unhatched eggs and prey delivered to chicks for hydrocarbon content; and identify potential restoration of losses.

Preliminary results revealed a significantly lower reproductive success for kittiwakes in oiled areas compared to un-oiled areas, however, analysis is not complete. Kittiwakes were contaminated externally as preliminary results show that 37% of birds observed at oiled colonies had oil on the breast feathers. Analysis of hydrocarbon content of kittiwakes, prey samples, and eggs, has not been conducted to date.

A preliminary report of results has been prepared for this study but comprehensive data synthesis and analysis have not been completed and, in some cases, has not been initiated. Data analysis and the preparation of a final report will be essential for understanding the injuries the spill caused to black-legged kittiwakes of Prince William Sound. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

	BUDGET ($K)
Salaries	$ 6.5
Travel	0.0
Contractual	0.0
Commodities	0.0
Equipment	0.0
Other Non-Contractual	0.0
Subtotal	$ 6.5
General Administration	1.0
Total	$ 7.5

BIRD STUDY NUMBER 9

Study Title: Assessment of Injury to Waterbirds Based On the Population and Breeding Success of Pigeon Guillemots in Prince William Sound

Lead Agency: USFWS

PROJECT JUSTIFICATION

Following the Exxon Valdez oil spill, the pigeon guillemot population of Naked, Peak, and Storey islands, located in the center of Prince William Sound, was studied to determine the effects of the spill. The guillemot population has been previously studied, thus pre-spill data was available for comparison. The objectives of the study include: determine if the total number of guillemots attending the colonies following the oil spill were significantly different; monitor nesting success and chick growth rates; monitor abundance and type of prey fed to chicks; determine if petroleum hydrocarbons were present in adults, unhatched eggs, dead chicks, and prey items; and identify potential restoration strategies.

Preliminary data analysis suggests that the number of pigeon guillemots attending colonies in the Naked Island area was significantly lower following the oil spill. To what extent this decline was due to an overall decline of the Prince William Sound pigeon guillemot population or to the oil spill is unknown; further analysis is required. However, the most heavily oiled areas at Naked Island were the areas with the largest declines in numbers. Reproduction appeared to be similar to previous years; however, sample size was too small to estimate the rate of successful nesting.

A preliminary report of results has been prepared for this study but comprehensive data synthesis and analysis have not been completed and, in some cases, have not been initiated. Data analysis and the preparation of a final report will be essential for understanding the injuries the spill caused to pigeon guillemots. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

	BUDGET ($K)
Salaries	$ 15.7
Travel	0.0
Contractual	0.0
Commodities	0.0
Equipment	0.0
Other Non-Contractual	0.0
Subtotal	$ 15.7
General Administration	2.3
Total	$ 18.0

BIRD STUDY NUMBER 11

Study Title: Injury Assessment of Hydrocarbon Uptake by Sea Ducks

Lead Agency: ADF&G

PROJECT JUSTIFICATION

The goal of this project was to determine whether the Exxon Valdez oil spill had measurable sublethal effects on six species of migratory and resident seaducks in Prince William Sound and the Kodiak Archipelago. The six seaduck species were harlequin ducks, Barrow's and common goldeneyes, and surf, black, and white-winged scoters. The harlequin ducks are both resident in and winter migrants to the oil spill area. The other species do not breed in the oil spill area but are winter migrants. The postulated mode of sublethal oil exposure to these seaducks was by ingestion of petroleum hydrocarbons through the food chain.

Results of biochemical sampling indicate a spectrum of petroleum residues contaminated liver tissue of harlequin ducks and Barrow's and common goldeneyes in western Prince William Sound and southwestern Kodiak Island. Concentrations of naphthalene and phenanthrene were found in bile extracts.

Results from necropsies indicated that there were a significantly greater number of harlequin ducks in physiologically poor condition (with minimal adipose tissue) in western Prince William Sound and Kodiak than in control sites. Other physiological effects included poor plumage condition and lethargy displayed by many individuals.

The most important oil spill effect documented by NRDA Bird Study Number 11 was the cessation of harlequin duck reproduction in the oil spill area of Prince William Sound. Harlequin ducks, although present in the Exxon Valdez oil spill area of western Prince William Sound, were observed not to form breeding pairs, display courtship behavior, nor seek nest sites. No harlequin broods were observed in the oil spill area in 1990. Only one brood was reported in the oil spill area in 1991. Harlequins reproduced normally in northern, eastern, and southern Prince William Sound in 1990-91.

The mode of sublethal petrochemical exposure to these ducks is highly likely consumption of oiled invertebrate prey items. The degree of exposure is related to the foraging areas of the respective species. The zone of maximum oil impact is the intertidal. Harlequin ducks, feeding on a wide variety of invertebrates in the intertidal, appear most exposed. Goldeneyes, which feed subtidally, appear moderately exposed; white-winged

scoter, feeding on benthic organisms such as scallops in deeper water, appear less exposed.

The goal of this closeout proposal is to produce a final report including food habits analysis and all results of chemical analyses of seaduck proventriculus samples, liver, bile, and histopathology. Pending petroleum toxicology analysis of blue mussels (Mytilus) and other invertebrates from seaduck proventriculus samples will be related to histopathological analyses and to the continued reproductive failure of Prince William Sound harlequin ducks.

	BUDGET ($K)
Salaries	$ 19.5
Travel	0.0
Contractual	0.0
Supplies	0.5
Equipment	0.0
Subtotal	$ 20.0
General Administration	2.9
Total	$ 22.9

BIRD STUDY NUMBER 12

Study Title: Assessment of Injury to Shorebirds Staging and Nesting in Prince William Sound and the Kenai Peninsula

Lead Agency: USFWS

PROJECT JUSTIFICATION

This study was divided into two parts. The first part was to estimate the number of spring migrant shorebirds using oil-affected portions of the Prince William Sound. Objectives included: estimate the amount of time shorebirds are exposed and number of shorebirds of each species exposed to contaminated beaches; estimate proportion of migrants contaminated; test for differences in feeding behavior; collect tissue samples for analysis and identify contamination pathways in the food chain; and determine nesting success of black turnstones.

Part two of the study dealt with black oystercatchers. The objectives of this research were to: 1) determine the effects of oiling on the reproductive success of oystercatchers; 2) determine habitat requirements of breeding oystercatchers; and 3) explore how the feeding strategy of oystercatchers may affect populations of invertebrate prey species.

Preliminary results for the shorebird portion of the study revealed that virtually all of the shorebirds were found using sites along Montague Island with heavy herring spawn deposition; these areas were lightly or negligibly oiled. More heavily oiled portions of the Prince William Sound probably did not receive a great deal of use by shorebirds. The proportion of birds directly contaminated by oil on plumage is undetermined but probably small. Clutch sizes of black turnstones on their western Alaska breeding grounds were reduced relative to pre-spill years, but no direct link could be drawn to the oil spill. Samples of prey items and birds have not yet been analyzed to evaluate the degree of contamination via the food chain.

Preliminary analysis revealed that black oystercatchers experienced reduced productivity in Prince William Sound following the oil spill. The relative egg volume of clutches was lower in 1989. Although clutch size, hatching success or fledgling success did not differ, growth rate of chicks was significantly lower in 1991. Additionally, intertidal prey organisms of the oystercatcher experienced diminished productivity and direct mortality.

Preliminary reports of results have been prepared for these studies but comprehensive data synthesis and analysis have not been completed and, in some cases, has not been initiated. Data analysis

and the preparation of a final report will be essential for understanding the injuries the spill caused to shorebirds and black oystercatchers. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

	BUDGET ($K)
Salaries	$ 18.0
Travel	0.0
Contractual	0.0
Commodities	0.0
Equipment	0.0
Other Non-Contractual	0.0
Subtotal	$ 18.0
General Administration	2.7
Total	$ 20.7

COASTAL HABITAT STUDY NUMBER 1A

Study Title: Comprehensive Assessment of Injury to Coastal Habitats

Lead Agency: USFS

PROJECT JUSTIFICATION

Preliminary analysis of the coastal habitat data indicate that the intertidal zone was the most severely contaminated habitat within the oil spill area. Recovery in the supratidal is progressing. However, recovery in the one and two meter drop of the intertidal zone is still retarded. Natural populations of intertidal organisms were significantly reduced along heavily oiled shorelines throughout the oil impact region. Densities of intertidal algae (Fucus), barnacles, limpets, amphipods, isopods, and marine worms were decreased. Although there were increased densities of mussels in oiled areas in 1990, mussels were significantly smaller than mussels in the unoiled areas and the total biomass of mussels was significantly lower. In 1991, mussel densities and biomass were both greater at control sites than oiled sites. Petroleum hydrocarbon accumulation in filter-feeding mussels experimentally placed in oiled areas indicate that oil remains available for uptake by other organisms. In both 1990 and 1991, oiled surfaces retarded settlement by juvenile barnacles when compared to unoiled sites.

Fucus, the dominant intertidal plant, was severely affected by the oil and subsequent cleanup activities. In 1991, Fucus densities continued to be depressed at oiled sites, probably due to the poor dispersal capability of this algae. The percentage of intertidal areas covered by Fucus was reduced following the spill, and coverage of opportunistic plant species which characteristically flourish in disturbed areas increased. In 1991, most algal species showed adverse affects of the oil spill, with only one species being more abundant at oiled sites than control sites. The average size of Fucus was reduced, the number of reproductive-sized plants greatly decreased, and the remaining plants of reproductive size decreased in reproductive potential due to fewer fertile receptacles per plant. There was also reduced recruitment of Fucus at oiled sites.

Samples which were collected and sorted from 1989-1991 will be processed and analyzed in 1992. The final analysis of these data will be used to meet the following objectives:

1) Estimate the quantity, quality, and composition of critical trophic levels in moderately and heavily oiled sites relative to non-oiled sites;

2) Estimate hydrocarbon concentrations in sediments and biological samples;

3) Establish the response of populations of intertidal organisms to varying degrees of oiling and subsequent clean-up procedures

4) Extrapolate impact results to the entire spill-affected area;

5) Estimate the rate of recovery of the habitats studied and their potential for restoration; and

6) Provide linkages to other studies by demonstrating the relationships between oil, trophic level impacts, and higher organisms.

	BUDGET ($K)
Salaries	$ 0.0
Travel	0.0
Contracts	2,300.0
Supplies	0.0
Equipment	0.0
Subtotal	$2,300.0
General Administration	58.5
Total	$2,358.5

COASTAL HABITAT STUDY 1B

Study Title: Pre-spill and Post-spill Concentrations of Hydrocarbons in Sediments and Mussels at Intertidal Sites within Prince William Sound and the Gulf of Alaska

Lead Agency: NOAA

PROJECT JUSTIFICATION

On March 26, 1989, sampling began at 10 historically established intertidal hydrocarbon baseline sites in Prince William Sound in response to the Exxon Valdez oil spill. Ten additional sites were established in Prince William Sound and on the Kenai Peninsula along the spill trajectory before oiling. These sites were also sampled after oiling to measure the change in hydrocarbon levels in sediments and mussels resulting from the spill.

This project has documented that levels of hydrocarbons in sediments and mussels in intertidal areas in Prince William Sound in 1989 before the Exxon Valdez oil spill were similar to concentrations measured by an earlier NOAA/NMFS project (1977-1980) which established a hydrocarbon baseline for sediments and mussels for the same general geographical area.

Subsequent sampling in 1989 and 1990 indicates some sites were impacted by crude oil. Preliminary sediment analyses at 3 sites showed impact by Exxon Valdez oil with different patterns of changes in petroleum hydrocarbon (PHC) concentrations over time. Mussels from one site had extremely high concentrations of PHCs in 1990 samples while mussels from 4 other sites showed intermediate PHC levels in 1989. There were no detectable aromatic hydrocarbons in mussel samples from 1977-1980. The limited data (from only 25 samples of >300 samples) currently available from 1989-91 samples precludes reliable interpretation at this time.

The goal of the project is to analyze and interpret hydrocarbon data from all samples and produce a final report. The final report for this study will provide data against which recovery and 'return to baseline levels' can be documented. Hydrocarbon data generated and analyzed to date is incomplete (i.e, there are no data from sites in the Kenai Peninsula available yet). This study furnishes essential background data and is linked directly to other NRDA projects on specific species and to some restoration/recovery Studies; provides topographical continuity to sediment data generated by Subtidal Studies 1 and 3; and complements the large Coastal Habitat Study 1A. This project will produce data that, along with other studies, provides a spatial and temporal distribution pattern of the impact of Exxon Valdez crude oil.

	BUDGET ($K)
Salaries	$ 42.6
Travel	1.0
Contracts	0.0
Supplies	1.4
Equipment	0.0
Subtotal	$ 45.0
General Administration	6.4
Total	$ 51.4

FISH/SHELLFISH STUDY NUMBER 1

Study Title: Salmon Spawning Area Injury

Lead Agency: ADF&G

PROJECT JUSTIFICATION

This project will complete the analysis of data from NRDA and restoration studies designed to improve the accuracy of wild pink salmon escapement estimates. Data analyses from ten weirs and more than 40 selected streams in the vicinity of each weired stream will be completed and summarized. Estimates of aerial survey bias and stream life from 1990 and 1991 studies represent a major advance in escapement estimation procedures. Results will dramatically improve past and future escapement estimates in Prince William Sound and will lead to more accurate and precise stock specific fisheries management. The commercial fishery in Prince William Sound is of major economic importance and also plays a major role in regulating populations of salmon in Prince William Sound. Wild stocks which were injured by the Exxon Valdez oil spill play a major role in the Prince William Sound ecosystem and are frequently intercepted in mixed stock fisheries dominated by hatchery fish. Accurate and timely estimates of spawning escapements are critical for biologists who seek to ensure reproductive success for wild populations by manipulating fisheries. Data analyses completed by this project will enable fisheries managers to improve inseason escapement estimates and identify escapement shortfalls. Injured wild populations may be protected and restored if escapement shortfalls can be quickly identified and corrected by selectively reducing harvests in areas where exploitation of injured stocks might occur.

	BUDGET ($K)
Salaries	$ 51.3
Travel	1.7
Contractual	1.2
Supplies	2.1
Equipment	0.2
Subtotal	$ 56.5
General Administration	7.8
Total	$ 64.3

FISH/SHELLFISH STUDY NUMBER 2

Study Title: Egg/Pre-emergent Fry Sampling

Lead Agency: ADF&G

PROJECT JUSTIFICATION

The goal of this project is to complete analyses and report results of a study to quantify effects of the Exxon Valdez oil spill on salmon eggs and fry. Results from this study show some of the more significant injury to salmon yet demonstrated. Injury includes significantly increased egg mortality and high incidences of somatic, cellular, and genetic abnormalities in alevins and fry from oiled streams. Summarization and publication of these results is important for the completion of damage assessment and for the planning of future activities.

	BUDGET ($K)
Salaries	$ 21.8
Travel	1.7
Contractual	0.8
Supplies	1.6
Equipment	0.1
Subtotal	$ 26.0
General Administration	3.3
Total	$ 29.3

FISH/SHELLFISH STUDY NUMBER 3

Study Title: Coded-Wire Tag Recovery and Analysis

Lead Agency: ADF&G

PROJECT JUSTIFICATION

This is a closeout budget for a damage assessment project based on coded-wire tagging of pink salmon in Prince William Sound. The tags applied as part of NRDA and restoration activities since 1989 have been partially recovered and the analyses of these data are needed to estimate reductions in salmon production attributable to injury from the Exxon Valdez oil spill. These data are important to understanding the nature of the spill-related injury as well as designing and assessing the success of important management-related restoration implementation projects. The commercial fishery in Prince William Sound is of major economic importance and also plays a major role in regulating populations of salmon in Prince William Sound. Wild stocks which were injured by the Exxon Valdez oil spill play a major role in the Prince William Sound ecosystem and are frequently intercepted in mixed stock fisheries dominated by hatchery fish. Fisheries cannot be managed to totally exclude the harvest of wild fish without compromising the quality of hatchery fish harvest. However, with prior knowledge of hatchery and wild stock abundance and distributions, fisheries managers may limit interceptions of wild fish. Data from this project will guide the design of future tagging projects. Future tagging projects for stock identification will be used to restore salmon populations by selectively reducing harvest of injured stocks while permitting the continued harvest of hatchery surpluses.

	BUDGET ($K)
Salaries	$ 103.7
Travel	2.4
Contractual	2.2
Supplies	2.4
Equipment	0.3
Subtotal	$ 111.0
General Administration	15.7
Total	$ 126.7

FISH/SHELLFISH STUDY NUMBER 4A

Study Title: Early Marine Salmon Injury Assessment in Prince William Sound

Lead Agency: ADF&G

Cooperating Agency: NOAA

PROJECT JUSTIFICATION

Recruitment to adult salmon populations appears to be strongly affected by the high mortality during the early marine life stage. During this period, slow-growing individuals sustain a higher mortality, because they are vulnerable to predators for a longer time than fast-growing individuals. In the laboratory, sublethal hydrocarbon exposure has been shown to cause reduced growth of juvenile salmon. Thus, in the wild, sublethal hydrocarbon exposure is expected to cause reduced growth resulting in increased predation.

Oil contamination may also have reduced survival by decreasing prey populations or disrupting migration patterns. Oil can be toxic to littoral and pelagic macroinvertebrates. Hydrocarbon exposure can injure olfactory lamellar surfaces and cause an avoidance reaction.

During the past decade, five salmon hatcheries have been established within Prince William Sound. These facilities, operated by private non-profit corporations, produced approximately 535 million juvenile salmon in 1989. Approximately one million of these fish were marked with a coded-wire tag (CWT). Recoveries of these marked fish in Prince William Sound has played a major role in our assessment of the impact of the oil spill on salmon.

This damage assessment project has provided evidence of reduced growth and fry-to-adult survival among juvenile salmon in oiled nearshore habitats. However, additional sample and data analysis is needed to quantify the effect of oil contamination on fry growth and fry-to-adult survival and adequately establish that environmental and oil effects are not confounded. This will be accomplished by comparing fry food consumption and food abundance between oiled and non-oiled areas. The data obtained during the three years of field studies will be completely analyzed and conclusions synthesized in a final report.

The final report will synthesize project results and provide data summaries. A fully documented database will be produced for incorporation into the Natural Resource Damage Assessment database being developed by the Alaska Department of Fish and Game.

SCHEDULES AND PLANNING

Date	Activity
1992	
March - August	Conduct otolith, stomach, and zooplankton sample analyses in laboratory
June - December	Data entry, database documentation, and data analysis
1993	
January 15	Complete all data analysis
January 31	Complete ADF&G technical data report
February 28	Complete final report

	BUDGET ($K)
Salaries	$ 89.8
Travel	4.0
Contractual	23.0
Supplies	7.0
Equipment	4.2
Subtotal	$128.0
General Administration	17.2
Total	$145.2

FISH/SHELLFISH STUDY NUMBER 4B

Study Title: Impact of Oil Spill on Juvenile Pink and Chum Salmon and Their Prey in Critical Nearshore Habitats

Lead Agency: NOAA

Cooperating Agency: ADF&G

PROJECT JUSTIFICATION

Preliminary results from this study have documented effects of the Exxon Valdez oil spill to juvenile pink salmon, including exposure and hydrocarbon body-burden, mixed-function oxidase (MFO) induction, and reduced growth in oiled areas. The hydrocarbon profiles in contaminated pink salmon indicate that ingestion of oil, either directly or through contaminated prey, was the route of contamination. Density of juveniles, abundance of prey, and temperatures in the areas sampled do not explain the differences in growth observed. Field studies in 1989 and 1990 showed that temperatures and abundance of zooplankton prey were not different between oiled and non-oiled areas sampled; littoral epibenthic prey resources tended to be higher in oiled areas; and abundance of juvenile salmon was higher in non-oiled areas. The differences in growth are thus attributed to effects of oil contamination. In support of this conclusion, preliminary analysis of laboratory experiments in 1991 showed that ingestion of whole oil in food can adversely affect growth and survival of juvenile pink salmon.

Many of the results and conclusions from this study regarding effects of oil contamination to juvenile salmon are preliminary and tentative at this time because of incomplete sample and data processing. From the 1989/1990 field collections, there are still outstanding hydrocarbon analyses; incomplete transfer of data on hydrocarbon analyses actually done; outstanding contracts on meiofauna analyses from experimentally oiled sediments, epibenthic crustaceans, MFO's, and pink salmon otoliths. From the 1991 oil-ingestion experiment, growth measures from RNA/DNA assays and otolith increment analysis are incomplete; and no data are yet available for hydrocarbon tissue measures or MFO induction. When these data sets are completed, a final report will be prepared.

	BUDGET ($K)
Salaries	$ 50.0
Travel	4.0
Contracts	37.0
Supplies	12.0
Equipment	6.0
Subtotal	$ 109.0
General Administration	10.4
Total	$ 119.4

FISH/SHELLFISH STUDY NUMBER 5

Study Title: Injury to Dolly Varden Char and Cutthroat Trout in Prince william Sound

Lead Agency: ADF&G

PROJECT JUSTIFICATION

This closeout budget represents the cost for final biometric review and preparation of final report for the data collected in this project through 1991.

	BUDGET ($K)
Salaries	$ 17.4
Travel	1.0
Contractual	0.5
Commodities	0.5
Equipment	0.0
Subtotal	$ 19.4
General Administration	2.8
Total	$ 22.2

FISH/SHELLFISH STUDY NUMBER 11

Study Title: Herring Injury

Lead Agency: ADF&G

PROJECT JUSTIFICATION

Pacific herring, Clupea harengus pallasi, are a major resource in Prince William Sound from both a commercial and ecological perspective. The timing of the Exxon Valdez oil spill overlapped with the annual spring migration of herring spawners to nearshore areas. Over 40% of the herring spawning and egg deposition areas, as well as 90% of the summer rearing and feeding areas, were lightly to heavily oiled prior to the spawning events. As a result, herring encountered oil during each of their four life stages in 1989 and, to a lesser extent, in 1990 and 1991. Adult herring traversed areas covered by oil sheens and mousse while traveling northward and eastward in Prince William Sound. Eggs were deposited on oiled shorelines and were "dipped" in sheen through tidal action while incubating. Larvae hatched that contained lipophilic petroleum hydrocarbons in their yolk sacs, and larvae encountered sheen near the surface while in their most sensitive stages. Post-larval or juvenile herring swam through and remained near lightly to heavily oiled shorelines, regularly encountering sheen, mousse and dissolved oil particulates and components through the summer while feeding in shallow nearshore bays and passes.

Egg and larval mortality, larval tumors, and other larval injury such as elevated anaphase aberration rates, increased cytogenetic and cytologic anomalies, and morphological abnormalities were much greater in oiled areas than in non-oiled areas in 1989 and 1990. Injuries were more common and more severe in oiled areas than unoiled areas, with injuries declining from 1989 to 1990. The broader ecological implications of the loss of these larvae to the food chain can only be contemplated at this time.

Observed injury to adult herring included stress-related hemorrhaging around the vent and enlarged bright gall bladders in 1989, as well as hydrocarbon metabolites throughout the whole fish and its bile. In addition, preliminary data from histopathological examinations revealed that herring captured near and in oiled areas in 1990 suffered increased hepatic lesions in comparison to herring captured in unoiled areas.

The goal of this project is to estimate the injuries accumulating to populations of herring in Prince William Sound. The level of injury needs to be established to evaluate natural restoration processes and to direct restoration activities. A summary of the lethal and sublethal injury will be completed. In addition, accurate and precise estimates of population abundance, age

structure, weight, and length composition data will be completed to measure changes at the population level. Sublethal injury to adults will be evaluated and interpreted in terms of potential impacts on the population and reproduction. An intensive modeling effort will be conducted to look at the overall effects of the Exxon Valdez oil spill on the larval and adult components of herring in Prince William Sound.

OBJECTIVES

1. Estimate the total level of injury of the Exxon Valdez oil spill to the early life stages by:

   a. Summarizing and synthesizing components of the egg mortality, egg incubation, and egg and larval cytogenetic and histologic examinations;

   b. Summarizing the larval herring distribution and abnormality index data from the 1989 larval trawl survey;

   c. Finalizing chemistry data from the hydrocarbon sample database;

   d. Combining components a., b., and c. to relate level of oiling with level of injury.

2. Summarize the results from the laboratory and field exposure dose-response studies and to compare effects of known dosing on egg survival, hatching success, percent viable hatch, larval abnormalities (Graded Severity Index), cytogenetics, and mixed function oxidase (MFO) levels to the field data collected in 1989-1991. This data will be used to refine Objective 1.

3. Complete the literature review and compare results from other studies to the findings in Objectives 1. and 2.

4. Estimate the total level of injury to herring at the adult stage by:

   a. Summarizing and synthesizing the histopathological presence and type of injury to tissues and vital organs from herring collected in oiled and non-oiled areas during 1989, 1990, and 1991;

   b. Summarizing the level of egg atrophy in adult female gonads (oocyte-loss) in samples collected during 1989, 1990, and 1991;

   c. Coordinate with National Marine Fisheries Service (NMFS/NOAA) to synthesize the results from the adult

dose-response experiment (1991 and 1992), the adult parasite study (comparing herring from oiled and unoiled area during 1989 and 1991), and from other studies reported in the scientific literature.

DELIVERABLES

Reports to be prepared by Department staff are listed below:

Title	Deadline
Temporal and spatial comparisons of fecundity of Pacific herring in Prince William Sound	Feb. 1993
Effects of the Exxon Valdez oil spill on Pacific herring eggs and larvae in Prince William Sound	Feb. 1993
Long-term effects of the Exxon Valdez oil spill on Pacific herring in Prince William Sound	Feb. 1993
Loss of Pacific herring eggs deposited in Prince William Sound	Feb. 1993.

In addition, two reports will be completed this year that will provide background and baseline information for the damage assessment summaries:

Estimates of spawning biomass of Pacific herring in Prince William Sound from spawning deposition surveys(review draft)	Feb. 1992
Historical summary of Pacific herring in Prince William Sound (review draft)	Feb. 1992.

Reports and work products that will be produced by the contractors are listed below:

Contractor, Product	Deadline
Hose, Final report on 1991 data and re-analysis of 1989 data (data includes cytogenetics, abnormality indices, cytologic, and oocyte loss)	May, 1992
Hose, Synthesis work product for preliminary modeling effort	August, 1992
Hose, Synthesis work product for final modeling effort	January, 1993
Kocan, Final report on 1991 dose-response experiment	March, 1992

Kocan, Literature review and first synthesis product
April, 1992

Kocan, Final report on 1992 dose-response work
August, 1992

Kocan, Synthesis work product for final modeling effort
January, 1992

Hinton, Final work product results on 1989 and 1990 adult histopathology and Dr. Hose's 1990 and 1991 larvae
February, 1992

Hinton, Preliminary results of 1991 adult histopathology and first synthesis work product April, 1992

Hinton, Final results of 1991 adult histopathology and larval data from Hose May, 1992

Hinton, Synthesis work product for final report
January, 1993

	BUDGET ($K)[1]
Salaries	$ 161.3
Travel	14.5
Contractual	92.6
Supplies	3.1
Equipment	1.4
Subtotal	$ 272.9
General Administration	30.7
Total	$ 303.6

[1] Budget is for all activities performed from March 1, 1992 to February 28, 1993. A detailed line item budget has been prepared and submitted separately to the Trustee Council.

FISH/SHELLFISH STUDY NUMBER 13

Study Title: Clam Injury

Lead Agency: ADF&G

PROJECT JUSTIFICATION

Part I

This project seeks to determine injuries to bivalves from the Exxon Valdez oil spill and has involved the study of four species. These are: 1) pacific littleneck clam (Protothaca staminea); 2) butter clam (Saxidomus giganteus); 3) cockle (Clinocardium nuttali); and 4) razor clam (Siligua patula). These animals are relatively sedentary, occur on beaches throughout the Exxon Valdez oil spill area, and are known to bioaccumulate hydrocarbons. The presence of elevated levels of hydrocarbons in bivalves is known to cause an increase in mortality, decrease growth, and other sublethal injuries. This study has focused on documenting the presence of hydrocarbons, decreased growth, and identifying other sublethal injuries.

This project will include the computerized entry of all data collected thus far, the analysis of this data with biometrics support, and a preliminary report outlining the injuries documented thus far.
This report is to be submitted for peer review and a determination made whether additional funding for a full project closeout will be recommended to the Trustee Council.

Part II

If a decision is made by the Trustee Council to provide funding for a full project closeout, any additional monies will be allocated to collection of growth and age data from clams collected in 1991, synthesis of hydrocarbon results from studies which shared adjacent study locations, submission of 1991 histopathology samples for analysis, finalization of descriptive mapping products in conjunction with the GIS group, and preparation of a final report.

	BUDGET ($K) (Part I)
Salaries	$ 25.9
Travel	1.5
Contractual	3.8
Supplies	0.8
Equipment	4.7
Subtotal	$ 36.7
General Administration	4.1
Total	$ 40.8

	BUDGET ($K) (Part II)
Salaries	$ 40.9
Travel	2.2
Contractual	14.7
Supplies	0.0
Equipment	0.5
Subtotal	$ 58.3
General Administration	7.2
Total	$ 65.5 *

* Pending peer review of Part I and approval of Trustee Council.

FISH/SHELLFISH STUDY NUMBER 28

Study Title: Salmon Oil Spill Injury, Life and Run Reconstruction

Lead Agency: ADF&G

PROJECT JUSTIFICATION

This project will quantify the injury to the wild salmon stocks of the Prince William Sound from the Exxon Valdez oil spill. Understanding this injury is necessary for continuing fishery management of injured stocks and rational restoration. One of the main tools being developed to reach this goal is a run reconstruction model. This model will be used to estimate production from each of the Prince William Sound wild stock groups, both before and after the oil spill. The adult tagging study described below will provide information that will improve the already good foundation of this run reconstruction model.

Because of extremely large increases in hatchery production, Prince William Sound as a whole is producing salmon at all-time record levels. These hatchery salmon are essentially inputs to the fishing industry. The wild stocks, which are an important component in the natural ecosystem, originate from a multitude of natal stream locations throughout the Prince William Sound. The aggregate hatchery component of the total production can be determined with coded-wire tags. The estimated percent of the hatchery pink salmon in the Prince William Sound harvest has fluctuated from slightly over 50% in 1987 to in excess of 90% in 1988 and the gap in proportions of wild and hatchery contributions to the run seems to be getting bigger.

The stock-specific origins of the wild portion of the harvest are unknown. This information is necessary to understand oil spill injury to manage the fishery, to protect affected wild stocks, and to begin other restoration measures. The run reconstruction model is a tool for detecting these stock-specific origins. This model is a mathematical description of wild stock return patterns, accounting for removal by harvest in a series of mixed stock fisheries. This accounting of the harvest, by stock, in mixed stock fisheries is the heart of the model.

The University of Alaska, Juneau Center for Fisheries and Ocean Sciences, has developed a run reconstruction model for this project for a single fishing district, although work continues on a computer implementation. The next level of complexity, the multi-district model, requires spacial and temporal information on the migratory movement of pink salmon in Prince William Sound. Data from previous adult tagging studies could not be used to complete this task. Exhaustive efforts were made to use the historical

data. These data have proved unsuitable because they are too incomplete: no record was made of the fraction of the fishery sampled to collect those tags that were recovered. An adult tagging study will take place during the 1992 season to estimate these key missing parameters. The study will use radio or sonic tags on a small number of fish. Rather than infer movement patterns from the recovery of a large number of tags, the study will attempt to directly observe the movement of a smaller number of fish.

OBJECTIVES

The objective of the Pink Salmon Adult Tagging Study is to quantify the migratory movement and rates of pink salmon through the Prince William Sound as they proceed to their natal streams. Movement of salmon through the Prince William Sound will be modeled by a probability transition matrix whose elements are the probabilities of salmon moving from one district to another.

Currently, it is assumed that pink salmon enter Prince William Sound through the Southwest District (226) and proceed in a clockwise direction through the Prince William Sound to their natal streams. This study will be used to examine this hypothesis and estimate daily district-to-district migratory rates.

Salmon Migration Example

As a hypothetical example, consider 100 salmon entering into the Prince William Sound via District 226 on an arbitrary day. Using the clockwise migration hypothesis the model will move the salmon toward Districts 223 and 222. Once in District 222 they are permitted to enter District 221 then into 228. The model will also allow salmon to exchange between Districts 226 and 227. A hypothetical transition matrix that will induce this type of movement is presented below.

$\underline{\Theta} = (\theta_{ij})$

	i	j district	1 221	2 222	3 223-24	4 225-26	5 227	6 228
Northeast	1	221	0.95	0	0	0	0	0.05
Northern	2	222	0.05	0.95	0	0	0	0
Coghill	3	223-24	0	0.01	0.99	0	0	0
Southwest-ern	4	225-26	0	0.02	0.02	0.95	0.01	0
Montague	5	227	0	0	0	0.01	0.99	0
Southeast-ern	6	228	0	0	0	0	0.01	0.99

Here each entry is the probability of salmon moving from the row district to the column district. Now, the simulation of movement is created by taking powers of the transposed transition matrix and pre-multiplying with the vector $n^{I} = (0, 0, 0, 100, 0, 0)$ (note the 100 in the fourth position represents 100 fish released into the fourth district, or Districts 225-26). This is denoted mathematically as

$$n(k) = (\Theta^{T})^{k} n$$

$$= \Theta^{T} n(k-1)$$

where k is the number of days in the Prince William Sound (see the Data Analysis section for more details).

The table below shows the hypothetical number of salmon in each district after $k = 1, 2, 5, 10, 20$ and 30 days in the Prince William Sound.

	Number of days in the Prince William Sound						
district	0	1	2	5	10	20	30
221	0	0	0.1	0.87	3.08	8.15	11.82
222	0	2	3.82	8.33	13.29	17.18	17.03
223-24	0	2	3.88	8.86	15.30	23.11	26.62
225-26	100	95	90.26	77.47	60.21	36.84	23.09
227	0	1	1.94	4.43	7.66	11.70	13.92
228	0	0	0	0.05	0.46	3.02	7.51

The reason for this simplified demonstration is not only to show how the transition matrix induces movement in the simulation model, but also to point out one property of the transition matrix: with large powers of the transition matrix the rows converge to constant values. That is, each row becomes identical. The example transition matrix converges to (0.0588, 0.0588, 0.1471, 0.0735, 0.3676, 0.2941) as k gets large (about 60 days). The implication is that the transition matrix does impose stock-like restrictions on the salmon: it determines the long run distribution of salmon among the districts at the end of the season. The key point to be made here is that one cannot arbitrarily create a transition matrix and use it in the run reconstruction model to estimate stock-specific catch rates without seriously biasing the results.

METHODS

Throughout July of 1992, a small number of adult pink salmon are to be tagged on the southern perimeter of the Prince William Sound each week. The tagged fish will then be move through the Prince William Sound to spawning areas. Some will be harvested in subsequent fishing periods. They will be turned in by fishermen. Some will escape the fishery and move into freshwater areas.

Tags

Fish will be tagged with a radio or sonic tag. The most appropriate tag has not yet been determined. Fish with one of these radio or sonic tags will also be tagged with an external spaghetti tag

indicating the district of tagging, and each will bear a unique number and Alaska Department of Fish and Game identification.

Tagging Operations

If possible, fishing vessels will be recruited on a volunteer basis with the use of giveaway hats and tee shirts with a tagging study logo. If necessary boats will be chartered on a daily basis from the Prince William Sound purse seine fishing fleet. One project scientist or technician will be aboard to actually conduct the tagging, provide instructions, record data, and control quality. Pre-printed, waterproof data sheets will provide for date, location, vessel, set number, personnel, time of day, weather conditions, tag numbers, and the number of injured or unsuitable fish. At the end of each tagging operation, the data will be transferred to a computer spreadsheet which will be backed up onto a diskette.

After the seine is set, the bunt end will be left in the water to form a bag alongside the boat. Each sampled salmon will be lifted into a tagging cradle, and the tags inserted. Each single set will constitute a tagging operation.

Number to Tag

The number to tag will be determined by the actual cost of the tags.

Tag Recovery

Tags will be detected by means of aircraft overflights if radio tags are used, or line transacts if sonic tags are used. Fishermen will be offered souvenir hats and tee shirts to return externally tagged fish that were harvested, if information on date and place of capture is provided.

DELIVERABLES

Data and report submission schedule

During 1992, the data collected by this study will allow the estimation of key parameters of the run reconstruction parameter model, as it exists now. A final report on the run reconstruction model, including the adult tagging operation, will be made by the fall of 1992. During the late fall of 1992, efforts will be redirected to the Salmon Life History Model, with particular attention to joining the run reconstruction with the life history information. After slight fine-tuning from the life history model, the run reconstruction model will be altered for use in other years, and estimates will be generated for several years before and after the oil spill.

Three basic reporting tasks are currently envisioned. First, there is to be a report documenting the run reconstruction model methods. The authors will include the cooperating scientists at the University of Alaska Fairbanks, and the two Alaska Department of Fish and Game investigators. Second, there is to be a document or series of documents covering the adult tagging operation. Third, documentation of the run reconstruction estimates themselves will be provided as an Alaska Department of Fish and Game technical report.

The life history model and injury estimates should follow similar reporting lines: a report documenting methods for the primary scientific literature, and a report of actual estimates. The documentation of the life history model will complete Study 28. A single final report covering all of the above will be prepared.

SCHEDULES & PLANNING

APPROXIMATE DATE	ITEM
1992	
March 15.	Begin purchasing equipment, tags, etc.
March 15.	Begin Life History data organization
May 15.	Hire Fishery Biologist I
Late June	Begin tagging operations in District 226
July 1.	Begin overflights or line transacts
Aug. 30.	Begin to assemble database
September	Continue on Life History model development
September	Provide basic data to run reconstruction modelers
November	UAF model fully completed
November	Begin Life History model reports
1993	
February	Final Reports due

	BUDGET ($K)
Salaries	$ 91.8
Travel	56.0
Contractual	43.0
Supplies	18.5
Equipment	25.7
Subtotal	$ 235.0
General Administration	16.8
Total	$ 250.6

MARINE MAMMAL STUDY NUMBER 1

Study Title: Effects of the Exxon Valdez Oil Spill on the Distribution and Abundance of Humpback Whales in Prince William Sound, Southeast Alaska, and the Kodiak Archipelago

Lead Agency: NOAA

PROJECT JUSTIFICATION

During 1989 and 1990, photographs of individual humpback whales occurring in Prince William Sound and Southeast Alaska were collected from May to September to assess the impact of the Exxon Valdez oil spill on humpback whale life history and ecology. In Prince William Sound, 547 days were spent traversing approximately 20,000 nautical miles in search of whales or while photographing whales. In Southeast Alaska, 230 days were spent conducting field research during the 1989 season to determine if Prince William Sound humpback whales were relocating to other areas.

In 1989, photographic analysis of Prince William Sound humpbacks revealed 59 identifiable whales in 119 encounters. In Southeast Alaska, 516 whales were identified in 1989, based on 2,448 encounters. During the 1990 season, photographic analysis of Prince William Sound humpbacks revealed 66 identifiable whales in 201 encounters. The total count represents the largest number of individual humpback whales ever photographed in Prince William Sound. A decline in the number of Prince William Sound humpback whales was not identified.

The distribution of humpback whales in Prince William Sound during the 1989 season was compared to their distribution in 1988. In 1988, more humpback whales used Lower Knight Island Passage area. The effect of increased vessel and aircraft traffic may be responsible for the whale distribution pattern observed in 1989. The distribution of whales in Prince William Sound during the 1990 season was compared to previous data. No apparent shift in distribution was noted in 1990. No observations were made of humpback whales swimming through oil. Despite considerable effort, Prince William Sound humpback whales were not observed during concurrent photographic studies in Southeast Alaska.

Synthesis of these data and the review of available scientific literature will allow the preparation of a final report which provides an interpretation of the results. This information may be useful to help manage the recovery of the North Pacific's endangered humpback whale population. Accordingly, preparation of a final report is warranted.

	BUDGET ($K)
Salaries	$ 15.0
Travel	0.0
Contracts	0.0
Supplies	0.0
Equipment	0.0
Subtotal	$ 15.0
General Administration	2.3
Total	$ 17.3

MARINE MAMMAL STUDY NUMBER 2

Study Title: Assessment of Injuries to Killer Whales in Prince William Sound and Southeast Alaska

Lead Agency: NOAA

PROJECT JUSTIFICATION

Photographs of individual killer whales occurring in Prince William Sound were collected from May to September in 1989, 1990, and 1991 to assess the potential impacts of the Exxon Valdez oil spill on killer whale life history and ecology. Over 25,000 nautical miles were traversed in search of whales or while photographing whales, reflecting 617 days of field research for the three-year period.

An unusually high number of killer whales were reported missing from one of the resident pods named AB pod. The stability of resident pods of killer whales is such that when an animal is listed as missing for more than one year, that animal is considered dead. Prior to the oil spill, the number of whales in AB pod changed from 35 to 36 (1984-1988). During this time period, 8 whales died and 9 whales were born.

During 1989, 7 whales were missing from the AB pod. During 1990, six additional whales from AB pod were added to the missing list. This represents an average mortality rate of approximately 20%, an order of magnitude greater than that seen in the 20-year study of killer whales in British Columbia and Washington State (1.8%) and more than three times the average mortality rate (6.1%) seen in AB pod during the 1984-88 period. Additionally, in 1989 and 1990, no calves were born in the AB pod. In 1991, one whale was reported missing and one calf was born to AB pod.

In addition to missing whales in the AB pod, significant changes occurred in the pod's social structure. Although carcasses of missing whales have not be found, there is a correlation between the discovery of unusually high mortality in AB pod and the Exxon Valdez oil spill.

For this closeout project, a complete analysis will be conducted. This will allow an evaluation of all aspects of the killer whale data. The final report will make available information useful in understanding and managing the killer whales of Prince William Sound.

	BUDGET ($K)
Salaries	$ 28.0
Travel	1.0
Contracts	0.0
Supplies	0.0
Equipment	0.0
Subtotal	$ 29.0
General Administration	4.3
Total	$ 33.3

MARINE MAMMAL STUDY NUMBER 6

Study Title: Assessment of Magnitude, Extent, and Duration of Oil Spill Impacts on Sea Otters

Lead Agency: USFWS

PROJECT JUSTIFICATION

The major NRDA studies on sea otters included: (a) estimates of distribution and abundance through aerial and boat surveys; (b) estimates of reproductive rates, survival rates and documentation of sea otter movements; (c) recovery of carcasses in the spill zone to determine age and evaluate patterns of mortality; (d) toxicology and pathology work such as histological examination of tissue samples, necropsy of several hundred carcasses, and analysis of blood, fat and milk for hydrocarbon content; (e) standard clinical evaluation of blood samples to determine the health/physiological status; (f) determination of prey species and collection of samples for hydrocarbon analysis; and (g) modeling work to estimate numbers of otters exposed to oil and population recovery.

Injury to sea otters resulting from the oil spill included 1,011 dead sea otters recovered from within the spill zone. A synthesis of loss estimates suggests that between 3,500 and 5,500 sea otters may have died from acute exposure to oil. Chronic injury to sea otters may result from either sublethal initial exposure and continued exposure to environmental hydrocarbons. Preliminary findings of the Coastal Habitat and Shellfish NRDA studies have identified elevated levels of hydrocarbons in intertidal and subtidal sediments and in several species of benthic marine invertebrates eaten by sea otters. Continuing injury is indicated by significantly higher numbers of prime age sea otter carcasses being recovered in comparison to pre-spill in western Prince William Sound and continued declines in sea otter abundance in oiled areas. Post-weaning pup mortality in the winter of 1990-91 was significantly higher in western Prince William Sound than eastern Prince William Sound. Significant differences in blood parameters were detected for adult males between eastern and western Prince William Sound; results suggest systemic hypersensitivity reactions in males sampled in western Prince William Sound.

A preliminary report of results has been prepared for this study but comprehensive data synthesis and analysis have not been completed.

The preparation of a final report will be essential for understanding the injuries the spill caused to sea otters. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

	BUDGET ($K)
Salaries	$ 127.2
Travel	0.0
Contractual	50.0
Commodities	0.0
Equipment	0.0
Other Non-Contractual	0.0
Subtotal	$ 177.2
General Administration	22.5
Total	$ 199.7

TERRESTRIAL MAMMAL STUDY NUMBER 3

Study Title: Assessment of the Effects of the Exxon Valdez Oil Spill on River Otter and Mink in Prince William Sound

Lead Agency: ADF&G

PROJECT JUSTIFICATION

The river otter and mink damage assessment study was initiated in 1989. Some mortality was documented soon after the oil spill and subsequent long-term sublethal effects have continued to be documented. Impacts have been demonstrated at the population level in this species through continued introduction of toxic oil substances in the habitat resulting in direct exposure and introductions through prey resulting in internal exposure.

Funds provided in 1992 will be used for completion of analysis of substantial amounts of data collected in the three years of this study and preparation of a final report.

	BUDGET ($K)
Salaries	$ 32.1
Travel	3.0
Contractual	30.0
Supplies	2.0
Equipment	0.0
Subtotal	$ 67.1
General Administration	6.9
Total	$ 74.0

SUBTIDAL STUDY NUMBER 1A

Study Title: Petroleum Hydrocarbon-Induced Injury to Subtidal Marine Sediment Resources

Lead Agency: NOAA

Cooperating Agency: ADEC

PROJECT JUSTIFICATION

The primary goal of Subtidal Study Number 1 is to determine the spatial and temporal distribution of oil in subtidal sediments in Prince William Sound and the Northeastern Gulf of Alaska. As of June 1990, subtidal sediments were contaminated by oil at no fewer than 15 sites within the Prince William Sound. Hydrocarbons had contaminated sediments to a depth of 20 m at least at 8 sites. In or near two heavily contaminated bays, petroleum hydrocarbons were detected in sediments at a depth of 100 m. There is also evidence suggesting a trend for petroleum hydrocarbons to move from the intertidal region to greater depths (3, 6, and 20 m) between May and November 1989 at Sleepy Bay. At Northwest Bay and Herring Bay there appeared to be a tendency toward an increase in contamination of the 6 and 20 m depths between July 1989 and June 1990. At least 7 sites along the Kenai and Alaska Peninsulas showed contamination of subtidal sediments by hydrocarbons. Petroleum hydrocarbons were detected below a depth of 6 m at three of those sites.

These results are based on a small number of samples because of delays associated with hydrocarbon analysis. In early fall of 1991, the results of the hydrocarbon analysis of 894 of the 1820 samples submitted to date were received. These data are currently undergoing the final stages of quality control. Analysis of the data from all these samples should provide a reasonably complete picture of contamination by the oil spill of subtidal sediments in Prince William Sound. A less complete summary will be available for the Gulf of Alaska. This proposal supports analysis of the data on these samples and write-up of the results of that analysis.

This study supports other studies requiring documentation of hydrocarbon contamination of subtidal sediments such as those studies of impacts on benthic communities as well as specific fish and invertebrate species. Results of the University of Alaska Fairbanks study on the responses of hydrocarbon degrading bacteria in subtidal sediments appear to be consistent with hydrocarbon results indicating contamination to a depth of 100 m at a minimum of two sites in Prince William Sound. Both the deep benthos (ST 2B) and the microbiological components of ST 1B are dependent on the results of the sediment hydrocarbon analyses.

	BUDGET ($K)
Salaries	$ 68.6
Travel	3.8
Contracts	13.5
Supplies	2.6
Equipment	3.8
Subtotal	$ 92.3
General Administration	11.2
Total	$ 103.5

SUBTIDAL STUDY NUMBER 1B

Study Title: Hydrocarbon Mineralization Potentials and Microbial Populations in Sediment

Lead Agency: ADEC

Cooperating Agency: NOAA

JUSTIFICATION

All of the field and laboratory work has been completed on this project. Results from 6 cruises from 1989 through 1991 are being analyzed and summarized into a final report.

Preliminary results show that microbial numbers and activity in sediments are good indicators of previous exposure to hydrocarbon contamination. In addition, these measurements yield information on the mobilization of oil to deeper sediments over time. Microbial activity, even in 1991, remains high at some sites presumably where relatively fresh oil is still present. The information collected in this project will be used in linking other NRDA studies and for prioritizing sediment hydrocarbon samples for analysis.

	BUDGET ($K)
Salaries	$ 12.4
Travel	1.9
Contractual	1.1
Commodities	0.6
Equipment	0.0
Subtotal	$ 16.0
General Administration	1.1
Total	$ 17.1

SUBTIDAL STUDY NUMBER 2A

Study Title: Injury to Shallow Benthic Communities

Lead Agency: ADF&G

PROJECT JUSTIFICATION

Benthic organisms associated with subtidal sediments generally represent good monitors for measuring effects of oil fluxing to the bottom. These organisms typically remain close to or at the site of larval settlement and, consequently, represent good monitoring organisms. The composition of the marine benthic fauna has been successfully used at various locations throughout the industrial world as a basis for measuring effects of pollutants on the bottom.

Shallow (<20 m) subtidal studies were initiated in Prince William Sound in the fall of 1989, and continued during the summers of 1990 and 1991. Thus far, the 1989-90 sampling effort has demonstrated the presence of oil (observed as sheens) and/or injury to marine plants, invertebrates, and fishes in sill fjord, eelgrass (Zostera) and Laminaria/Agarum bay habitats (Jewett et al., 1992).

Deep (>20 m) benthos studies were initiated in the Prince William Sound in July 1990. Six of the deep benthos sites sampled in 1990 were adjacent to eelgrass sites sampled by the shallow benthic program. Preliminary results from the deep benthos study indicated significant differences for infauna within oiled embayments in comparison with unoiled embayments.

OBJECTIVES

Determine the temporal and spatial effects of the Exxon Valdez oil spill on the infaunal invertebrate communities within eelgrass embayments. These objectives will also be attempted on communities within Laminaria bays, on a "time available basis only" at no additional cost.

METHODS

The final phase of this project will concentrate on processing samples, analyses, and reporting on the shallow subtidal communities that were sampled in the Prince William Sound eelgrass (Zostera) habitat in 1991. This habitat, as well as Laminaria bays, was chosen because of relative ecological importance, history of prior injury, and on proportion of total habitat in the oiled Prince William Sound area. Six of the sites within the eelgrass habitat are also the deep benthos sites. All studies were conducted at oiled sites (selected at random when possible) and

control sites that are matched to the oiled sites with regard to geomorphology, degree of freshwater input, substrate type, and general circulation and wave exposure regimes.

Other areas (Kenai and Kodiak regions) were excluded because it is anticipated that effects were greatest within Prince William Sound and because of logistics of sampling in those other regions.

	BUDGET ($K)
Salaries	$ 7.1
Travel	0.0
Contractual	95.0
Commodities	0.0
Equipment	0.0
Subtotal	$ 102.1
General Administration	7.7
Total	$ 109.8

SUBTIDAL STUDY NUMBER 2B

Study Title: Deep Water Benthos

Lead Agency: ADF&G

PROJECT JUSTIFICATION

Part I

A peer review of the Status Report for this project suggests that the biological data be reanalyzed to sort out sedimentological effects and to relate biotic parameters to petroleum contaminants in sediments. The objective of this work is to complete sediment analyses for all stations examined and to analyze the data to relate the biological results to sediment parameters as suggested by the peer review.

OBJECTIVES

1. To reanalyze the deep benthic data to assess the relationship - or lack of relationship - of benthic faunal distributions to sedimentological parameters between the oiled and unoiled sites.

2. To assess the deep benthic data in relationship to petroleum contaminants in the sediments at the study sites, contingent upon receipt of hydrocarbon data from NOAA.

It is anticipated that at least six to seven weeks will be needed to obtain sediment data for the 1990 samples. This work entails sediment analysis of 14 stations x 3 depths = 42 sediment samples. A short report assessing the results of the expanded analyses will be submitted no later than June 30.

Part II

Assuming that reanalysis of the deep benthic biological data relative to sediment parameters at the study sites reinforces the conclusions in Feder (1991), the deep benthic study will be continued until all samples have been examined and a Final Report can be written. The fourteen study sites chosen on the NOAA ship in July 1990 were selected at random with 7 oiled and 7 unoiled sites chosen.

It is the intent of this damage assessment final report to compare all of the 1990 and 1991 deep benthic biological and associated sediment data from oiled and unoiled bays in Prince William Sound. The composition of the marine benthic fauna has been successfully

used at various locations throughout the industrial world as a basis for measuring effects of pollutants on the bottom, inclusive of oil that has settled after oil spills. Assessment of the benthic fauna within Prince William Sound should prove useful for assessing biological effects of the Exxon Valdez oil spill in the Sound. Preliminary examination of benthic biological data from the 14 sites, three depths at a site, suggests that oil on the bottom in bays subjected to impact from the Exxon Valdez oil spill may have affected the faunal composition. Verification of this suggestion is contingent upon analysis of sediment differences between sites and petroleum hydrocarbon composition on the bottom at the sites. The former analysis is to be completed no later than May 30, 1992.

OBJECTIVES

1. Completion of the taxonomic determinations of benthic samples from stations at 100 m and >100 m collected in July 1991.

2. Sediment analysis, inclusive of organic carbon and nitrogen determinations as well as carbon isotopic determinations, for the sediment samples collected in July 1991.

3. Completion of statistical and other analyses of the 1990-91 biological data.

4. Completion of all multivariate analyses involving sediment and hydrocarbon parameters (if the latter data are available).

5. Completion of a Final Damage Assessment Report no later than November 30, 1992. This report will represent a compilation of 1990 and 1991 deep benthic data and will examine the data for possible effects resulting from the Exxon Valdez oil spill.

	BUDGET ($K) (Part I)
Salaries	$ 0.0
Travel	0.0
Contractual	10.0
Supplies	0.0
Equipment	0.0
Indirect Costs	0.0
Subtotal	$ 10.0
General Administration	0.7
Total	$ 10.7

	BUDGET ($K) (Part II)
Salaries	$ 1.8
Travel	0.0
Contractual	70.0
Supplies	0.0
Equipment	0.0
Indirect Cost	0.0
Subtotal	$ 71.8
General Administration	5.1
Total	$ 76.9

SUBTIDAL STUDY NUMBER 3A

Study Title: Bioavailability and Transport of Hydrocarbons

Lead Agency: NOAA

Cooperating Agency: ADEC

PROJECT JUSTIFICATION

The goal of the NOAA component of project Subtidal Study #3 is to document petroleum hydrocarbon loading in near shore waters impacted by the Exxon Valdez oil spill. In 1989, hydrocarbon loading was monitored by direct sampling of seawater in Prince William Sound and in 1989, 1990, and 1991 by deployment of hydrocarbon-free mussels along the oil spill trajectory for exposure periods of 1 to several months.

In 1989, chemical analysis of the seawater samples showed the presence of aromatic hydrocarbons of petroleum origin. Total aromatic hydrocarbon concentrations ranged up to about 8 µg/l (ppb) at the most heavily contaminated sites 8 days after the spill, but after 6 weeks declined to below detection limits. Although higher than concentrations reported by Exxon, these concentrations were still lower than those known to cause detectable adverse effects on biological marine resources following relatively short-term exposures.

Caged mussels are sensitive indicators of oil in seawater, because they effectively contact large volumes of seawater, and selectively filter and ingest organic particulates. In 1989, both aromatic and aliphatic hydrocarbons of petroleum origin were detected in tissue of caged mussels at concentrations ranging up to 100 µg/g wet tissue (ppm), and were detected at all stations and depths inside Prince William Sound along the spill trajectory. Outside Prince William Sound, hydrocarbon concentrations were generally low and highly variable among replicates. However, mussels exposed at Tonsina Bay and Chignik showed moderate levels of contamination. Oil contamination levels in the caged mussels declined after May 1989 and approached control levels by Fall 1989. In 1990, oil contamination levels that were significantly above control levels were low and sporadic.

These results from the caged mussels indicate that biologically available hydrocarbons from the Exxon Valdez oil spill were generally pervasive in the upper water column along the spill trajectory inside Prince William Sound during the summer of 1989. This biological availability may result from association of petroleum hydrocarbons with particulate organic material in the water column that can be ingested by larval herring and juvenile

salmon, thus providing a mechanism for the adverse effects observed in these fish (see Fish/Shellfish studies).

The Alaska Department of Environmental Conservation component of project Subtidal Study #3 involved the deployment of sediment traps at selected locations within Prince William Sound. Results indicate that petroleum hydrocarbons associated with near-shore sediments or organic particulates can migrate to greater depths. In 1991, caged mussels were deployed with the sediment traps to determine the biological availability of trapped hydrocarbons. These results will help to evaluate additional injury to biological resources caused by these migrating hydrocarbons.

The analysis and interpretation of these results will be completed and a final report produced in 1992.

	BUDGET ($K)
Salaries	$ 32.1
Travel	2.2
Contracts	0.0
Supplies	0.0
Equipment	0.0
Subtotal	$ 34.3
General Administration	4.8
Total	$ 39.1

SUBTIDAL STUDY NUMBER 3B

Study Title: Bioavailability and Transport of Hydrocarbons in the Nearshore Water Column

Lead Agency: ADEC

Cooperating Agency: NOAA

JUSTIFICATION

The Alaska Department of Environmental Conservation (ADEC) has deployed sediment traps in Prince William Sound since November 1989 to monitor nearshore sedimentation in the wake of the Exxon Valdez oil spill. These sediment traps capture particulates settling out of the water column, which are then analyzed for hydrocarbon chemistry, organic carbon/nitrogen and mineralogy. The objectives of the ADEC portion of Subtidal Study #3 are, 1) to determine the presence or absence of petroleum hydrocarbons in the water column, and 2) to collect data on the mobility of petroleum hydrocarbons in the near shore. The study will show whether hydrocarbons are present in the particulate matter utilized by filter-feeding organisms in the water column (mussels) and whether there is a continuing input of petroleum hydrocarbons to the subtidal from these settling particulates. Sediment grain size data will provide information relating particle size to hydrocarbon chemistry. These size data are important because many filter feeders show a preference for certain particle size ranges, and because hydrocarbon adsorption and particle settling rates are also dependent on size. Data from sediment cores in the vicinity of the traps will add knowledge of petroleum hydrocarbon contamination of benthic sediments due to mixing and bioturbation. Besides providing a connection between oiled particulates and uptake into the food chain, the sediment traps present an opportunity to investigate the continued mobility and transport of petroleum hydrocarbons into subtidal areas from shorelines where surface or subsurface oiling remains.

The analysis and interpretation of the data collected from 1989 through 1992 from this study should be completed and published because: 1) this study represents the longest monitoring of settling particulates after a major oil spill; 2) the study provides a potential connection between shoreline and subtidal oiling and uptake by marine organisms; and, 3) because the results may shed light on questions regarding the efficacy and environmental benefit of shoreline treatment and the possible continuing inputs of oil from remaining shoreline contamination. Results to date found significant quantities (>200 ppm) of oil in settling particulates two years after the oil spill at several of the study sites where there is a continued presence of subsurface shoreline oiling.

	BUDGET ($K)
Salaries	$ 16.5
Travel	4.4
Contractual	25.1
Commodities	0.7
Equipment	0.0
Subtotal	$ 46.7
General Administration	4.2
Total	$50.9

SUBTIDAL STUDY NUMBER 4

Study Title: Fate and Toxicity of Spilled Oil From the Exxon Valdez Oil Spill

Lead Agency: NOAA

PROJECT JUSTIFICATION

This study, originally called Air/Water Project Number 6, was designed and undertaken by NOAA in 1990. The study was designed to: a) determine the toxicity of oiled environmental samples, using standard toxicity tests; b) examine the extent to which any observed toxicity may be attributed to oxygenated, polar products in weathered oil (versus the parent hydrocarbons found in fresh crude); and c) promote the synthesis of data and information (generated largely by other projects) on the geographic distribution, weathering, and potential effects of petroleum on living marine resources.

Toxicity testing has been conducted on sediment samples taken both inside and outside of Prince William Sound in 1989, 1990 and 1991. Petroleum hydrocarbon concentrations were estimated by ultraviolet fluorescence spectroscopy on the sediment samples collected in 1989 and 1990. Between 1989 and 1991, oil concentrations declined in intertidal sediments sampled at most oiled locations, while the concentrations in shallow subtidal sediments (3-20 meters) remained about the same, or in some cases, rose slightly. Patterns of sediment toxicity to test organisms (marine amphipods and larval bivalve molluscs) reflected similar patterns. In 1990, significant toxicity was associated only with intertidal sediment samples from heavily oiled sites, but in 1991, toxicity was associated primarily with sediment samples from the shallow subtidal zone. The toxicity of sediments from oiled sites was generally greater than that from unoiled reference sites in both 1990 and 1991. Final interpretation of sediment toxicity will require data on hydrocarbon chemistry and grain size of the sediments (expected from Technical Services Study Number 1). These analytical data are now available for 1989 and 1990, but have not yet been analyzed in detail; data for 1991 are not yet available.

The study determined the extent to which any toxicity present in oiled sediments and interstitial waters may be attributed to polar oxidation products (as opposed to parent hydrocarbons) in petroleum. Intertidal sediments and interstitial waters from oiled and reference sites in Prince William Sound were extracted and separated into polar and nonpolar fractions, and the fractions were tested for relative toxicity. Polar fractions from most heavily oiled sites exhibited toxicity similar to that associated with the nonpolar fractions, but this toxicity was detectable only at very high concentrations. A draft final report on these tests is

expected in March 1992. Extracts of mussel tissues from oiled and unoiled sites were chemically fractionated into nonpolar and polar constituents and analyzed by ultraviolet fluorescence spectroscopy. Polar constituents occurred in mussel tissues from oiled sites at levels that were proportional to, or less than proportional to, the amounts present in the original parent oil simultaneously accumulated in the tissues. These analyses have verified that toxicity associated with oiled sediments may arise in part from polar constituents and/or metabolites; however the toxicity levels associated with polar and nonpolar constituents were generally similar for all of the endpoints tested.

Relevant literature and data have been identified and assembled for the petroleum budget (objective c above), and a synthesis workshop still is recommended as an important step in completing this synthesis task.

No new field work is proposed under this project, and a final report will be prepared at the end of the year on all aspects of the projects. The synthesis and integration of data and information of the fate of the spilled oil through time will provide essential context for the interpretation of initial injury to, and subsequent recovery from the spill.

	BUDGET ($K)
Salaries	$ 29.0
Travel	15.0
Contracts	4.0
Supplies	0.0
Equipment	0.0
Subtotal	$ 48.0
General Administration	4.6
Total	$ 52.6

SUBTIDAL STUDY NUMBER 6

Study Title: Injury to Rockfish

Lead Agency: ADF&G

PROJECT JUSTIFICATION

This closeout budget represents the cost for preparation of a final report for the data collected in this project through 1991. Work will not begin on this activity until receipt of sample analyses results in June.

	BUDGET ($K)
Salaries	$ 13.5
Travel	0.0
Contractual	1.0
Supplies	0.0
Equipment	0.0
Subtotal	$ 14.5
General Administration	2.1
Total	$ 16.6

SUBTIDAL STUDY NUMBER 7

Study Title: Assessment of Oil Spill Impacts on Fishery Resources: Measurement of Hydrocarbons and Their Metabolites, and Their Effects

Lead Agency: NOAA

PROJECT JUSTIFICATION

Beginning in late spring of 1989, Subtidal 7 (earlier designated as Fish/Shellfish 24), has systematically evaluated the exposure of several fish species to petroleum hydrocarbons both in Prince William Sound and at numerous sites along the path of the Exxon Valdez oil spill, to Kodiak Island and beyond. Both shoreline and demersal species have been studied. In addition to assessing exposure, reproductive parameters have been measured in Dolly Varden char and yellowfin sole, and histopathological structure has been examined in most species. To date, petroleum exposure has been assessed in over 1,400 fish, and indicators of reproductive function have been evaluated in about 400 adult female fish.

The analyses of fish sampled in 1989 showed that Dolly Varden, Pacific halibut, salmon and three species of flounder (yellowfin sole, rock sole, and flathead sole) had been exposed to petroleum-derived compounds. The degree of exposure was found to have decreased in 1990 in some species (Dolly Varden), but to have remained constant in three benthic species. Preliminary evidence of histopathological alteration of gill epithelium in rock sole was observed. By 1991, exposure to petroleum-derived compounds had generally decreased in all fish species, but the results suggested that some fish continued to be exposed at sites inside Prince William Sound. The data obtained in 1991 do not indicate a substantial impact on reproductive processes in the species examined.

Results of the Subtidal 7 studies indicate that spilled oil from the Exxon Valdez oil spill moved to the benthic environment and benthic fish species showed signs of exposure to oil during the first three years after the oil spill. A detailed examination of all the data collected will provide valuable information concerning the potential impact of the oil spill on demersal fishes.

These studies have generated a large quantity of data showing that substantial portions of the populations of flatfish in areas in or near the path of the Exxon Valdez oil spill have been, and apparently continue to be, exposed to petroleum products. Moreover, some shoreline species, such as Dolly Varden char, were substantially exposed during the first months following the spill, but exposure had declined markedly by 15 months after the spill. The funding proposed for 1992 is specifically aimed at putting all

of these data into a context of how this exposure has been changing with time, and what the implications of such exposure might be. For example, some indications of reproductive changes and histopathological alterations have been noted in the studies funded under Subtidal 7. An examination in detail of all data collected, together with review of available scientific data from 1) other NRDA studies and 2) previously published studies of the effects of oil exposure in fish, will allow for a balanced interpretation concerning the potential impact of the oil spill on demersal fishes.

	BUDGET ($K)
Salary	$ 48.5
Travel	2.5
Contracts	2.0
Supplies	0.0
Equipment	0.0
Subtotal	$ 53.0
General Administration	7.4
Total	$ 60.4

1C. DAMAGE ASSESSMENT CONTINUATION

Six projects begun under damage assessment will continue in 1992. Several of these projects provide service or supporting data for other projects and are needed for accurate analysis and final reporting of those projects. Service and support projects include hydrocarbon analysis, Technical Services Study Number 1 (TS1), geographic information system (GIS) mapping and analysis (TS3), mussel tissue and sediment hydrocarbon data synthesis, Subtidal Study Number 8 (ST8), and database management, Fish/Shellfish Study Number 30 (FS30). Other projects are continuing because the population level impacts of injuries to early life history stages of some species will not become apparent for several years. These include injury to shrimp (ST5) and sockeye salmon (FS27).

The sockeye overescapement project (FS27) may not have a clear estimation of injury until fish from eggs laid in 1989 return as adults in 1993 and beyond. Commercial fishing for sockeye in Cook Inlet and the Kodiak area was closed in 1989 when fish could not be harvested without contaminating them by means of oiled gear. Consequently so many fish escaped to some freshwater systems that the juveniles produced by these fish could not be supported by the production of these systems. Few smolts were observed leaving the systems in 1991. Unless the food base in these systems recovers, injury to other year classes may also occur. This study will continue to observe these systems and document continuing injury or recovery.

Fish/Shellfish Study 30 provides a data storage and retrieval mechanism by which investigators can gain access to data produced by other investigators (though they do not have the ability to change those data) even though they may be in different locations in the state. Investigators will, as with TS1, TS2, and ST8, be able to synthesize their results and make meaningful comparisons among studies.

The shrimp study (ST5) requires investigators to sample shrimp in late fall, several months after field work for other projects has ended. Because shrimp injury analysis lags behind that of other species, peer review of 1991 results has not yet occurred. If their review indicates that further investigation is necessary, additional sampling will take place in the fall of 1992.

In order to document the presence of oil at specific locations, investigators for many of the damage assessment studies collected mussel and sediment samples from each of the sites at which they were conducting their studies. Therefore, investigators studying birds, mammals, fish and shellfish all collected mussel and sediment samples to determine presence or absence of oil. Some also took tissue samples from the project animals to determine exposure of individuals to oil.

Analytical chemical results are often confusing to investigators who may lack the ability to interpret the hydrocarbon data from TS1. The investigators from ST8 provide this service to them. Because ST8 analyzes data from many projects, the investigators will be able to synthesize these results and provide a broad picture of where oiling occurred and to what degree. These ST8 investigators will also provide some quality assurance for the results of TS1 and identify contaminated samples.

TS1 has been responsible for processing these samples, but since so many were collected, a backlog developed. Completing the reports for many of the damage assessment studies requires this information so that the injuries observed can be compared to the degree of oiling.

Data from TS1 and ST8 are entered into the oil spill GIS of TS3 to produce maps of the movement and fate of oil. These maps support and are incorporated into the final reports for other damage assessment projects.

FISH/SHELLFISH STUDY NUMBER 27

Study Title: Sockeye Salmon Overescapement

Lead Agency: ADF&G

PROJECT JUSTIFICATION

This study is a continuation of the oil spill damage assessment program initiated in 1990. Recent findings have suggested major economic damage to commercial, subsistence, and sport fisheries may result from overescapement. The continuing program is essentially identical to the previous study plans with minor modifications. These modifications are highlighted in the following revised plan.

Commercial fishing for sockeye salmon in 1989 was curtailed in Upper Cook Inlet, the outer Chignik districts, and the Kodiak areas due to presence of oil and subsequent contamination of catches in the fishing areas from the Exxon Valdez oil spill. As a result, the number of sockeye salmon entering four important sockeye producing systems (Kenai/Skilak, Chignik/Black, Red, and Frazer Lakes) and two less important lake systems (Akalura and Afognak or Litnik lakes) greatly exceeded levels thought to be optimal. Sockeye salmon spawn in lake-associated river systems. Adult salmon serve an extremely important role in the ecosystem, providing food for marine mammals, terrestrial mammals, and birds. Additionally, carcass decomposition serves to charge freshwater lake systems with important nutrients. Juvenile salmon which rear in lakes for one or two years serve as a food source for a variety of fish and mammals. Sockeye salmon are also an important subsistence, sport, and commercial species. The ex-vessel value of the commercial catch of sockeye from these lake systems has averaged about $42 million per year since 1979, with the 1988 catch worth $115 million. Sockeye salmon returns to the Kenai River system support some of the largest recreational fisheries in the State.

Overly large spawning escapements may result in poor returns by producing more rearing juvenile sockeye than can be supported by the nursery lake's productivity (Kyle et al. 1988). In general, when rearing fish abundance greatly exceeds the lake's carrying capacity, prey resources are altered by changes in species and size composition (Mills and Schiavone 1982, Koenings and Burkett 1987, Kyle et al. 1988) with concomitant effects on all trophic levels (Carpenter et al. 1985). Because of such changes, growth of juvenile sockeye is reduced, mortality increases, larger percentages holdover for another year of rearing, and the poor quality of smolts increases marine mortality. Where escapements are two to three times normal levels, the resulting high juvenile densities crop the prey resources to the extent that more than one year is required to return to normal productivity. Rearing juveniles from

subsequent brood-years suffer from both the poor quality of forage and from the increased competition for food by holdover juveniles (Townsend 1989). This is the brood year interaction underlying cyclic variation in the year class strength of anadromous fish.

This project will examine the effects of large 1989 spawning escapements on the resulting progeny for a select subset of the above mentioned sockeye nursery lakes. Three impacted lake systems where the 1989 escapements were more than twice the desired levels (Kenai/Skilak in Upper Cook Inlet; Red and Akalura lakes on Kodiak Island) were selected. Tustumena Lake in Upper Cook Inlet and Upper Station Lake on Kodiak did not receive a large escapement and will be examined as controls.

This study is necessary to obtain a more timely assessment of impact as adult sockeye, produced from the 1989 escapement, will not return until the 1994/1995 season. Further, total return data are not available for individual Kodiak sockeye systems due to the complex mixed-stock nature of the commercial fisheries and the inability to estimate stock-specific catches.

In addition to continuing previously identified activities, several new activities are proposed to ensure study results are valid. The Red River system is being evaluated based on fry and smolt production of Red Lake. Estimation of spawner distribution outside of Red Lake will be completed by establishing an adult weir on Red River immediately below the lake. In addition, the very low numbers of outmigrating smolt estimated by the current mark-recapture method has raised some doubt about violating assumptions of the technique. Approximately 60% of the river flow is intercepted by the traps but recapture efficiency remains below 10%. This indicates avoidance by the marked fish, violating the assumption that all fish have the same probability of being captured. If avoidance rate is great then significant biases may occur. A full smolt weir is proposed to enumerate smolt and verify the current smolt mark-recapture method.

On the Kenai River system additional smolt samples will be collected from the Russian River to verify the aging techniques. The current method is suspect because age classes known to be produced from the Russian River do not appear in the smolt traps further downstream. Smolt trapping will also be continued into July to insure current projections of smolt production failure from the Kenai River lake systems are not an artifact of some unknown sampling bias.

Finally, a late fall fry sampling period will be conducted on the major Kenai Peninsula lakes. Approximately 50% of the weight gain from fry to smolt on the Kenai River system occurs outside of the current sampling regime. If poor survival occurs because of limitations in rearing habitat quality during this period, these

data are crucial for determining the validity of density of fry causing decreased over-wintering survival.

OBJECTIVES

A. Estimate the number, age, and size of sockeye salmon juveniles rearing in selected freshwater systems.

B. Estimate the number, age, and size of sockeye salmon smolts migrating from selected freshwater systems.

C. Determine effects of large escapements resulting from fishery closures caused by the Exxon Valdez oil spill on the rearing capacity of selected nursery lakes through:

   a. Analysis of age and growth of juveniles and smolts;
   b. Examination of nursery area nutrient budgets and plankton populations.

METHODS

Numbers of adult sockeye salmon that entered selected spawning systems outside Prince William Sound prior to and during 1989 have been estimated at weir stations or by sonar. This information was collected during projects routinely conducted by the ADF&G as part of their resource management program. Optimal escapement levels, which on the average should produce maximum sustained yield, have been based on either past relationships between spawners and returning progeny or the extent of available spawning and rearing habitat. The baseline program will continue at each site including, but not limited to, estimates of adult sockeye escapement and collection of scales for age analysis.

For each of the 4 lake systems identified, the response (abundance, growth, and freshwater age) of rearing juveniles from the 1989 escapement will be studied through its likely period of freshwater residence, early summer 1990 to spring 1992.

The total number of juvenile sockeye in each lake will be estimated through hydroacoustic surveys conducted during the summer (late June) and fall (September-October) of 1990, 1991, and 1992. Age and size information as well as diet items will be obtained from samples of juvenile sockeye collected from concurrent mid-water trawl netting surveys. Survey transect designs for hydroacoustic sampling and tow-netting have been established for Kenai and Skilak lakes (Tarbox and King 1989), and will be developed for each additional lake in the study. The basic survey design will be a stratified random sample where each lake is subdivided into areas

and survey transects randomly selected in each area. Such programs, funded through other studies, are already in place for Tustumena and Afognak lakes. Depending on densities of rearing juvenile sockeye, estimates of fish densities will be made for each transect either by echo integration or by echo counting. Total fish population estimates will be computed, by summing transect populations, along with 95% confidence intervals (Kyle 1989).

Freshwater growth and age of sockeye salmon rearing juveniles from all study systems will be determined from scale and otolith measurements made either by direct visual analysis of scales or on an Optical Pattern Recognition system. In cases where data are available (e.g., Kenai and Skilak Lakes), growth of progeny from the 1989 spawning escapements will be compared with growth (size) of progeny produced from spawning within these systems during prior years.

Scale analysis used to age Kenai River smolt has been questioned because the numbers of two year old smolt from the Russian River system is far below expectation. Therefore, smolt samples will be taken during the summer of 1992 from the Russian River to verify that these smolt appear in the Kenai River smolt traps and that the current aging techniques are accurate.

The total number of smolt migrating from each system will be estimated with a mark-recapture study during 1990, 1991 and 1992 using inclined plane traps after Kyle (1983), and Tarbox and King (1989). Smolt will be captured in traps, sampled for age and size information, marked with Bismark Brown Y (a biological dye), and transported upstream of the traps and released for subsequent recapture (Rawson 1984). Periodic retesting will determine the capture efficiency of the traps under changing river conditions during the spring. Total population estimates (with 95% confidence intervals) will be made using catch efficiencies, and weekly number weighted smolt size and age information will be calculated using a computer spreadsheet developed by Rawson (personnel communication, 1985). Size and ages of sockeye smolts from the 1989 spawning escapements will be compared with smolt information from spawning within these systems during prior years. Finally, smolt programs consistent to those for the study lakes are planned, under separate funding, for Tustumena and Afognak Lakes.

In addition, a full weir will be established on the Red River to get a total enumeration of outmigrant smolts. This will be manned 24 hours a day and will be used in comparison with the traps established the previous year for smolt estimation.

Limnological studies will monitor the response of the lakes to the high juvenile rearing densities and to estimate the carrying capacity parameters of euphotic volume, nutrient budgets (carcass enrichment), and zooplankton biomass, body-sizes, and population shifts. Approximately six limnology surveys will be conducted at

two stations, during 1992 to determine zooplankton species abundance and body sizes, nutrient chemistry, and phytoplankton abundance for Kenai/Skilak, Red, Akalura, and Upper Station lakes. Carrying-capacity parameters exist for Afognak and Tustumena lakes based on ongoing studies by FRED and Commercial Fish Divisions.

In cases where seasonal data are available (e.g., Akalura, Kenai, and Skilak lakes), limnological parameters taken during residence of the juveniles from the 1989 spawning escapements will be compared to parameters within these systems during prior years.

The holistic approach proposed here involves several evaluation procedures to assess the effects of sockeye salmon overescapement.

First, freshwater production from the 1989 escapements will be assessed in Kenai/Skilak, Red, Akalura, and Upper Station lakes. This will be accomplished through analysis of growth, freshwater survival (in particular over-winter survival), and freshwater age of sockeye smolt populations. Any anomalies will be determined by analysis of freshwater growth recorded on archived scales, historical freshwater age composition, and modeled freshwater survivals; and from results of previous studies as well as the 1991 smolt characteristics from each of the study systems. Also, planktonic food sources will be assessed through estimation of abundance of zooplankton prey biomass and numbers of species.

Second, future sockeye salmon production from the 1989 parent year and subsequent parent years will be estimated based on spawner/recruit relationships incorporating a brood-year interaction term. Losses of adult sockeye production from subsequent parent years may result from negative effects of progeny of the 1989 escapement on the lake's carrying capacity. The spawner/recruit relationships will be estimated from historical stock specific return data (where available), and generalized spawner/recruit data scaled to the carrying capacity parameters (i.e., euphotic volume and zooplankton biomass) of the nursery lakes where stock specific return data are not available (Geiger and Koenings 1991). If it is determined that in any of the affected systems, the density dependent effects are occurring outside of the traditional models, the effects will be isolated by examining a broader time window of the rearing life history of these species.

Third, experimental and empirical sockeye life history/production models (Koenings and Burkett 1987, Koenings et al 1989) will be used to compare salmon production by life-stage at escapement levels consistent with management goals to the 1989 escapements.

Additionally, in the case of the Kenai system, effects of the 1989 escapement will be viewed independently of the effects on previous brood years with high escapement.

DATA ANALYSIS

Analysis of the data will follow the techniques outlined in the references cited in the methods section. Where new analysis and problems are identified upon review of data obtained, appropriate standard techniques will be utilized.

DELIVERABLES

A report will be submitted by November 27, 1992. Format and content will follow the two previous reports. Damage assessment final report will be submitted at deadlines and in the format to be decided by the Trustees. Data collection on injury may continue up until recovery has been observed in the populations of sockeye salmon under investigation.

SCHEDULE AND PLANNING

This study is a continuation of ongoing investigations. Continued processing of field samples collected during the previous summer is occurring presently. Upon breakup, field sampling schedules will resume following sampling schedules as reported in the NRDA Annual Report for 1990 under FS #27. Enhanced sampling activities will require collection of samples later in the fall and early winter of 1992-93. Other activities will parallel those as reported previously and as described in previous detailed study plans.

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	BUDGET ($K)
Salaries	$329.9
Travel	12.0
Contractual	124.8
Supplies	52.1
Equipment	6.0
Subtotal	$524.8
General Administration	58.2
Total	$583.0

FISH/SHELLFISH STUDY NUMBER 30

Study Title: Database Management

Lead Agency: ADF&G

PROJECT JUSTIFICATION

FS-30 addresses the need to catalogue and maintain the principal electronic copies of raw data collected by the ADF&G Natural Resource Damage Assessment & Restoration (NRDA) Fish/Shellfish and Subtidal projects.

Assessment of injuries, successful restoration, and ongoing monitoring efforts ultimately are grounded in the data sets generated by NRDA studies.

Because of the fundamental role these data play in determining the effectiveness of any restoration program, it is important that care be taken to adequately document, archive, and maintain these principal electronic data sets.

In addition, the ADF&G personnel associated with FS-30 are directly responsible for the maintenance of critical historical fisheries databases referenced by many NRDA projects. This connection provides several added benefits to the NRDA effort, including direct access to historical data, technical expertise, and the use of the ADF&G Commercial Fisheries Wide Area Network (WAN) for electronic correspondence and transfer of data.

Principal Copy of
Electronic Data Sets

- NRDA:
FS-1, 2, 3, 4A, 11, 13, 27, 28,
ST-5, (FS-5, ST-2AB, ST-6).

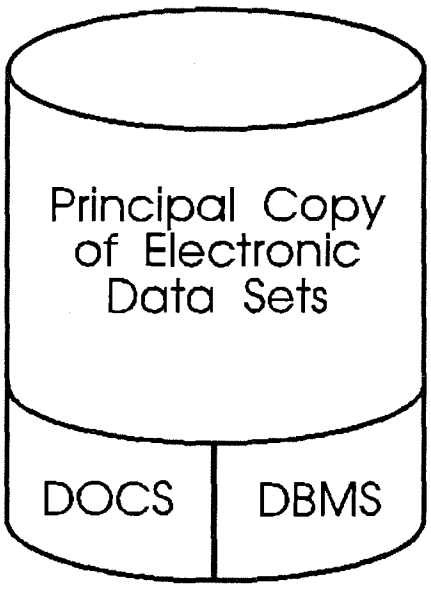
- Historical Data:
Commercial fisheries harvest
Fisheries escapement data

- Restoration Projects:
R-53, 58, 59, 60ABC, 105, and
113, (R-90, 106).

Documentation (DOCS) Database Management System (DBMS)

FS-30 supports 17 NRDA and restoration projects, with ancillary support to an additional 6 projects. Including historical data sets, the current amount of raw electronic data involved is estimated to be between 1,500,000,000 and 1,800,000,000 bytes. Tracking this volume of information requires significant time and effort; leaving it to Principal Investigators (PIs) would severely limit their ability to focus on project work. Ignoring data management entirely would ultimately lead to the loss of millions of dollars in data collection effort as projects complete or personnel transition to other projects. In brief, this project:

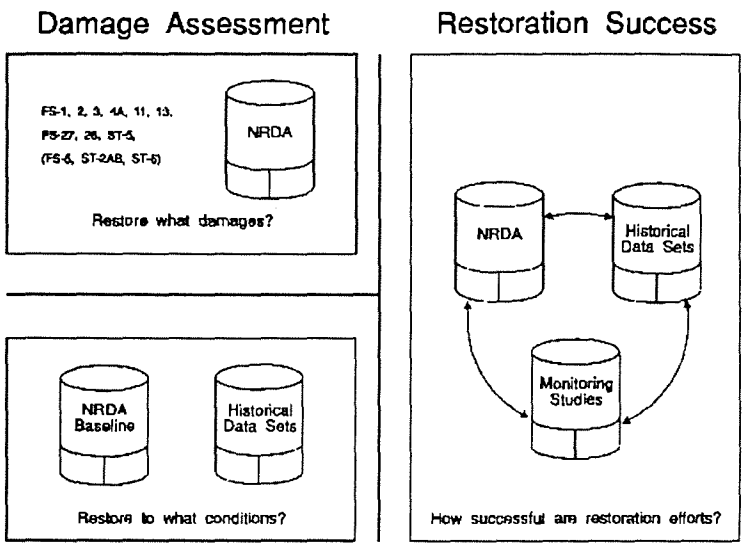
- Catalogues, archives, and maintains the principal copy of raw electronic data sets for FS-1, 2, 3, 4A, 11, 13, 27, 28, ST-5, (FS-5, ST-2AB, ST-6).
- Facilitates direct access by PIs to historical fisheries data sets essential to NRDA studies. Historical data includes commercial fisheries catch and escapement figures.
- Provides data processing and technical support for PIs and NRDA functions, including the use of ADF&G Commercial Fisheries WAN.
- Proposes to unify the data catalogues and maintenance of principal data sets for continuing ADF&G fisheries assessment, restoration, monitoring projects. This should facilitate sharing raw data between agencies and the ability to provide this information to the public.
- Proposes to catalogue, archive, and maintain the principal electronic data sets for R-53, 58, 59, 60ABC, 105, 113, (R-90 and 106).



Demonstration of the success of restoration effort depends directly on measurable results. Any restoration assertion is ultimately linked to principal assessment, restoration, and historical data sets.

For this reason, it is important that principal data sets of NRDA studies be documented, archived, and maintained.

OBJECTIVES AND PRINCIPAL COMPONENTS



Synthesis

Most of the original NRDA projects are targeted at the species level. Restoration projects which are targeted at the ecosystem level require synthesis of broadly disparate electronic data sets.

In addition, future restoration studies at the species level will depend heavily on access to established assessment and historical data.

FS-30 documents the content of existing NRDA and relevant historical data sets, making the sharing of data between projects possible. (This documentation covers all types of data relevant to a given study, and is not limited to chemical or GIS information.)

Data Management

It is important that a principal copy of raw data be identified and archived. When data is shared between projects, multiple copies often diverge; any resulting conflicts must be resolvable through reference to a recognized true copy of the data.

FS-30 is responsible for storing true copies of raw data, and documenting changes made through ongoing quality control. Inherent in this responsibility is need to limit access to authorized parties. FS-30 also implements regular back-ups of electronic data sets.

Requests for Information

When NRDA data are released by the Trustees, the public demand for this information may overwhelm PIs and support staff, thereby limiting their ability to focus on restoration work. By providing a central catalogue of raw data, and a recognized true copy of data sets, the extra work resulting from information requests should be reduced.

Confidentiality

The dissemination of certain data integral to NRDA projects is limited by Alaska statute. Personnel associated with FS-30 are charged with tracking this information, and ensuring that state law is not violated.

Technical Support

FS-30 is staffed by data processing and computer professionals. By its nature, this project has close contact with PIs and is aware of their technical needs. FS-30 assists PIs and their affiliates with technical issues, and thereby allows these individuals to focus on restoration work.

The ADF&G section charged with FS-30 also supports a statewide computer network (separately funded and maintained by ADF&G), which greatly facilitates sharing of information between PIs, Managers, and the Trustee Council. Current and future proposals, their support, and on-going requests for additional information rely heavily on this network.

General

FS-30 is responsible for constructing a cost effective database management system (DBMS) to readily retrieve and order selected data from original data in electronic form according to user specified criteria of time, space, and other variables. The DBMS should be constructed to meet the following criteria, in order of priority:

1. Completeness of contents

2. Speed of retrieval

3. Ease of use in assembling primary data into datasets for further analysis by other software

Specific Objectives

1. Continue maintenance of the secure repository for identified FS and ST studies NRDA and Restoration Project Data.

   The data generated from studies relating to the Exxon Valdez oil spill are an important resource for the State of Alaska, the Federal Government, and the scientific community. Besides providing information for improved management of natural resources, these data will play a vital role in determining the success of ongoing restoration and enhancement projects.

The data will also serve an important role in subsequent legal actions related to the Exxon Valdez oil spill. Due to the data's potential role in the settlement of legal disputes, it is important that the conclusions derived from raw data be reproducible. When dealing with large raw data sets, reproducibility can only be ensured if a single repository of the data is acknowledged. Without a recognized (single) repository, proliferation of updates and changes in the data across multiple copies may lead to contradictory conclusions.

2. Protect project data from accidental loss.

   The datasets from NRDA and Restoration Projects should be adequately protected from inadvertent loss. Placing a study's principal copy of electronic data on a database server with regularly scheduled backup procedures should reduce the responsibility of the principal investigators in this important task.

3. Provide easy access to designated individuals and agencies.

   It is essential that principal investigators have ready access to raw data. Research efforts should not be limited by access to data.

4. Limit unauthorized access.

   The data storage facility must provide mechanisms for adequate security. Only designated individuals should have access to the data obtained from NRDA and Restoration projects.

5. Establish procedures for sharing data between studies and agencies.

   It is recognized that the collective data of the NRDA studies may lead to conclusions which were not anticipated on a study by study basis. The data should be stored in such a fashion that it is possible to test hypotheses which span multiple studies. To this end, the data from the individual studies must be catalogued and stored in a way that facilitates sharing between studies and agencies.

6. Catalogue NRDA data and future Restoration Project data.

   A complete catalogue of Assessment and Restoration Project data should include both general and detailed descriptions of the data. General descriptions should allow an independent party to determine the content and potential relevance of a dataset; detailed descriptions are essential for incorporating data into further studies.

7. Expedite information requests.

   It is anticipated that future legal action on the Exxon Valdez oil spill may place heavy demands on PIs and staff, both in the form of standard requests for information, as well as through the deposition process. While only the PIs and individuals associated with a specific study are qualified to evaluate and conduct analyses of data, a properly constructed repository of data and clearly defined procedures for accessing raw data should ease the burden of information requests and the demands on individuals involved in deposition.

8. Establish procedures for maintaining the repository data.

   Clearly identified procedures will be implemented for maintaining information in the data repository. Such procedures should address the means for adding, deleting, and modifying data in the datasets, and should provide suitable documentation of relevant maintenance activities.

9. Describe the WAN database, and its implications.

   A central repository of the data is envisioned. This repository should contain the current principal copy of electronic data for any given study. For performance reasons, it may be necessary to distribute portions of this database to local offices; procedures must be elaborated for synchronizing distributed copies of the datasets.

10. Provide both text and Graphical User Interface (GUI) access to historical data bases catch, escapement etc.

    Develop direct access to important historical databases, including the capability for customized record selection, summary, and formatting. PIs can, from personal computers attached to the ADF&G Commercial Fisheries WAN, select data subsets using their own criteria, custom summarize data to 10 levels, then electronically transfer their new dataset to their location for use in their study environment (R:BASE, SAS, etc.) Records on a detailed level will be available, selected and sorted to the user's specifications.

STUDY METHODOLOGY

Access to historic databases in support of NRDA studies will be provided through an interface capable of providing summary and detail records sorted in a variety of output formats according to user specifications. The system will be accessible by authorized IBM-compatible personal computers on the ADF&G Commercial Fisheries WAN. It will be made available through a linked system of Local

Area Networks (LANs) covering offices in Kodiak, Anchorage, Cordova and Juneau. The interface allowing non-programmer access to the database will be developed for text and GUI platforms.

The NRDA study databases will be cataloged and stored in a central secure repository. Access to these data will be available to authorized staff. Documentation will include descriptions of each data set, covering aspects of physical layout, fields contained, purpose of data set, and author. This documentation should facilitate sharing data between PIs and agencies. Also, subsequent requests by the public will be facilitated by this documentation.

The original scope of data for FS-30 was commercial species from Prince William Sound, Kodiak, Cook Inlet, and Chignik areas. After discussions with assessment and restoration researchers we have changed the priority and type of observations to be incorporated. They are, in order of priority:

1. NRDA project data of global interest.

2. Commercial fisheries catch and effort data by area, species, and gear type.

3. Salmon escapement data, including aerial survey counts, stream counts, weir counts, and sonar counts.

4. Pre-emergent and egg density counts.

5. Biological data including age composition, size, sex, growth, and stock composition.

6. Groundfish and shellfish survey data.

This project will make use of an ADF&G statewide database network infrastructure being separately developed with State of Alaska general funds. Exxon Valdez oil spill settlement monies are not used to develop this network.

NRDA Project Data Sets

1. A secure database/file server system has been installed. (Objectives 1, 2, 3, 4).

   A database server has been installed in the Region II ADFG office. Separate areas for each of the NRDA studies have been established. Procedures are being developed for establishing accounts, granting access, and ensuring appropriate backup of the datasets.

2. The documentation of NRDA (FS,ST) datasets is proceeding in two phases. (Objectives 5, 6, 7).

In the first phase, a general description of the datasets for a given NRDA study are completed. Included for each study are a qualitative description of the dataset, an estimate of the size of the dataset, the working format of the dataset, the individual responsible for the content of the data, the primary fields represented, and an estimate of the dataset's completeness and an estimate of the extent to which the data has been verified. In addition, primary investigators and their associates are identified as part of this general documentation process.

In the second phase, detailed descriptions of the data are elaborated. In addition to a textual description for each data field, the following data are defined at the field level: type, size, key status (must exist, must be unique), data validation rules, lookup tables (foreign keys), null values, value justification in the field, and leading fill characters. Synonyms for the fields are included where appropriate and known. Record definitions are defined as aggregates of the field definitions.

3. Procedures for data maintenance are under development. (Objectives 1, 8, 9).

   Procedures are being developed for maintaining data in the repository. The repository holds the current principal copy of raw data for any given study. Procedures for reporting suspect data, modifying and updating datasets, and logging versions are under development. Performance of the WAN must be monitored before the procedures for data maintenance can be finalized.

Commercial Fisheries Historical Data

1. Programs have been written to analyze historic harvest data for errors. To date over 3.5 million records from spill affected areas have been searched.

2. Original documents have been obtained for incorrect records and corrections applied to the database.

3. Documentation has been written and assembled for changes made to the historic database (samples attached).

4. The technical card documenting codes has been revised and will be printed and distributed soon.

5. The detailed project plan for developing the historic commercial catch database has been substantially revised, now with an emphasis on NRDA direct access to detailed and summary data, and output formats in ASCII, spreadsheet, and R:BASE formats. (See attachments).

6. Purchase and development of a batch processor (separately funded) is under way and the interim detail data made available to NRDA researchers could be replaced by late spring.

7. The lead programmer is working closely with Commercial Fisheries networking staff to ensure that access to the wide area network is available and compatible with Oil Spill division administration and NRDA projects.

8. The Anchorage office is now connected to the department's wide area network. Cordova is scheduled to be connected by the end of November. The NRDA PIs, their affiliates, and Oil Spill Division staff now communicate and exchange documents via electronic mail.

DELIVERABLES

The primary deliverables for FS-30 include:

- Documentation of principal electronic data sets for selected NRDA FS/ST studies and future restoration projects. This documentation includes general description of data set content, import/export mechanisms facilitating data sharing between projects and agencies, and detailed data element definitions.

- Archives of principal electronic data sets, and modification logs to principal data.

- Support documentation (in electronic form) for selected NRDA FS/ST studies and future restoration projects.

- Software systems providing direct access to selected historical fisheries data sets by designated PIs and their affiliates.

SCHEDULE AND TIMELINES

The work of FS-30 is tied directly to the progress of NRDA FS, ST, and Restoration projects. Data collected by studies that FS-30 supports is keyed and subjected to quality control measures by the principal investigators of the specific FS, ST, or Restoration Project. After QC is completed, a principal copy is made available to FS-30 for inclusion in the data repository. Concurrent with QC efforts are data documentation procedures which support the principal data sets.

Historical fisheries catch data is currently available to PIs through the Commercial Fisheries Fish Ticket System. New user

interfaces will be in place for direct access to this data by the end of the state's fiscal year. Additional work on the Fish Ticket system will be completed May 1, 1992. (This additional work, which develops the existing system according to user requests, is separately funded through ADF&G's Commercial Fisheries budget).

FS-30 Database Management:

- Catalogues, archives, and maintains the principal copy of raw electronic data sets for FS-1, 2, 3, 4A, 11, 13, 27, 28, ST-5, (FS-5, ST-2AB, ST-6).
- Facilitates direct access by PIs to historical fisheries data sets essential to NRDA studies. Historical data includes fisheries catch and escapement figures.
- Proposes to unify the data catalogues and maintenance of principal data sets for continuing ADF&G fisheries assessment / restoration / monitoring projects. This should facilitate sharing raw data between agencies and providing this information to the public.
- Proposes to catalogue, archive, and maintain principal electronic data sets for R-53, 58, 59, 60ABC, 105, and 113, (R-90, and 106).
- Provides data processing and technical support for PIs and NRDA functions, including the use of ADF&G Commercial Fisheries WAN (wide area computer network).

ACRONYMS AND ABBREVIATIONS

DBMS - Database Management System
EVOS - Exxon Valdez Oil Spill
FS - Finfish / Shellfish (also, some Subtidal Studies)
FT - Fish Tickets
GUI - Graphic User Interface
NRDA - Natural Resource Damage Assessment
PI - Principal Investigator
WAN - Wide Area Network

SCENARIOS

FS-30 is unique among NRDA projects, in that it participates in the responsibility for maintaining principal copies of raw electronic data from other NRDA studies. The unique roll FS-30 plays in NRDA efforts is exemplified by the following possible scenarios.

1.) Different copies of a particular data set are used leading to different conclusions. The validity of the data is questioned, and the entire data set is deemed unusable.

FS-30 defines and archives the principal copy of data, and ensures that any changes made to this data are appropriately catalogued.

2.) A given data set is inadequately documented, and units are omitted. For example, is a given value in fathoms, meters, feet, or yards?

FS-30 directly addresses and eliminates this problem through the data catalogue it maintains.

3.) A PI retires or moves on to other work. A recognized copy of raw data may not exist. The value of any existing primary raw data is questionable without adequate support documentation.

FS-30 archives and documents existing data sets, thereby facilitating transition of personnel.

4.) The raw data from a given study proves vital to a number of external public agencies and/or private concerns. The PI is overwhelmed with requests for information, leading to a compromise of effort on current restoration activity.

FS-30 can provide a first point of inquiry regarding raw data, including both general and detailed descriptions of principal data sets. Most initial information should be obtainable without direct interaction with the PI.

5.) Because a federal or state agency is not familiar with the details of data from an existing NRDA study, effort is expended to re-obtain information. Alternatively, a project is never proposed, because the prospective PI is unaware of existing data obtained through the efforts of other studies.

FS-30's catalogue of data sets should provide a general description of what is currently available, and what the possibilities are for future restoration.

	BUDGET ($K)
Salaries	$154.0
Travel	6.9
Contractual	10.4
Supplies	4.6
Equipment	2.8
Subtotal	$178.7
General Administration	23.8
Total	$202.5

SUBTIDAL STUDY NUMBER 5

Study Title: Injury to Shrimp

Lead Agency: ADF&G

PROJECT JUSTIFICATION

PART I

This project is aimed at assessing possible injury to spot shrimp, (Pandalus platyceros), due to oil spilled from the T/V Exxon Valdez, and is a continuation of Fish/Shellfish Study 15 conducted during 1989 and 1990 and Subtidal Study 5 conducted in 1991.

Spot shrimp is a representative species of the deepwater nearshore benthic ecosystem, serving as a food source for a variety of fish and shellfish. Spot shrimp share aspects of their distribution and food habits with other economically important fish and shellfish species (Butler 1980). Spot shrimp themselves support important commercial, subsistence and recreational fisheries in Prince William Sound. This species favors steep, rocky habitat which is found in patches throughout Prince William Sound. Much of this habitat is contained within the traditional harvest area of the spot shrimp commercial pot fishery, which includes the area west of a line from Montague Point to Bidarka Point. A large portion of this harvest area was in the direct path of the 1989 Exxon Valdez oil spill.

Adult spot shrimp, along with other pandalid shrimp, are known to be sensitive (lethal and sublethal effects) to oil contamination (Anderson et al. 1981, Rice et al. 1979, Sanborn and Malins 1980, Stickle et al. 1987, Vanderhorst 1976). Larval and juvenile shrimp are known to be more sensitive than adults: lower concentrations of oil will kill half the study group in less time (Brodersen et al. 1977, Brodersen 1987, Mecklenburg et al. 1977, Rice et al. 1984). Also, larval and juvenile shrimp may be exposed to higher concentrations of oil contamination toxins than adults since larvae occur in surface waters and juveniles tend to inhabit shallow subtidal areas while adults live well below the surface (Barr 1971, Barr 1973, Butler 1964, Butler 1980).

Sample collection for spot shrimp takes place in the fall, leaving no time for sample analysis prior to the reporting period at the end of November each year. Consequently, peer reviewers have not had an opportunity to adequately review 1991 results. The Trustee Council has approved a sufficient budget to analyze and report 1991 results which will be forwarded to peer reviewers. Based upon their recommendations, the project will go forward with additional sampling in the fall of 1992 or be terminated. Two budgets appear at the end of this detailed plan. The first is the budget

authorized through the end of 1991 sample analysis and reporting (Part I). The second is the budget which may be authorized by the Trustee Council if peer reviewers recommend continued sampling (Part II).

OBJECTIVES

1. Determine the relative abundance by weight, number and sex of spot shrimp, as well as the relative abundance by weight of incidentally caught pink (Pandalus borealis) and coonstripe (Pandalus hypsinotus) shrimp, in oiled and non-oiled areas, and compare these values to those obtained from surveys conducted in 1989, 1990, and 1991.

2. Use historic catch data from the commercial spot shrimp fishery to estimate fishing mortality and effort to:

   a). Evaluate the feasibility of incorporating fishing mortality into relative abundance estimations, to improve accuracy of stock assessment estimates.

   b). Compare fishing effort in oiled and unoiled areas between pre- and post-oil spill years.

3. Compare size and age frequencies of spot shrimp (by sex) among sites using various methods of length frequency analysis (mixture modal analysis).

4. Compare fecundity, egg mortality, and other sublethal effects between oiled and non-oiled areas over time, and determine whether these effects caused decreased reproductive viability.

5. Document injury to spot shrimp tissue samples and compare differences between oiled and non-oiled sites and among years.

6. Synthesize information on spot shrimp stock status, hydrocarbon exposure and injuries to determine whether a restoration plan to manage the spot shrimp resource is needed.

PART II

The following field work will proceed only if peer reviewers recommend additional sampling after review of 1991 results.

Methodology developed in previous studies (Kimker and Donaldson 1987, Donaldson 1989, Donaldson and Trowbridge 1989, and Kruse and Murphy 1989) will be used again this year.

Data obtained in this study when combined with 1991 study results, will indicate whether spot shrimp juveniles and larvae were exposed

to lethal levels of oil contamination (though little knowledge will be gained on whether sublethal exposure occurred). Given the sampling gear used and the growth rate of spot shrimp, 1991 would have been the first year in which recruitment from the 1988 and 1989 year classes would have been observed. In the 1992 season, all of the 1988 and most of the 1989 year classes should have recruited in to the sampled population.

To determine what effects hydrocarbons from the spill had on spot shrimp, samples will be collected from the same three oiled and three non-oiled sites in western Prince William Sound surveyed in 1989 and 1990. An additional oiled site (Snug Harbor), first sampled in 1991, and an unoiled site (Whale Bay) to be sampled for the first time this year, will be added to the study to give a more balanced design and to use an unoiled area in the southwest Prince William Sound.

METHODS/DATA ANALYSIS

Samples will be collected during November 1992 using the ADF&G research vessel Montague. This time frame, while a departure from the 1990 study plan, follows the 1991 study plan in which samples were taken following the fall molt and when egg extrusion was completed. Specific data to be collected are described below.

Study Sites

Spot shrimp habitat within Prince William Sound was divided into oiled and unoiled strata. Localized spot shrimp distribution in these areas was determined from commercial fishermen interviews and results of previous ADF&G studies. Unoiled areas are generally located in the northwestern portion of Prince William Sound: Unakwik Inlet, a site used for previous ADF&G studies on abundance and growth of spot shrimp (Kimker 1984, 1985; Kimker and Donaldson 1986, 1987); Port Wells (Golden); Culross Passage; Whale Bay. Oiled areas are located in central and southwestern Prince William Sound: Green Island, an ADF&G test fishing site in 1981, Chenega Island (northeast corner); Herring Bay; Snug Harbor.

Sample Design

Each of the eight sites will be sampled at depths between 35 and 130 m. This approach differs from the sampling design used in 1989, 1990 and 1991 in which depths greater than 130 m were also sampled. Data collected during the last three survey years has shown that spot shrimp were not abundant below 130 m at all sample sites. Thus to lower necessary effort and to make a more balanced statistical design, only one depth stratum will be used this year. Also, 1992 sampling will be directed at younger individuals which tend to occur at shallow depths. Reduction in sampling effort at each site will allow two additional sites to be sampled in 1992.

Eleven commercial pots of a standard size, spaced 18.5 m apart, will be fished on a long line. Each string of pots, spanning a distance of 185 m, constitutes a sampling station. A minimum of three stations will be fished at each site. Thus, a total of 264 pots (33 pots at each of the 8 sites) will be deployed over the course of the survey. If necessary, pots will be reset and deployed an additional day at each site to obtain adequate sample sizes for length frequency analysis. Spot shrimp caught in these extra sets will not be included in relative abundance estimates, since extra sets will be made at depths where large concentrations of shrimp were caught during previous sets.

Data Collection

Station information including location (latitude and longitude), depth (fathoms) and time (hours) pots were fished will be recorded by the vessel skipper on a standard form.

Environmental Samples

Water temperature, salinity, and dissolved oxygen concentration at each site will be recorded using a Sea Bird Electronics Conductivity, Temperature and Depth (CTD) meter. Data will be transferred from the CTD to a micro-computer and stored on diskette. CTD casts will be taken within 1 km of each site. The CTD will be lowered at a rate of 60 meters per minute, to provide environmental data at half meter intervals. Due to the configuration of the CTD, only readings from the downcast will be used.

Biological Samples:

Total weight of catch, subsample weight, and total weight of each species in a subsample will be recorded at the time each pot is retrieved on a standard form. Total weight of shrimp per pot will be determined by weighing the contents of each pot on an electronic scale. The average number of shrimp per kilogram will also be determined. If less than 500 spot shrimp are estimated caught at a station all of them will be sampled. If more than 500 spot shrimp are estimated caught at a station a constant proportion by weight will be subsampled from each pot to obtain approximately 500 spot shrimp.

All spot shrimp in samples and subsamples will have their carapace length measured to the nearest 0.1 millimeter using a digital caliper, and their sex determined according to the methods (Standard Operating Procedure) described by Trowbridge and Coyer (1989: Appendix C). For female spot shrimp the following information will be noted: egg color and stage of development (eyed or uneyed); relative clutch size; presence of breeding dress, occurrence of egg and external parasites. Each female retained for fecundity analysis will be identified with a code number to allow

cross-referencing of fecundity and other data. All data collected will be recorded on a standard data form.

Histopathology Samples:

Specimens to be used for histopathology analysis will be removed from pots before catches are weighed and processed. This will ensure that only freshly killed samples are analyzed. Twenty shrimp from a single station will be selected randomly for each histopathology sample. Each histopathology sample will be weighed and recorded on a standard form. Histopathology samples will be labeled with the date, station number, latitude and longitude, sample number, project leader's name, species, and agency. Samples will be prepared according to methods specified by Dr. Donald Lightner, associate professor, University of Arizona.

Fecundity Samples:

Fifteen egg-bearing females will be randomly selected from each station to estimate fecundity and egg mortality. This will yield a total of 360 females. Specimens from each station will be individually labeled with a fecundity number, their carapace length measured, and placed together in a plastic bag. Each sample bag will be labeled with the project leader's name, species name, "eggs", date, station, and agency. Data taken at the time of subsampling will be recorded on a standard form and later entered into an R:base computer file.

Fecundity will be determined by removing all eggs from the pleopods, drying each egg mass to a constant weight, weighing a subsample containing a known number of eggs, and multiplying the weight of the entire clutch by the number of eggs per unit weight in the subsample.

Total number of spot shrimp examined for fecundity estimation will be determined by time and budget constraints. If all 15 shrimp from each of the station samples cannot be processed, subsamples will be processed from each station. A minimum of ten shrimp from each station will be sampled to provide an adequate sample size for detecting differences in fecundity among oil impact areas.

Fish Tickets and Log Books:

Voluntary log books from commercial spot shrimp fishermen will be collected and copied in Cordova. Fish ticket information will be accessed through the ADF&G records in Juneau. The fish ticket records will be sent on computer diskettes via the United States Postal Service.

Data analysis

Objective number 1 (estimation of relative abundance) will be addressed by calculating average species catch per pot by weight, number, and sex. Analysis of variance (ANOVA) will be used to test for significant differences (p-value < .05) in each of these categories among sites and between oiled and non-oiled areas, using the following model:

$$CPUE_{ijk}=\mu+\alpha_i+\gamma_{j(i)}+\epsilon_{ijk}$$

where μ is the grand mean, α_i is the oiling effect, $\gamma_{j(i)}$ is the site effect nested within oiling strata and ϵ_{ijk} as the error term.

Changes in average catch per pot over time among different sites and between oiled and non-oiled areas will be analyzed using the above ANOVA model with a time term, β_l, added.

To meet objective number 2 (examination of fishery trends), information from commercial fishing log books and fish tickets collected both before and after the Exxon Valdez oil spill, will be used to estimate effort and catch in areas frequently fished. A weighted fishing intensity term, θ_m, may be added to the above ANOVA model to determine whether differences occurred among sites and between oiled and unoiled areas. A weighted fishing intensity term will be used since information may be incomplete and biased and differences in effort occurred throughout Prince William Sound.

A size frequency distribution of spot shrimp will be made by sex to address objective number 3 (determination of differences in size and age composition). The hypothesis that no significant difference exists among oil impact areas in size frequency distribution of spot shrimp catches will by tested using quantile-quantile plots, Chi-square (χ^2) tests or other appropriate methods. A t- or Mann-Whitney test will be used to test for similarity between means. Changes in size frequency distribution over time will be examined using either a t- or Mann-Whitney test for comparing means and an appropriate method for comparing frequency distributions.

To meet objective number 4 (examination of sublethal effects), the relationship between spot shrimp size and fecundity will be examined. For each station the following will be determined: percentage of female spot shrimp bearing eggs; stage of egg development; percentage of egg fouling and mortality; fecundity by size; relative clutch size. χ^2 tests will be used to test for site differences and treatment levels since data will be expressed as percentages. Differences in fecundity and relative clutch size among sites, and between oil and unoiled areas will be tested using ANOVA procedures.

To address objective number 5 (documentation of injury), the percentage of shrimp with abnormal tissues in oiled and non-oiled areas will be determined. A χ^2 test will be used to determine whether differences in the percentage of shrimp with abnormal tissues among sites, and between oiled and unoiled areas.

To meet objective number 6 (development of restoration plans), it will be necessary to examine changes in catch per unit effort, age class strength, and reproductive viability to determine whether management actions implemented to restore injured stocks are having the desired effect. Further regulation of human use, including time and area closures may be necessary to reduce fishing mortality on oil-injured stocks and allow them to recover. Additionally, the need for continued stock monitoring to evaluate effectiveness of recovery methods will be assessed.

All catch, size, and station data will be entered into R:BASE computer files using portable micro computers. Statistical tests will be conducted using commercially available software such as SAS, Minitab, Lotus and SYSTAT software.

SCHEDULES AND REPORTS

Date(s)	Activity
November 1992	Field program will last approximately 10 days. (Approximately Nov., 1992); Sampling will occur daily while in the field. One of the eight sites will be sampled each day, day one will be used for travel to the area and setting the initial 3 strings of pots. The remaining time will be used for resetting pots at sites for which 500 spot shrimp were not obtained.
December-February 1993	Data entry & analysis
February-March 1993	Preliminary report on impacts of oil on shrimp.
December 1993	Final report on damage assessment on spot shrimp

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Table 1. ADF&G SPOT SHRIMP SAMPLING PLAN

I. SITES

A. Non-oiled
1. Unakwik Inlet
2. Port Wells (Golden)
3. Culross Pass
4. Whale Bay

B. Oiled
1. Herring Bay
2. Chenega Island
3. Green Island
4. Snug Harbor

II. STATIONS

A. Exact station locations at each site were chosen with the help of fishermen experienced at spot shrimp fishing in those areas.

B. Each station will consist of one string of eleven pots fished on a long line. Pots will be spaced 18.5 m (approximately 10 fathoms) apart for a total length of 185 m for each string of pots.

III. FISHING PLAN

A. Weekly Schedule

1. Day 1 Sail to Unakwik Inlet set stations 1, 2 and 3.
Day 2 Pick Stations 1, 2 and 3. Sail to Port Wells and set stations 4, 5 and 6.
Day 3 Pick stations 4, 5 and 6. Sail to Culross Passage and set stations 7, 8 and 9.
Day 4 Pick stations 7, 8 and 9. Sail to Herring Bay and set stations 10, 11 and 12.
Day 5 Pick stations 10, 11 and 12. Sail to Chenega Island and set stations 13, 14 and 15.
Day 6 Pick stations 13, 14 and 15. Sail to Whale Bay and set stations 16, 17 and 18
Day 7 Pick stations 16, 17 and 18. Sail to Snug Harbor and set stations 19, 20 and 21.
Day 8 Pick up Stations 19, 20, 21. Sail to Green Island and set stations 22, 23 and 24.
Day 9 Pick stations 22, 23 and 24. Return to Cordova, end of trip.

Additional days will be allocated at a given site if the sample size objective of 500 shrimp per site is not achieved.

B. Daily Schedule

1. Gear will fish a standardized overnight period of 16 to 18 hours.
2. Pots will be pulled in the morning and subsequently set such that the desired soak time will be achieved. If the desired soak time cannot be achieved, pots will be fished to minimize variance from this desired fishing time.

BUDGET ($K)
(Part I - 1991 Analysis and Report only)

Salaries	$17.3
Travel	0.8
Contracts	0.9
Supplies	0.8
Equipment	0.2
Subtotal	$20.0
General Administration	2.7
Total	$22.7

BUDGET ($K)
(Part II - Full Study Pending Peer Reviewer Recommendations)

Salaries	$43.0
Travel	1.8
Contracts	12.3
Supplies	2.4
Equipment	1.9
Subtotal	$61.4
General Administration	6.5
Total	$67.9

SUBTIDAL STUDY NUMBER 8

Study Title: Mussel Tissue and Sediment Hydrocarbon Data Synthesis

Lead Agency: NOAA

INTRODUCTION

The goals of project Subtidal Study #8 are (1) to evaluate the internal consistency of sediment and mussel tissue hydrocarbon data, and (2) to objectively identify the presence of Exxon Valdez petroleum hydrocarbons in these samples. The first goal is necessary to minimize the effects of errors in sample collection, documentation, and analysis that are inevitable with a large number of samples collected for several different projects, and that are chemically analyzed using a complex procedure. The more of these errors that can be objectively identified, the greater will be the power of subsequent statistical tests. The second goal is necessary to provide an objective evaluation of the persistence and geographic extent of petroleum hydrocarbon contamination of these samples. This evaluation will provide a common reference for the participating projects, will minimize duplication of expensive analytical effort, and will provide the most comprehensive view of contamination possible with these data.

Inconsistent hydrocarbon data are identified using computer-based statistical methods to identify groups of samples that are clearly biased systematically, or that have been clearly exposed to extraneous contamination unrelated to the oil spill. Computer-based methods are necessary because thousands of sediment and mussel tissue samples have been analyzed for 63 independent analytes each. However, these methods are also very powerful just because of the large number of samples involved. Once identified, these samples may be excluded from subsequent statistical tests, which may greatly enhance the power of these tests.

The presence of Exxon Valdez petroleum hydrocarbons in analyzed samples is objectively determined using a computer-based pattern recognition method called principal component analysis (PCA). This method provides an objective and consistent way of determining the presence and relative amount of oil in samples, and works particularly well with NRDA oil spill samples because the oil spill is by far the major source of hydrocarbons found in Prince William Sound after March 1989.

Once Exxon Valdez petroleum hydrocarbons have been objectively and reliably identified in samples, the results can be mapped to yield a picture of the overall extent of contamination. By including results from all the projects that collected sediment or mussel tissue samples, the most complete and detailed maps of oil

contamination will be prepared, providing a common reference for the participating projects. This, in turn, will provide scientific investigators and the general public with the most accurate indication of the persistence and geographic extent of oil-contaminated sediments and mussels.

OBJECTIVES

A. Develop appropriate criteria for the final acceptance of hydrocarbon data prior to further analysis.

B. Calculate a hydrocarbon summary index that expresses quantitative amount and qualitative character of all hydrocarbons detected in sediment and mussel tissue samples.

C. Provide PIs with evaluated sediment and mussel tissue hydrocarbon summaries in the form of tables, charts, graphs and maps.

D. Prepare a comprehensive interpretation of sediment and mussel tissue hydrocarbon data identifying patterns of contamination across all the NRDA projects that generated these samples.

METHODS

A. Sampling methods: No samples will be collected by this project.

B. Standard operating procedure requirements: See Data Analysis, below.

C. Quality assurance and control plans: See Data Analysis, below.

D. Information required from other investigators: Hydrocarbon analysis data and associated sampling data from the Technical Services #1 database.

E. Safety requirements: N/A

F. Animal health and welfare: N/A

DATA ANALYSIS

Evaluation of Hydrocarbon Data Consistency

Hydrocarbon analytical data will be examined for conformance with two expectations. First, hydrocarbon concentrations in replicate

samples are expected to be more or less similar. Second, samples collected from a priori control sites are not expected to contain hydrocarbons characteristic of crude oil.

A. Replicate Sample Similarity

The procedure described below includes two basic parts; identification of "deviant" samples, followed by an examination of the way these deviant samples are distributed among batches of samples analyzed. Samples may be deviant for many very legitimate reasons. However the samples identified as deviant should not be contained within a very few batches of samples analyzed. If they are, then the batches comprising these deviant samples merit close examination.

Great dissimilarity in hydrocarbon concentrations among samples that are replicates may result from patchiness in the way hydrocarbons are distributed in the matrix sampled, or from systematic bias introduced during sampling, sample storage, or sample analysis. Dissimilarity arising from the way hydrocarbons are distributed in the matrix should be preserved, because one object of sampling is to describe this distribution, so attempts to eliminate such dissimilarity will introduce bias into the data. However, dissimilarity arising from systematic bias should be minimized, to realize the power of subsequent statistical tests.

The samples that contain deviant hydrocarbon concentrations, when compared with their respective replicate samples, should be nearly randomly distributed among all collected samples, if the deviance arises from the way hydrocarbons are distributed in the matrix sampled. Consequently, a very non-random distribution of such dissimilar samples may be taken as an indication of systematic bias. For example, if all the deviant samples identified were analyzed on the same day at the same laboratory, then introduction of systematic bias would be suspected. We will therefore determine the probability that such deviant samples have the distribution observed among sample batches, or catalogues, using the procedure following, and assuming a random distribution among catalogues. Highly unlikely associations of such samples will be removed from consideration until the distribution of the remaining deviant samples is plausible. In this way, systematic bias will be identified and reduced, without compromising the integrity of the remaining data.

1. Identification of Deviant Samples

To determine the probability of an observed distribution of deviant samples among catalogues on the assumption of an underlying random distribution, the deviant samples must first be identified. After these deviant samples are identified, the distribution of them

among sample analysis catalogues can be compared with random distributions of the same number of deviant samples.

Each sample is analyzed for 63 different hydrocarbons. A sample will be considered deviant if the concentrations of more than 9 of these are simultaneously very different, when compared with respective concentrations in the remaining replicate samples. The justification for this criterion, together with a quantitative definition of what is meant by "very different", is contained in the following procedure that will be used to identify deviant samples.

For each hydrocarbon, the logarithm of the squared range of the hydrocarbon for each set of replicate samples is plotted against the logarithm of the median for that set. (Sets of replicates that have zero range for the hydrocarbon considered are not included.) The log-log plot accounts for the expected increase in the variance of each hydrocarbon at higher concentration. A linear regression line is calculated for this plot, and the replicate sets associated with the highest 5% of positive deviations from this regression line are identified. (Only positively deviant replicates on the plot are identified because these have the largest ranges; the negatively deviant replicates are those that agree most closely for the hydrocarbon under consideration.) Within each set of replicates in the highest 5%, the sample with the deviant hydrocarbon concentration is identified, and that sample is given a score of 1. A tally is then made of the number of hydrocarbons having a score of 1 in each sample of each set of replicates. Thus, each replicated sample will contain some number, n, of hydrocarbon concentrations that are identified as deviant using the above procedure.

If the distribution of these deviant hydrocarbon concentrations were random within and among samples, then each hydrocarbon has a 5% probability of being deviant in each sample. The probability, P, that a sample will contain n deviant hydrocarbons simultaneously under these assumptions is:

$$1. \quad P = \binom{k}{n}(0.05)^n(0.95)^{k-n}$$

where k = 63 is the number of hydrocarbons analyzed in the sample. According to equation 1, the probability that more than 9 hydrocarbons are simultaneously deviant within a sample is less than 0.2% (k=63, n=10). This means that the above procedure will misidentify less than 0.2% of the samples as deviant, if instances of deviation really are randomly distributed within and among samples. If deviant samples are identified, they are flagged, and the above process is reiterated using a log-log plot that does not include replicates of the flagged samples. The process is reiterated because exclusion of the flagged samples and their replicates

changes the regression line of the log-log plot for each hydrocarbon, which may then reveal new deviant samples. Reiterations of the process continue until no additional deviant samples are revealed. Thus, the above provides an objective way of identifying deviant samples.

2. Identification of Suspect Catalogues

Samples may be deviant due to the way hydrocarbons are distributed in the matrix sampled, or due to systematic bias. To evaluate these alternatives, we examine the way deviant samples are distributed among sample catalogues, based on an approach that is analogous with eq. 1. Given j samples identified as deviant among a total of J samples initially considered, the probability P that a catalogue containing L samples of which m are deviant is:

$$2. \quad P = \binom{L}{m}\left(\frac{j}{J}\right)^{m}\left(1-\frac{j}{J}\right)^{L-m}$$

assuming the underlying distribution of deviant samples among catalogues is random. These probabilities are calculated for each catalogue, and the plausibility of the observed probabilities is evaluated using a chi-square test. An estimate of chi-square is calculated as:

$$3. \quad \chi^2 = \sum_{i=1}^{h} \frac{((j/J)L_i - m_i)^2}{(j/J)L_i}$$

where h is the number of catalogues considered. If this estimate is higher than the critical value of chi-square at $\alpha = 0.05$ and h-2 degrees of freedom, then all the deviant samples associated in the least probable catalogue are flagged as systematically deviant. A new estimate of chi-square is calculated for the remaining catalogues, where both j and J are reduced by the m and L, respectively, of the excluded catalogue. The new estimate of chi-square is compared with the critical value, and the process is reiterated until the chi-square estimate is less than the critical value. The catalogues that contain samples flagged as systematically deviant are listed as type I suspect catalogues.

B. Evaluation of Hydrocarbons in Control Site Samples

A second list is obtained by reviewing the results of the hydrocarbon analysis for the control site samples. These samples were collected from locations picked a priori by the PI for each project, and are not expected to contain hydrocarbons characteristic of crude oil, on the basis of independent evidence (such as other chemical analyses, absence of hydrocarbon degrading bacteria, etc.). The PIs will be polled to identify the sample numbers of

such control site samples, and then the number of these catalogue will be determined. Catalogues containing at least 5% of these control site samples will be identified, and the control site samples in these catalogues will be examined for evidence of extraneous hydrocarbon contamination. Extraneous hydrocarbon contamination will be considered present if more than 5 hydrocarbon analytes in the following hydrocarbon classes are present at greater than 5 times their respective method detection limits (MDL): fluorenes, dibenzothiophenes, phenanthrenes, chrysenes, and phytane. Catalogues containing at least 5% control site samples, of which one or more control site samples contain extraneous hydrocarbon contamination, are listed as type II suspect catalogues.

C. Final Data Evaluation

The final acceptability of samples in these catalogues will depend on which of six categories the catalogues belong. First, consider catalogues that contain more than 5% control site samples; there are four possibilities. If a catalogue is neither type I nor type II suspect, then all of the samples in that catalogue will be accepted. Alternatively, if a catalogue is both type I and type II suspect, then none of the samples in that catalogue will be accepted. If a catalogue is type I but not type II suspect, then all the identified deviant samples, together with all other samples in the catalogue that do not have replicates, will not be accepted. If a catalogue is type II but not type I suspect, then none of the samples in that catalogue will be accepted.

Second, consider catalogues that contain less than 5% control site samples; there are two possibilities - they may or may not be type I suspect. At a minimum, all the identified dissimilar samples, together with all other samples in the catalogue that do not have replicates, will not be accepted in these type I suspect catalogues.

Samples that are accepted after evaluation using the processes described above will be used for the further statistical tests below.

Hydrocarbon Data Interpretation

There are three main phases to be completed in order to satisfy the objectives of this project after all spurious data have been removed. Each of these phases must be completed for both the sediment and mussel tissue hydrocarbon data. Initially, the hydrocarbon analyses will be resolved into a simple index that describes the amount of oil observed at each site. The second phase provides each PI with a summary of their samples and associated amounts of oil. In addition, patterns in the data will be highlighted and statistically interpreted. Finally, the indices

will be used in conjunction with a GEO/SQL database to explore the data across projects, and perform the indicated analyses.

A. Development of Hydrocarbon Index

An index reflecting the amount of oil in a sample will be developed for accepted samples. This index will be the first component score from a principal component analysis (PCA) for the whole data set. Previous work with a small subset of this data has shown the first component score to be highly correlated with hydrocarbons characteristic of crude oil. PCA is an ordination technique where final component scores are derived from the data matrix alone, and no extrinsic values are required. PCA resolves the data set into a space described by **k** axes (components) so that each axis accounts for progressively smaller amounts of variance. Ideally, the first few components account for the majority of the variance; and the system can be discussed in terms of the reduced space (For a complete description see Gauch 1982). Scores will be obtained by submitting the data set to a PCA routine in the Statistical Analysis System (SAS) computer system. After the PCA is completed each PI will receive a report listing the samples retained in the data set, the concentration of each of the hydrocarbons, and the component 1 score.

B. Pattern Recognition and Interpretation

After PCA scores are obtained the scores will be mapped using a GEO/SQL mapping system. Map symbols will be developed that reflect various hydrocarbon quantities and the overall component 1 score. Additional symbols will be developed for each project. The symbols will be mapped onto their geographic locations permitting identification of patterns in oil distribution and response variables. PIs will be provided with summaries of each analysis, test results, associated maps and rationale.

C. Identification of Patterns Across Projects

Once the PIs have been provided with summaries of hydrocarbon analysis for their projects we will begin to explore patterns in oil distribution and response across all projects. Response and oiling symbols will be mapped using a GEO/SQL computer system. While each project provides insight into the effects of the Exxon Valdez oil spill, the most complete picture will emerge by combining the results of all contributing projects.

DELIVERABLES

A. Data - Lists of evaluated samples and associated hydrocarbon indexes will be provided to the PIs who collected the samples.

B. Maps - Maps of hydrocarbon indexes and summary contamination levels will be produced for each project that collected samples, and for all projects together, for 1989 and 1990 samples.

C. Reports - A final report will be prepared describing in detail the final procedures and criteria used, the results, and conclusions supported by the results.

SCHEDULES AND PLANNING

Data and Report Submission Schedule

MILESTONE	EXPECTED COMPLETION DATE
Identification of suspect catalogues	Mar. 16 1992
Development of hydrocarbon index	Mar. 31 1992
Pattern recognition and interpretation	Aug. 30 1992
Pattern recognition across projects	Dec. 1 1993
Final Report	Feb. 28 1993

Sample and Data Archival

Data will be archived in the Technical Services #1 database, where additional fields will be added to identify samples associated with suspect catalogues, types of suspect catalogues, and final petroleum hydrocarbon indexes arising from the principal component analysis. Maps will be archived with Technical Services #3.

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	BUDGET ($K)
Salaries	$ 118.6
Travel	1.8
Contracts	40.0
Supplies	9.6
Equipment	15.0
Subtotal	$ 185.0
General Administration	20.6
Total	$ 205.6

TECHNICAL SERVICES STUDY NUMBER 1

Study Title: Hydrocarbon Analytical Support Services and Analysis of Distribution and Weathering of Spilled Oil

Lead Agency: NOAA, USFWS

INTRODUCTION

To document the exposure of natural resources to oil spilled by the T/V Exxon Valdez, NRDA projects collected samples of these resources to be analyzed for petroleum hydrocarbons. The data from the analysis of these samples define the exposure of that resource to spilled oil, indicate the possible effects of the oil on the resource, and provide information on the subsurface transportation and residence time of the oil. These uses require that the analytical data be accurate, precise and comparable across projects and throughout the time of the NRDA process.

Technical Services #1, a cooperative project between NOAA and FWS coordinates the chemical analysis of all samples collected by the NRDA studies to develop a single set of analytical data from the Exxon Valdez NRDA effort. This dataset is made up of data and information from all the NRDA projects, supports all the NRDA projects and allows the synthesis of the individual project data and information to form general interpretations and system-wide conclusions.

The NOAA manages those samples from federal or state studies involving water, sediment, fish, shellfish and marine mammals - with the exception of sea otters. The NOAA-managed samples represent 90% of the samples in the sample inventory. The FWS manages those samples from studies involving birds, sea otters and terrestrial mammals. The majority of these samples are being analyzed through a FWS contract with Texas A&M University, the remainder by NOAA/NMFS laboratories. The NOAA bears main responsibility for implementing the Quality Assurance programs and updating and maintaining the sample inventory and analytical databases.

OBJECTIVES

1. Develop a single, integrated, coordinated set of analytical data from the Exxon Valdez NRDA effort. This dataset will consist of analytical data and information from all the NRDA projects, support all the NRDA projects and allow the synthesis of the individual project data to form general interpretations and system-wide conclusions.

2 Develop and manage a Quality Assurance program to assure and demonstrate the accuracy, precision and comparability of all chemical analytical data developed by the NRDA.

METHODS

This project will coordinate the analysis of samples for petroleum hydrocarbons and the metabolites of petroleum hydrocarbons. In cooperation with the Project Leader, samples for analysis will be selected based on the quality and relevance of the sample. Samples will be selected for analysis in an iterative manner to provide the strongest description of injury for the minimum of cost. The project will arrange for analysis and track the samples through this process; provide analytical data to the Project Leader in a timely and useful fashion; and, if requested, assist in the interpretation of these data.

The project will:

- Develop and implement Quality Assurance programs for the measurement of petroleum hydrocarbons and their metabolites.
- Select analytical laboratories based on their performance.
- Review and maintain analytical SOPs.
- Develop and provide quality control materials for the metabolite assay.
- Monitor the data from the analysis of all quality control materials, i.e. field and analytical blanks and calibration, reference and control materials, to ensure compliance with data acceptance criteria.
- Plan and conduct intercomparison exercises to demonstrate the accuracy and comparability of the analytical data.
- Conduct audits of sample and data handling processes.
- Develop and implement electronic systems for a) sample inventory and tracking and b) the archival, manipulation and retrieval of the analytical data.
- Define samples in terms of the material collected or subsampled and document it to an exact field collection location and time.
- Assign a unique identification code to every sample and subsample to assist in sample and data archival and tracking.
- Archive all analytical data, bulk parameters and supporting QC data as hard copy, electronic copy and supporting documentation, e.g. chromatograms.
- Examine all data for reasonableness.
- Develop a preliminary interpretation of the data and return the results to the Project Leaders.

BUDGET ($K)

	NOAA	USFWS	Totals
Salaries	$ 100.5	$ 42.2	$ 142.7
Travel	1.5	1.5	3.0
Contracts	707.5	118.1	825.6
Supplies	0.5	0.2	0.7
Equipment	0.0	0.0	0.0
Subtotal	$ 810.0	$ 162.0	$ 972.0
General Administration	41.7	14.6	56.3
Total	$ 851.7	$ 176.6	$1028.3

TECHNICAL SERVICES STUDY NUMBER 3

Study Title: Geographic Information System (GIS) Technical Support

Lead Agency: USFWS, DNR

PROJECT DESCRIPTION

During 1989 and 1990 this study focused on the acquisition, development and distribution of the centralized NRDA database. This information was incorporated into two basic categories: primary which includes shoreline oiling, shoreline treatment, coastal morphology, bathymetry, hydrography, wildlife habitat, land status, and land cover; and thematic which includes hydrocarbon information, and wildlife distribution and abundance data. In 1991, the study focus shifted toward analytical services through the integration of primary and thematic layers. Examples of products for NRDA data synthesis include distribution of results in a comprehensive manner, relating various themes simultaneously, calculating proximity of one or more themes, and predictive and interpretive modeling of unsampled areas.

This project will support NRDA studies that have outstanding GIS components to their data analysis. This information will provide necessary data analysis for the preparation of final reports. The preparation of final reports will be essential for understanding the spill injuries. If this information is not clearly and completely available to those responsible for restoration, it will not be possible to adequately address the restoration needs of the resource.

BUDGET

The budget for each agency and the total budget will be developed following Trustee Council approval of projects to be included in the 1992 Work Plan. A placeholder of $375.2K has been identified for this project.

2. RESTORATION

2A. RESTORATION INTRODUCTION

The ultimate aim is to see the Exxon Valdez oil spill area restored to its pre-spill condition. Although natural recovery is effective for some resources, for others restoration will significantly augment the rate of recovery. If the rate of natural recovery is determined to be insufficient, certain actions can be taken to assist recovery. These actions may vary from management actions that affect use of the natural resources in the region, to actively effecting changes through enhancement or manipulation measures, to acquiring and protecting habitat. The following subsections describe restoration projects that have been approved by the Trustee Council for public review.

2B. RESTORATION TECHNICAL SUPPORT

The computer technology offered by the Geographic Information System (GIS) group provides graphical and analytical support to the field of natural resource management. GIS provides four levels of information management services that include: input; data management (storage and retrieval); manipulation and analysis; and output (maps and tables). It provides an information synthesis and analysis tool for restoration activities. Use of GIS for traditional map making will continue to be important to the process, along with data analysis capabilities in a geographic context.

RESTORATION PROJECT NUMBER 92

Study Title: Geographic Information System Technical Support

Lead Agencies: USFWS, ADNR

Cooperating Agency: USFS

INTRODUCTION

The Geographic Information System (GIS) technical group was created following the Exxon Valdez oil spill to acquire, develop, and distribute a centralized Natural Resource Damage Assessment (NRDA) database. The information was divided into two basic categories: primary and thematic. Primary data layers include general inventory information such as shoreline oiling, surface oiling, shoreline treatment, coastal morphology, bathymetry, hydrography, wildlife habitat, land status, land cover, and land use. Thematic layers are specific to individual NRDA studies and include hydrocarbon information, wildlife distribution and abundance data, and survey transect designs. The GIS workload was distributed between the Alaska Department of Natural Resources (ADNR) and the U.S. Fish and Wildlife Service (USFWS) to better utilize computer resources and staff expertise. The USFWS focused mainly on development of thematic data layers for wildlife resources and provision of analytical services to NRDA studies.

The GIS will provide a reservoir of geographic data and assure the consistency and quality of these data. It also will provide managers, investigators, and peer reviewers with tools for spatial analysis as a means to better understand complex data. The overlay analysis and data integration capabilities of GIS provide an opportunity to create summaries useful for further statistical analysis by investigators.

The USFWS will use GIS primarily as a synthesis and analysis tool for restoration activities. Examples of specific applications include: (a) relating marbled murrelet nest and activity data with land cover and timber information to help describe habitat requirements; and (b) using results from synthesis efforts to identify land protection measures needed to enhance recovery.

OBJECTIVES

The GIS technical support group will develop information as needed by project leaders to evaluate or implement specific restoration objectives identified in their detailed study plans.

Objectives are:

1. to provide a reservoir of geographic data in support of the restoration process;

2. to assure the consistency and quality of these data;

3. to provide managers, investigators, and peer reviewers with the tools for spatial analysis as a means to better understand complex data; and

4. to produce and disseminate maps and analytical products for participants in the restoration process.

METHODS

ARC/INFO, GIS software will be used to automate, manipulate, analyze, and display NRDA and restoration geographic data in digital form. The ARC/INFO data model (ESRI 1989) organizes geographic data using a relational and topological model to efficiently handle locational features (points, lines or areas) and the attribute data that describe the characteristics of those features. Examples of features include: points - Technical Services #1 (TS-1) hydrocarbon sample database; lines - Environmental Sensitivity Index (ESI) shoretype data; areas - bathymetric depth zones from NOAA source data. These data and all NRDA and restoration data layers are described in the NRDA study plan and report (GIS Technical Group 1989, 1991).

The following list of GIS data layers are available for the restoration process:

Oil on the Water
* ADEC - June 20, 1989 cumulative oiling map
* NOAA - Hazmat trajectory model output data; Oiling is depicted in point, line and polygon (areas) formats

Shoreline Surface Oiling
* ADEC - Summer 1989 shoreline assessment data (cumulative oiling)
* ADEC - Fall 1989 shoreline assessment data
* Multi-agency spring 1990 survey (SSAT)
* Multi-agency spring 1991 survey (MAYSAP)

Shoreline Type
* ESI coastal morphology

Land Ownership
* Comprehensive for spill zone at survey section level of resolution

Hydrography, Anadromous Streams

* Comprehensive for Prince William Sound and Cook Inlet/Kenai, only hydrography for Kodiak/Alaska Peninsula

Bathymetry

* Depth zones, comprehensive for Prince William Sound, Cook Inlet/Kenai and Kodiak/Alaska Peninsula

Topography

* USGS 1:250,000 scale digital elevation model for Cordova, Seward, Seldovia and Kenai quadrangles

USFWS Surveys and Studies

* Designs and results from NRDA boat and aerial surveys for birds and sea otters
* Bald eagle nest database
* Seabird colony locations
* Sea otter radiotelemetry study data
* Marbled murrelet study data for Naked Island, Prince William Sound
* Black oystercatcher nest locations in Prince William Sound study

Hydrocarbon Database (TS-1)

* Point data for samples at various stages of completion

The functional areas of GIS data manipulation are: 1) input; 2) analysis; 3) data management; and, 4) display and conversion. All restoration projects to be supported will require effort in one or more functional areas. Based on review of draft restoration study plans, most projects will require some level of data input to include digitizing, editing, or reformatting data into a usable form. Input may be required for data collected by other cooperating agencies. For example, some data from U.S. Forest Service (USFS) such as timber type maps may need to be digitized for certain study areas.

Information Required from Other Investigators

* Landcover, forest or timber data (USFS)
* Landcover, forest or timber data (ADNR)

DATA ANALYSIS

It is assumed that all data acquired from cooperators or other investigators in a digital form have been checked and edited for transcription and automation errors. It is also assumed that all source and integrated data will be at a comparable input scale.

This project will utilize the analytical capabilities of GIS, taking advantage of the ability to synthesize a variety of data

layers and output results for more rigorous statistical analyses by the various PIs. Overlay analysis will be performed with the ARC/INFO data model (ESRI 1989). The overlay process will allow us to combine physical and biological data layers, and output results that depict spatial relationships among the data.

For example, analyzing patterns of marbled murrelet activity in relationship to the physical environment, such data as landcover or timber type from USFS will help locate, describe and quantify important components of their habitat. Analysis of marine bird boat survey data with overlays of bathymetry and ESI shoreline information will provide descriptions of important use areas.

DELIVERABLES

GIS products will include new data layers for the restoration database, results from spatial analysis of newly integrated data, and appropriate displays of data for reports, briefings or distribution.

All requests for deliverables will be channeled through the GIS project approval process for Technical Service Number 3 (TS-3), adopted by the Restoration Team (RT).

SCHEDULES & PLANNING

Data and Report Submission Schedule

Following the guidelines of the operating procedures for TS-3, adopted by the RT, all GIS services will be channeled through a screening committee for approval. After the first quarterly screening committee meeting, a GIS activity timeline will be developed for those projects receiving committee approval. The GIS project schedule will be amended, if necessary, following screening committee recommendations.

Data Archival

Data will be stored and managed by GIS project staff. System security measures will be implemented and backup copies of digital data will be maintained. All appropriate restoration data will be exchanged with ADNR GIS group to provide additional data backup.

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BUDGET ($K)

The current budget estimate is $125,500. The actual breakout of costs between ADNR and USFWS will be determined during a GIS synthesis meeting in the spring of 1992.

2C. RESTORATION RECOVERY MONITORING

Estimates of the rate and adequacy of natural recovery are fundamental to selecting restoration measures. In some cases, it may be appropriate to allow natural recovery to proceed without human intervention. Determining when, and if, natural recovery restores injured resources or services to their pre-spill baseline conditions is essential to understanding how the oil-affected environment is responding to the healing effects of time. This will be an important concept in considering the effectiveness of no-action/natural recovery as a restoration alternative.

To maximize the benefits of restoration expenditures, it will be necessary to consider whether natural recovery has occurred or is occurring before investing restoration funds. As restoration options are implemented, recovery monitoring will also be important to evaluate the effectiveness of restoration and to identify where additional restoration actions may be necessary. In a scientific sense, full ecological recovery will have been achieved when the full contingent of pre-spill flora and fauna are again present and productive, and affected environments have achieved normal age distributions indicating a healthy system.

The duration of recovery monitoring will depend upon the time necessary to establish recovery or a trend for recovery. This, in turn, will depend upon the severity of the acute effects of the spill and implications of the chronic effects of the spill at the population level.

RESTORATION PROJECT NUMBER 11

Study Title: Murre Restoration Project

Lead Agency: USFWS

INTRODUCTION

The 1989 oil spill in Prince William Sound prompted surveys of seabird colonies in Prince William Sound and other areas westward along the spill trajectory. Most of these colonies have had censuses at least two and up to six different years out of the 18 years prior to the oil spill. Murres and kittiwakes on one nearby colony site, Middleton Island, have been censused 14 of the last 18 years. Cliff-nesting species such as the black-legged kittiwake and common murre were the primary emphasis of the 1989-90 censuses. Timing of egg laying and productivity (numbers of fledging chicks) were also noted for these species. In 1990, and continuing in 1991, the major effort was placed on replicate counts of murres in those areas that showed the most drastic changes relative to historical data. Semidi Islands and Middleton Island monitoring continued as the main control sites for murres (Nysewander, 1990; Nysewander and Dippel, 1990; Nysewander and Dippel 1991 - NRDA studies).

Approximately 320 seabird colonies, not including the Semidi Islands, occur within the area affected by the oil spill. These colonies contain about 1 million breeding seabirds of which about 300,000 are breeding murres (U.S. Fish and Wildlife, Catalog of Alaskan Seabird Colonies--Computer Archives 1986). Diving seabirds like murres are known to be easily impacted by oil spills (King and Sanger, 1979). In addition, these species are long-lived with low reproductive rates, thus making any mortality of adults a critical factor in these species' ability to recover. Direct mortality immediately following the spill was estimated at about 300,000 murres, including wintering and non-breeding birds.

This project will monitor the recovery of breeding common and thick-billed murres in the Barren Islands and Puale Bay colonies on the Alaska Peninsula. The reductions in numbers of breeding adults at these colonies, the delayed reproductive chronology, the lack of synchrony of egg laying, and the low or zero reproductive success seen the last three years at these colonies in the oil spill area are the major injuries that will be monitored by this study. The murre population in the oil spill area began to show some slight signs of recovery in 1991. However, the population may have essentially produced no young for three years, which could greatly extend the time needed for full recovery. The next several years of monitoring data for murres will give us important insight on how a murre colony recovers from such injury and how recovery might be

facilitated if desirable. The extent and persistence of injury will determine the level of restoration necessary.

OBJECTIVES

1. Document rate of recovery of murres breeding in the Barren Islands and at Puale Bay by determining the number of breeding adults and their reproductive success and chronology.

2. Use time lapse video camera equipment to improve methods of censusing murre colonies for reproductive data where boat-based censusing has historically been the only option.

METHODS

A and B. Sampling Methods and SOP Requirements

Two methodologies will be utilized: replicate population counts and chronology/productivity plots.

1. Population counts will be a combination of total island or subcolony counts and plot counts. These counts will be accomplished by a combination of land-based and boat-based counts, depending on the historical and feasible options for each site. In all cases, the population counts will be replicated over 5-7 separate days when conditions are optimal during the period in the reproductive cycle when most birds are incubating eggs. Large format photo documentation will also be used on the plots and colonies. Photos taken simultaneously while a count is being done have the potential for establishing correction factors of photo interpretation. Standard methodologies for counts will be followed (Byrd 1989; Hatch and Hatch 1988 and 1989; Irons et al. 1987; Nishimoto and Rice 1987). The specific procedures of boat-based counting are the following:

a) Anchor the boat or hold it in one position by motoring.

b) Use the largest boat available or feasible, ideally boats no smaller than 25 feet. Conduct boat censuses when seas are less than three feet and there is little or no rain.

c) Murres are counted individually in small colonies or cliff sections and in blocks of ten for larger concentrations.

d) Three to five people count a plot or section of a plot at least two times each without revealing their counts to each other.

e) The counts are then compared to see if they fall within 5-10% of each other, thus catching any obvious lapses or double counts (quality control).

f) More counts are made if there is much difference in the counts.

g) The mean of the majority of counts (at least four to five) that clump together are used for the count in reporting for that particular plot.

h) This process is repeated on five or more days during the incubation phase of murre reproduction.

In the past (NRDA bird study number 3), population counts have been done at the major murre colonies near Puale Bay, Cape Aklek and Cape Unalishagvak, using the M/V Surfbird as the counting platform. Funding for these counts is no longer available, since these counts are not possible without the use of a larger support vessel. For the Barren Islands, several one-week trips will be planned to cover the extended breeding season.

2. Chronology and productivity will be studied using land-based plots. At the Barren Islands, traditional land-based monitoring of productivity has not been possible due to geographic and logistical concerns. However, past efforts will be expanded by putting some blinds on sites like E. Amatuli Light. The use of time lapse video cameras will also be expanded. For Puale Bay, nesting phenology and reproductive performance on land-based plots will be determined by viewing nests at regular intervals of approximately three days. Nest sites will be numbered on plot photographs and drawings and then checked throughout the field season. Attendance of adults, nest starts, and the presence or absence of eggs or chicks will be recorded for kittiwakes and fulmars, while the presence of an egg or chick is the prime observation on murres. For murres, it is frequently not possible to see the contents of a nest site because the birds remain motionless for long periods of time. Distinctive behavior (e.g. wings held over the back so that tips do not cross, tail down, back slightly humped) is used to indicate that a murre is incubating an egg. However, because it is possible to misinterpret such posture, a bird must be observed in "incubating posture" on at least three consecutive checks to consider the site as having an egg. Observations of wing positioning will be used to indicate that a murre has a chick. However, only one sighting of wing mantling is necessary to consider a murre to have a chick or to be in a "brooding posture". The conventions of murre monitoring (Mendenhall 1991) as used by the Alaska Maritime National Wildlife Refuge are and will be used to resolve any questions of interpretation.

C. Quality Assurance and Control Plans

To ensure that standard censusing procedures are followed, all personnel will participate in trial surveys prior to initial censusing. This training, along with previously mentioned methods, will ensure the integrity of the data collected.

D. Information Required from Other Investigators.

Information required from other investigators should be minimal. Improved oil drift maps with shorter time intervals will be helpful in answering some questions (provided by the GIS technical support group).

E. Safety Requirements

All personnel are required to participate in the Alaska Maritime National Wildlife Refuge safety program before going into the field. Included in this training are small boat operation, immersion suit use, cold water survival, shore survival, bear encounter training, and CPR and first aid training. The safety plan is on file at the Refuge headquarters.

F. Animal Health and Welfare

Animal health and welfare is not a concern with this study since trapping or capturing of murres is not planned.

DATA ANALYSIS

The standard procedures and assumptions used by the U. S. Fish and Wildlife Service for censusing colonies in the Alaska Maritime National Wildlife Refuge are described by Garton 1988 and Byrd 1989. Key assumptions include: 1)Plots, by necessity, are not random and selection is based on accessibility; hence this study assumes that plot counts are representative of the entire colony. 2)Plot counts and counts of entire colonies are considered indices; and this study assumes that changes in these indices represent the changes occurring in the colony. 3)Plot counts are unlikely to be normally distributed and are more likely to be skewed and clumped. This type of data requires either very large sample sizes, the use of a non-parametric test, or logarithmic transformation prior to testing by the appropriate parametric test. Logarithmic transformation normalizes the data and is required for valid application of statistical tests when sample sizes are small (Fowler and Cohen 1986; D. Robson pers. comm.). Under standard USFWS procedures trends among years are compared using replicate counts where all plots are censuses each count day and these counts are replicated on successive days. Within-year replication is useful to test for annual variation, but annual variation is anticipated even without the influence of a factor such as an oil spill. The important

question is therefore whether the post-oil colony numbers are outside the annual variation in colony numbers that would be expected from past historical data without oiling effects.

DELIVERABLES

A final report will be generated in January, 1993.

SCHEDULES & PLANNING

A. Data and Report Submission Schedule

Puale Bay field camp deployment: 15 June 1992
Begin Barren Island colony census: 6 July 1992
Complete Barren Island colony census: 3 September 1992
Puale Bay field camp closed: 30 September 1992
Complete final report: 25 January 1993

B. Data Archival

Data from this study will be archived in the U.S. Fish and Wildlife Service Seabird Colony Catalog. All data forms and log books will be kept at the Alaska Maritime National Wildlife Refuge office in Homer, Alaska. Copies of these data will be sent to the FWS oil spill files in the Anchorage Regional Office.

C. Management Plan

This study will be managed by a principal investigator, who will be responsible for either coordinating the collection of, or generating field data, and for the timely reporting of the data in draft and final reports. The interim principal investigator will be Dave Nysewander.

D. Logistics

To complete the proposed study will require the use of the M/V Sandlance (25ft Boston Whaler) and support from a larger vessel able to accommodate up to six field personnel. A field camp is required at Puale Bay. See appendix for map of areas covered by this study.

PERSONNEL QUALIFICATIONS

Principal Investigator - David Nysewander: Dave Nysewander received his B.S. from the University of Michigan and Principia College in 1965 and his M.S. in wildlife biology from the University of Washington in 1977. From 1973 to 1975 he worked in Washington State on colony censuses and reproductive biology of marine and

shorebirds. He joined the U.S. Fish and Wildlife Service in Alaska in 1975. Between 1975 and 1989 he has held several positions with the Service: 1) from 1975 to 1980 he served as biologist and camp leader on pelagic and colony studies, specializing on Gulf of Alaska sites associated with the Offshore Continental Shelf Evaluation and Assessment Project in the Service's Office of Biological Services/Coastal Ecosystems; 2) from 1980 to 1986 he served with the Marine Bird Management Project in Alaska as wildlife biologist and later as acting project leader, specializing in distribution, colony census, and productivity of marine birds and mammals in Prince William Sound, southeastern Alaska, Kodiak Island, Cook Inlet, and eastern Aleutian Islands; 3) from 1986 to the present he served with the Alaska Maritime National Wildlife Refuge primarily as a supervisory wildlife biologist, whose work has dealt with colony censuses and monitoring, reproductive biology, and distribution of marine birds along with management concerns like eradication of introduced predators and reintroduction of endangered species; 4) from 1989 to present he has been the principal investigator for the Exxon Valdez oil spill natural resource damage assessment - bird study #3 which, in essence, this study will continue. In 1991 he served as a peer reviewer for the Apex Houston oil spill which occurred along the California coast.

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	BUDGET ($K)
Salaries	$ 121.2
Travel	5.8
Contractual	93.5
Commodities	29.0
Equipment	42.5
Other Non-Contractual	0.0
Subtotal	$ 292.0
General Administration	24.7
Total	$ 316.7

RESTORATION PROJECT NUMBER 60C

Study Title: Injury To Salmon Eggs and Pre-emergent Fry In Prince William Sound

Lead Agency: ADF&G

INTRODUCTION

Pink salmon (Oncorhynchus gorbuscha) is a key species in the Prince William Sound marine ecosystem both as juveniles and adults. Huge spring seaward migrations of pink salmon fry function both as dominant predators on zooplankton populations and as important prey items for other fishes and birds. Millions of adult salmon returning from the high seas to spawn and die provide a unique and vital mechanism for transport of nutrients and energy from feeding areas in the North Pacific to nearshore waters and upstream areas of Prince William Sound.

Wild pink salmon production in Prince William Sound has ranged from 10 to 15 million fish in recent years. As much as 75% of the total pink salmon run spawns in intertidal areas. The proportion of intertidal spawning is greatest in streams on the southwestern portion of Prince William Sound. Oil from the March 24, 1989, Exxon Valdez oil spill was deposited in layers of varying thickness in the intertidal portions of streams utilized by spawning salmon. Salmon eggs deposited in oiled intertidal spawning areas in western Prince William Sound in 1989 and subsequent years have been adversely affected by this contamination. Injuries from spawning ground contamination include increased egg mortality as well as a high incidence of physical and genetic abnormalities in alevins and fry. Emergent salmon fry and smolt from throughout Prince William Sound migrated through and developed in areas contaminated by oil. These fry had diminished growth and lowered survival. This suite of injuries has led to an apparent decline in the size and overall well-being of wild pink salmon which may persist for several years.

The Alaska Department of Fish and Game (ADF&G) has sampled pink and chum salmon pre-emergent fry since the 1960's in order to predict the magnitude of future salmon returns. The oil spill had the potential to cause mortality to the critical egg and fry life stages, and thus an increased and more comprehensive fry sampling program was necessary. An expanded NRDA study of eggs and fry along with NRDA F/S Studies 1, 3, and 4 supported a comprehensive and integrated determination of injury to Prince William Sound salmon stocks. Results included documentation of oil in intertidal salmon spawning habitat, pre-spill and post-spill estimates of total adult returns of wild and hatchery stocks, wild stock spawning success, wild stock egg to fry survival, and early marine survival of wild and hatchery stocks. Information on the extent

and persistence of oil in the intertidal zone has been supplemented by Coastal Habitat Study 1A.

The goal of continuing the egg and pre-emergent fry damage assessment project as a restoration project is to monitor recovery of Prince William Sound wild pink salmon stocks injured by the Exxon Valdez oil spill. Injury to pink salmon eggs, alevins and juveniles from the oil spill may be persistent since oil remaining in streams may continue to cause reduced survival, and genetic damage from oil contamination may persist for several generations. Efforts to restore injured pink salmon populations depend upon the ability to identify sources of reduced survival and to monitor their disappearance or persistence.

OBJECTIVES

1. Estimate the density, by tide zone, of pre-emergent fry in 48 streams and eggs in 31 streams using numbers of live and dead eggs and fry.

2. Estimate egg mortality and overwinter survival of pink and chum salmon eggs in both oiled and unoiled (control) streams.

3. Document hydrocarbon contamination in pre-emergent fry using tissue hydrocarbon analysis and for eggs and pre-emergent fry using mixed-function oxidase (MFO) analysis.

4. Investigate probable causes of continued high mortality of eggs in oiled streams in 1991. Investigations may include but will not be limited to cytogenetic studies designed to document genetic damage to germ cells in populations exposed to oil as eggs or fry in 1989 and 1990. Pending a peer review meeting with other project scientists, detailed methods cannot be described for achieving this objective.

5. Assess any loss in adult production from changes in overwinter survival using the results of NRDA F/S Studies 1, 2, 3, and 4.

METHODS

There are approximately 900 anadromous fish streams in Prince William Sound. Pre-emergent fry sampling from some of these streams has historically provided a pink salmon abundance index which was used to forecast future returns. In recent years, 25 index systems considered representative of pink and chum salmon producing streams have been sampled. Sampling had been performed on as many as 45 streams prior to 1985. This study is designed to compare rates of mortality and abundance among areas with various levels of oil impacts.

Sampling will consist of egg deposition surveys performed from late September to mid-October and pre-emergent fry sampling conducted from mid-March to mid-April. Spring fry sampling in 1992 will be conducted on 48 streams. These will include the 25 streams in the ongoing ADF&G pre-emergent index program plus 23 additional streams. The additional streams are located in Central and Southwest Prince William Sound where most of the oiling occurred. New study streams were selected using the following criteria:

1. Adult salmon returns were expected to be large enough to indicate a high probability of success in egg and fry sampling.

2. Egg and fry sampling had been done in past years.

3. Streams with low to no oil impact, i.e., controls, were selected in the immediate vicinity of high oil impact streams to help account for possible variability in egg and fry survival due to different environmental conditions.

Most of the streams with suspected or obvious oil impact were not sampled prior to the Exxon Valdez oil spill. The 30 streams in low impact areas include 27 with a history of sampling; six suspected of having received some impact including four with a history of sampling; and 12 streams with oil visibly present in the intertidal zone, including five with a history of sampling.

Egg sampling will be conducted in the fall on 31 of the 48 streams sampled for pre-emergent fry. Streams included in the fry sampling program but not in the egg program are traditional fry sampling streams located on the eastern and northern shore of Prince William Sound. These streams are outside the area studied for oil impact effects. The 13 streams in low impact areas left in the egg sampling program include four with a history of sampling. Streams suspected of having some oil impact and streams which had visibly obvious impact are included in both the egg and fry sampling programs.

Sampling methods are identical for the pre-emergent fry and egg sampling and are modeled after procedures described by Pirtle and McCurdy (1977). On each study stream, four zones, three intertidal and one above most tidal influence, will be identified and marked during pre-emergent fry sampling. The zones are 1.8-2.4 m, 2.4-3.0 m, 3.0-3.7 m above mean low water, and upstream of mean high tide (3.7 m). Separate linear transects 30.5 m in length will be established for egg and pre-emergent fry samples in each zone (one transect for each type of dig in each zone). The transects will run diagonally across the river with the downstream end located against one bank and the upstream end against the opposite bank. Overlapping of transects will be minimized to control the influence of fall egg sampling on perceived abundance of fry during spring sampling. Fourteen 0.3 m^2, circular digs (56 per stream) will be systematically made along each transect using a high pressure hose

to flush eggs and fry from the gravel. Eggs and fry will be caught in a specially designed net.

The following data will be collected for each tide zone transect during both egg and fry sampling:

1. The sample date.
2. The sample tide zone.
3. The start and stop time for each tide zone transect.
4. Numbers and condition (live or dead) of fry and eggs by species for each dig.
5. A subjective estimate of the overall percent yolk sac absorption for fry in each dig sample.

Data will be entered from "Rite in the Rain" books into a Lotus spreadsheet for editing and summarization.

Pink salmon eggs will be separated from chum and coho (*O. kisutch*) salmon eggs by their smaller size. Chum salmon eggs will be separated from coho salmon eggs by their greater development and different coloration. An egg will be considered dead if it is opaque or discolored with concentrations of lipids. Pink salmon fry will be differentiated from chum salmon fry by their smaller size and lack of parr marks. Sampling will often kill fry (especially newly hatched fry), so fry will only be considered dead if decomposition is evident.

Pre-emergent pink salmon fry will be collected for tissue samples from the intertidal channels of streams. Tissue samples will be analyzed for the presence of hydrocarbons characteristic of those found in oil from the T/V Exxon Valdez.

Fry sampled for hydrocarbon analysis will be collected from the intertidal stream bed at a level approximately 2.5 m above mean low water. Samples will be collected when the tide is below that level to avoid contamination from any surface oil film. A clam rake will be used to dislodge the fry from the gravel. A stainless steel strainer, pre-rinsed in dimethylchloride and dried, will be used to catch fry as they are swept downstream. Captured fry will be placed in jars with teflon lined lids and frozen. Replicate samples of fry will be collected whenever possible.

Eggs and fry from each tide zone will also be collected for mixed-function oxidase (MFO) analysis. Live eggs and fry will be separated from dead eggs and fry for all digs in a transect and then randomly selected from the total. Whenever possible, two samples of at least 50 live eggs and fry and one sample of at least 50 dead eggs and fry will be collected and placed in glass jars containing phosphate buffered formalin solution.

DATA ANALYSIS

Numbers of live and dead pre-emergent fry and eggs will be summarized by date, stream, level of hydrocarbon impact, and stream zone. Densities of live eggs for stream i, zone j in m^2 (E_{ij}) will be estimated by:

$$\hat{E}_{ij} = \frac{\Sigma LE_{ijk}}{0.3n_{ij}} \quad , \tag{6}$$

where LE_{ijk} is the number of live eggs found in the k^{th} dig, in stream i, zone j, and n_{ij} is the number of digs from stream i, zone j. Densities of dead eggs as well as dead and live fry will be calculated using the same estimator with appropriate substitutions.

Pink salmon egg mortality will be estimated for each stream using the following relationship:

$$\hat{M}_{ij} = \frac{\Sigma (DE_{eijk} + DF_{eijk})}{\Sigma (LE_{eijk} + DE_{eijk} + LF_{eijk} + DF_{eijk})} \quad , \tag{7}$$

where DE_{eijk}, DF_{eijk}, LE_{eijk}, and LF_{eijk} are the number of dead eggs, dead fry, live eggs, and live fry for the k^{th} dig from stream i, zone j, collected during egg dig e, respectively.

The Arcsin square root transformation will be examined as well as the Logit transform of egg mortality [ln (odds)].

$$Logit_{ij} = \ln \left[\frac{\Sigma (DE_{eijk} + DF_{eijk})}{\Sigma (LE_{eijk} + LF_{eijk})} \right] \tag{8}$$

Pink salmon egg to pre-emergent fry survival will be estimated as:

$$\hat{S}_{ij} = \frac{(\Sigma LF_{fijk}) \ / \ n_f}{\Sigma (LE_{eijk} + DE_{eijk} + LF_{eijk} + DF_{eijk}) \ / \ n_e} \quad , \tag{9}$$

where LF_{fijk} is the number of live fry for the k^{th} dig from stream i, zone j, collected during fry dig f, and n_e and n_f are the number of digs for stream i, zone j for egg dig e and fry dig f.

Differences in egg mortality and survival will be examined using a mixed effects two-factor experiment with repeated measures on one factor (Neter, Wasserman, and Kutner, 1985):

$$Y_{ijk} = \mu_{...} + O_i + Z_j + (OZ)_{ij} + S_{k(i)} + e_{(ijk)}. \qquad (10)$$

The two treatments will be extent of oiling, (O_i, 2 levels; oiled and unoiled), and height in the intertidal zone (Z_j, 4 levels; 2.1, 2.7, and 3.4 m above mean low water, and upstream) both fixed effects. The data will be blocked by stream ($S_{k(i)}$), a random effect nested within extent of oiling. The interaction of extent of oiling and height in the intertidal zone will also be examined. Equality of variances will be tested using the F_{max}-test (Sokal and Rohlf, 1969), while normality will be visually assessed using normal quantile-quantile and box plots (Chambers et al. 1983). If the data appear to be non-normal, data transformations will be examined. If a significant difference due to oiling is detected ($\alpha = 0.05$), four contrasts (oil vs. unoiled for the four stream zones) and corresponding Bonferroni family confidence intervals ($\alpha = 0.10$ overall) will be estimated.

Extent of oiling for analysis will be based on visual observations of streams (NRDA F/S Study 1 and 2) and the hydrocarbon results from mussel samples (NRDA F/S Study 1). Different groupings of oiled and unoiled streams will be analyzed if evidence of oiling is not consistent.

Power of the test was estimated for the analysis of variance using data from the 1976 and 1977 egg and pre-emergent fry samples in Prince William Sound. These data indicated the ability to detect an increase of 15% in egg to fry mortality (e.g. 10% mortality to 25% mortality) at $\alpha = 0.05$, 95% of the time.

DELIVERABLES

The main product from this project will be a report which summarizes the results of the current-year egg and pre-emergent fry data. The most significant information on injuries demonstrated in 1989 through 1991 will be written up as a close out report for the NRDA Study.

SCHEDULES AND PLANNING

Field Work, Data Analysis and Report Submission Schedule

Dates	Activity
March 16-April 10, 1992	Pre-emergent fry sampling on 48 streams.
May 1-September 1, 1992	Analysis and preliminary summarization of 1992 pre-emergent data.
September 15-October 15, 1992	Egg deposition sampling.
October 30-December 15, 1992	Analysis of egg data and final report for egg and fry data.

A final report will be completed by February 28, 1993.

Sample and Data Recording, Processing and Archival

Numbers of live and dead eggs and fry by stream, tide zone, transect, dig location and species are recorded in pre-printed "Rite in the Rain" books which are archived in local storage in the Cordova ADF&G office. Data from notebooks will be entered into an R:BASE data base which will be added to an existing historic egg and fry sampling data base dating back to 1960. There is a row in the data base for each $0.3m^2$ sample which is identified by stream number (ADF&G Stream Catalogue), stream name, elevation above mean low tide, a standardized transect location code, and a sequential sample site number within each transect. Each row also contains the number of live and dead eggs and fry by species in each $0.3m^2$ sample, a sample condition code which describes stream conditions affecting sampling (ie. stream dry or iced over), and a code for other species or parasites present (i.e. flat worms, copepods, etc.).

R:BASE is used for basic data summarization and additional detailed statistical analyses are done in LOTUS, SYSTAT, SPSS, and other micro-computer based statistical packages. All raw and summarized data and reports are stored as hard copy and electronically on diskettes and on magnetic tape in two separate ADF&G offices in Cordova.

Biological samples for hydrocarbon, MFO, histopathology, and genetics analyses are clearly labeled both on the inside and outside of the container. Labels are in indelible ink on write in the rain paper and include an ADF&G stream catalogue number, stream

name, stream-mouth latitude and longitude, sample transect height above mean low tide, sample date and time, sample collectors, preservative used, species, and tissue type. Standard chain of custody forms are filled out for all samples and samples are stored in locked storage in the ADF&G warehouse prior to shipment for analyses.

MANAGEMENT PLAN

Overall supervision of this project will rest with the ADF&G Fisheries Biologist III, principal investigator. The Fisheries Biologist III will supervise a Fisheries Biologist assistant and the daily activities of a data entry technician or research analyst. Field work will be reviewed periodically by the principal investigator but daily supervision will be the responsibility of the Fisheries Biologist I project assistant. The project assistant will supervise a field crew of three or at times four Fish and Wildlife Technicians. All payroll and administrative tasks for this project will be completed by ADF&G Oil Spill Impact Assessment Division and ADF&G Division of Administration personnel. The consulting Biometrician II will review all operational plans, project reports, and be responsible for all statistical products and statistical reporting.

LOGISTICS

Sampling crews will be transported between sampling locations by the ADF&G R/V Montague which will be used for the purpose. Crews will be housed and fed aboard the R/V Montague and will be transported to shore at each stream in a project skiff piloted by a vessel crew member. Sample sites for pre-emergent fry and egg deposition are shown in Figures 1 and 2.

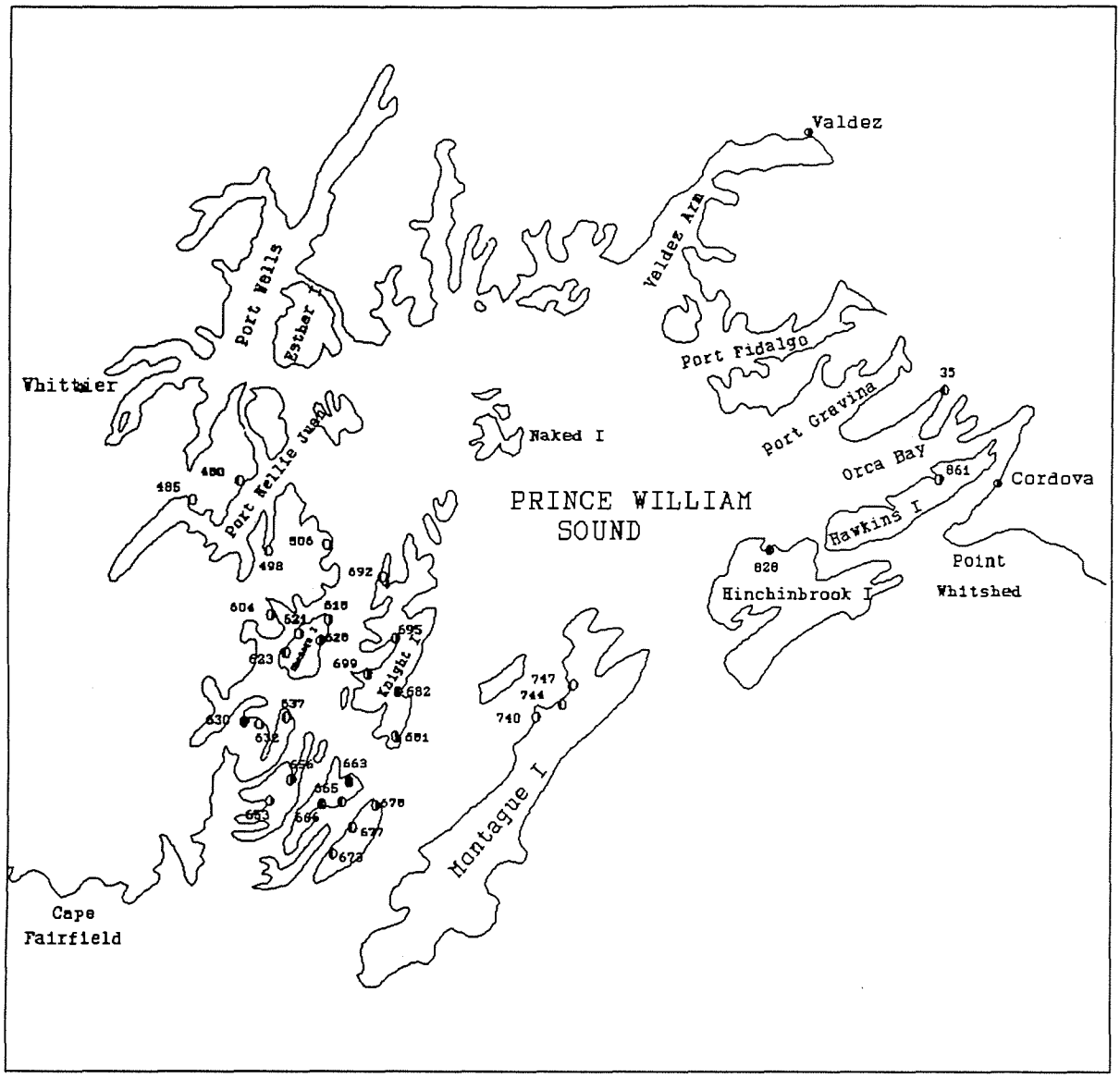

Figure 1. Location of streams to be sampled for egg deposition.

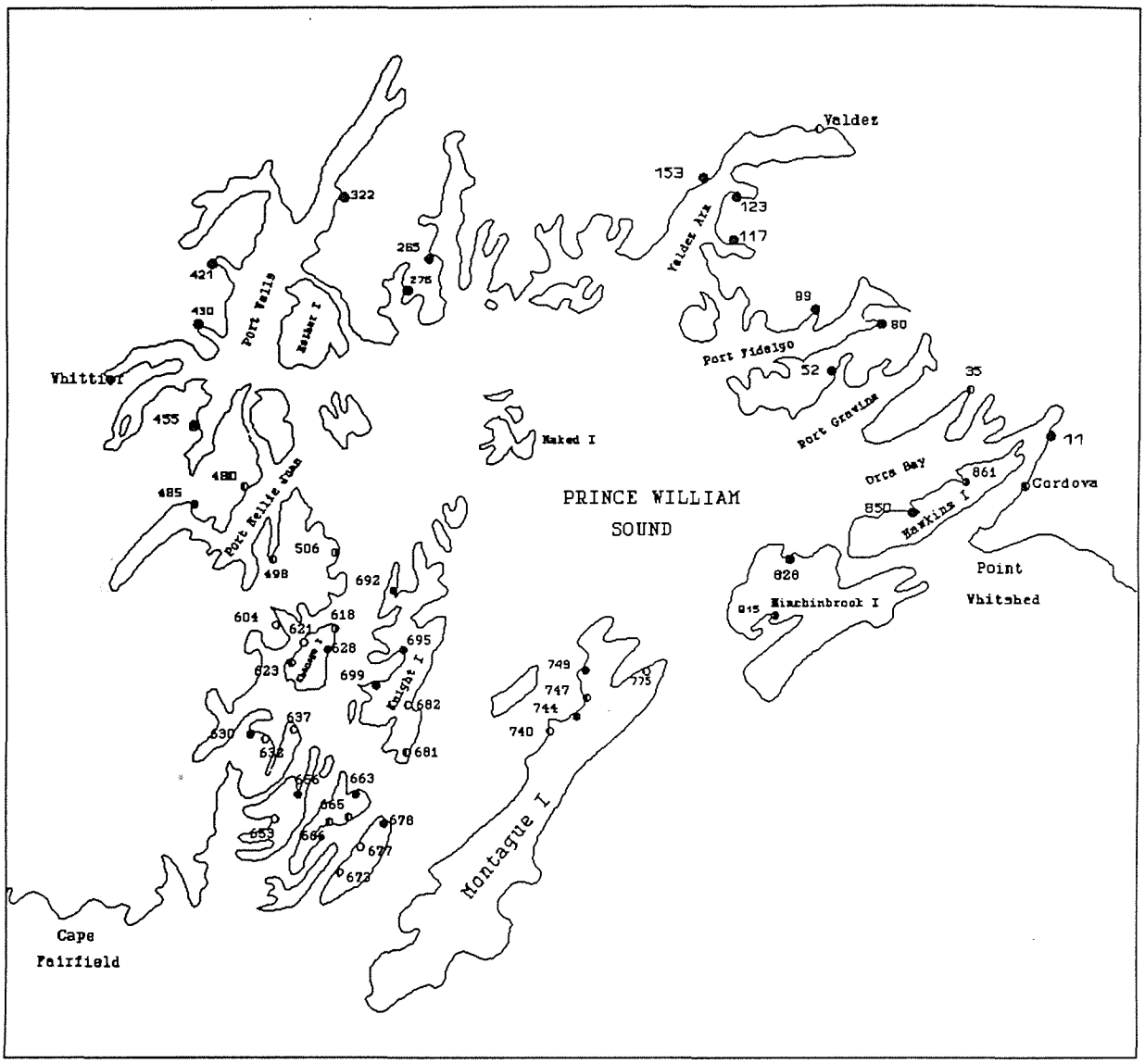

Figure 2. Locations of streams to be sampled for pre-emergent fry.

PROJECT PERSONNEL

Fisheries Biologist III Principal Investigator - Samuel Sharr

Mr. Sharr received a Bachelor of Science degree in Biology from the University of Washington in 1968. He has been a research biologist for ADF&G since 1979 and has worked on Prince William Sound salmon and herring since 1981. He assumed his present position as the ADF&G, Division of Commercial Fisheries, Biologist III, Prince William Sound Area Finfish Research Project Leader in 1986. In this capacity, Mr. Sharr oversees all the salmon and herring research conducted by the Division of Commercial Fisheries in Prince William Sound. His involvement with the Prince William Sound salmon escapement aerial survey program dates from the early 1980's. Mr.Sharr has supervised a total re-edit of the historic aerial and ground survey data and designed a new R:BASE data base for inseason escapement analyses. Mr. Sharr wrote the original operational plans for NRDA F/S Studies 1,2 and, 3 and has been the Principal Investigator for those projects since their inception.

Fisheries Biologist I Project Assistant - Andrew Craig

Mr. Craig has a Bachelor of Science in Fisheries from Cornell University. He has been employed by ADF&G since spring of 1991. He has experience supervising adult salmon weirs and has a field season of experience in the NRDA egg deposition study (F/S Study #2).

Biometrician II - Brian G. Bue

Brian Bue has a Bachelor of Science in Biology and a Bachelor of Science in Fisheries from the University of Alaska, Fairbanks. He also possesses a Masters degree in Fisheries with an emphasis on quantitative studies from the University of Alaska, Fairbanks. Brian has worked with the Alaska Department of Fish and Game from 1974 through present in many capacities. He has worked as a consulting biometrician on oil spill damage projects since the first days of the Exxon Valdez spill.

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Neter, J., W. Wasserman, and M.H. Kutner. 1985. Applied Linear Statistical Models. Irwin, Homewood, Illinois, USA.

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Sokal, R.R., and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Company, San Francisco, California, USA.

BUDGET ($K)

Salaries	$ 200.3
Travel	14.8
Contracts	53.6
Supplies	30.5
Equipment	56.7
Subtotal	$ 355.9
General Administration	33.9
Total	$ 389.8

RESTORATION PROJECT NUMBER 90

Study Title: Injury to Dolly Varden Char and Cutthroat Trout Monitoring

Lead Agency: ADF&G

PROJECT JUSTIFICATION

This closeout budget represents the cost for removal of weir material and camp equipment from all field locations, and for the production of a final report.

	BUDGET ($K)
Salaries	$ 45.6
Travel	2.0
Contractual	31.7
Supplies	3.0
Equipment	0.0
Subtotal	$ 82.3
General Administration	9.2
Total	$ 91.5

RESTORATION PROJECT NUMBER 102

Study Title: Coastal Habitat Restoration

Lead Agency: ADF&G

PROJECT JUSTIFICATION

This project description will be developed after a synthesis meeting in the spring of 1992.

	BUDGET ($K)
Salaries	$ 5.1
Travel	0.0
Contracts	458.0
Supplies	0.0
Equipment	0.0
Subtotal	$ 463.1
General Administration	22.5
Total	$ 485.6

2D. RESTORATION IMPLEMENTATION PLANNING

In some cases the feasibility of a restoration option is well established, but the Trustees lack site-specific information needed to determine which methods are appropriate given the physical and biological characteristics of the specific sites. Without this site-specific information, it may not be possible to identify all the actions needed, nor to estimate the costs.

Thus, implementation planning projects are intended to provide the information needed to evaluate and execute restoration projects in the field. In 1992, the Trustee Council proposes carrying out one implementation planning project, "Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Anadromous Fish."

RESTORATION PROJECT NUMBER 105

Study Title: Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Anadromous Fish

Lead Agency: ADF&G

Cooperating Agency: USFS

PROJECT JUSTIFICATION

The Exxon Valdez oil spill injured wild pink and chum salmon in Prince William Sound. Various amounts of oil were deposited in intertidal habitats where up to 75% of the spawning occurs. Salmon eggs deposited in 1989 and all subsequent years have been contaminated and direct egg mortality has been documented. A higher incidence of somatic, cellular, and genetic abnormalities were also found among alevins and fry in oiled creeks. Wild salmon fry were further injured when they entered the nearshore marine environment and consumed oil-contaminated prey. This caused reduced growth and fry-to-adult survival, because predators targeted the smaller, slower growing fish. Migration patterns indicated that nearly all the salmon fry exiting Prince William Sound passed through heavily oiled habitats in the southwestern Prince William Sound. Diminished growth and survival during the early marine period may have reduced the wild and hatchery reared salmon return to Prince William Sound in 1990 by 15 to 25 million fish. Recently detected genetic injuries may further reduce the productivity and fitness of wild salmon populations in Prince William Sound for many years to come.

This project has focused on identifying the most appropriate restoration techniques for injured anadromous fish spawning habitats and specific stocks of anadromous fish. The project was initiated in 1991, by the Alaska Department of Fish and Game (ADF&G). The study area includes Prince William Sound, lower Cook Inlet, and Kodiak Island. In 1992, the project will be conducted cooperatively by the ADF&G and the U.S. Forest Service (USFS). The USFS will provide expertise in habitat restoration in Prince William Sound, and the ADF&G will focus on stock and habitat restoration in the Exxon Valdez oil spill impact area. The USFS will conduct hydrological surveys at sites in the National Forest, further evaluate fish pass sites identified in 1991, and determine appropriate restoration techniques for anadromous fish (salmon and trout) stocks and habitats in the most heavily oiled streams in Prince William Sound. The ADF&G will estimate the area of salmon spawning habitat injured by the oil spill in Prince William Sound, determine the most appropriate techniques for replacing this habitat within the oil spill impact area, and coordinate with the USFS on evaluation of fish stock restoration techniques.

Results from ongoing genetic studies will be used to determine the most appropriate restoration techniques for stocks in oiled areas. If genetically discrete stocks are identified within the oiled area, restoration efforts will concentrate on restoring or replacing injured habitat or stocks. If genetically discrete stocks are not identified within the oiled area, injured habitat and stocks will be restored throughout the Exxon Valdez oil spill impact area using the most cost-effective methods.

Specific study sites were identified in 1991 from previous reports, aerial photographs, aerial surveys, and ground surveys. Identification of study sites will continue in 1992. More intensive investigations of sites identified in 1991 will also be conducted. Appropriate restoration or enhancement techniques may include spawning channels and improvement of fish passage through fish ladders, or step-pool structures to overcome physical or hydrological barriers. These measures will provide oil-free spawning habitat to replace oil-impacted spawning areas. Additional wild salmon stock rehabilitation measures may include stream-side incubation boxes, remote egg-takes and incubation at existing hatcheries for fry stocking in oil-impacted streams, and fry rearing.

OBJECTIVES

1. Review existing literature and databases, determine preliminary restoration techniques for specific sites, and identify sites where field studies are needed.

2. Conduct field studies at specific sites to collect additional data needed to evaluate restoration techniques.

3. Compile available data and select the most appropriate fish restoration projects.

4. Collect additional field data if necessary to develop project design and cost estimates, and write proposals for specific projects.

5. Estimate the total area of anadromous fish spawning habitat that was oiled in Prince William Sound.

METHODS

Objective 1:

Although many potential instream habitat and fish stock restoration sites were identified in 1991, review of existing literature and databases will continue in 1992 to ensure that all potential sites have been evaluated.

Additional data will be included in a benefit-cost analysis initiated in 1991. This analysis will determine the most cost effective wildstock restoration techniques in general. A summary of previous project costs will be developed after a literature review. When no data are available for a given technique, preliminary project budgets will be developed. Pink and chum salmon survival rates in natural streams, in the ocean, and resulting from various enhancement techniques will be summarized. The information gathered from this review will be used to evaluate the cost effectiveness of various enhancement techniques for wild salmon populations in general. The results from this analysis will be used to focus restoration survey efforts on the most effective and beneficial techniques.

Spawning channel sites described in the literature will be evaluated on the seasonal stability of groundwater height, groundwater temperature, groundwater gradient, groundwater chemistry, flooding risk, availability of substrate, and availability of broodstock (Sanner 1982b). Streams identified as potential spawning channel sites from the literature review will be further evaluated using aerial photographs and topographic maps. Data from topographic maps will be used to estimate surface gradient and stream length. These variables are likely correlated with groundwater gradient and stability.

The feasibility of fry rearing at various streams will be evaluated using aerial photographs, historical spawning escapement and pre-emergent fry index data collected by the ADF&G, and shoreline oil-contamination maps constructed by the Alaska Department of Natural Resources (ADNR) and the Alaska Department of Environmental Conservation (ADEC). Criteria used to evaluate potential fry rearing sites will include the degree of oil contamination in intertidal spawning habitats, probable magnitude of fry outmigrations, availability of mooring sites for net pens, feasibility of operating fry weirs, and proximity of weir sites to net pen sites.

Salmon stocks that might be best restored by remote eggtakes will be identified using historical salmon spawning escapement data, anadromous stream catalogs, and shoreline oil-contamination maps. Criteria used to evaluate remote eggtakes at these sites will include degree of oil contamination, probable spawner abundance, and availability of mooring sites for net pens.

Objective 2:

Two potential fish pass sites were identified in Prince William Sound and six sites in the Kodiak area in 1991. More detailed investigations will be conducted at these sites in 1992. Other potential fish pass sites will continue to be evaluated from aerial and ground surveys. The abundance of spawning salmon, barrier falls height, stream width, stream depth, stream gradient, and substrate type will be estimated from aerial surveys. The information gained

from these surveys will be used to eliminate some streams from further consideration. More extensive ground surveys will be conducted at sites that appear suitable from aerial surveys. The following physical measurements will be made during ground surveys. Barrier falls height will be estimated with a clinometer and measuring tape. The USFS stream habitat foot survey methods will be used to estimate available spawning habitat above the barrier (Olsen and Wenger 1991).

Fifteen potential spawning channel sites were identified in Prince William Sound and one site in lower Cook Inlet in 1991. Additional aerial and ground surveys will be conducted at these and other sites as needed. Aerial surveys will be conducted to identify specific sites that appear suitable for spawning channels within river valleys. The apparent size composition of the substrate, groundwater level, flooding risk, and ease of access will be criteria used to identify specific sites. Ground surveys will be conducted at sites that appear suitable from aerial surveys. A preliminary ground survey will be conducted to determine flooding risk, the approximate depth of groundwater, and the size composition of the substrate. If the area appears to be unaffected by floods, the groundwater is shallower than 2 meters, and the substrate is composed largely of gravel or cobbles, additional survey work will be conducted.

Standpipes will be installed at the fifteen potential spawning channel sites identified in 1991. Ground surface gradients and drainage basin lengths at these sites range from 0.3% to 2.5% and 0.5 to 19.0 miles, respectively. Standpipes will be installed at each of these sites to a depth at least 2 m below the groundwater level, parallel to the surface gradient, along the most likely location of the spawning channel. Standpipes will be constructed from 1.5 m sections of 5 cm diameter galvanized well pipe, with a sandpoint, and galvanized couplers. Electronic water level recording devices will be installed on selected standpipes to monitor changes in groundwater height. Data obtained from the recorders will be used to evaluate groundwater stability and the rate of intragravel flow at each site. At two potential spawning channel sites, two standpipes with water level recorders will be installed 50 m and 150 m from the mainstem stream channel to evaluate the relationship between groundwater stability and distance from the mainstem channel. Each standpipe will be covered with insulation at the surface and marked with a pole and flag.

Six potential fry rearing sites were identified in Prince William Sound and one site in lower Cook Inlet in 1991. Additional field surveys will be conducted to identify other potential fry rearing sites in the Exxon Valdez oil spill impact area. Fry rearing study sites will be aerially surveyed when the tide is at about the six foot level. A video camera will be used during the aerial survey of each stream for later review. A ground survey will be conducted to measure the distance across the stream channel, mean stream depth,

and mid-channel current speed at the intended location of the fry weir. The estuarine area near the potential weir site will be surveyed to locate a suitable area to moor net pens. The distance between net pen mooring sites and fry weir sites will be measured with a rangefinder. If possible, potential fry weir sites will be visited at high tide immediately after a storm.

No ground surveys were required to determine the feasibility of eggtakes at remote sites. Suitable sites for net pen mooring will be identified from aerial photographs and aerial surveys. Spawner abundance will also affect the feasibility of remote eggtakes. Aerial surveys conducted immediately before eggtakes will be required to estimate spawner abundance.

All restoration survey efforts will be coordinated with local landowners and governments.

Objective 4:

Full proposals will be developed for projects that receive a high ranking in the decision matrix. Additional field work may be required to collect engineering data needed for development of detailed project designs. USFS and ADF&G engineers will work on these projects as needed to collect engineering data and design structures.

Objective 5:

The total area of anadromous fish spawning habitat that was oiled will be estimated from aerial photographs. This information will be used to help determine the area of fish spawning habitat that needs to be replaced within the Exxon Valdez oil spill impact area by construction of fish passes or spawning channels. The ADF&G Habitat Spill Response Group (HSRG) has compiled a list of oiled anadromous streams in Prince William Sound. Aerial photographs will be taken of these streams at low tide. A planimeter will be used to estimate the area of intertidal fish spawning habitat on each photograph. The total area of intertidal fish spawning habitat in these streams will be estimated by summing the area estimates for the individual streams. Data collected by the HSRG and the ADF&G Commercial Fisheries Division will be used to estimate the average proportion of intertidal spawning habitat that was oiled in streams for which data is available. The total area of anadromous fish spawning habitat that was oiled will be estimated by applying this proportion to the estimated total area of intertidal spawning habitat in the streams on the HSRG list.

DATA ANALYSIS

Objective 2:

Data obtained from electronic water level recording devices will be analyzed to evaluate groundwater stability and the probable rate of intragravel flow at potential spawning channel sites. The rate of intragravel flow is an important variable affecting egg-to-fry survival in salmon spawning beds (McNeil 1966). The power spectrum will be estimated for each groundwater height time series (Jenkins and Watts 1968). The information contained in the power spectrum will be used to evaluate the variance of groundwater height and the principal frequencies of variability. These characteristics of the groundwater variability will be related to distance from the mainstem channel, substrate type, and drainage basin area and gradient. This analysis will provide insight into factors affecting groundwater flow and stability that will be useful for identifying other suitable spawning channel sites in the Exxon Valdez oil spill impact area.

Objective 3:

After all necessary data has been collected, a weighted decision matrix will be used to establish priority among potential projects. Detailed proposals will be developed for projects that receive a high ranking. The following criteria (unweighted) will be used in the decision matrix:

1. Oil-spill injuries to spawning habitats and salmon stocks;

2. The estimated increase in fish production resulting from the proposed project;

3. The importance of the estimated increase in fish production to subsistence, sport, and commercial user groups;

4. The estimated benefit/cost ratio of the proposed project;

5. The potential for the proposed project to maintain the genetic characteristics of the affected salmon population;

6. Level of genetic damage within the stock;

7. Demonstrated effectiveness of the restoration technique;

8. Requirement for future project maintenance;

9. Ability of the resource to recover naturally;

10. Ability to document the success of the project;

11. Compatibility of the proposed project with established land uses in the area; and

12. Compatibility of the proposed project with regional salmon enhancement plans.

DELIVERABLES

The results from 1992 investigations will be summarized in a report prepared by the USFS and ADF&G.

SCHEDULES AND PLANNING

Date	Activity
June - October	Conduct stream habitat surveys at selected sites in cooperation with the USFS,
	Conduct aerial photographic surveys of oiled anadromous streams in Prince William Sound and estimate area of fish spawning habitat in each stream,
	Survey potential spawning channel sites and install standpipes.
September - February	Re-visit potential spawning channel sites and collect data from water-level recorders
	Compile and evaluate data, select sites for development of detailed project proposals, and collect additional engineering data if necessary
October - February	Prepare engineering designs and detailed project proposals

PERSONNEL QUALIFICATIONS

Mark Willette:
Master of Science, Fisheries Oceanography, 1985; Bachelor of Science, Fisheries Science, 1983; Area Biologist, ADF&G, Fisheries Rehabilitation and Enhancement Division (FRED) Cordova, March 1991-present. Conduct various fisheries enhancement projects in Prince William Sound including limnological investigations of sockeye salmon producing lakes, and quality control of coded-wire tagging at private hatcheries. Principal Investigator on NRDA studies on juvenile salmon in Prince William Sound. Instructor/ Assistant Research Professor, University of Alaska Fairbanks, 1986-1991. Conduct various fisheries research projects. Design and implement a

program of education, research, and public service in northwest Alaska.

Nick Dudiak:
Bachelor of Science, Zoology, 1968; Area Biologist, lower Cook Inlet, ADF&G FRED Division, 1977-present; Project Leader: Paint River fishway feasibility study, Chenik Lake sockeye salmon rehabilitation program, Leisure Lake sockeye salmon stocking and fertilization program, Tutka Hatchery pink and chum salmon evaluation program.

Lorne White:
Bachelor of Science, Biology, 1973; Area Biologist, Kodiak, ADF&G FRED Division, 1987-present; Project Leader: Rehabilitation of sockeye salmon at Karluk Lake; Asst. Project Leader: Scallop mariculture feasibility study; Research Experience: evaluation of 15 proposed fish passes on Kodiak Island, fertilization, instream habitat studies related to hydroelectric development.

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	BUDGET ($K)		
	ADF&G	USFS	TOTAL
Salaries	$91.7	$40.0	$131.7
Travel	3.9	6.3	10.2
Contractual	91.5	26.0	117.5
Supplies	17.8	1.4	19.2
Equipment	37.8	3.2	41.0
Subtotal	$242.7	$76.9	$319.6
General Administration	20.5	8.0	28.5
Total	$263.2	$84.9	$348.1

2E. RESTORATION MANIPULATION/ENHANCEMENT

Manipulation/enhancement projects are active intervention measures which actively promote recovery of injured resources or provide an alternate service to those who use the resources. A fish ladder would be an example of an activity which promotes recovery of the resource by expanding the area of a stream accessible to spawning fish. Stocking fish in a location other than that of the injured resource could provide a service to those people who had used that resource. With the exception of one project, the Trustee Council chose not to implement manipulation and or enhancement activities until full public participation in the project selection process was possible. The one project described below has severe time constraints necessitating an early start. Most of the work for that project will not be carried out until after public review.

Red Lake sockeye salmon restoration, Restoration Project Number 113 (R113), seeks to restore sockeye salmon in Red Lake (Kodiak Island) by incubating sockeye eggs and short-term rearing the fry in Pillar Creek Hatchery, returning fingerlings to Red Lake and fertilizing the lake. The egg incubation and fry rearing is based upon predictions of poor adult returns in 1993; most activities will not begin until then. The level of funding provided by the Trustee Council allows advance purchase of hatchery equipment needed in 1993. Poor juvenile and smolt survival due to the oil spill will not be reflected in poor adult returns until 1993 and major manipulation/enhancement activities will not be needed at Red Lake until then. Therefore, despite 1992 funding for equipment purchases, full funding for this project in 1993, like other projects in this category, will be subject to full public scrutiny.

RESTORATION PROJECT NUMBER 113

Study Title: Red Lake Sockeye Salmon Restoration

Lead Agency: ADF&G

PROJECT JUSTIFICATION

Red Lake, located on the southwest side of Kodiak Island, has historically been one of the most consistent producers of sockeye salmon for the Kodiak commercial salmon fishery. The Department of Fish and Game's annual escapement goal for this system ranges from 200 to 300 thousand sockeye (Malloy 1988). The mean harvest of Red Lake sockeye has been 450,000 since 1980 and ranged from 25,000 to 1.5 million. The mean annual value of this harvest is $2.2 million to the fisherman.

In 1989, as a result of the Exxon Valdez oil spill, some commercially harvested fish were oiled, which resulted in closures over most of Kodiak Island waters. This resulted in an escapement of 786,000 sockeye into Red Lake, which equated to a 2.5 fold increase over the maximum desired escapement. Careful management of the number of spawning fish is required to maintain this fishery. If too many adult sockeye spawn in the lake system, an overabundance of juvenile sockeye will deplete their plankton food source, resulting in decreased freshwater growth and high mortality. This will then result in fewer smolt migrating to the ocean and a significant decrease in the return of adult sockeye.

Data gathered from Fish/Shellfish Number 27 (sockeye overescapement) showed low survival of juvenile sockeye from the 1989 escapement year (Schmidt 1991). Hydroacoustic and tow net surveys showed low levels of juveniles in the lake in the fall of 1990, and smolt enumeration in the spring of 1990 and 1991 showed reduced levels of migrant smolts. This information indicates that a significantly reduced number of sockeye will return as four, five and six year old fish in 1993, 1994 and 1995. According to this data the return may fall below the desired escapement of 150,000 fish. If this occurs, the productivity of the lake would be underutilized and the fishery and local economy would be seriously impacted. Immediate action would be required to avoid this impact. Therefore, supplemental production would be implemented immediately to restore the sockeye run, through the collection of 6 million Red Lake sockeye eggs and the resultant stocking of 4.9 million fry in to the lake. This stocking would produce approximately 146,000 adult sockeye. This restoration project would cost approximately $70,000 annually after FY93 until returns are restored to pre-spill levels.

DISCUSSION

The Red Lake restoration project will improve the rate of recovery of Red Lake sockeye if the projected injury, due to overescapement, occurs. Fry plants are a proven method used by FRED Division of ADF&G to rehabilitate and enhance sockeye stocks. FRED Division has pioneered the culture of sockeye salmon in Alaska with great success. Survival from egg deposition to fry lake entry ranges from 4 - 10% (Drucker, 1970) in wild stocks. When incubating eggs in artificial conditions in a hatchery, survival from egg to fry is usually greater than 80%. This increased survival total will subsequently increase the number of ocean migrating smolt and returning adults.

The restoration of Red Lake sockeye, through fry planting, will be monitored through various mechanisms to assure that no other factors hinder recovery. Such mechanisms include: smolt survival monitoring, escapement counts, water quality monitoring, zooplankton abundance, and hydroacoustic surveys. These mechanisms will occur directly through this project and indirectly through the linkage to Fish/Shellfish Number 27.

It should also be noted that other species are directly affected by the Red Lake sockeye runs, such as mammals that feed on sockeye (bears, otters, birds, etc.) and also would benefit from this project. It is important to be prepared to supplement the sockeye production at Red Lake if the sockeye overescapement does result in a depressed return of adults in 1993. These preparations will need to begin in this year to assure readiness to collect eggs, receive eggs, and incubate and rear eggs and fry, if the escapement levels are below 150,000 by August 1 in 1993.

OBJECTIVES

1. Increasing the incubation and rearing capacity of Pillar Creek Hatchery to support additional Red Lake eggs and fry.

2. Collecting 6 million early run Red Lake sockeye eggs, beginning in 1993 and continuing through 1995, contingent upon Red Lake escapement falling below the minimum escapement goal of 150,000 by August 1.

3. Incubation of 6 million Red Lake sockeye eggs at Pillar Creek Hatchery with 90% survival from green to eyed eggs.

4. Rearing of approximately 5.4 million Red Lake sockeye fry at Pillar Creek Hatchery to the size of .25 grams with 90% survival.

5. Evaluating freshwater survival and the success of hatchery fry plants, by thermally marking otoliths of fry prior to stocking into Red Lake.

6. Stocking of approximately 4.9 million fed fry (.25 gm) into Red Lake with timing parallel to the period of wild stock recruitment.

7. Producing approximately 146,000 adult red salmon from annual fry plants (3% fry to adult survival).

METHODS

Pillar Creek Hatchery will be modified where required under ADF&G-FRED Division guidelines to assure isolation of Red Lake sockeye eggs from other stocks present in the facility. This will require an incubation module used solely for Red Lake eggs. An additional 24 Kitoi box incubators will be acquired and plumbed into this module and 8 aluminum raceways will be brought on line for rearing requirements.

Net pens, net pen frames, beach seines, weatherports, safety gear and egg take supplies for a remote egg take of 6 million Red Lake eggs will be staged in Kodiak in July each year until the run is restored. Red Lake sockeye escapements will be monitored each year through counts from the ADF&G Commercial Fish Division adult enumeration weir. If escapement levels are below 150,000 by August 1 of each year, the egg take would proceed. Operational monies will be held as a contingency pending escapement counts in each of these years. The appropriate federal permits will be obtained from the U.S. Fish and Wildlife Service prior to conducting any work on Kodiak National Wildlife Refuge lands in which the Red Lake system is included.

Aerial and foot surveys will be conducted to determine when sufficient sockeye are holding near the mouth of major spawning tributaries. Brood will be seined and sorted by sex and held in net pens in Red Lake until females have ripened. Remote egg collection will follow procedures outlined in FRED Division sockeye egg take Standard Operating Procedures. After fertilization, disinfection and water hardening, eggs will be chilled to delay development in preparation for transport to the city of Kodiak. Eggs will be placed in coolers with ice. Disease screening will be conducted to determine titer levels of IHN virus in ovarian fluid. Eggs will be transported by float plane to the city of Kodiak and then transported to Pillar Creek Hatchery. Eggs will be seeded into Kitoi box incubators after being water temperature acclimated if necessary. Egg density in each incubator will be 250,000 with flows set at 10 gpm. A fertility check will be conducted each day eggs are seeded into the incubators as a quality control measure to assure high green to eyed egg survival.

During the incubation period, temperature units (TU) will be monitored daily to track egg development. Eggs will be treated with formalin as required to control fungus. Other general maintenance will be conducted according to FRED Division fish culture standard operating procedures (Fish Culture Manual, 1983). After reaching the eyed stage of development, eggs will be shocked and dead and live eggs will be enumerated to calculate green to eyed egg survival. Artificial substrate will be added to each incubator with the live eggs after all the dead eggs have been removed. Incubators will be maintained throughout the rest of the incubation period following FRED standard operating procedures as previously mentioned.

During incubation, between the eyed and hatched stages, eggs will be marked by thermally induced otolith banding. The mark will be induced by using a rapid temperature change of 2 - 3° C.

Sockeye fry will voluntarily migrate from incubators to raceways. Red Lake fry will be segregated from other hatchery stocks in raceways according to FRED Division compartmentalization policy. Fry will be enumerated as they enter the raceways using an electronic counter. Fry will be fed, beginning with Oregon Moist Pellet (OMP) semi-moist starter mash. After reaching 0.3 gm in size, fry will be fed OMP semi-moist pelletized feed. Fry will be reared according go FRED Division Standard Operating Procedures and sampled weekly to estimate feed conversion and growth.

After fry reach 0.25 gm and/or when Red Lake surface water temperatures reach 6° C, fry will be stocked into Red Lake. Fry will be removed from raceways and transported in an oxygenated tank from Pillar Creek Hatchery to float plane staging area. There they will be transferred to a transport tank in a float plane where they will be monitored by a fish culturist while in transit to Red Lake. Fry will released into Red Lake after being acclimated to the lake water temperature.

As part of Fish/Shellfish Number 27 (sockeye overescapement), Commercial Fish Division enumerates Red Lake smolt as they migrate from the lake to the ocean. A smolt sample will be collected and preserved in alcohol. Otoliths from these smolt will be analyzed to determine hatchery and wild fry-to-smolt survival.

Commercial Fish Division monitors Red Lake sockeye returns at an adult weir site. Escapement counts will be important to monitor this restoration project.

Since this project is closely linked to Fish/Shellfish Number 27, data will be shared between the two projects. Specifically, smolt enumeration and sampling data, and juvenile fry population estimate data will be provided by the Project Leader for NRDA study # 27. In addition, Commercial Fish Division will provide weir escapement counts to the Project Leader of this study on a daily basis.

DELIVERABLES

A project report will be completed at the end of 1992.

TENTATIVE SCHEDULE AND PLANNING

(FY93)

Event	Begin	End
1. Purchasing incubators, raceways, pipeline, and plumbing	7/92	1/93
2. Purchasing egg take supplies	1/93	2/93
3. Project Status Report	11/92	12/92
(FY94)		
4. Preparation of Pillar Creek Hatchery for receiving of eggs; incubator, raceways, and pipeline installation, egg take camp set up and supply ordering	3/93	6/93
5. Egg take site preparation	7/93	8/93
6. Red Lake sockeye egg take and site breakdown	8/93	9/93
7. Project Status Report	11/93	12/93
8. Red Lake sockeye incubation and rearing	8/93	2/94
(FY95)		
9. Continue Red Lake sockeye incubation and rearing	3/94	6/94
10. Thermal otolith marking	4/94	5/94
11. Stocking fry into Red Lake	6/94	6/94
12. Red Lake sockeye egg take and site breakdown	8/94	9/94
13. Project Status Report	11/94	12/94
14. Red Lake sockeye incubation and rearing	8/94	2/95

Project Management: Responsibilities

Project Leader: Lorne White- overall project management and report writing.

Lead Fish Culturist: Chris Clevenger- hatchery operations, remote egg take, incubation and rearing.

Assisting Personnel: Steve Honnold- assisting project Leader with project management and report writing.

Field Fish Culturist: Steve Schrof- remote egg take.

Logistical requirements for this project include: 1) transport of all remote egg take and field camp gear by float plane from Kodiak to Red Lake; 2) transport of all field personnel from Kodiak to egg take site; 3) during the remote egg take, supplies will also be flown in along with ice to chill the eggs on a daily basis; 4) chilled eggs will be flown out of Red Lake to Kodiak, and then to Pillar Creek Hatchery after each day's egg take; 5) egg take site and field camp will be dismantled and all material returned to Kodiak by float plane; 6) personnel will be returned to Kodiak as required by egg take work schedule; 7) fry stocking in Red Lake will require transport by float plane from Kodiak.

PERSONNEL QUALIFICATIONS

Lorne White: Area Biologist, FRED Division, ADF&G for 6 years; Fishery Biologist, FRED Division, for 13 years.

Chris Clevenger: Hatchery Manager, Pillar Creek Hatchery, for 2 years; Assistant Hatchery Manager, Big Lake Hatchery, for 5 years.

Steve Honnold: Assist Area Biologist, FRED Division, ADF&G for 3 years; Fish Culturist, Big Lake Hatchery, for 3 seasons.

Steve Schrof: Fish Culturist, Pillar Creek Hatchery, for 1 season; Fisheries Technician, Snettisham Hatchery, for 4 years.

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	BUDGET ($K)
Salaries	$9.2
Travel	0.9
Contractual	4.8
Supplies	6.6
Equipment	32.7
Subtotal	$54.2
General Administration	1.7
Total	$55.9

2F. RESTORATION HABITAT PROTECTION PLANNING

Adequate habitat is essential to resources and the services they provide, and one means of encouraging the recovery of resources and services injured by the Exxon Valdez oil spill is to afford additional protection to important habitat. There are various means by which protection measures can be implemented, and these range from purchase of land, purchase of "conservation easements", to landowner agreements, or changes in future land management actions. (Conservation easements involve the purchase of certain rights to use land, e.g. standing timber, without the purchase of the land itself.)

The Volume I: Restoration Framework lays out a five-step process for identifying and protecting strategic habitats and recreation sites.

Before protection measures are pursued, it is necessary to determine which areas are the most important to fish and wildlife. Several of the proposed projects do this for biological resources. For example, the Harlequin Duck Restoration Project (R71) and the Marbled Murrelet Restoration Project (R15) will determine, among other things, the nesting habitat requirements of those species, both of which were injured by the spill. Another project, Stream Habitat Assessment (R47), will focus on assessing the habitat value of streams and adjacent habitat on lands that are scheduled for land use alteration in the near future. This project will evaluate habitats for several injured species, including pink salmon, Dolly Varden, cutthroat trout, harlequin ducks, and bald eagles.

Habitat protection will be considered through the development and implementation of a comprehensive Restoration Plan.

RESTORATION PROJECT NUMBER 15

Study Title: Marbled Murrelet Restoration Study

Lead Agency: USFWS

Cooperating Agency: USFS

INTRODUCTION

The marbled murrelet (Brachyramphus marmoratus) is a small seabird which largely depends on old-growth forests for nesting (Binford et al. 1975, Marshall 1988, Manley and Kelson 1991, 1992, Quinlan and Hughes 1990, Singer et al. 1991, 1992, Nelson et al. 1992). The species currently is being considered for threatened or endangered status throughout most of its range, excluding Alaska. Prince William Sound is one of three major population centers of the marbled murrelet in Alaska (Mendenhall 1988). This population suffered substantial direct mortality from the Exxon Valdez oil spill. Based on an eight percent chance of carcass recovery (Ford et al. 1991), an estimated 9,570 murrelets were directly killed. In Prince William Sound, marbled murrelets were 12% of retrieved carcasses, which is proportionally more of the seabird population than the numbers at risk at the time of the spill (Piatt et al. 1990). Additionally, petroleum hydrocarbon contamination has been found in the livers of unoiled murrelets collected in 1989 in oiled areas of the Prince William Sound (Kuletz 1992a). Murrelets collected in unoiled areas of Prince William Sound after the spill were uncontaminated.

The Prince William Sound marbled murrelet population has declined significantly, from approximately 300,000 in 1972 to 100,000 in 1989-1991 (Laing 1991), thus it is difficult to determine the contribution of the Exxon Valdez oil spill to this decline. There was no significant difference in murrelet counts between oiled and unoiled shoreline in the Prince William Sound boat surveys or the Naked Island area surveys. Since only about 25% of the murrelets occupy waters within 200 m from shore (Laing, unpubl. data), and murrelets are highly mobile in foraging, it is unlikely that an oiling effect could be detected using the current methods of analysis.

The limited data available on murrelet breeding biology suggests that their reproductive success is quite low (Hamer and Cummins 1991, Kuletz 1992b, Nelson et al. 1992, Singer et al. 1991, 1992). Murrelets face additional impacts from loss of nesting habitat due to logging, which could threaten natural recovery. Protection of forested nesting habitat through acquisition is one potential approach for aiding recovery of murrelets in the oil spill area.

Integral to this approach is the ability to identify appropriate habitat for protection. However, because so little is known about the murrelet's habitat requirements or its breeding distribution, further efforts are needed to achieve this goal. Two primary components are intimately linked in identification of appropriate sites - what are the characteristics of murrelet nesting habitat and which potentially suitable areas in the oil spill area are being used by the species? Documenting areas used by nesting murrelets is elusive because nests are generally difficult to find. This study will attempt to answer these questions.

An attempt will be made to locate a relatively large number of murrelet nests in an area in which ground search techniques have proven to be an effective means for finding nests (Kuletz 1992b). At these sites critical elements of nesting habitat will be quantified and behaviors, vocalizations and activity patterns associated with nesting will be defined. These results will be used to establish criteria for inferring use of an area by nesting murrelets, for refining nest search techniques and for determining nesting habitat requirements (Objective 1). Censuses will also be conducted at various locations in Prince William Sound to locate high use areas. The results from known nest sites will then be used to interpret the significance of murrelet activity (Objective 2).

Marbled murrelets typically forage in shallow nearshore waters during the breeding season. This area is particularly vulnerable to oil pollution and human disturbance. Consequently, proper management of the adjacent marine environment is also important in protecting murrelet habitat. Thus, delineation of nearshore murrelet distribution relative to nesting areas has been included in Objectives 1 and 2. The results of this study will be integrated with other sources of data on murrelets in the Exxon Valdez oil spill area (Objective 3). These data will be analyzed, synthesized and used to corroborate nesting requirements and appropriate protection measures.

Completion of this phase of the study in 1992 will result in knowledge of murrelet nesting habitat requirements and identification of uplands with the most potential for murrelet nesting. This study will also provide guidelines for identifying nesting habitat throughout the oil spill area.

OBJECTIVES

1. Determine marbled murrelet nesting habitat requirements and develop criteria for documenting occupied nesting habitat within forested portions of the Exxon Valdez oil spill area.

2. Survey uplands throughout portions of the oil spill area to investigate murrelet use of those habitats.

3. Compile, analyze and synthesize all murrelet data relevant to the oil spill area.

METHODS

Sampling Methods

Field training will be conducted prior to field work according to the training procedure. This session will be held on the south side of Kachemak Bay or on Naked Island (Appendix A) immediately following establishment of the field camp. Participants will be trained to identify marbled murrelets, to distinguish between marbled and Kittlitz's murrelets and to conduct dawn watch surveys. The dawn watch survey is the fundamental method used for recording murrelet activity at dawn, the peak period when murrelets fly between their marine foraging sites and inland nesting areas.

Objective 1. Determine marbled murrelet nesting habitat requirements and develop criteria for documenting occupied nesting habitat within forested portions of the Exxon Valdez oil spill area.

Nest Searches

To determine nest habitat requirements and develop criteria for documenting occupied nesting habitat, as many nests within the Naked Island Archipelago will be located as possible. Nest searches will be conducted in areas previously established as nesting or suspected nesting habitat, based on results of the 1991 Restoration Project and the 1990 pilot study (Kuletz 1991, 1992b). Initial efforts will focus on Naked Island (e.g. near nest sites in South Cabin Bay, McPherson Bay, and suspected nest sites in Northwest Naked and Bass Harbor), then Storey and Peak islands. Nest searches will begin mid-May to include the prospecting and incubation stages of nesting. During these stages, murrelets are most visible or predictable around nests, and nests are most likely to be found then (Naslund, N, FWS, unpubl. data). Focusing efforts during these stages is critical to maximizing the sample size of nests. Forty-five dawn nest search surveys will be implemented to identify potential nest sites, or find nests when possible. This search technique will be supplemented with pre-dawn observations at possible nest trees using a night viewing device. Areas identified as promising through dawn nest search surveys will be thoroughly checked from the ground using binoculars and spotting scopes. If no murrelets are readily visible from the ground, an intensive nest search will be undertaken. When behavior at dawn indicates nesting but view of the suspected nest is obscured by vegetation, a tree adjacent to the suspected nesting tree will be climbed. The climber will then visually search for signs of nesting from this elevated vantage point. Additionally, the ground below potential nest trees will be searched for eggshell fragments, as has

successfully been done in Washington (Becking 1991, Reed and Wood 1991, Hamer and Cummins 1990, 1991).

Identifying Occupied Nesting Habitat

Use of potentially suitable nesting habitat can be determined through two means: 1) finding nests and 2) inferring use by certain observable behaviors. Four sources of information from nests found in 1992 will be used to identify and define flight behaviors and vocalizations indicative of nesting and to refine nest search techniques. In turn, these data will be used to define occupied and unoccupied forest stands and to determine the best method for assessing occupied and unoccupied status of forest stands. These results will be used to interpret murrelet activity observed throughout Prince William Sound (under Objective 2). These results will also be used to assess potentially occupied murrelet nesting habitat at specific sites within the Exxon Valdez oil spill area in the future. The four methods are as follows:

1. Dawn watch surveys. Dawn watch surveys will be carried out four times each during the incubation phase and nestling phase at three nests. These data will be analyzed and compared with murrelet activity recorded at non-nesting sites.

2. Dawn nest search surveys. Behaviors observed during nest search efforts will be used to supplement findings from dawn watch surveys when establishing criteria for occupied status.

3. 24-hour nest monitoring. 24-hour video recordings will be implemented bi-weekly at 2 nests. A spotting scope and a night viewing device will alternately be attached to the video camera to enhance observations. Activity patterns will be analyzed to determine the appropriate time of day to conduct intensive nest searches in future nest search efforts.

4. Inside/outside stand comparisons. Twenty paired dawn watch surveys, with one observer stationed inside and one stationed outside a stand, will be done in known nesting habitat to determine the best census method for documenting flight behaviors and vocalizations needed to assess occupied and unoccupied status of forest stands.

Nesting Habitat Requirements

To assess nesting habitat requirements and the potential recovery of murrelets through habitat acquisition, the following methods will be used. An attempt will be made to find all nests within selected stands for density estimates. Each documented nest will be checked at least once to determine nesting outcome. The 1991 nest trees will be checked bi-weekly for signs of reuse. Murrelet

nest, tree, and stand characteristics will be quantified upon the completion of nesting efforts. The information gained will assist management in determining the appropriate amount of acreage for habitat protection and to predict subsequent recovery rates.

Three survey types will be used to gather data on the marine distribution of murrelets which will be integrated with data on terrestrial habitats. Results can be used to guide appropriate management of the nearshore environment adjacent to proposed habitat acquisitions. The survey types include:

1. Bi-monthly shoreline censuses of Cabin and Outside bays on Naked Island will be done following the dawn watch surveys at the three upland monitoring sites, described under 'Seasonal Variation' below. The shoreline censuses will be conducted by two observers using an inflatable boat; all murrelets within 200 m of shore will be counted. Results of these surveys will be analyzed to determine how well the morning nearshore distribution corresponds to inland habitat use.

2. A complete shoreline census will be conducted around Naked, Peak and Storey islands in June to determine murrelet nearshore distribution during the incubation period.

3. Murrelet distribution within 5 km of Naked, Peak and Storey islands will be censured once each in the early, mid and late nesting season, following the methods implemented in the 1991 pilot study.

Predator Counts

Evidence indicates that nesting murrelets are quite vulnerable to predation (Singer et al. 1991, Kuletz 1992b, Nelson et al. 1992). Therefore, predation risk is an important component of murrelet nesting habitat. Potential avian predators associated with nesting habitat will be investigated using the fixed-point count survey method near each nest and from analysis of the 24-hour video recordings at nests discussed above.

Seasonal Variation

Bi-monthly dawn watch surveys will be conducted at three upland monitoring sites established in 1990 and 1991 (e.g. sites #1, #2 and #5, see Kuletz 1991, 1992b). These data will be used to monitor seasonal and annual variation, for comparisons with documented nesting phenology and dawn watch surveys at nest sites, for comparisons with activity recorded elsewhere in Prince William Sound (Objective 2), and for murrelet marine-terrestrial habitat associations.

Objective 2: Survey uplands throughout portions of the Exxon Valdez oil spill area to investigate upland murrelet use of these habitats.

General Procedures

This objective of the study will be to identify areas of high murrelet upland activity, indicative of nesting habitat. Building on results from the Naked Island portion of this project, surveys in high-use areas may be required in later years to identify 'documented use' stands. In 1992, upland activity by murrelets will be assessed in various locations in Prince William Sound from a boat anchored near shore. The basic sampling method will be the 'dawn watch' survey, as described in the Pacific Seabird Group protocol (Paton et al. 1990), with some modifications for Alaskan conditions. One dawn watch will be conducted at each site. This project is not designed to define sites as unoccupied by murrelets, since that would require a minimum of four visits to each site for verification (Nelson 1991). Results from these surveys will be integrated with USFS habitat data and analyzed for significant murrelet - habitat associations.

This survey will be conducted by three USFWS and three USFS field personnel operating from a chartered 58-foot vessel. Half of the dawn watches will be conducted from the deck of the large vessel by one of the USFWS observers. This method was tested in Prince William Sound in 1991 and proved useful (Kuletz 1992). A second crew of two observers, also based on the larger vessel, will travel to adjacent sites in an inflatable boat and conduct dawn watches at shoreline or further inland at some locations. The latter effort is designed to make a paired comparison between murrelet detection levels observed from the anchored boat and those detected further inland.

Sample Size

The survey period for marbled murrelets in Alaska is from early May to early August (Kuletz 1991). Surveys will begin approximately 5 May and continue until 8 August. A minimum of 60 shoreline sites and 20 adjacent inland sites is the survey goal for 1992. A 58-foot vessel will be chartered for 55 days, to allow for weather days and logistical delays. Thus, there will be 40 days available for dawn watch surveys, or 40 'anchor sites'. At 20 anchor sites, a remote crew of two people will move to an adjacent inland site to conduct a dawn watch for comparison with the watch done from the anchored vessel. At the other 20 sites, a remote crew will travel via inflatable raft to a nearby cove or bay to conduct a separate dawn watch from shore. Thus, there will be a minimum total of 60 sites surveyed from shoreline, with 20 of those having a paired inland site, for a total of 80 dawn watch surveys.

Site Selection

Currently, a comprehensive habitat data base for Prince William Sound upland habitat is unavailable, thus, sample sites for this portion of the study will not be pre-selected based on habitat criteria. In 1992, sampling effort will be concentrated in the western half of Prince William Sound where USFWS surveys indicate murrelet concentrations are generally high in the summer (Irons, unpubl. data; Laing, unpubl. data). Dawn watch sites will be selected to include both private and public lands. Selected sites will be divided between areas with high and low at-sea murrelet densities, using the transect data from USFWS boat surveys. Sites will be clustered to facilitate the sampling efforts of the USFS habitat crew. Logistical constraints will be a factor in site selection and seasonal distribution of sampling effort.

Habitat Classification

Once at the anchor site, habitat within view will be defined and photographically recorded. Four basic habitat categories will be included in the sampling effort: densely forested, mixed forested/unforested, muskeg/meadow and alpine. Detailed habitat data for the areas surrounding the anchor sites will also be gathered by USFS botanists. The USFS habitat plots will be central to one or several USFWS dawn watch sites. The USFS data will contribute to the database for the ecological mapping units, to allow access through their GIS system. Use of the GIS will allow more precise analysis of murrelet habitat data.

Marine Habitat Use

This study will include a limited effort to study murrelet use of the nearshore environment for two reasons. First, future upland surveys will benefit if it is shown that at-sea counts are indicative of upland nesting nearby. If this is true, at-sea surveys can be used to focus upland surveys to find nesting habitat. Second, a correlation between at-sea counts and upland flights would suggest that proximity to forage habitat is an important component of murrelet nesting habitat, and these nearshore foraging areas should be managed to reduce human disturbance during the breeding season. The null hypothesis of independence between at-sea counts and adjacent upland activity will be tested with three data sets:

a. Selected sites will be divided between those in association with transects of high and low at-sea murrelet density, based on USFWS boat survey data. The dawn activity levels will be compared between the areas associated with high and low at-sea counts.

b. Fixed-point counts: Following the dawn watch from the anchored vessel, the observer will count all murrelets within

200 m of the boat. The area within view will be outlined on a marine chart for later calculation of area and conversion of murrelet counts to densities.

c. Shoreline surveys: Since all of the Prince William Sound shoreline has been delineated into transects for standard shoreline boat surveys of marine birds and mammals (Irons et al. 1987, Klosiewski and Hotchkiss 1990), each anchor site used for a dawn watch survey will be associated with a USFWS transect. At every anchor site (including the shoreline site surveyed by the remote crew), a shoreline survey will be done along the associated shoreline transect. Two observers will cruise in an inflatable boat 100 m offshore and count birds out to 200 m from shore, using binoculars.

Objective 3. Compile, analyze and synthesize all murrelet data relevant to the Exxon Valdez oil spill area.

Data in a variety of formats are available for marbled murrelets in the oil spill area. This information will be valuable in determining future restoration efforts, interpretation of on-going projects and as a baseline for documenting recovery. These data have not been easily accessible because of the range of data types, different degrees of compilation and analysis, and the variety of agencies involved in data collection.

This objective of the study will locate and synthesize information which will aid restoration efforts for the marbled murrelet. Some of the data sets which will be accessed include, but will not be limited to:

1. Outer Continental Shelf Environmental Assessment Program (OCSEAP) from the 1970's;

2. Surveys of the Kodiak Archipelago by the Kodiak National Wildlife Refuge;

3. Surveys of the Lower Cook Inlet and Kenai Peninsula by the Alaska Maritime National Wildlife Refuge and Kenai Fjords National Park;

4. Surveys of Prince William Sound by USFWS in 1972-1973, 1984-1985 and 1989-1991;

5. Unanalyzed data from marbled murrelet damage assessment studies in 1989-1990 with emphasis on effects of human disturbance and daily and seasonal variation in at-sea distribution;

6. Bathymetric features and shoreline habitats of Prince William Sound, to be integrated via GIS with at-sea data and results of the 1992 upland surveys;

7. Published and unpublished reports of Brachyramphus nests and juveniles found by various people throughout the Exxon Valdez oil spill area;

8. Information on prey species used throughout the oil spill area from USFWS food studies, including unpublished results; and,

9. Gillnet mortality records for Prince William Sound from the NOAA Marine Advisory Program.

Standard Operating Procedures

These standard operating procedures will be used to meet Objective 1 and are fully described in "Other Information" below:

1. Training procedure
2. Dawn nest search survey
3. Intensive nest search
4. Dawn watch survey
5. Nest site sampling
6. At-sea transects

Quality Assurance and Control Plans

Quality control will be provided for the dawn watch, the basic sampling method, by training all field personnel in Anchorage and on-site, following the Standing Operating Procedure. Data taken on hand-held recorders during the dawn watch will be transcribed by the observer as soon as possible, using the data sheet developed for this study. The data sheet will be field-checked by the field supervisor, entered at the USFWS Anchorage office, checked against the raw data, and corrected.

Habitat classification will be checked by USFS personnel on site, to assure standardization of habitat types during the Prince William Sound surveys. At nest sites, habitat classification and plant identification will be conducted by or checked by USFS personnel. Vegetation samples taken from nests will be kept in paper bags, catalogued and identified by USFS personnel. Eggshell samples will be catalogued and the majority of samples archived at the University of Alaska, Fairbanks museum.

All at-sea murrelet counts will follow SOPs. Standardization of distance judgements will be assured by practice and occasional observer calibration with use of a buoy on a 100 m line trailed from the censusing vessel. Data will be transcribed directly onto a waterproof data sheet and field checked.

The principal investigator will be responsible for study design and analysis of data, which will be submitted for peer review.

Information Required from Other Investigators

This study is a cooperative project with the USFS. It will also require cooperation with GIS support services of both USFS and USFWS oil spill offices. Prince William Sound boat survey data will be provided by NRDA Bird Study 2.

Safety Requirements

All field personnel will attend standard USFWS safety training, which will include CPR, first aid, marine safety and survival, bear and gun safety. In addition, they will attend a four-day tree-climbing workshop given by Chuck McDonald (USFS, Quinalt Ranger District, Washington). Field personnel will also attend a map reading and orienteering class in preparation for upland surveys. Float plans will be submitted prior to every marine trip. Emergency procedures and standard safety operations followed in 1991 will be reviewed and maintained.

DATA ANALYSIS

All data will be entered into a Paradox Relational Database (Release 3.0, Borland International) and will be transferred to SAS (Release 6.04, SAS institute, Inc.) for analysis. Steve Klosiewski, Biometrician for Migratory Bird Management, USFWS, will be consulted for assistance in analysis and interpretation of statistical results. Mapping and integration of GIS data will be done with the assistance of Tom Jennings and Barbara Boyle, USFWS.

The three dawn watch sites in Cabin Bay at Naked Island to be used as monitoring sites will be censured on the same day and all detections combined for examining trends in detection levels. Morning detection trends will be graphed in five minute intervals before and after sunrise. Seasonal trends will be examined by graphing the total detections for each bi-monthly monitoring survey between May and August. Seasonal changes in certain behavioral observations will be examined by graphing the frequency distribution of each behavior over time, and testing for significant differences in presence/absence of the behavior using a contingency table and Chi-square statistic. A similar test will be done between those sites known to be near a murrelet nest and those with no known nest.

For comparison between dawn surveys done inside and outside a forest stand, paired t-tests will be done on the total number of detections, number of visual detections and numbers of specific types of behaviors per watch.

For both the Naked Island dawn surveys and those done throughout Prince William Sound, the rank correlation between number of upland detections and the at-sea counts conducted the same mornings will

be tested using the Kendall's Tau-b statistic, to compensate for 'outlier' data points. Among the Prince William Sound survey sites, the mean number of detections between areas chosen for their high at-sea counts vs. those chosen for their low at-sea counts will be tested for a significant difference with a t-test.

For the Prince William Sound surveys, the number of murrelet detections recorded during dawn watch surveys will be graphed to determine if there is a definitive separation between 'high-use' and 'low-use' sites. If so, these categories will be used to test (by T-test for continuous variables, Chi-square test for categorical variables) for significant differences in habitat features between sites with high vs. low murrelet activity. Otherwise, a multivariate analysis will be done using habitat variables against the dependent variable of number of murrelet detections.

DELIVERABLES

This project will provide three reports:

1. A field season status report one month after completion of the field season;

2. A preliminary report for peer review; and,

3. A final report, in three sections, to address the three prime objectives. Three sets of maps will be provided using the GIS:

    a) the Prince William Sound upland survey sites and their relative murrelet upland activity levels;

    b) the Naked Island survey sites, and the location of any murrelet nests, in conjunction with the ecological mapping units defined by the USFS; and,

    c) the at-sea distribution of murrelets, based on the randomly chosen transects around the Naked Island complex, once each for May, June and July.

The Naked Island nesting habitat component will also provide a detailed description of nesting habitat and nest trees, plus definitions of behavioral cues indicative of nesting. This component of the project will result in a refined training program and manual for conducting dawn watch surveys in Alaska, including audio tapes (and possibly video).

SCHEDULES & PLANNING

A. Data and Report Submission Schedule

1992 March	Secure charter vessel Hire personnel Order selected equipment
April	Preparation for field season (procurement and personnel, safety training, contracting)
1 - 10 May	Dawn-watch survey training
10 May - 20 Aug	Field season for Naked Island component
10 May - 8 Aug	Field season for Prince William Sound survey component
31 Aug	Status report on 1992 field season
10 Aug - Sept	Data entry and compilation
Oct - Dec	Data analysis and report writing
Dec	Preliminary report
1993 March	Final report

Sample and Data Archival

All nest samples and data will be archived at the Oil Spill Office, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Management Plan

The Principal Investigator, Kathy Kuletz, will coordinate activities and data exchange with the U.S. Forest Service. The USFS will have a botanist and two biological technicians gathering habitat data in the field. The Principal Investigator will be responsible for study design, coordination, data analysis and completion of final products. Two USFWS wildlife biologists (one for the Prince William Sound surveys and one for the Naked Island nesting habitat study) will be responsible for field operations and field checking of data. They will also assist in data entry, synthesis and analysis. In addition to the field supervisors, five USFWS biological technicians will assist in gathering data and data entry.

Logistics

Objective 1, the nesting habitat portion of this project, will be based on Naked Island, Prince William Sound. The four permanent personnel based at this site will maintain a 25-foot Boston Whaler on site for at-sea transects, transport among islands, resupply trips to Whittier and as an emergency backup transport. They will also have a 12-foot inflatable boat for local transport. The camp supplies and gas barrels will be delivered by barge in early May, and picked up in mid-August. Personnel will be equipped for overnight backpacking trips for surveying or locating nests distant from base camp.

Objective 2, the Prince William Sound survey of upland habitat use, will rely on a chartered 58-foot vessel equipped with at least one inflatable boat. The vessel, Auklet, under USFS contract, will be scheduled for use on this project with the cooperation of the vessel's owners and USFS. The Auklet sleeps six plus crew, and will provide for all food and fuel for the Prince William Sound surveys. Personnel will also be equipped for overnight backpacking and camping for surveying sites away from the anchor sites.

Objective 3, may require some travel by the PI or an assistant to review or retrieve data from the agency of origin. Travel and per diem expenses are included in the budget.

PERSONNEL QUALIFICATIONS

Principal Investigator: Kathy Kuletz received her M.S. from the University of California, Irvine, in 1983. Her thesis, based on research done at Naked Island, Prince William Sound, was on foraging and reproductive success of pigeon guillemots. Ms. Kuletz has worked in Alaska since 1976 for the USFWS, Dames and Moore Consulting and LGL Alaska Research. In 1988, she conducted an independent study on at-sea censusing of murrelets for the Alaska Maritime National Wildlife Refuge. Since 1989, Ms. Kuletz has been P.I. for the marbled murrelet damage assessment study and the restoration feasibility study for marbled murrelets.

Naked Island field supervisor: Nancy Naslund did her M.S. thesis research on the breeding biology of marbled murrelets in central coastal California. This work led to the discovery of two murrelet tree nests and represents the only in depth study yet conducted on murrelet breeding behavior. Part of this study also resulted in the development of a ground search technique for locating murrelet tree nests. In addition, Ms. Naslund has conducted field work since 1980 on a variety of terrestrial and marine bird species including the California least tern, peregrine falcon and California condor. Ms. Naslund was part of the 1991 team for the marbled murrelet restoration feasibility study.

Prince William Sound Survey field supervisor: Dennis Marks completed his M.S. at the University of Oregon Institute of Marine Biology where he studied the feeding ecology of several species of bottom fish. In 1990 he participated in the marbled murrelet and pigeon guillemot damage assessment studies. In 1991 he was part of the Marbled Murrelet Restoration study. Previous to these studies, Mr. Marks spent several years coordinating field projects on the west coast and abroad.

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OTHER INFORMATION

STANDARD OPERATING PROCEDURE REQUIREMENTS

A. Training procedure. All new field personnel will undergo training and verification prior to conducting dawn watch surveys. The training program will consist of three phases. Trainees will first attend an introductory lecture explaining survey procedures and initial instruction on murrelet identification using videos of flying murrelets and audio recordings of murrelet calls and calls of other species that may be encountered. The next phase will include three days during which trainees are instructed in the field on the identification of flying murrelets and their calls, behavior classifications, and proper completion of data forms. Finally, trainees will be tested in the field. Successful completion of the course will occur when a trainee adequately records 80% of the murrelet detections recorded by the instructor during a dawn watch survey.

B. Dawn watch surveys (for forest and alpine habitats). Dawn surveys of murrelet activity will be conducted using established protocol for "Intensive Inventory Surveys" (Paton et al. 1990). The following revisions will be made, based on prior studies at Naked Island and elsewhere:

1. Dawn watch surveys will begin 1 hour prior to official sunrise (instead of 45 minutes) to compensate for the increased pre-dawn light levels associated with northern latitudes, relative to more southern latitudes where murrelet survey protocols were initially developed;

2. Additional data on flight behaviors and vocalizations, potentially important for interpreting murrelet activity, will be recorded (Nelson 1989, 1991; Naslund et al. 1990b; Singer et al. 1991; Kuletz, unpubl. data; Naslund, unpubl. data); and

3. The presence of other avian species will be recorded to determine the presence of potential avian predators.

C. Nest search protocols. A ground search technique developed in California (Naslund et al. 1990b) with appropriate revisions based on results of efforts on Naked Island in 1991 (Kuletz and Naslund, unpubl. data) will be used to search for nests. This technique has two primary components and is summarized as follows:

1. Dawn nest search surveys. Searches begin 1 hour prior to and last 1 hour after official sunrise or

15 minutes after the last detection, whichever is later. Two or three observers are stationed at vantage points affording good visibility of the tree crown or stand canopy of interest. Observers are located at opposing sides of the tree or stand so that visual and auditory detections of murrelets can be triangulated to determine specific areas of use. Observers focus on flight patterns that may indicate nearby nesting including 'fly-bys', 'flying in tandem', 'stall-outs', and landings and departures as well as vocalizations associated with incubation exchanges. During the nestling phase, surveys will continue an additional half hour since murrelets are known to fly in to feed chicks throughout the day (Hamer and Cummins 1991; Naslund et al. 1990a); and

2. Intensive nest search. An observation spot is established at least 25 m from the suspected nest tree with good visibility of the potential nest branch. Observations are made through a spotting scope and data recorded on a microcassette recorder. The objective is to observe the murrelet turning its egg, the time when an otherwise camouflaged murrelet becomes most visible. Observation periods last for at least 2 uninterrupted hours during the morning to maximize the chance of observing a turning bout (based on activity patterns in California, Naslund et al. 1990a).

D. Nest site sampling. Established protocol for collecting data on nests, nest trees and nest tree stands (Varoujean and Carter 1989) will be used, with one exception. The dimensions of stand composition plots will be measured on the ground surface instead of a horizontal plane, to enable quantitative comparisons between plots (Mueller-Dombois and Ellenburg 1974).

E. At-sea transects. At-sea transects will repeat the pilot effort conducted in 1991, which tested the applicability of stratified random sampling in a relatively small area of marine habitat. A 1 km grid was overlaid on a nautical chart, with three strata being used:

1. shoreline to 200 m from shore, using a complete shoreline census;

2. 200 m to 2 km from shore, creating a "buffer zone" surrounding Naked, Storey and Peak islands and;

3. 2 km to 5 km from shoreline, thirty blocks were randomly chosen in each of the last two strata, and within selected

blocks, the actual transect line was chosen among five possibilities, in increments of two degrees.

These sixty 200 m-wide, 1 km-long transects will be censused once each in May, June and July to monitor seasonal changes in at-sea distribution. To minimize day-to-day effects, the complete census should be done over three consecutive days. To minimize effects of diel activity patterns, the transects will only be censused between 0600 and 1200 hours. Seas should be calm (<.5 m) and visibility good. The driver and observers will use binoculars for positive identification and scan in a forward direction. Boat speed will be approximately 8 knots. All birds and marine mammals will be counted, but priority will be given to murrelet counts and identification where aggregations of birds are encountered. Murrelets that cannot be positively identified to species will be categorized as *Brachyramphus* murrelet. Data will be recorded directly onto a waterproof data sheet (Appendix D) by one of the observers.

BUDGET ($K)

	USFWS	USFS	TOTAL
Personnel	$ 185.5	$ 38.9	$ 224.4
Travel	15.0	4.5	19.5
Contractual	61.8	23.0	84.8
Commodities	12.0	0.9	12.9
Equipment	36.7	1.5	38.2
Subtotal	$ 311.0	$ 68.8	$ 379.8
General Administration	32.1	7.4	39.5
Total	$ 343.1	$ 76.2	$ 419.3

RESTORATION PROJECT NUMBER 47

Study Title: Stream Habitat Assessment

Lead Agency: ADF&G

INTRODUCTION

Coastal stream systems and associated riparian areas are important habitat for a number of species that were injured by the Exxon Valdez oil spill. Stream surveys by ADF&G intend to focus on habitats that are of potential importance to pink salmon, Dolly Varden char, cutthroat trout, harlequin ducks, and bald eagles. These species are documented to have sustained injuries as a result of the oil spill, and all are associated to some extent with stream environments. Pink salmon, Dolly Varden char and cutthroat trout are anadromous species of fish that utilize freshwater environments for important life functions such as spawning, rearing and overwintering. Harlequin ducks use freshwater streams for nesting and feeding activities. Bald eagles frequently nest in the vicinity of freshwater streams where feeding opportunities are abundant.

Pink salmon exhibited higher than normal egg mortality rates in oiled areas (70 percent in 1989; 50 percent in 1990), and fry showed evidence of gross physical abnormalities. Dolly Varden char and cutthroat trout sustained higher than normal annual mortalities (up to 32 percent) compared to unoiled areas; cutthroat trout had reduced growth rates in oiled areas. In excess of 200 harlequin ducks died from direct exposure to oil in 1989, and studies indicate that ducks may have suffered a nearly complete reproductive failure in the Prince William Sound oil spill area during 1990 and 1991. At least 144 bald eagles died as a result of direct exposure to oil or by eating oiled carrion, and bald eagles have experienced higher rates of nest failure in oiled areas.

Certain development activities, particularly clearcut logging of mature forests, represent a potential threat to fish and wildlife resources that rely on these habitats for critical life functions. This threat is expressed as an incremental loss of habitat that may impede the recovery of injured species populations or may inflict additional injury. The proposed surveys are intended to focus on private lands that are scheduled for logging or other types of major habitat alteration. Unless these surveys are conducted in 1992, opportunities may be lost to identify and protect key habitats that sustain fish and wildlife populations. The surveys will cover the entire spill area.

Survey data will be designed and presented to provide the basic habitat information needed to identify and prioritize the most important habitat areas for protection and enhancement decisions.

Another benefit is that previously unidentified streams will be added to the ADF&G Catalog and Atlas of Anadromous Waters and consequently protected under the provisions of the state's Anadromous Fish Act and Forest Practices Act.

Stream habitat surveys will be coordinated with ADF&G Sport Fish and Wildlife Conservation division efforts to restore other injured species habitats. In the case of Dolly Varden/cutthroat trout, surveys may enhance the possibility of recovering tagged study fish and provide new information on Dolly Varden/cutthroat trout distribution and habitat, particularly in areas outside of Prince William Sound. In the case of harlequin ducks, key habitat requirements remain undefined for birds in the oil spill area; therefore, survey results can assist in documenting features that promote habitat use. It is also possible that surveys may record observations of previously unidentified bald eagle nesting habitat.

OBJECTIVES

The overall goal of this project is to facilitate the recovery of injured species and prevent additional injury by protecting important stream habitats and riparian zones in the oil spill area from logging and other potentially detrimental activities. This goal will be met by accomplishing the following objectives and tasks:

Objective 1:

Using the Trustee Council process for identifying and evaluating lands and habitats necessary and appropriate for protection, identify and prioritize private lands where an imminent and significant habitat alteration threat exists.

Task:

A. Evaluate private lands by employing aerial photographs and the ADF&G Anadromous Waters Catalog to select potential areas for expanding fish distribution or identifying new streams.

B. Determine development schedules. Obtain approvals for access to private lands for purposes of conducting stream habitat surveys.

C. Review permit application and approvals.

Objective 2:

Initiate surveys on private lands to document anadromous fish distribution and stream habitat characteristics.

Task:

A. Locate sites and record habitat characteristics using a Global Positioning System (GPS). Record the upstream distribution of fish using a backpack electroshocker.

Objective 3:

Provide decision-makers with products that can be used in implementing protective measures or developing acquisition strategies.

Task:

A. Conduct post-processing of GPS locational data and integrate with the survey results into a Geographic Information System (GIS) database. Develop maps delineating fish distribution and habitat parameters. Compile an project report detailing results of stream surveys. Provide digital data upon request to supplement related restoration projects.

METHODS

A. Sampling Methods

In order to be responsive to the needs of the restoration program, study site selection will be influenced by the following factors: 1) a prioritized list of private lands in the oil spill area that are scheduled for development within the next five years; 2) policy decisions by the Trustees that focus on certain lands for potential acquisition or some other protection strategy; 3) the approval of land owners to access lands for purposes of conducting surveys; 4) existing Anadromous Waters Catalog information that depicts a potential for expanding anadromous fish resources in candidate areas; and 5) integration with other upland habitat assessment studies.

Once potential sites are selected, one or two reconnaissance visits will be conducted in each area to assess general hydrologic, topographic and vegetative features. This information will be used to determine the overall approach to conducting a more detailed survey of the area. Considerations to be addressed during initial site reconnaissance are access, vegetative cover, helicopter logistics, obvious barriers to upstream fish migration, and estimated time to complete the survey.

Surveys will employ standard, established techniques for recording information and documenting fish distribution. Streams will be surveyed after spawning has begun during the

months of July, August and September. A field crew will walk stream channels and record site locations and habitat characteristics using a Global Positioning System (GPS). Streams will be segmented into homogeneous reaches in order to accurately describe physical features. Habitat characteristics that will be recorded include substrate, gradient, stream width, bank incision, riparian vegetation, and instream debris. In addition, a backpack electroshocker will be used to sample for fish presence. All wildlife observations will be recorded.

The information generated during a stream survey will be downloaded to a laptop computer from handheld GPS receivers and post-processed to provide accurate locational and attribute data. It is intended that this digital data will then be imported to a geographic information system (GIS) for further analysis and mapping. The database structure that is to be used in cataloging various habitat parameters is included in Section XI (Other Information).

Field crews will be based on-site at logging camps, or will utilize other facilities such as recreational cabins for base camps.

B. Standard Operating Procedures

Not applicable.

C. Quality Assurance and Control plans

All habitat parameters and species counts will be integrated with location data to form a GIS database. Geographic coordinates will be logged at regular intervals using a Trimble GPS Pathfinder receiver, and attributes such as species counts and habitat parameters will be entered into the data logger through bar codes. During post processing, the coordinates will be verified and adjusted through a differential correction process, utilizing base station control positions. Upon arrival at a survey site, aerial photographs will be taken of the stream to obtain as large a coverage as possible to allow for further verification of location data.

The stream habitat portion of the data will be transferred to a laptop computer after each survey. Downloaded data and forms containing species counts and general stream information will be reviewed prior to submittal for data processing, and after data entry.

D. Safety Requirements

Prior to onset of the field season all personnel who will go on any survey will be trained or updated as necessary to be current on the following: Red Cross First Aid and CPR, bear training and wilderness survival training. According to current FAA procedures, the survey crew is briefed on specific helicopter safety procedures by the pilot before each takeoff.

F. Animal Health and Welfare

Not applicable.

DATA REDUCTION AND ANALYSIS

A. Methods

The intent of this study is to document the presence of anadromous fish species and the upper limits of their distribution, and to map habitat parameters within these limits. As such, statistical analyses are not warranted and data reduction will be limited to GIS processes and production of tables. Upon data entry and QA/QC, the data will be loaded into R:BASE, and integrated into GIS through Geo/SQL for final output in Autocad. It is intended that this process will occur in real time. R:BASE will serve as the basis for data storage, table generation and data transfer.

DELIVERABLES

Data output will consist of color coded maps and overlays depicting stream sections and their associated habitat parameters, annotated incidental species catches, and documented upper limits of anadromous species. Tables of this information with additional references to wildlife observations, sampling conditions and location information will be generated, accompanied by a summary report. Digital data and Autocad transfer files will be available upon request. An accompanying report will describe survey methodology and results in narrative form.

SCHEDULES AND PLANNING

A. Data Report and Submission Schedule

April 1, 1992
Work with Restoration Team to fit project into land and habitat identification draft process.

May 15, 1992
Land identification process completed. Access approvals obtained.
June 1, 1992
Training for field personnel. Equipment purchases. Specific survey planning.
July 1, 1992
Stream surveys begin. At biweekly intervals, data will be submitted to the Anchorage regional office and processed. Surveys will continue on a 10 day on, 4 day off schedule throughout the next ninety days.
September 30, 1992
End of data collection.
October 30, 1992
Data QA/QC has been completed for all streams surveyed during the season. Generation of final maps and data tables begins.
November 30, 1992
Maps and tables undergo final review. Report production begins.
December 15, 1992
Report and data submission deadline.

Field staff will be deactivated on November 30. The principal investigator and data management coordinator will continue through the remainder of the fiscal year. Ongoing responsibilities include 1) coordination with the Restoration Team (RT) on land acquisition and protection strategies; 2) coordination with private land owners on land development planning; 3) coordination with NRDA and restoration scientists on survey results; 4) administrative and logistical planning.

B. Sample and Data Archival

Data forms, field logs, diskettes and rolls of photos will be transferred to the Anchorage office. Upon transfer, copies of the above will be submitted to RT for archiving. The originals will be archived at Habitat, ADF&G in Anchorage. For each stream surveyed, a stream file will be set up that will contain all updates and documentation pertaining to this stream. Data files will be backed up after each modification, along with a digital file listing in detail each modification.

C. Management Plan

Coordination and overall project supervision will occur in Anchorage. The principal investigator will attend all necessary meetings, participate in the land identification process, conduct site reconnaissance surveys and participate in stream habitat surveys. In addition, the principal

investigator will be responsible for all administrative duties including budgeting, logistics, and training. The data management coordinator will oversee all data-related functions, including GPS post-processing, database development, GIS mapping and report generation. The data management coordinator will also serve as the primary field supervisor. The remainder of the field crew, including one crew leader and two technicians, will be responsible for acquiring stream habitat data.

D. Logistics

Logistics are contingent upon the region in which the study is located. For surveys in Kachemak Bay and the outer Kenai Coast, field personnel will reside in Homer and fly daily by helicopter from Homer to the survey streams. For surveys in Prince William Sound and on Afognak Island, the field crews will be accommodated in logging camps or Forest Service cabins. A helicopter and pilot will be stationed with the crew at each camp in order to minimize the number of lost days due to poor weather between the flight service and the crew's location. Fuel will be cached near the base camps by boat prior to the field season. Estimates of helicopter charter costs are based upon previous ADF&G experience conducting stream habitat surveys on Montague Island in Prince William Sound. Actual helicopter needs will vary with specific site conditions.

PERSONNEL QUALIFICATIONS

Principal Investigator:

Mark N. Kuwada. Habitat Biologist with the Alaska Department of Fish and Game for 12 years. Extensive experience in mitigating major project impacts and restoring injured habitats: Susitna Hydroelectric Project; Bradley Lake Hydroelectric Project; Diamond Chuitna Coal Project. Response Coordinator, Exxon Valdez oil spill, for ADF&G.

Project Assistant:

Kathrin Sundet. Habitat Biologist and Fisheries Biologist with the Alaska Department of Fish and Game for 7 years. Data management for Kinnetic Labs, America North Inc., and environmental consulting companies in California for 4 years. Experience in management of biological databases, GIS, fish habitat evaluations and various fisheries related field projects: Susitna Hydroelectric Project and Exxon Valdez oil spill.

	BUDGET ($K)
Salaries	$211.0
Travel	7.8
Contractual	85.4
Supplies	31.0
Equipment	25.0
Subtotal	$360.2
General Administration	39.4
Total	$399.6

RESTORATION PROJECT NUMBER 71

Study Title: Harlequin Duck Restoration and Monitoring

Lead Agency: ADF&G

PROJECT JUSTIFICATION

Component I

The Exxon Valdez oil spill of March 24, 1989, heavily impacted the harlequin duck (Histrionicus histrionicus) population in western Prince William Sound. The Sea Duck Study in Bird Number 1 reported sublethal symptoms of petroleum hydrocarbon contamination, including an apparent reproductive failure in harlequin ducks (Patten 1991).

Harlequin ducks breed along mountain streams in coastal old growth forests in Prince William Sound. Harlequin ducks have a relatively low reproductive rate because of small brood size (3.4 ducklings/brood in Prince William Sound), second year sexual maturity and low breeding frequency (<50%) of hens (Dzinbal 1980, Crowley 1991). Harlequin ducks have high fidelity to breeding and wintering areas (Bengtson 1972). Kuchel (1977) stated that several consecutive years of very low production or injury to winter and breeding habitat could completely eliminate a local harlequin duck population.

The Harlequin Duck Restoration Project (Crowley 1991) documented successful harlequin duck reproduction in 1991 in unoiled northern, eastern, and southern (referred to collectively as "eastern" unless specified) Prince William Sound. This area was not impacted by the oil spill. However, large tracts of harlequin duck breeding habitat in old growth forest of prime commercial value are currently scheduled for logging in Prince William Sound.

The impaired status of harlequin duck populations in the Exxon Valdez oil spill area of western Prince William Sound may necessitate protection and management of populations in the non-impacted areas of Prince William Sound. A large population of harlequin ducks in eastern Prince William Sound could provide a pool of immigrants to western Prince William Sound. Recolonization of the oil spill area by reproducing harlequin ducks should eventually occur provided that petroleum hydrocarbons are at sufficiently low levels in the intertidal zone. Management of harlequin duck populations could be accomplished through protection and possible enhancement of undisturbed riparian corridors within timber sale areas. Required width for protection of harlequin ducks using riparian corridors has not been determined conclusively. Nest locations in 1991 indicated that current buffer strips required for protection

of anadromous fish streams may not protect all harlequin duck breeding habitat.

Harlequin ducks are among the least understood waterfowl species in North America. Prior to the 1990 feasibility study, which reported characteristics of streams on which harlequin duck broods were observed, little was known about habitat requirements of harlequin ducks breeding in Prince William Sound. The harlequin duck restoration crew began locating and recording harlequin duck nesting habitat in 1991.

The harlequin duck restoration project in 1992 will continue to document nesting and brood-rearing habitat requirements of breeding harlequin ducks by capturing and radio-tagging hens. Study of nest site habitat, including nest bowl (down-lined depression containing eggs) cover, may provide information for habitat enhancement. By documenting breeding stream habitat within the structure of a hierarchical stream profile, a model predicting potential breeding habitat will be developed for use in the oil spill area and other coastal areas. A catalog of harlequin duck breeding streams in eastern Prince William Sound will be completed. Duckling survival and productivity will be determined by monitoring radio-tagged hens throughout the brood-rearing period. Molting habitat and population status will be determined using standardized boat survey methods developed in 1991.

OBJECTIVES

1. Locate, identify and describe harlequin duck nesting streams in Prince William Sound.

2. Identify habitats used by nesting and brood-rearing harlequin ducks by documenting topographic, hydrologic and vegetative characteristics at nest sites and brood-rearing areas.

3. Identify other harlequin duck breeding habitat parameters such as distance from nest to coast, distance from nest to stream and physical features of nest sites.

4. Construct a model that predicts potential harlequin duck nesting streams and high quality habitat along those streams using the characteristics identified in objectives 2 and 3.

5. Measure harlequin duck breeding productivity by identifying clutch size, hatching success, and duckling survival to fledgling.

6. Document sightings of harlequin duck breeding behavior including pair-bonding, nest prospecting, nesting, and brood-rearing in eastern Prince William Sound to provide a study control for

the harlequin duck monitoring study in the Exxon Valdez oil spill area.

7. Determine width of forested buffer strips required to protect harlequin duck breeding sites from the effects of timber harvest in Prince William Sound.

8. Determine feasibility of stream habitat enhancement by erecting artificial nesting cavities (nest boxes) along known breeding streams and testing for use by harlequin ducks.

METHODS

The Prince William Sound Harlequin Duck Restoration Project is now in its second year; the methods described below have been used and modified as necessary.

If present, breeding harlequin ducks of both sexes and nonbreeding hens can be readily captured during twilight hours as they fly to and from estuaries from breeding stream habitat in spring and early summer. Harlequin duck trapping efforts will begin in late May 1992 on streams used by breeding harlequin ducks in 1991. Harlequin ducks will be caught during their nest prospecting, egg-laying and incubation periods by suspending mist nets over breeding streams.

All captured harlequin ducks will be weighed, measured and banded with a USFWS leg band. A blood sample will be drawn from each harlequin duck to help determine if harlequin ducks from eastern Prince William Sound may winter in the Exxon Valdez oil spill area. Blood samples will also be used to compare physiological condition of harlequin ducks between study areas. Captured harlequin hens, regardless of breeding status, will be tagged with a small (4.5 g) radio transmitter and released. Transmitters are glued to the bases of center tail feathers and will be shed in early September. The transmitter did not noticeably affect diving, preening or breeding of harlequin ducks in 1991.

When harlequin duck nests are located, eggs will be counted, weighed, measured and candled to determine approximate stage of incubation (Weller 1956). Project staff will return to nests located in 1992 and to those located in 1991 again during the 1992 field season to count membranes and addled eggs to determine hatching success. The Mayfield method (Klett and Johnson 1982) will be used to determine nesting success. Terrestrial and aquatic habitat of breeding and non-breeding streams will be recorded and statistically compared using a principal components analysis. This test will determine habitat characteristics important for nesting and brood-rearing harlequin ducks.

The use of wooden nest boxes by harlequin ducks will be tested by placing 20-25 boxes along known breeding streams, near known nest sites in spring 1992. A box design has been developed based on specifications of nesting boxes used by aviculturalists to breed harlequin ducks in captivity. If harlequin ducks follow behavioral patterns described for other sea ducks, limited use of nest boxes would be expected during the first year and increased use in subsequent years, especially by first-time breeders. Should the results indicate that harlequin hens readily select artificial cavities for nesting, and if nest cover is a limiting factor on streams in Prince William Sound, this technique could potentially increase stream nesting density of harlequin ducks. Such an increase would accelerate restoration of harlequin ducks in western Prince William Sound, provided that petroleum hydrocarbons are no longer present in the intertidal food chain.

During the last two weeks of May, approximately 350 miles of unoiled coastline and estuaries from Cordova to Valdez will be surveyed for harlequin duck flocks and breeding pairs. Surveys will be repeated in late June through early July in both study areas to locate and document important molting habitat, and repeated again in August for brood documentation.

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Component II

The Division of Wildlife Conservation, Alaska Department of Fish and Game, will conduct a 1992 monitoring study of a population of harlequin ducks that suffered reproductive failure in western Prince William Sound as a result of the Exxon Valdez oil spill of March 24, 1989.

Harlequin ducks are a resident waterfowl species breeding in Prince William Sound during the spring and summer (Isleib and Kessel, 1973; Hogan, 1980). Harlequin ducks, because of their resident, breeding status and intertidal foraging habits, have been considered substantially at risk from effects of the Exxon Valdez oil spill (King and Sanger, 1979).

Harlequin ducks feed in the intertidal zone and consume a wide variety of intertidal clams, snails, small blue mussels, and limpets (Koehle, Rothe and Dirksen, 1982; Dzinbal and Jarvis, 1982; Vermeer and Bourne, 1982). Bivalves, particularly blue mussels (Mytilus), and small clams (Macoma), are well-known for their ability to concentrate pollutants at high levels (Shaw et al, 1976). The crude oil spilled from the T/V Exxon Valdez injured marine invertebrates that support sea ducks throughout the year (Stekoll, Clement, and Shaw, 1980). Bioaccumulation in the food chain may result in uptake of petroleum hydrocarbons by sea ducks over a long period (Dzinbal and Jarvis, 1982; Sanger and Jones, 1982).

Other studies in the seabird literature have indicated that low doses of petroleum exposure through ingestion have resulted in failure to reproduce (Fry et al, 1986). Birds fed single doses of petroleum oils exhibited altered yolk structure and reduced hatchability of eggs (Grau et al, 1977). These results are in accordance with theoretical predictions of effects of petroleum exposure through the food chain to higher trophic level invertebrate predators such as seaducks. The duration of this reproductive failure is unknown.

Consumption of oiled invertebrate prey items is the probable mechanism of sublethal petroleum hydrocarbon exposure. The degree of exposure is in turn most likely related to the foraging areas of the respective species. The zone of maximum oil impact is demonstrably the intertidal area. Harlequin ducks, because of their intertidal foraging habitats, appear most exposed of six seaduck species examined.

Buried oil occurs in Prince William Sound and relatively unweathered crude oil remains in mussel beds where harlequin ducks and

other seaducks feed. As long as substantial oil remains in Prince William Sound, particularly in the intertidal, harlequin ducks may fail to breed, and monitoring is required. Since harlequin ducks are sensitive to disturbance, the lessening of the massive disturbance associated with clean-up activities in Prince William Sound also provides the setting for a natural monitoring experiment to test the effects on harlequin duck reproduction.

Post-oil spill reproduction, recolonization, and survival of harlequin ducks in the oil spill area of Prince William Sound are to be addressed in this study. Harlequin ducks may serve as an indicator of the health of the recovering ecosystem, but their recovery will be impeded as long as their food chain remains contaminated with petrochemicals.

OBJECTIVES

1. Monitor scope, magnitude, and duration of harlequin duck reproductive failure in western Prince William Sound; determine the extent of this phenomenon in northern and southern Prince William Sound. In other words, where does normal harlequin duck reproduction begin? Extend monitoring of harlequin duck reproductive failure within Prince William Sound; conduct surveys to establish areas of use; survey numbers of harlequin ducks using oiled vs. non-oiled streams.

2. From the concluding Damage Assessment Study, relate pending petroleum toxicology analysis of blue mussels (Mytilus) and other invertebrates from seaduck proventriculus samples collected in '89 -'90 to histopathological analyses and to continued reproductive failure of Prince William Sound harlequin ducks in monitoring study.

3. Relate the reproductive status of harlequin ducks in the Monitoring Study to the presence of Exxon Valdez oil in established blue mussel (Mytilus) beds in Prince William Sound.

4. Compare habitat, food items, and other characteristics associated with streams on which successful reproduction is occurring in eastern Prince William Sound with "similar" streams having no reproduction in western Prince William Sound.

5. Determine effect of reduction of disturbance associated with cessation of clean-up activities on reproductive performance of harlequin ducks in Prince William Sound.

6. Continue review of issue of sport and subsistence harvests of harlequin ducks, especially in reference to Kenai Peninsula and Kodiak Island. Hunting in Prince William Sound was closed to take of harlequin ducks for the month September 1991 in order

to protect remaining resident individuals from additional mortality.

METHODS

This project uses established methodology derived during three previous years of harlequin duck damage assessment studies and two previous years of harlequin duck restoration work.

ADF&G will perform an analysis of the reproductive failure of harlequin ducks observed in the oil spill area of western Prince William Sound in 1990-91. This activity will answer physiological and behavioral questions such as: what is the nesting status of harlequin females along streams in western Prince William Sound? Were all females exhibiting fidelity to nest sites removed from the western Prince William Sound population by the oil spill and thus no nesting? If nesting is occurring, are eggs viable? Are hatching and fledging success depressed? If ducklings fledge in the oil spill area in 1992, brood size (a productivity measurement) will be compared to unoiled areas of Prince William Sound.

The ADF&G will conduct extensive surveys of anadromous streams and molting sites used by harlequin ducks in Prince William Sound. Harlequin duck breeding pairs and young females normally prospect for nest sites during twilight hours in spring along mountain drainages flowing into Prince William Sound. Incubating females fly from nest sites to feed in intertidal estuaries. Mist nets were placed by ADF&G personnel across the mouths of twelve of the larger anadromous fish streams in western Prince William Sound in spring and summer 1991. If harlequin ducks attempt reproduction in the oil spill area in spring 1992, incubating females will be mist-netted and radio-tagged at stream mouths. These harlequin ducks will be radio-tracked along streams to nesting sites. Nesting females are secretive and nests otherwise difficult to locate. If breeding is verified, ADF&G will determine harlequin duck productivity by following radio-tagged hens and offspring through the nesting and brood-rearing cycle. Clutch size, hatching success, and brood size (a productivity index) will be obtained from sample nest sites in oiled areas. Limnological work on nesting and non-nesting streams will be expanded using standard techniques. Results will be compared to the harlequin duck restoration study in unoiled eastern Prince William Sound, which acts as an unexposed (control) case.

File searches at the Oil Spill Public Information Center and US Coast Guard Exxon Valdez oil spill libraries will also be conducted to obtain existing documentation of presence of oiled mussel beds in Prince William Sound and will cooperate fully with the proposed 1992 NOAA mussel bed restoration study.

Toxicological and histopathological tissue sample results will be obtained from the concluding Seaduck Damage Assessment Study. These results will be related to the physiological and reproductive data in the monitoring study.

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	BUDGET ($K)
Salaries	$191.3
Travel	50.0
Contractual	74.3
Supplies	35.0
Equipment	40.0
Subtotal	$390.6
General Administration	33.9
Total	$424.5

2G. RESTORATION MANAGEMENT ACTIONS

The Trustee agencies were responsible for managing the resources affected by the Exxon Valdez oil spill prior to its occurrence. Management actions control human access to and harvest of a resource in order to ensure its continued abundance in the future. At one extreme no harvest of a resource would be allowed, or perhaps access to nesting sites would be restricted. Some birds often fall into this category. At the other extreme, commercial fishing for a particular species is often allowed up to the maximum sustainable yield (that maximum level of harvest which does not cause a decline in recruitment to future populations). The Exxon Valdez oil spill increased the effort and expense of management actions needed to provide the same level of resource protection as prior to the spill. Therefore the Trustee Council decided that expenditure of settlement monies was appropriate for projects that make management actions possible which would promote recovery of injured species. Five projects in this category were funded to go forward and two received sufficient funds to close out the projects.

Kenai River Sockeye Salmon Restoration, Restoration Project Number 53 (R53), and Assessment of Genetic Stock Structure of Salmonids (R59) combine efforts to identify stocks of sockeye from different Cook Inlet drainages. Techniques perfected in 1992 will be used in 1993 (the first year of expected poor adult returns) to identify stocks of salmon as they enter Cook Inlet. Fishing for stocks bound for the Kenai system will be restricted or closed while fishing for non-impacted stocks will be allowed. Because of this, sufficient adults may avoid the fisheries and return to the Kenai River to spawn and restore these stocks while commercial fishermen are still able to harvest some fish bound for non-Kenai systems.

Pink Salmon Stock Identification (R60AB) will recover and read coded wire tags placed in Prince William Sound pink salmon in 1991. Outmigrating fry were tagged with codes unique to each stream. The tags are removed from the heads of returning adults and read with a microscope. This knowledge helps managers re-direct the fisheries away from impacted wild stocks. Many people are required to recover these tags from fisheries, canneries and streams, but this effort in 1991 helped many wild streams make escapement goals.

In 1989, most oiled mussel beds were subjected to aggressive treatment. In 1990 and 1991, oiled mussel beds were purposefully spared from these types of treatment because it was believed that more harm than good would result from application of these techniques. Because of the nature of mussel beds, oil was trapped between mussels and the rocks to which they were attached and has remained unweathered to the present. Mussel communities are important in the diets of several oil-impacted birds and mammals. Destruction of the oiled beds would remove a food source for these

animals whereas leaving the beds continues to expose the animals to toxic mussels and oil. The Oiled Mussel Bed Project, Restoration Project Number 103 (R103), will determine the effects of oiled beds on these other animals and devise amelioration options.

In the cleanup process following the Exxon Valdez oil spill, many archeological sites were discovered or became more widely known. Vandalism of some of these sites occurred and because of the increased awareness of their existence, vandalism may increase in the future. Some sites are sacred to Alaska's Native peoples and other sites will provide information about native heritage if they are excavated using scientific archaeological techniques. Vandalism desecrates some sites and forever destroys the opportunity to learn from others. Protecting these sites is not an easy task and is a skill requiring instruction. Site Stewardship (R104A) recruits, educates and involves local people from throughout the spill zone in the process of protecting archeological resources.

The two projects being brought to a close by the Trustee Council, the Harbor Seal Restoration Study (R73) and Technical Support for the Restoration of Dolly Varden and Cutthroat Trout, Restoration Project Number 106 (R106), have some costs associated with completing the field work and preparing final reports. The information in these reports will be used by resource managers to reduce human use of these species until they can recover.

RESTORATION PROJECT NUMBER 53

Study Title: Kenai River Sockeye Salmon Restoration

Lead Agency: ADF&G

PROJECT JUSTIFICATION

Sockeye salmon (Oncorhynchus nerka) which spawn in the Kenai River system (Figure 1) were injured by the Exxon Valdez oil spill. Greatly reduced fishing time in the Upper Cook Inlet area due to the oil spill caused sockeye salmon spawning escapement levels in the Kenai River system to exceed the desired amount by three times. The biological impact of the oil spill on Kenai River sockeye salmon stocks is expected to be serious. Data collected by NRDA Fish/Shellfish Study 27, Sockeye Salmon Overescapement, indicated greatly reduced survival of juvenile sockeye salmon during the winter-spring rearing period. The extremely high escapement may have initially produced more rearing juvenile sockeye salmon than could be supported by nursery lake productivity. In general, when rearing salmon abundance greatly exceeds lake carrying capacity, the species and size composition of prey resources are altered, which affects all trophic levels. Because of such changes, juvenile sockeye growth is reduced, freshwater mortality is increased, greater proportions of fry remain in the lake for another year of rearing, and smolt condition is reduced and marine mortality is increased. Limiting sockeye salmon fry production by closely regulating the number of spawning adults may be the only way to restore the productivity of these rearing areas. However, the number of adult sockeye salmon returning from the 1989 escapement may be so low that a severe reduction, or complete elimination, of human use of this species may be necessary starting in 1993 to ensure minimum escapements.

The goal of this project is to restore Kenai River sockeye salmon stocks injured by the Exxon Valdez oil spill. This will be accomplished through improved stock assessment capabilities, more accurate regulation of spawning levels, and modification of human use. Restoration of Kenai River sockeye salmon stocks will be achieved when average fry, smolt, and adult production can be maintained. Prey resources of rearing lakes must also be restored to normal levels (This will be monitored under another restoration study, which will be based on information obtained from NRDA Fish/Shellfish Study 27).

OBJECTIVES

The objectives of this study are to:

1. Improve stock identification capabilities by combining parasite and genetic stock identification information with available scale growth data in algorithms to provide estimates of Kenai River stocks in the mixed stock fishery of Upper Cook Inlet (UCI);

2. Increase the accuracy and precision of escapement monitoring by replacing obsolete hydroacoustic equipment; and,

3. Provide more accurate estimates of abundance of Kenai River sockeye salmon within UCI by increasing the sampling power of the offshore test fishing program.

METHODS

Stock identification

Stock identification studies used to regulate human use of UCI sockeye salmon have in past years relied on scale growth patterns. The accuracy and precision of this technique has varied considerably from year to year (Waltemyer, D., personal communication, ADF&G). Kenai stocks typically dominate the total return, and their scale patterns are generally distinct enough to provide some separation from other stocks. However, when runs to other systems are more abundant (as may occur in 1993 and 1994) separation of Kenai stocks will be much more difficult. To be able to identify the contribution of Kenai River sockeye salmon to the total run accurately in this situation will require improvements in stock identification procedures. Recent work by the Principal Investigators, in cooperation with National Marine Fisheries Service staff, has shown that parasite occurrence can be used to improve estimates of stock contribution during the fishing season. The combination of scale patterns, parasites and genetic stock identification techniques (Restoration Science Study Number 59) should greatly increase the accuracy of UCI stock assessment estimates.

Sockeye salmon escapements into major drainages of Upper Cook Inlet (Table 1) will be sampled for genetic, parasite, scale and otolith characteristics. During the first year, 25 baseline populations will be sampled for genetic characteristics. In addition, mixed stock samples will be collected from four mainstem sites and from two drift net fishing periods. Sample sizes for allozyme baseline collections have been set at 100 to maximize the precision around allele frequency estimates (Allendorf and Phelps 1980, Waples 1990). Mixed stock sample sizes have been set at 200 (Pella and Milner 1987) and will be adjusted in 1993 based on the results of simulation studies conducted with 1992 baseline data (Restoration Science Project R59).

Muscle, liver, eye, and heart will be dissected from recently killed sockeye salmon. Tissues will be placed in labeled cryovials

stored in liquid nitrogen until transferred to -80^{0}C storage freezers in Soldotna or Anchorage. Soldotna samples will be shipped to the Anchorage laboratory on dry ice or liquid nitrogen and again placed in -80^{0}C storage until processed.

The body cavity of each sockeye salmon will be examined for the presence of the nematode Philonema oncorhynchi (Tarbox et al. 1991). Scales will be taken from the left side of each sockeye salmon sampled. These scales will be removed from a location approximately two rows above the lateral line on the diagonal row that extends down from the posterior insertion of the dorsal fin (Koo 1955). Sacculus otoliths will be taken using procedures of Williams and Bedford (1973).

Escapement Monitoring

Bendix Corporation side scan hydroacoustic equipment has been used to count adult sockeye salmon entering the Kenai River to spawn. This equipment has been used since 1976 and, while repairs and modifications have been done by a retired Bendix employee under contract to the State, is no longer manufactured by Bendix Corp. Not only has it been difficult to obtain parts for these units, but advances in hydroacoustic technology have made this equipment obsolete. New units are able to track individual fish, obtain target strength measurements, and document calibration. Court actions associated with the Glacier Bay oil spill in UCI placed the hydroacoustic escapement monitoring program under intense scrutiny. Although Ehrenberg (1992) concluded that the Bendix counters produced reliable escapement counts under conditions found in UCI systems, it is imperative that replacement alternatives be pursued. Lack of Bendix replacement parts and the inability to purchase new Bendix counters may compromise the future ability to provide escapement estimates. Accuracy of estimates would certainly be enhanced through use of newer, more technically advanced equipment.

Two hydroacoustic equipment manufacturers will be selected to perform "in situ" tests of their equipment during the 1992 field season. Criteria for selection of hydroacoustic contractors will include: 1) historical performance (counting precision and accuracy) in similar environments; 2) specifications on manufactured systems including frequency, transducers; pulse repetition rates, multiplexing ability, beam characteristics, repair record, total cost (including maintenance), remote site use, and fish passage rate limitations; 3) data processing requirements, including software and hardware; 4) real time ability to track individual fish, calculated hourly passage rate, estimate target strength, determine direction of fish travel, and provide permanent data; and 5) personnel training required to operate system, including specialized areas of expertise.

"In situ" field tests will be conducted on the Kenai River. A minimum of 48 hours of data will be collected during a 72 hour

period on each river bank (a total of 96 hours of data collection). This data will be compared with data from the existing Bendix counters. Operation of the equipment will be the responsibility of the manufacturer's representatives. Individual target and site information will also be required. These data will include transducer aiming and bottom characteristics, counting range, threshold used, pings/target, target strength, direction of fish travel, fish tracking parameters used, calibration records for each hydroacoustic unit used, beam pattern factors, and standard "in situ" target measurements.

Evaluation of 1992 tests will result in selection of the most appropriate replacement system. During the 1993 and 1994 field season the manufacturers, under the direction of ADF&G, may conduct continuous operations on both river banks during a three week period (to encompass the peak of the sockeye salmon run). During this period the Bendix counters will also be operated so that redundant counting systems will be in place and additional comparison data can be generated.

Offshore Test Fish Program

The sockeye salmon total run to UCI has been estimated early during the season by test fishing between Anchor River and Red River delta (Tarbox, 1992). Sockeye salmon returning to UCI are captured with a drift gill net at a series of stations. Salmon are identified to species and sex and length measurements made. Estimates of total sockeye salmon return are made several times during the season by estimating expected total test fishery catch per unit of effort (CPUE) for the season and catchability of sockeye salmon in the test fishery. Analysis of historical data has indicated that existing sampling effort and catch has not been proportional to abundance. To assess run size more accurately, additional sampling effort will be added to the existing program. Starting in 1992 hydroacoustic equipment and techniques will be developed through a contractor experienced in marine salmon investigations. This technique will be used to monitor and verify drift gill net results. This information, when combined with improved information on stock identification and escapement monitoring, should allow better regulation of human use to ensure spawning goals are met.

During the 1992 field season a feasibility study will be conducted in the area of the existing test fish program. Replicate transects, each covering 6 km, will be made. Preliminary estimates indicate that a minimum of four transects per day can be completed. However, the actual number of replicates obtained will depend on weather and other factors. The contractor will be responsible for all aspects of the project including field data collection and data analysis. Anticipated results include: 1) operating parameters of the hydroacoustic system used, 2) real time estimates of fish density, 3) fish distribution across the transects, and 4) definition of run timing models and total return estimates.

Quality Assurance and Control Plans

Written instructions for the collection and analysis of all data will be prepared and made available to each project participant. In addition, a team, composed of Al Menin (designer of the Bendix sonar counters), representatives of the Chief Fisheries Scientist office, and local staff will be formed to thoroughly review all aspects of the hydroacoustic studies. Written findings of the review team will be maintained as part of the project records.

Information required from other investigators

Analysis of genetic samples will be conducted under Restoration Science Study 59. Incorporation of genetic data into UCI stock identification models will remain part of this investigation.

Safety requirements

Personnel will be trained in standard safety procedures required for ADF&G work. Special instruction in handling liquid nitrogen for storage of genetic samples will be provided under Restoration Science Study 59.

Animal Health and Welfare

Sockeye salmon will be killed to obtain genetic samples.

DATA ANALYSIS

Stock Identification

Stock composition of mixed stock fishery samples can be estimated using scale pattern analysis (Bethe et al. 1980, Cross et al. 1981, 1982, 1983, 1986), parasite data (Tarbox et al. 1991), genetic data (Pella and Milner 1987), or a combination of all three (Fournier at al. 1984, Wood et al. 1987, 1989).

Stock resolution will be enhanced by using several kinds of biological marker data simultaneously. Typically a maximum-likelihood estimation procedure for a mixture problem with learning samples has been used to combine these data (Millar 1987; Wood et al. 1987). Scale, parasite, and genetic data have been combined for sockeye salmon returning to British Columbia, Canada, and Southeast Alaska (Wood et al. 1989), while parasite data has been used in conjunction with scale data in Southeast Alaska (personal communication Kathleen Jensen, ADF&G, Douglas, Alaska).
This methodology assumes there are a total of K stocks which could occur in the mixture. For each stock j, an independent random sample of fish is taken and for each fish r, a vector of character-

istics $\mathbf{X}_{jr}$ (scales, parasites, genetics) is observed. It is assumed that for each stock the vector of observed characteristics for a fish from that stock is a random vector with a probability mass function $f_j(\mathbf{X};\mathbf{A}_j)$ which depends on the unknown parameters $\mathbf{A}_j$. In addition, there is also a random sample of fish indexed by s which is taken from the mixture, and $\mathbf{Y}_s$ is the vector of characteristics of the sth fish taken from the mixture.

Let p_j, $j = 1,\ldots,K$, be the proportion of the mixture which is composed of the jth stock. The maximum-likelihood estimates for the A_j and p_j are found by maximizing the likelihood function, i.e. finding the solution to the problem

$$\max_{p_j A_j} \left[\sum_j \sum_r \log_e(f_j(X_{jr};A_j)) + \sum_s \log_e\left(\sum_j p_j f_j(Y_s;A_j) \right) \right] \qquad (1)$$

subject to the constraints

$$p_j \geq 0 \quad and \quad \sum_j p_j = 1.$$

Rather than dealing with the somewhat difficult maximization problem (1), Fournier et al. (1984) first found the values $\hat{A}_j$ which solve the problem

$$\max_{A_j} \left[\sum_j \sum_r \log_e(f_j(X_{jr};A_j)) \right] . \qquad (2)$$

These are the maximum-likelihood estimates for the $\mathbf{A}_j$ given the learning samples alone. They then estimate the p_j by finding $\hat{p}_j$ which solve the problem

$$\max_{pj} \left[\sum_s \log_e\left(\sum_j p_j f_j(Y_s;\hat{A}_j) \right) \right] . \qquad (3)$$

Escapement monitoring

Regression analysis will be used to compare tested sonar units to the Bendix units. Residuals of the regression will be visually examined and appropriate data transformations used, if necessary, to insure that assumptions are met. A formal statistical test will be used to determine if a correlation exists (H_o : $b_1 = 0$; Neter et al. 1990). If a relationship is detected, a second test will be preformed to determine whether the slope is different from 1.0 (H_o : $b_1 = 1.0$). A slope of 1.0 indicates no detectable difference in

counting performance between the counters. All statistical tests will be performed at $\alpha = 0.05$.

DELIVERABLES

A report detailing the 1992-1993 sample acquisition and sample analysis will be completed by February, 1993.

Periodic progress reports at the completion of significant phases of the project (e.g. selection of hydroacoustic equipment for purchase) will be completed prior to starting the next phase.

SCHEDULES AND PLANNING

Data and Report Submission Schedule

Date	Activity
1992	
March - April	Purchase hardware and supplies for genetic samples
	Develop hydroacoustic criteria for selecting contractors, prepare contract for 1992 field season.
May - June	Award bid for hydroacoustic contracts
July - September	Collect genetic samples
	Test hydroacoustic equipment in Kenai River
	Conduct offshore test fishing feasibility study
October - December	Prepare reports on field activities
1993	
January - February	Submit final report
	Purchase hydroacoustic equipment

Sample and Data Archival

Both hard and electronic copies of data will be archived. Original data will be maintained in the Soldotna office of ADF&G.

Management Plan

Principal investigators will manage activities in close coordination with Lisa Seeb, Anchorage office (Principal Investigator of project 59).

Management Team:

Person	Responsibilities
Kenneth E. Tarbox	Supervise staff, data collection, analysis and report writing, budget responsibility
Linda Brannian	Data base management, data handling and transfer, biometrics support, budget responsibility
Fish Bio II	Supervise permanent/seasonal staff, field data collection, prepare data summaries, preliminary analysis, report preparation
Biometrician	Stock identification model building, statistical design and review of data analysis procedures.
Other staff	Field crew leaders, primary data collectors

Logistics

Support requirements for this project are extensive. Genetic sampling covers 25 systems in UCI, most of which are remote. Therefore, field crews will be required to live in remote field camps for part of the study. Escapement monitoring logistics will require the duplication of counting operations during the peak of the sockeye return. This will require coordination to ensure system compatibility and support. The offshore test fish project will require the contractor to hire a vessel and coordinate with existing ADF&G test fish vessels.

PERSONAL QUALIFICATIONS

Principal Investigator

Kenneth E. Tarbox has been the Research Project Leader for the Commercial Fisheries Division, UCI, ADF&G since 1980. Prior work experience includes 8 years with Woodward Clyde Consultants, Anchorage. He has authored numerous reports and presently he is a co-principal investigator for NRDA study 27.

Linda Brannian is the Regional Biometrician for the Commercial Fisheries Division, Anchorage, ADF&G. She has participated in numerous research projects since joining ADF&G in 1983.

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Table 1. Locations of sockeye salmon stocks to be sampled for genetic, parasite, scale, and otolith characteristics.

River/Drainage/ Fishery	Location	Production Potential[a]	Timing[b]	Sample Size
Susitna River:				
Mainstem	Composite[c]		JUL3	400
Upper	Stephan Lake	63700	SEP1	100
Talkeetna	Larson	45100	AUG4	100
Lower	Redshirt Lake	69500	AUG3	100
Yentna	Composite		JUL3	400
	Chelatna Lake	389200	AUG3	100
	Hewitt/Whiskey	83000	SEP1	100
West Fork	Unnamed Slough		AUG4	100
Skwentna	Shell Lake	103800	SEP1	100
Talachulitna	Judd Lake	59500	SEP2	100
	Trinity/Movie	19300	AUG3	100
Subtotal				1700
Knik Arm:	Fish Creek	192352	SEP1	100
Kasilof River:				
Mainstem	Composite		JUL2	400
	Nikolai Creek	36000	AUG2	100
	Bear Creek	127532	AUG2	100
	Glacier Flat	121400	AUG3	100
	Moose Creek	21200	AUG3	100
Subtotal				800
Kenai River:				
Russian	early		JUN2	100
Russian	late	112000	JUL3	100
Mainstem	Composite		JUL2	400
	Hidden Creek	70000	JUL3	100
	between lakes		AUG3	100
	outlet Skilak Lake		AUG3	100
	Quartz Creek	73345	AUG3	100
Subtotal				1000

Table 1. (Con't.)

River/Drainage/ Fishery	Location	Production Potential[a]	Timing[b]	Sample Size
Bishop Creek:	Daniels Lake	7800	SEP2	100
Westside:				
Big River	Wolverine Creek	32980	JUL4	100
Beluga	West Fork Coal	12000	AUG3	100
Chakachatna	Chilligan	38576	SEP2	100
Subtotal				300
Crescent River:				
Mainstem	Composite	120219	JUL3	200
Subtotal				200
Kalgin Island:	Packers Creek	50026	JUL2	100
Subtotal				100
Total Escapement				4300
Commercial Fishery:				
Drift	Composite (2 fishing periods)		JUL	400
Grand Total				4700

[a] Production potential represents a maximum survey count or escapement estimate.

[b] Timing represents the time period for sampling and is coded; for example, JUL3 represents the third week of July.

[c] Composite represents a mixture sample of subpopulations that will be taken from existing project sampling sites.

	BUDGET ($K)
Salaries	$156.9
Travel	12.0
Contractual	232.3
Supplies	29.1
Equipment	204.1
Subtotal	$634.4
General Administration	39.8
Total	$674.2

RESTORATION PROJECT NUMBER 59

Study Title: Assessment of Genetic Stock Structure of Salmonids

Lead Agency: ADF&G

PROJECT JUSTIFICATION

The overescapement that occurred after the Exxon Valdez oil spill is expected to cause a severe decline in adult returns in 1993 and 1994. Total closure or severe reduction of the commercial and sport sockeye fisheries may be necessary in those years to enable recovery of this species. Genetic stock identification (GSI) techniques will be implemented to manage the harvest of these spill-injured stocks in Cook Inlet mixed harvest areas. GSI has only recently been applied as an in-season management tool, and it has proven to be extremely effective for allocating and adjusting the harvest of stocks intercepted in stock mixtures such as those that occur in Cook Inlet (e.g., White and Shaklee 1991).

Starting in 1992, baseline genetic data will be collected from 28 subpopulations from the Kenai, Kasilof, and Susitna Rivers. Samples from the Cook Inlet commercial harvest will be analyzed and reduced to stock components using these data and GSI techniques in subsequent years. Area managers will use this information to modify fishing areas and openings in order to facilitate harvest of the surplus Kasilof River and Susitna River stocks while protecting the oil spill-injured Kenai River stocks.

Fishing time in the Upper Cook Inlet area was greatly reduced in 1989 due to the presence of oil from Exxon Valdez oil spill. As a direct result, sockeye salmon spawning in the Kenai River system exceeded optimal escapement goals by three times. This extremely high escapement may have produced enough fry to not only deplete invertebrate prey populations and cause high fry mortality, but also to alter the species composition and productivity of prey populations for several years. Controlling sockeye salmon fry production by closely regulating the number of spawning adults may be the only way to restore the productivity of these rearing areas.

Attempts to use stock identification to manage harvest of Cook Inlet sockeye salmon relied on scale growth patterns in the past. Alaska Department of Fish and Game (ADF&G) evaluated both scale pattern analysis and GSI during the mid-1970's, and at that time, with only three genetic markers and limited baseline data available (e.g., see Grant et al. 1980), decided to pursue the use of data from scales. However, the accuracy and precision of the scale technique alone has not been great, and it is insufficient to permit the in-season protection of the injured Kenai River stocks.

Fortunately, GSI analyses have proven extremely effective for stock management in recent years (Seeb et al. 1986, 1990, Shaklee and Phelps 1990, White and Shaklee 1991), and many additional genetic markers have been found which discriminate stocks of sockeye salmon (e.g., Wilmot and Burger 1985, Tony Gharrett and Paul Aebersold, NMFS, personal communication). Seeb and Wishard (1977) found five marker loci which resolved mixed-stock samples of sockeye salmon from the Lake Washington drainage; Grant et al. (1980) showed a high degree of success using the three markers to classify samples from the Kasilof and Susitna drainages, but incomplete baseline data confounded the Kenai River classifications. Strong supporting evidence (described above and including sockeye salmon data from Bob Davis, ADF&G, unpublished; and Richard Wilmot, USFWS, unpublished) indicate that GSI analyses including many marker loci and complete baseline data will provide accurate estimates of stock composition for in-season protection of the Kenai River stocks.

Additionally, ADF&G and NMFS personnel recently discovered that parasite data may provide stock discriminating power for Cook Inlet stocks (Tarbox et al. 1991). The ADF&G plans to evaluate the use of all possible techniques to maximize the accuracy and precision of stock identification analyses (cf., Wood et al. 1989, R-53) and will incorporate parasite data into the GSI models.

OBJECTIVES

The objectives of this study are to:

1. Obtain baseline genetic data (during 1992-1995) from all significant spawning stocks contributing to mixed-stock harvests of sockeye salmon in Cook Inlet.

2. Obtain genetic data each week from samplings of the various mixed-stock harvests occurring in 1993 and 1994.

3. Use GSI algorithms (e.g., Pella and Milner 1987) to provide weekly estimates of the presence of Kenai River stocks in the different mixed-stock areas so that managers may modify area and time of harvest in order to protect these injured stocks while targeting surplus Kasilof River and Susitna River stocks.

METHODS

Sampling Methods

Baseline and mixed stock samples will be collected by personnel conducting R53 - Kenai River Sockeye Salmon Restoration. During the first year 28 baseline populations will be collected (Appendix A). In addition, mixed stock samples will be collected from three

mainstem sites and from cannery samplings of four driftnet fisheries. Sample sizes for allozyme baseline collections will be 100 to maximize the precision around the allele frequency estimates (Allendorf and Phelps 1980, Waples 1990). Mixed stock sample sizes will be set at 200 (Pella and Milner 1987) and will be adjusted in 1993 based on the results of simulation studies conducted using the 1992 baseline data.

Muscle, liver, eye, and heart will be dissected from freshly killed individuals. Tissues will be placed in labeled cryovials and transferred into liquid nitrogen. Tissues will be stored on liquid nitrogen until transferred to -80°C storage in Soldotna or Anchorage. Soldotna samples will be transferred to the Anchorage laboratory on dry ice or liquid nitrogen and again placed in 80°C storage where they will remain until laboratory analysis.

A comprehensive examination for discriminating gene markers will be done. It will focus on the use of allozyme data because of its successful application in similar studies and the promising pilot work completed in Cook Inlet. Mitochondrial DNA markers have shown promise in some situations (e.g., see Lansman 1981, Bermingham 1990), and a subset of samples will be so screened to evaluate any potential additional resolving power.

Allozyme electrophoretic data (Utter et al. 1987, Seeb et al. 1987) will be collected for the loci identified in sockeye salmon (Grant et al. 1980, Wilmot and Burger 1985, Appendix B). Allozyme techniques will follow those of Harris and Hopkinson (1976), May et al. (1979), and Aebersold et al. (1987); nomenclature rules will follow the American Fisheries Society standard (Shaklee et al. 1990). A photographic record of each polymorphic gel will be made.

The DNA will be extracted from liver and heart tissue (Chapman and Brown 1990, Bermingham et al. 1991) using phenol/chloroform extractions and ethanol precipitation (Sambrook et al. 1989) from a subsample of the baseline individuals. After extraction, the DNA will be amplified using the polymerase chain reaction (PCR) (Kocher et al. 1989, Chapman and Brown 1990, Carr and Marshall 1991). Primer selection for PCR will include both universal (Kocher et al. 1989) and other unpublished primers (Kessing et al. 1989) and include those from the D-Loop, cytochrome *b*, and ORF5/6 regions of mtDNA. Amplified DNA will be cut with up to 20 restriction enzymes and separated on agarose gels. Fragments will be visualized under UV light, and a photographic record will be made of each gel.

Quality Assurance and Control Plans

All tissues will be placed in individually labeled cryotubes. Individual sample numbers will be assigned to uniquely identify all genetic tissues and the associated collection and parasite

information. As a minimum, labels will include the following information: 1) species, 2) collection site and/or code, 3) collection date, 4) individual number, and 5) tissue type. Samples will be stored at -80° C until analysis. A telephone alarm will be connected to the freezers to notify laboratory personnel in the event of a power outage.

A collection of mobility standards for all scored alleles will be constructed and used to verify alleles. Similar procedures will be followed with unique mtDNA haplotypes. After analysis, the remaining tissue samples will be retained until the results of the study have been finalized.

Information Required From Other Investigators

Again, genetics samples will be collected by Soldotna field staff conducting R-53. Parasite data collected by Soldotna field staff will be incorporated into GSI models. The principal investigators of the two studies will work in close collaboration throughout the duration of the studies and coordinate all aspects including sample collection, laboratory, and data analyses.

Safety Requirements

Personnel will be trained in the safe handling of liquid nitrogen. Additionally, instructions for the use of liquid nitrogen are included as part of the sampling instructions. Laboratory safety procedures and training will follow guidelines outlined in the Genetics Laboratory Hazard Communications Program. This program is currently being developed with the assistance of the Alaska Department of Occupational Safety and Health.

Animal Health and Welfare

Not applicable to this study--only frozen tissues will be analyzed.

DATA ANALYSIS

Tests

The allozyme data will be analyzed using the genetic analysis program, BIOSYS-1 (Swofford and Selander 1981). Genotypic and allelic frequency estimates will be calculated for each baseline and mixed-stock sample at every locus. Genetic distance measures (Nei 1978), which summarize multi-locus data into a single number, will also be calculated between all pairs of spawning locations. These values will be used to construct branching diagrams using numerical taxonomic techniques (UPGMA, Sneath and Sokal 1973) which provide a representation of overall phenetic similarity. The stability of the resulting dendrogram will be evaluated using the jackknifing procedures of Lanyon (1985). Chi-square goodness-of-

fit to Hardy-Weinberg equilibrium will be performed to test for random mating within each population.

Homogeneity of allelic frequencies among the various collections will be tested using a log-likelihood ratio analysis (G-statistic) (Smouse and Ward 1978) ($\propto$=0.01) (Cooper 1968). Rejection of the null hypothesis of homogeneity is indicative of discrete spawning populations. The total gene frequency dispersion at each locus will be subdivided into within-and among-river system components in a hierarchical fashion. Hierarchical levels will be organized to test for homogeneity of 1) within drainages of the systems, 2) among drainages within river systems, and 3) among river systems with Cook Inlet. The likelihood analysis will use the computational formula of Sokal and Rohlf (1981). This statistic is distributed approximately as the chi-square statistic with (no. of alleles - 1) X (no. of region - 1) = (degrees of freedom). The likelihood values (G) can be summed over all loci to obtain a total value at each level of analysis.

The mtDNA data will be analyzed using the REAP analysis program (McElroy et al. 1991). Evolutionary divergence (*d*) will be estimated between mtDNA haplotypes (Nei and Li 1979, Nei 1987). Pairwise *d* values will be used to construct a UPGMA clustering diagram (Sneath and Sokal 1973). The extent of geographic heterogeneity in population frequency distributions will be analyzed using the Monte Carlo simulation techniques of Roff and Bentzen (1989).

Stock contribution to mixed fishery samples will be estimated using a conditional maximum likelihood program (GIRLSEM) developed by National Marine Fisheries Service (NMFS) (Pella and Milner 1987, Masuda et al. 1991). Both allozyme and parasite data will be used; parasite presence/absence will be treated as a discrete character in combination with a multi-locus genotype (Masuda et al. 1991). The precision of the stock composition estimates will be determined by bootstrap resampling (Efron and Tibshirani 1986). In bootstrapping, individuals of the stock and mixture samples are randomly resampled with replacement to obtain new samples equal in size to the original samples. Standard errors of stock composition estimates due to sampling errors in the stock and mixture samples can be estimated from the standard errors of composition estimates over resamplings of the bootstrap. Approximately 100 bootstrap resamplings should provide sufficiently accurate estimates of standard error (Masuda et al. 1991). Accuracy graphs will be obtained by constructing simulated samples of mixtures with specific stock proportions and then by bootstrap resampling the baseline to obtain estimates of stock proportions. This same type of simulation will be used to evaluate the effect of mixture sample size on the accuracy and precision of the stock composition estimates and will be used to adjust mixture sample size in succeeding years.

Simulation studies will be performed to test the additional resolution that could be provided by mtDNA data. The mtDNA data will be treated as a single character with multiple alleles corresponding to haplotypes and will be used in conjunction with parasite and allozyme data.

DELIVERABLES

A project report detailing the 1992-1993 sample acquisition and sample analysis will be prepared February 1993.

SCHEDULES AND PLANNING

Data and Report Submission Schedule

Date	Activity
March-April 1992	Hardware and supplies acquisition; -80°C freezer set-up in Soldotna and Anchorage
April-June	Collect test-lots of smolts for primary genetic screening; optimize allozyme and DNA protocols for resolution of genetic variation
July-August	Mixture collections/coordination with project R53
August-December	Baseline sample collection of adults/ coordination with project R53
July-December	Laboratory analyses of mixture populations
January-April 1993	Laboratory analysis of baseline populations
February	Final report preparation
April-May	Laboratory analyses of mixtures; numerical analyses of stock structure
May-June	Post-season analyses of mixed-stock composition; modelling for 1993 mixture analyses

Sample and Data Archival

Tissue storage will be in -80° C freezers strategically located in Soldotna and Anchorage. Each freezer will be equipped with an alarm-activated telephone monitoring system to notify personnel in case of power outages. Multiple subsamples of tissues expressing variant alleles will be archived at -80°C to provide mobility standards for future allelic comparisons.

Both hard and electronic copies of data will be archived. Original lab notebooks will be maintained in the ADF&G genetics laboratory in Anchorage. All raw and processed data will also be electronically stored on databases in Anchorage, archived on the local area network, and archived through FS30 database management. These Wordperfect and R:BASE files will be readily retrievable.

MANAGEMENT PLAN

The co-principal investigators will manage activities in close coordination with Ken Tarbox, Soldotna area office, and Linda Branian, Anchorage office (Principal Investigators of project R53). Soldotna staff will handle field logistics and collect the specimens. Anchorage genetics staff will conduct all laboratory analyses, perform GSI analyses and modelling, and provide training for field crews on handling of liquid nitrogen, sample dissection and storage, etc. Laboratory staff will be cross-trained in both allozyme and DNA methods of analysis.

Genetics Team

Person	Responsibilities
Lisa W. Seeb, co-PI	Supervise lab staff during DNA analyses, supervise biometrician and GSI analyses, report writing
James E. Seeb, co-PI	Supervise lab staff during allozyme analyses, coordinator with Soldotna, budget manager, report writing
Project Biometrician	Data-base management, data handling and transfer, GSI analyses, simulation and modeling
Laboratory Staff Fish Bio II	Lab logistics, allozyme and DNA team leader

Fish Tech III	allozymes and DNA
Fish Tech III	allozymes and DNA

Logistics

Logistics will be limited to the routine acquisition of supplies for lab analyses, normal equipment maintenance and repair, and sample shipping and storage. Field crews will return either to Anchorage or Soldotna with samples (depending upon point of departure and location of collection site). Samples stored in the -80^0 C freezer in Soldotna will be allowed to accumulate until their number warrants a pick-up by the Anchorage-based genovan (special ADF&G truck equipped with dry ice coolers).

PERSONNEL QUALIFICATIONS

James E. Seeb, Principal Geneticist
Fisheries Rehabilitation Enhancement and Development
Alaska Department of Fish and Game
Anchorage, Alaska 99518 (907) 267-2385

EDUCATION: B.S., Biology, 1974, University of Puget Sound
M.S., Fisheries, 1982, University of Washington
Ph.D., Fisheries, 1987, University of Washington

PROFESSIONAL EXPERIENCE:

1990-	Principal Geneticist, FRED Division, ADF&G
1988-1990	Assistant Professor, Southern Illinois University
1987-1988	Research Assistant Professor, University of Idaho
1982-1986	Graduate Research Assistant, University of Washington
1980-1982	Fish Biologist, Pacific Fisheries Research, Olympia,WA
1978-1980	Fish Biologist, Washington Department of Fisheries

Lisa W. Seeb
Statewide Geneticist, Division of Commercial Fisheries
Alaska Dept. of Fish and Game
Anchorage, Alaska 99518 (907) 267-2249

EDUCATION:

A.B. Zoology, 1973, University of California, Berkeley
M.A. Zoology, 1977, University of Montana
Ph.D. Fisheries, 1986, University of Washington

PROFESSIONAL EXPERIENCE:

1991-	Statewide Geneticist, ADF&G, Anchorage
1988-1990	Assistant Professor, Southern Illinois University
1984-1988	Research Assist. Prof., University of Idaho

1978-1981 Fish Geneticist, Pacific Fisheries Research, Olympia WA
1977-1979 Geneticist, National Marine Fisheries Service, Seattle

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APPENDIX A

Proposed sampling locations for Cook Inlet sockeye salmon GSI study.

River/Drainage	Location or Timing	N
SUSITNA RIVER		
Mainstem	Mixed stock	200
- Talkeetna	Larson	100
	Stephan Lake	100
- Lower	Redshirt Lake	100
- Yentna	Mixed stock	200
	Chelatna Lake	100
	Hewitt/Whiskey	100
- West Fork	Unnamed slough	100
- Skwentna	Shell Lake	100
- Talachulitna	Judd Lake	100
	Trinity/Movie	100
KASILOF RIVER		
Mainstem	Mixed stock	200
	Nikolai Creek	100
	Glacier Flat	100
	Moose Creek	100
	Bear Creek	100
KENAI RIVER		
Mainstem	Mixed stock	200
	Outlet Skilak	100
	Between lakes	100
	Hidden Creek	100
	Quartz Creek	100
Russian	Early	100
	Late	100

River/Drainage	Location or Timing	N
WESTSIDE		
- Beluga	West Fork Coal	100
- Chakachatna	Chilligan	100
- Big River	Wolverine Creek	100
CRESCENT RIVER		
- Mainstem		100
KALGIN ISLAND	Packers Creek	100
DRIFT FISHERY	Mixed stock	800

APPENDIX B

Enzymes or proteins to be screened in Cook Inlet sockeye salmon. Enzyme nomenclature follows Shaklee et al. (1990), and locus abbreviations are given. Variable loci are those observed by Grant et al. (1980), Wilmot and Burger (1985), and personal communications (P. Aebersold, NMFS, Seattle; A. J. Gharrett, NMFS, Auke Bay)

Enzyme or Protein	Enzyme Number	Locus	Known to be Variable
Aspartate aminotransferase	2.6.1.1	*sAAT-1,2*	yes
		sAAT-3	yes
		sAAT-3	no
		mAAT-1	yes
		MAAT-2	no
Acid phosphatase	3.1.3.2	*ACP*	no
Adenosine deaminase	3.5.4.4	*ADA-1*	yes
		ADA-2	no
Alcohol dehydrogenase	1.1.1.1	*ADH*	yes
Aconitate hydratase	4.2.1.3	*mAH-1,2*	yes
		MAH-3	yes
		sAH	yes
Adenylate kinase	2.7.4.3	*AK*	no
Alanine aminotransferase	2.6.1.2	*ALAT*	yes
Creatine kinase	2.7.3.2	*CKA-1*	no
		CKA-2	no
		CKC-1	no
		CKC-2	no
Esterase-D	3.1.1.-	*ESTD*	yes
Fructose-biphosphate aldolase	4.1.2.13	*FBALD-1*	no
		FBALD-2	no
		FBALD-3	no

Enzyme or Protein	Enzyme Number	Locus	Known to be Variable
		FBALD-4	yes
Fumarate hydratase	4.2.1.2	*FH*	yes
beta-N-Acetylgalactosaminidase	3.2.53	*bGALA*	yes
Glyceraldehyde-3-phosphate dehydrogenase	1.2.1.12	*GAPDH-1*	no
		GAPDH-2	no
		GAPDH-3	no
		GAPDH-4	yes
		GAPDH-5	no
Guanine deaminase	3.5.4.3	*GDA-1*	yes
		GDA-2	yes
N-Acetyl-beta-glucosaminidase	3.2.1.53	*bGLUA*	no
Glycerol-3-phosphate dehydrogenase	1.1.1.8	*G3PDH-1*	yes
		G3PDH-2	yes
		G3PDH-3	no
		G3PDH-4	no
Glucose-6-phosphate isomerase	5.3.19	*GPIB-1*	yes
		GPIB-2	yes
		GPIA	yes
		GPIR	yes
Glutathione reductase	1.6.4.2	*GR*	yes
beta-Glucuronidase	3.2.1.31	*GUS*	no
Hydroxyacylglutathione hydrolase	3.1.2.6	*HAGH*	yes
Hexokinase	2.7.1.1	*HK*	no
L-Iditol dehydrogenase	1.1.1.14	*IDDH-1*	no

Enzyme or Protein	Enzyme Number	Locus	Known to be Variable
		IDDH-2	no
Isocitrate dehydrogenase (NADP+)	1.1.1.42	*mIDHP-1*	yes
		mIDHP-2	yes
		sIDHP-1	yes
		SIDHP-2	yes
L-Lactate dehydrogenase	1.1.1.27	*LDHA-1*	no
		LDHA-2	no
		LDHB-1	yes
		LDHB-2	yes
		LDHC	yes
Lactoylglutathione lyase	4.4.1.5	*LGL*	no
alpha Mannosidase	3.2.1.24	*aMAN*	yes
Malate dehydrogenase	1.1.1.37	*sMDHA1,2*	yes
		sMDHB1,2	yes
		mMDH-1	yes
		mMDH-2	no
Malic enzyme (NADP+)	1.1.1.40	*sMEP1*	yes
		sMEP2	no
Mannose-6-phosphate isomerase	5.3.1.8	*MPI*	yes
Dipeptidase	3.4.-.-	*PEPA*	no
Tripeptide aminopeptidase	3.4.-.-	*PEPB-1*	no
Proline dipeptiase	3.4.13.9	*PEPD-1*	no
		PEPD-2	no
Peptidase-LT	3.4.-.-	*PEPLT*	yes
Phosphogluconate dehydrogenase	1.1.1.44	*PGDH*	yes
Phosphoglucomutase	5.4.2.2	*PGM-1*	yes

Enzyme or Protein	Enzyme Number	Locus	Known to be Variable
		PGM-2	yes
		PGM-3	no
		PGM-4	no
Phosphoglycerate kinase	2.7.2.3	*PGK-1*	yes
		PGK-2	no
Pyruvate kinase	2.7.1.40	*PK-1*	no
Pyruvate kinase		*PK-2*	yes
Purine-nucleoside phosphorylase	2.4.2.1	*PNP-1*	no
		PNP-2	no
Superoxide dismutase	1.15.1.1	*sSOD-1*	yes
		mSOD	no
Triose-phosphate isomerase	5.3.1.1	*TPI-1*	yes
		TPI-2	no
		TPI-3	yes
		TPI-4	yes
Xanthine oxidase		*XO*	

	BUDGET ($K)
Salaries	$ 202.3
Travel	5.5
Contractual	8.0
Supplies	34.5
Equipment	39.7
Subtotal	$ 290.0
General Administration	30.9
Total	$ 320.9

RESTORATION PROJECT NUMBER 60AB

Study Title: Prince William Sound Salmon Stock Identification and Monitoring Studies

Lead Agency: ADF&G

INTRODUCTION

This project has evolved from former Natural Resources Damage Assessment Fish/Shell Fish Studies #1 and #3 but now includes only the tag recovery aspects of each of those projects. The goal of combined studies 60A and 60B is to provide inseason time and area specific estimates of the catches of injured wild stocks and inseason assessments of escapement performance for injured stocks. Fisheries managers will use this information to reduce exploitation rates on injured stocks which need protection. To assess the effectiveness of this restoration tool and monitor the recovery of the injured wild stocks, the project will also provide post-season estimates of the total returns of tagged stocks.

Functionally, wild stock returns include both catch and escapement components. To estimate the total return by stock, the catch must be enumerated, the component from the tagged population must be estimated, and the adult escapements for each tagged stock must be totally enumerated. In addition, adult escapements of tagged stocks must also be scanned for coded-wire tags to account for changes in the untagged to tagged ratios between fry and returning adults due to tag loss and differential mortality. Finally, based on evidence for straying of hatchery and wild fish from NRDA F/S Study 1 in 1991, some effort must also be expended to account for the portion of tagged returns which stray to non-natal streams and are not accounted for in either the catch or the natal stream escapement components.

The proposed study 60A is for recovery of coded-wire tags in the catches in Prince William Sound. Study 60B enumerates escapements for the six tagged wild stocks, recovers tags in the escapements to verify tagged to untagged ratios used in catch contribution estimates, and includes limited examination of neighboring streams to assess the degree of straying to non-natal streams. While studies 60A and 60B are both tag recovery projects the objectives and methodology for recoveries in catches and escapements are quite distinct and for sake of clarity have been retained as separate sections in a unified operational plan. Processing of heads for tag extraction is identical for both catch and escapement samples but for the sake of simplicity has been included in the budget for Study 60A which accounts for the majority of heads and tags recovered.

Wild stock production of pink salmon in Prince William Sound has ranged from 10 to 15 million fish in recent years. Much of the spawning for pink salmon (up to 75% in some years) occurs in intertidal areas. Intertidal spawning areas are susceptible to marine contaminants and there is strong evidence the Exxon Valdez oil spill adversely affected spawning success and early marine survival in Prince William Sound (Sharr et al. 1991). Salmon stocks impacted by the oil spill are also heavily exploited in commercial, sport, and subsistence fisheries. These stocks can most effectively be restored through stock-specific management practices designed to reduce exploitation on impacted stocks. The stocks from areas heavily impacted by the oil spill are present in fisheries dominated by hatchery and wild stocks from unaffected areas of the Prince William Sound. The management of this mixed stock fishery has historically been based on maintaining good temporal and spatial distribution of spawning escapement for groups of stocks in eight major fishing districts. The success of this management strategy relies upon the manager's ability to control stock-specific exploitation rates. Restoration premised on stock-specific management of the commercial fishery for reduced exploitation of impacted stocks will require even more accurate inseason catch stock composition estimates if different harvest rates are to be achieved for injured wild stocks versus unimpacted wild stocks or hatchery stocks.

This project is designed to provide accurate, real time, catch contribution estimates for the pink salmon stocks of Prince William Sound. Accurate escapement estimates from another proposed restoration program will enable managers to identify stocks which are experiencing escapement shortfalls. Accurate and timely catch contribution estimates from this coded-wire tag recovery project will enable managers to identify times and areas where exploitation of these depleted wild stocks can be minimized and still permit the harvest of surplus hatchery returns. Post-season analyses of the catch contribution estimates together with results from the proposed salmon escapement enumeration project will provide stock specific estimates of total return and survival and enable managers to assess the effectiveness of stock specific management strategies.

In the absence of improved stock specific management capabilities afforded by this project, salmon stocks in western Prince William Sound which have already been stressed and depleted by the oil impacts will potentially be over-exploited in the commercial, sport and subsistence fisheries. Population levels of stocks may be reduced below those needed for rapid recovery and in some instances may result in virtual elimination of impacted stocks. If adequate stock monitoring programs are not in place, changes in fishing effort to areas of less oil impact could also result in over-exploitation of otherwise healthy, unimpacted stocks.

The foundations for this project were established in feasibility studies which were conducted beginning in 1986 and extending through 1988. During the damage assessment process in Natural Resources Damage Assessment (NRDA) Fish/Shellfish (F/S) Study #3 large scale tagging and recovery projects (Attachment 1) were instituted and perfected. Some of the tags applied using NRDA or Restoration funds have been recovered but others have not. If recovery efforts proposed here are not instituted in 1992 important restoration and population monitoring data will be irretrievably lost. Tags applied to wild pink fry from six streams (three oiled and three unoiled) in 1991 are among those which must still be recovered. Although privately funded, tagging also continued for all hatchery releases of pink salmon in 1991 and those tags could be recovered concurrently.

Results of this study will provide estimates of hatchery and wild stock contributions to commercial harvests, hatchery cost recovery harvests, hatchery brood stocks and wild stock escapements. Stock specific catch contributions will be by date and fishing district and will be used inseason by fisheries managers to reduce effort on injured stocks and target effort on healthy hatchery returns. Post-season analyses of current year as well as historic tag recovery data will be coupled with escapement data for wild stocks to make estimates of wild stock total returns and survival. These data are important as a tool for assessing the effectiveness of various management strategies. Post-season analyses of tagging data will also identify trends in the time and distribution of stocks in the fisheries. These data are important to fisheries managers who must anticipate the effects of fishing strategies in future years if depleted stocks are to be protected. Stock-specific management strategies for fish returning to oiled streams as well as other populations affected by altered fisheries management will be developed using tagging and escapement data. Similar data from coded-wire tagging projects funded by the NRDA process have been used to justify time and area fishery closures and effectively reduce exploitation on oiled stocks in portions of southwestern Prince William Sound in 1990 and 1991. Serious escapement shortfalls were avoided despite intense fishing pressure on surplus hatchery fish in adjacent areas.

OBJECTIVES - 60A

A. Recovery of coded-wire tags and otoliths from catches of pink salmon to:

   1. Estimate temporal and spatial contributions of tagged wild stocks to Prince William Sound commercial and hatchery harvests. (Since coded-wire tagging of hatchery fry is expected to continue independently of the restoration process, these tags will also be recovered from harvests.

These data will also be used to enhance restoration efforts directed at wild stocks.);

2. Provide timely inseason estimates of stock contributions to harvests by time and area to fisheries managers so they can closely regulate exploitation of injured wild stocks;

3. Examine the feasibility of using otoliths as a stock identification tool that will complement or replace coded wire tagging. (This objective must also consider the test application of thermal otolith banding to all fry released from two hatcheries in 1992. Therefore, otolith samples collected in 1992 will be used as baseline samples for testing the ability to distinguish hatchery applied thermal marks in 1992 from naturally occurring banding patterns.)

B. Recovery of coded-wire tags and pink salmon otoliths from spawning populations to:

1. Estimate tag loss and mortality of tagged pink salmon;

2. Determine total return and overall survival of tagged pink salmon stocks, including sub-populations within the same stream tagged in intertidal and upstream zones. (To be accomplished, this objective will require tag recovery data from catches.);

3. Compare growth and survival of pink salmon returning to oiled and unoiled spawning sites, and to upstream and intertidal spawning sites within the same stream, using otoliths collected from tagged pink salmon;

4. Examine effects of egg and fry densities, fry migration timing, nearshore zooplankton abundance, and juvenile growth and survival upon adult survival;

5. Collect samples for documentation of pervasive somatic, cytologic, and genetic abnormalities in adults returning to oiled streams.

6. Estimate straying rates of hatchery and wild stocks of pink salmon. Straying of hatchery fish into streams which were impacted by the spill may alter the genetic composition and reduce the fitness of injured wild populations.

METHODS - 60A

Personnel policy, purchasing practices, field camp operations, safety procedures, and project administration will be in compliance with the ADF&G Division of Commercial Fisheries Manual of Standard Operating Procedures. Data collection procedures are similar to

those used in NRDA F/S Study #3. These procedures have been thoroughly reviewed by the NRDA peer review process and approved by the Management Team.

Tag Recovery

Commercial Catches

The Alaska Department of Fish and Game will oversee the recovery of coded-wire tagged fish in commercial salmon harvests in Prince William Sound. The recovered samples will be from a stratified random sample (Cochran 1977). Fisheries will be stratified by district and discrete time segments. The recovery will be further stratified by processor as described in Peltz and Geiger (1988). For each time and area specific stratum, 15% of the pink salmon catch will be scanned for fish with a missing adipose fin. Catch sampling will be done in four fish processing facilities in Cordova, one facility in Seward, and three facilities in Valdez. When feasible, sampling will occur at facilities in Kodiak, Kenai, Anchorage, and Whittier and on large floating processors. All deliveries by fish tenders to these facilities will be monitored by radio and by daily contact with processing plant dispatchers to ensure that the catch deliveries being sampled are district specific.

Scanning commercial pink salmon catches for coded-wire tags involves visually selecting adipose clipped fish from a mixture of unclipped and clipped fish on a conveyor belt. Samplers will select fish on the basis of whether they have a good view of the adipose fin region; negative sampling bias may occur by consistent exclusion of tagged fish. This possible sampling bias will be periodically tested for by comparing the tag recovery rates of sampled fish to recovery rates in a censuses of sampled loads of fish. In addition to catch sampling at the processing facilities, approximately 15% of the fish in the hatchery terminal harvest areas will be scanned for fish missing adipose fins.

Hatchery Brood Stocks and Wild Escapements

Brood stock and escapement sampling are critical to estimating hatchery and wild contributions. Due to differential mortality between tagged and untagged fish as well as differential tag loss between release groups, the tag expansion factor at release for hatchery fish may no longer accurately reflect the tag expansion factor in the adult population. Theoretically, brood stock and spawning escapements are composed of 100% fish which originated from the hatchery or stream where sampling occurs and are representative of returns from each fry or smolt release group. Based on this assumption, tag recovery rates from brood stock and escapements can be used to adjust the initial tag expansions for each tagged hatchery release group or each wild stream out-migration.

There will be a brood stock tag recovery effort at each of the three hatchery facilities where tags were initially applied. Technicians will be stationed at each of the 5 Prince William Sound hatcheries to scan the brood stock during egg take for all five species of salmon. After the salmon are manually spawned, technicians will use visual and tactile methods to scan approximately 95% of the fish. Total number of fish scanned and total number of fin-clipped fish found will be recorded on a daily basis.

There will be an intensive survey of adult pink salmon returning to natural systems. Weirs will be operated for sampling adult sockeye salmon on those systems where sockeye salmon were tagged. Carcasses will be scanned for coded-wire tags in adult pink salmon returning to the six tagged wild stock streams: Loomis, Cathead, Herring, Totemoff, O'Brien, and Hayden Creeks. Only carcasses with a visible adipose region will be counted. Heads will be removed from the adipose clipped carcasses, soaked in a brine solution, and put into plastic bags. Total number of carcasses and total number of adipose clipped fish will be recorded on a daily basis for each stream surveyed. Heads and their corresponding data sheets will be picked up on a regular basis and returned to Cordova for editing and shipping to the Juneau tag lab.

Untagged Wild Escapements

Based on tag recovery results from NRDA F/S Study #3 in 1991 it appears portions of spawning escapement and hatchery brood stocks may consist of fish which stray and do not return to their hatchery or parent stream. Significant straying could bias tag recovery results if it is not accounted for. To quantify the extent of straying, approximately 8 to 10 additional streams near weired streams will be sampled for coded-wire tags. Recovery methods will be identical to those already described for wild pink salmon systems where tags were applied.

DATA ANALYSIS - 60A

Estimates of Valid Tags

Following the application of tags at hatcheries and at wild stock streams, the total number of fry with valid tags was estimated as:

$$T_{vt} = (T_t - M_{ot})(1 - L_{ot})\ C \quad ,$$

where

T_t = total number of fish tagged from group t,
M_{ot} = overnight mortality of tagged group t fish,
L_{ot} = overnight tag loss rate of group t fish,
C = good clip rate.

At least one hatchery facility includes a term for short term mortality of tagged fish from treatment group t during saltwater rearing (S_t). The number of tagged fish released for that facility becomes:

$$T_{vt} = (T_t - M_{ot} - S_t)(1 - L_{ot})\ C.$$

Contribution Estimates

The first step in the coded-wire tag analysis will be to estimate the harvest of salmon from each tag lot, in units of adult salmon. Adult salmon from these tagged lots will be recovered in the common property fishery, the hatchery cost recovery fishery, and the adult brood stock. For the hatchery stock, a modification of the methods described in the ADF&G technical report by Clark and Bernard (1987) will be used. The specific methods are described in ADF&G technical reports on two previous studies of pink salmon in Prince William Sound: Peltz and Geiger (1988), and Geiger and Sharr (1989). Additional references on methods of tagging pink salmon in Prince William Sound can be found in Peltz and Miller (1988). In the case of the wild stocks, the methods and estimators and necessary assumptions are described by Geiger (1988).

The basic principle behind the estimates can be described as follows. The contribution of a particular tag lot, to a particular fishery stratum, is estimated by multiplying the number of tags recovered in the structured recovery survey, by the inverse of the proportion of the catch sampled (the inverse sampling rate), and by the inverse of the proportion of the tag lot that was actually tagged (the inverse tag rate). The escapement (brood stock) of each tag lot will be estimated using methods unique to the particular situation. After the contribution to each fishery is estimated for the tag lot, the survival is calculated by summing the estimated harvest of the tag lot in each fishery, and the estimated escapement (brood stock), and dividing by the estimated number of fish represented by the tag code.

Total catches stratified by week, district, and processor will be obtained from summaries of fish sales receipts (fish tickets) issued to each fisherman. The total hatchery contribution to the commercial and hatchery cost recovery harvest is the sum of the estimates of contributions in all week, district, and processor strata:

$$\hat{C}_t = \Sigma_i\ X_{ti}\ (\ N_i\ /\ S_i\ )\ p_t^{-1}$$

where:

$\hat{C}_t$ = catch of group *t* fish,
X_{ti} = number of group *t* tags recovered in *i*th strata,
N_i = number of fish caught in *i*th strata,
S_i = number of fish sampled in *i*th strata,
p_t = proportion of group *t* tagged.

For sampled strata, we used a variance approximation which ignores covariance between release groups (Geiger 1988):

$$\hat{V}(\hat{C}_t) = \Sigma_i X_{ti}(N_i/S_i p_t)^2[1 - (N_i/S_i p_t)^{-1}].$$

The assumptions necessary to estimate C and the associated variances and confidence intervals are as follows:

1. The numbers of tagged fish and untagged fish are known exactly;

2. The tagged sample of the original hatchery tag group is a simple random sample;

3. The tags do not affect the fish with respect to the items under study (survival, timing, homing, etc.);

4. None of the tags or marks are lost;

5. The number of fish in the fishery and the number of fish in the fishery sample are known exactly;

6. The sample of the fishery is a simple random sample (i.e., every fish in the collection of fish under consideration has an equal probability of selection independent of every other fish in the sample); and

7. All marks are observed and all tags are decoded.

The average tag recovery rate for all processors in a week and district will be used to estimate hatchery contribution in catches delivered to processors not sampled for that district and week.

DELIVERABLES - 60A

Catch contributions will be reported bi-weekly to the Fishery Manager from mid-July through August. A report, which summarizes the results of the current-year study, will be completed in February, 1993.

SCHEDULES AND PLANNING - 60A

Date(s)	Activity
March 15-June 15, 1992	Pink salmon wild stock tagging
October 1, 1992	Tag application report

June 9-September 10, 1992	Tag recovery in commercial, cost recovery, and adult spawning populations of pink salmon.
May 15-September 30, 1992	Tag recovery in commercial and cost recovery harvests, and adult spawning populations of chum, sockeye, coho and chinook salmon.
December 30, 1992	Draft Report
February 15, 1993	Final Report

SAMPLE AND DATA RECORDING, PROCESSING AND ARCHIVAL - 60A

In the catch, terminal harvest, brood stock, and natural system surveys, the total number of fish scanned and the number of scanned fish with missing adipose fins will be recorded. The heads will be removed from fish with missing adipose fins. Each head will be tagged with uniquely numbered strap tags. Recovered heads will be assembled and pre-processed in the Cordova area office. Heads will then be sent to the FRED Division Coded-Wire Tag Laboratory in Juneau for decoding and data posting.

A statewide coded-wire tag lab is located in Juneau and operated by FRED Division of ADF&G. Coded-wire tag sampling forms will be checked for accuracy and completeness. Sampling and biological data will first be entered onto the laboratory's database. Next, the heads will be processed. This involves removing and decoding the tags, and entering the tag code and the code assigned in the recovery survey into the database. Samples will be processed within five working days of receipt. Sampling information and tag codes entered into the database will be available for analysis the following morning. Data will be automatically transferred from Juneau to Cordova. Eventually, online access from Cordova will provide in-season information to fisheries managers in Cordova to allow assessment of oil spill impacts and implementation of any required in-season management actions. Catch and sampling information will be integrated with tag codes to automatically calculate in-season and post-season hatchery contribution estimates. A historic database of coded-wire tag information from Prince William Sound tagging and tag recovery programs will be maintained and will be easily accessible by managers and researchers.

MANAGEMENT PLAN

The Principal Investigator (PI) for the project is a Fisheries Biologist III with the Alaska Department of Fish and Game. The PI will be responsible for writing project operational plans, administering project budgets, quality control of data collection, supervising data analyses, and co-authoring final reports. The PI will be assisted by a Fisheries Biologist II Project Leader (PL) who will hire project personnel, supervise day to day project operations, maintain data quality, assist in data analyses, and coauthor final reports. The PL will be assisted by two Fisheries Biologist I's. One of these assistants will be in charge of supervising day to day sampling activities in Cordova, Seward, and at remote camps. The other will supervise sampling activities in Valdez, Anchorage, Whittier, and Kodiak. Crews at each port city will have Fisheries Technician III crew leaders. The remainder of each crew will be Fisheries Technician I's and II's. Each day, two persons on each crew will scan pink salmon at each processing plant and, where needed, an additional person per facility will scan other species. Under the supervision of the project Fisheries Biologist I's, two Fisheries Technician III's in Cordova will conduct the daily data logging, editing, and archiving activities. The consulting Biometrician I will review all operational plans, project reports, and be responsible for all statistical products and statistical reporting.

PROJECT LOGISTICS - 60A

Tag Recovery in Commercial and Cost Recovery Harvests

Sampling materials, data forms, and sampling equipment will be purchased or shipped to Cordova from the ADF&G, FRED Division Tag Lab no latter than May 1, 1992. Fisheries Biologists for this project are already employed as part of the NRDA close out for F/S Study #3 and will assume their restoration duties in mid-May when recovery activities for sockeye salmon begin. Some Fish and Wildlife Technicians employed for sampling chum, sockeye and chinook salmon will be hired in May 1992. The remainder of the sampling crews will be hired in June. Crews sampling in Anchorage, Whittier, Seward, Kenai, and Kodiak will be hired locally and will provide their own room and board. Project biologists will visit each port a minimum of once every two weeks to answer questions, and provide quality control supervision.

Crews employed by the proposed adult salmon escapement enumeration project will conduct tag recovery activities on wild stock spawning grounds. Biologists for the Coded-wire Tag project will coordinate with biologists from the escapement enumeration project and provide quality control supervision for tag recovery operations at remote sites.

PERSONNEL QUALIFICATIONS - 60A

Fisheries Biologist III Principal Investigator - Samuel Sharr

Mr. Sharr received a Bachelor of Science degree in biology from the University of Washington in 1968. He has been a research biologist for ADF&G since 1979 and has worked on Prince William Sound salmon and herring since 1981. He assumed his present position as the ADF&G, Division of Commercial Fisheries, Biologist III, Prince William Sound Area Finfish Research Project Leader in 1986. In this capacity, Mr. Sharr oversees all the salmon and herring research conducted by the Division of Commercial Fisheries in Prince William Sound. His involvement with the Prince William Sound salmon escapement aerial survey program dates from the early 1980's. Mr. Sharr has supervised a total re-edit of the historic aerial and ground survey data and designed a new R:BASE database for inseason escapement analyses. Mr. Sharr wrote the original operational plans for NRDA F/S Studies 1, 2, and 3 and has been the Principal Investigator for those projects since their inception.

Fisheries Biologist II Project Leader - Carol Peckham

Ms. Peckham has a Bachelor of Science in Wildlife Biology from the University of Alaska and has completed all course work requirements for a Masters degree in statistics. She has been employed by ADF&G since 1984. As a college intern for the ADF&G Stock Biology Group Ms. Peckham gained valuable experience in a wide variety of biological sampling and stock identification techniques in Cook Inlet and Prince William Sound. Ms. Peckham has been involved in coded-wire tag recovery activities in Prince William Sound since their inception and since 1987 she has been the Fisheries Biologist in charge of coded-wire tag recovery operations for Prince William Sound salmon. She has excelled in that capacity. Her experience includes supervision of sampling activities spread throughout south-central Alaska. She has co-authored several reports in the ADF&G Technical Data Report series and she was a coauthor of the 1991 NRDA F/S Study #3 interim status report.

Fisheries Biologist I Assistant Project Leader - Jodi Smith

Ms. Smith has a Bachelor of Science in Marine Biology from the University of Alaska. Prior to working for ADF&G, Ms. Smith worked for four years in aquaculture related activities including hatchery work in Prince William Sound. Ms. Smith has worked for ADF&G Division of Commercial Fisheries since 1989 when she became a Fisheries Biologist I for NRDA F/S Study #3. In 1990 Ms. Smith supervised tag recovery activities in Valdez and in 1991 in Cordova. She also supervised quality control for tagging activities at Prince William Sound hatcheries in 1990 and 1991. Ms. Smith is presently assisting in close out activities for NRDA F/S Study #3.

Biometrician I - David G. Evans

David Evans received a Bachelor of Science in Soil Science from the University of Nottingham (Great Britain) in 1981. He went on to obtain his Masters and Ph.D. in Soil Science from the University of Guelph (Canada) in 1984 and 1988. He obtained a Masters in Statistics from Oregon State University in 1991. Dr. Evans began working with coded-wire tags in mid-December 1991.

LITERATURE CITED - 60A

Clark, J.E., D.R. Bernard. 1987. A compound multivariate binomial hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in southeastern Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 261.

Cochran, W.G. 1977. Sampling Techniques, 3rd ed. John Wiley and Sons, New York, New York.

Geiger, H.J. 1988. Parametric bootstrap confidence intervals for estimates of fisheries contribution in salmon marking studies. Proceedings of the international symposium and educational workshop on fish-marking techniques. University of Washington Press, Seattle. In press.

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Peltz, L., and J. Miller. 1988. Performance of half-length coded-wire tags in a pink salmon hatchery marking program. Proceedings of the international symposium and educational workshop on fish-marking techniques. University of Washington Press, Seattle. In press.

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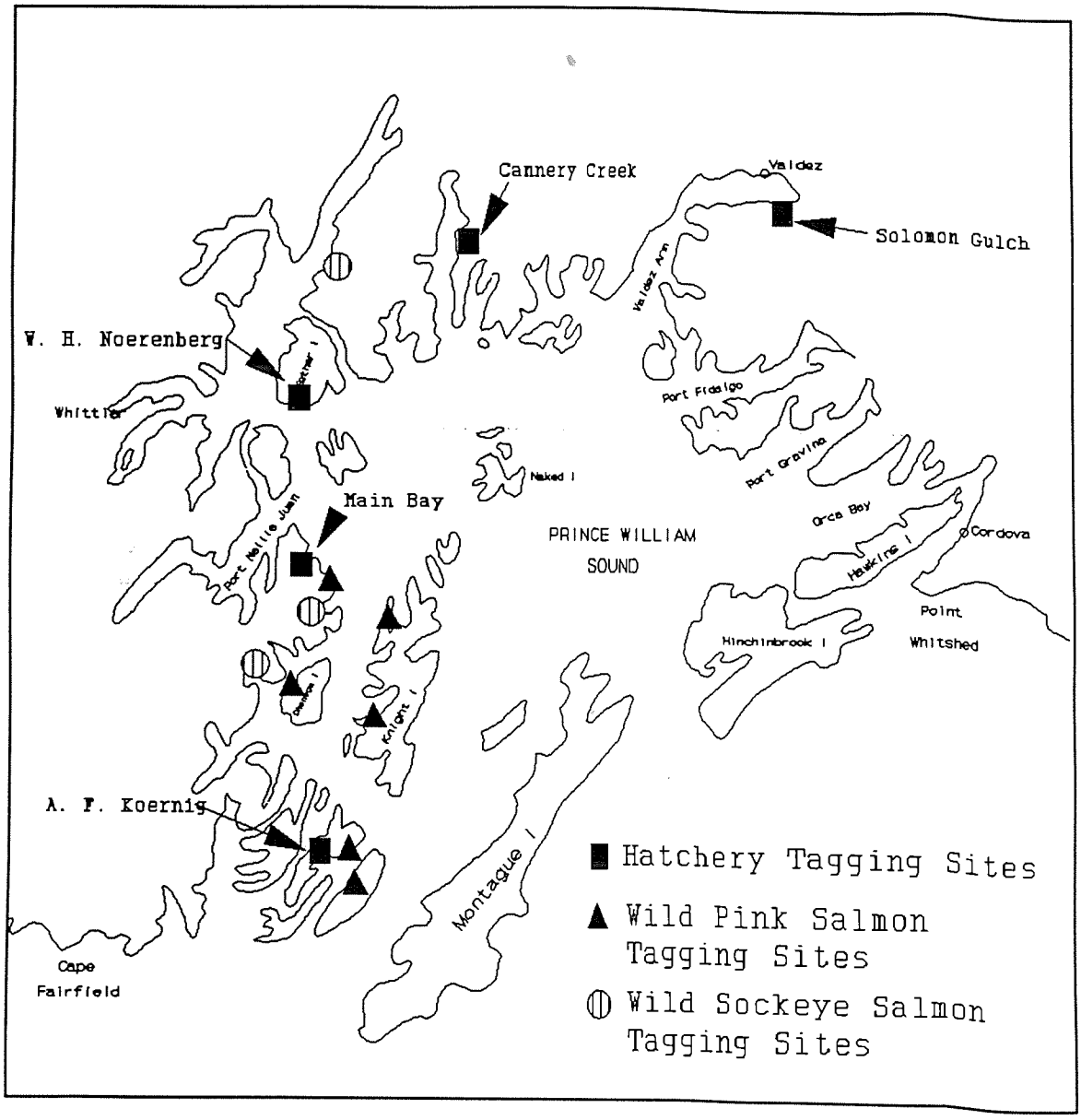

Attachment 1. Map showing the location of tagging sites for Hatchery and wild stocks of salmon which will contribute to adult returns in 1992.

Biometrician I - David G. Evans

David Evans received a Bachelor of Science in Soil Science from the University of Nottingham (Great Britain) in 1981. He went on to obtain his Masters and Ph.D. in Soil Science from the University of Guelph (Canada) in 1984 and 1988. He obtained a Masters in Statistics from Oregon State University in 1991. Dr. Evans began working with coded-wire tags in mid-December 1991.

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and total area of upstream spawning habitat was estimated for 100 of the 138 streams. In 1989 and 1990 ground surveys to count pink salmon spawners were made for all 138 streams. Total pink salmon spawning escapement was counted at weirs for 4 streams in 1990 and 7 streams in 1991. Stream residence time (stream life) of spawners was also estimated for 22 streams in 1990 and 40 streams in 1991. The damage assessment program in 1991 was supplemented by Restoration Study 9 (RS 9), a project similar to the one proposed in this detailed study plan. RS 9 included escapement enumeration at weirs on 3 additional streams as well as stream life estimates in 8 additional streams.

To determine whether oil from the Exxon Valdez oil spill was present in intertidal spawning areas, visual surveys of the habitat were made and mussel (Mytilus sp.) samples for hydrocarbon analysis were collected at the mouths of all 138 streams in the ground survey program in 1989 and 1990. Additionally, tissue samples for hydrocarbon analysis were collected from spawning pink salmon in 12 oiled and 10 unoiled streams during 1990 and 1991 ground surveys.

This project is focused on restoration of specific stocks of pink salmon. Work will emphasize more detailed and intensive data collection on fewer streams than were included in NRDA F/S 1. Streams in the oil impacted areas of western Prince William Sound, as well as streams representative of unimpacted areas in eastern Prince William Sound, will be included in this study. Weirs will be placed on the same streams studied in 1991 as part of NRDA F/S 1 and RS 9. Six of these are streams where pink salmon fry were counted and tagged in 1990 and 1991 as part of NRDA F/S 3. Ground surveys, stream life, and tag recovery studies will be continued at all streams with weirs as well as approximately 8 additional streams. Visual surveys for oil as well as collection of tissue samples from adult pink salmon will be done at all surveyed streams for the duration of the project.

Results of the proposed restoration study will furnish estimates of average stream life for pink salmon in Prince William Sound, provide bias adjustment factors to increase the accuracy of aerial survey spawner counts, and use this information to develop accurate escapement estimates for all 218 streams included in the department's aerial survey program for the current as well as prior years. All available aerial survey data will be used to construct run timing curves and set escapement goals for individual pink salmon stocks. This information will be used to direct management actions to regulate human use of Exxon Valdez oil spill injured pink salmon stocks, as well as to ensure that other stocks are not under- or over-exploited. Data from RS 9 were used to set time and area fishery closures which effectively reduced exploitation on Exxon Valdez oil spill injured pink salmon stocks in southwestern Prince William Sound. This allowed adequate escapements to be obtained for those stocks despite intense fishing pressure on surplus hatchery fish in adjacent areas.

This study will also document recovery of pink salmon stocks from oil injury and provide important information to develop and implement future efforts which may be needed to restore injured stocks (e.g. stream rehabilitation). The study will provide estimates of post-oil spill spawning distribution within streams and among streams; total available intertidal and upstream spawning habitat for each stream; marine survival of 6 wild pink salmon stocks using coded wire tagging and recovery. Finally, proposed work will document any continued presence of oil in intertidal spawning habitat and provide an atlas of aerial photographs and detailed maps of important spawning sites.

OBJECTIVES - 60B

A. Weir and Ground Survey Enumeration of Prince William Sound Pink Salmon Escapements

1. Enumerate total intertidal and upstream spawning escapement of pink salmon through weirs installed on 10 representative streams in the aerial and ground escapement survey programs.

2. Estimate the number of spawning salmon within standardized intertidal and upstream zones in weired streams using systematic daily ground survey counts of live and dead fish.

3. Estimate average stream life of pink salmon in weired streams using a variety of techniques.

4. Enumerate spawning escapements and assist in spawning ground recovery of coded wire tags in streams where wild pink salmon were tagged in 1991.

5. Document pink salmon straying by assisting in recovery of coded wire tags in streams where pink salmon were not tagged. This information will help define stock structure and rebuilding.

6. Document the persistence of oil in intertidal spawning habitats through visual observations.

7. Collect tissue samples from spawning pink salmon to determine the persistence of sublethal morphological, cytogenetic or histopathological injuries in oil impacted stocks. These samples will also be used to identify the genetic structure of salmon stocks in oil impacted areas.

B. Aerial Estimation of Prince William Sound Pink Salmon Escapements

1. Increase the accuracy, precision, and timeliness of aerial escapement estimates for the 218 streams routinely monitored

by the department. This will permit fishery managers to regulate human use and protect injured stocks while harvesting other wild and hatchery stocks.

2. Correct bias and error in total escapement estimates based on aerial observations by using paired comparisons of weir or ground survey data with concurrent aerial survey data obtained from the same streams.

3. Provide corrected estimates of total pink salmon escapements to the 218 aerial index streams from 1961 through the current year based on aerial survey average observed error and stream life data from 1990-1992.

4. Develop spawning goals and run timing curves for all pink salmon stocks in the department's aerial survey program to improve inseason stock specific management and allow rebuilding of injured stocks.

METHODS - 60B

Personnel policy, purchasing practices, field camp operations, safety procedures, and project administration will be in compliance with State Standard Operating Procedures (SOP). Data collection procedures will be similar to those used in NRDA F/S 1 and RS 9. These procedures have been thoroughly evaluated in the NRDA peer review process and approved by the restoration team.

The technology and methodology for escapement enumeration using systematic aerial and ground surveys, as well as weirs, have been well established and have a long history of success in Alaska. The historic aerial and ground survey database for Prince William Sound is one of the most extensive in the world. These data provide the basis for inseason management decisions and will be critical components of stock specific restoration efforts. NRDA F/S 1 and RS 9 greatly enlarged the scope of pre-spill escapement enumeration projects. The proposed pink salmon escapement enumeration project is needed to improve the accuracy and resolution of fisheries management actions in order to ensure restoration of injured stocks. The methods proposed are a logical extension of existing management programs and the NRDA process.

Aerial Surveys

Aerial survey estimates of pink salmon in 209 index streams will be flown by experienced personnel from ADF&G Division of Commercial fisheries (Figure 1). The historic survey program includes approximately 90 streams in the oil impacted area of Prince William Sound. Nine additional streams in oiled areas were incorporated into the program in 1989, and approximately 40 additional streams were added in 1991. Surveys have historically been flown weekly

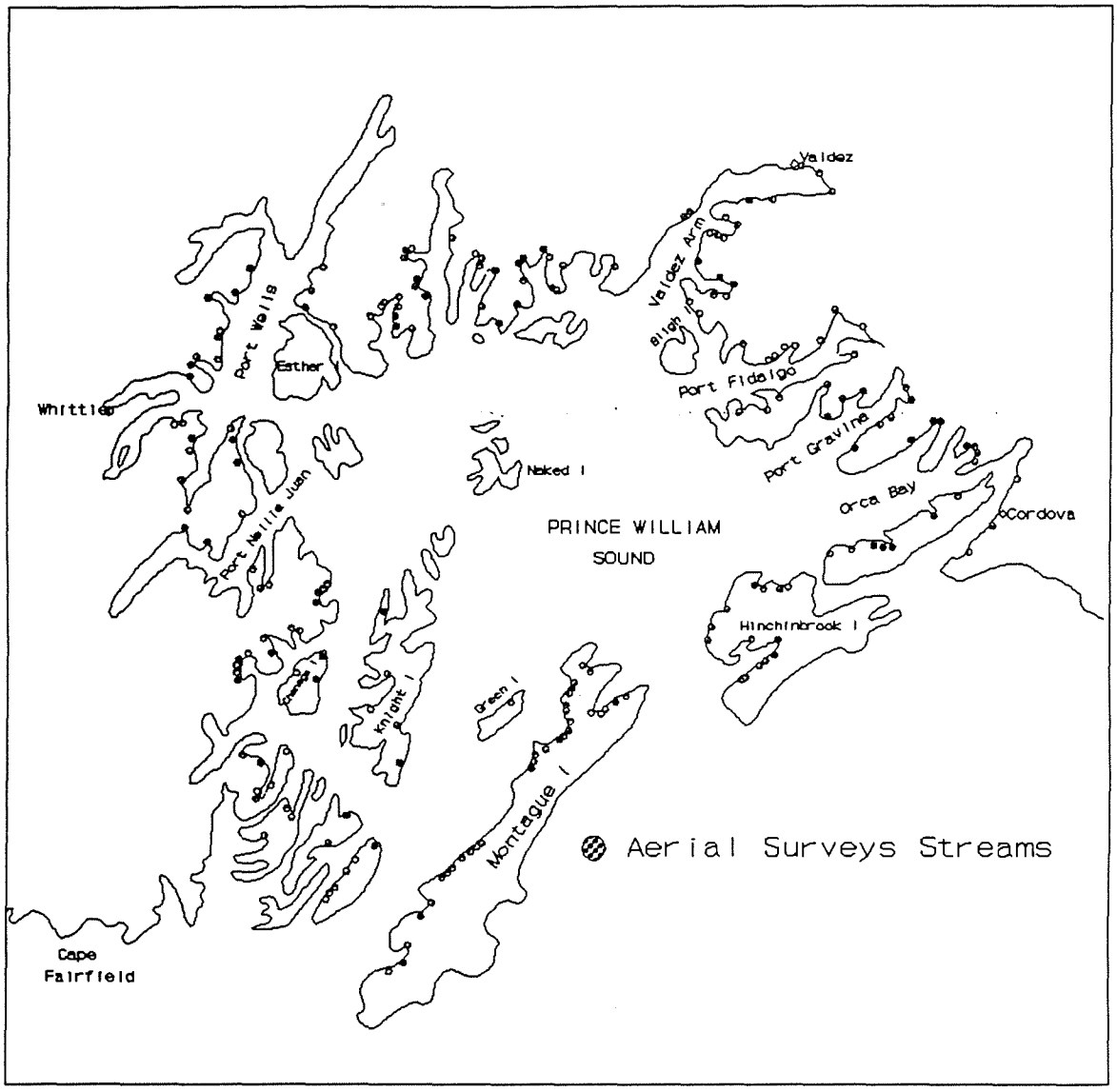

FIGURE 1. Streams included in the aerial survey programs for estimating pink and chum salmon escapement to Prince William Sound.

from mid-June to mid-September each year since 1961. In 1992, the survey frequency will be increased to twice weekly. Counts of live salmon by species are recorded for the bay at the terminus of each stream, the mouth of each stream, and within the stream (Pirtle, 1977). Counts for 18 streams included in the weir and foot survey program will be further stratified into intertidal and upstream counts. The mean high tide mark (3.7 m) at each of these streams will be marked with a large orange float which will be clearly visible from the air.

Paired aerial and weir data will be used to calibrate aerial estimates and examine observer bias. Aerial data from randomly selected streams which have not been historically surveyed will be used to estimate escapement into unsurveyed streams.

Total Enumeration Studies

Weirs for total escapement enumeration will be installed on 10 streams in 1992 (Figure 2). These same streams had weirs in 1991 and include those with weirs in 1990 as part of NRDA F/S 1 as well as the 6 streams in which wild pink salmon fry were marked with coded-wire tags for NRDA F/S 3. Two stream weirs are in eastern Prince William Sound. Both these streams have extensive upstream spawning areas typical of many streams in this area. The remaining weirs include oiled and unoiled streams in western Prince William Sound. These streams have moderate to no upstream spawning areas. All weirs will be installed near the 1.8 meter tide level or the lower range of intertidal spawning. Field crews will record daily passage through each weir.

Ground Surveys of Escapements

The 10 Prince William Sound streams (Figure 2) to be weired and surveyed were selected based on the following criteria:

1. each stream must be included in the department's aerial survey program;
2. the set of streams must represent the variety of sizes and types where pink salmon spawning has been documented;
3. the set of streams must receive spawning escapements which represent the full range of run timing and abundance documented;
4. the set of streams must include both oiled and unoiled areas;
5. each stream was included in 1989-1991 stream life studies;
6. each stream was included in prior spawning ground foot survey programs;
7. each stream was included in NRDA F/S 3 (tagging wild fry);
8. where possible streams from NRDA F/S 2 (documenting injury to eggs and fry) and in RS 60C (monitoring recovery of injury to eggs and fry) were included.

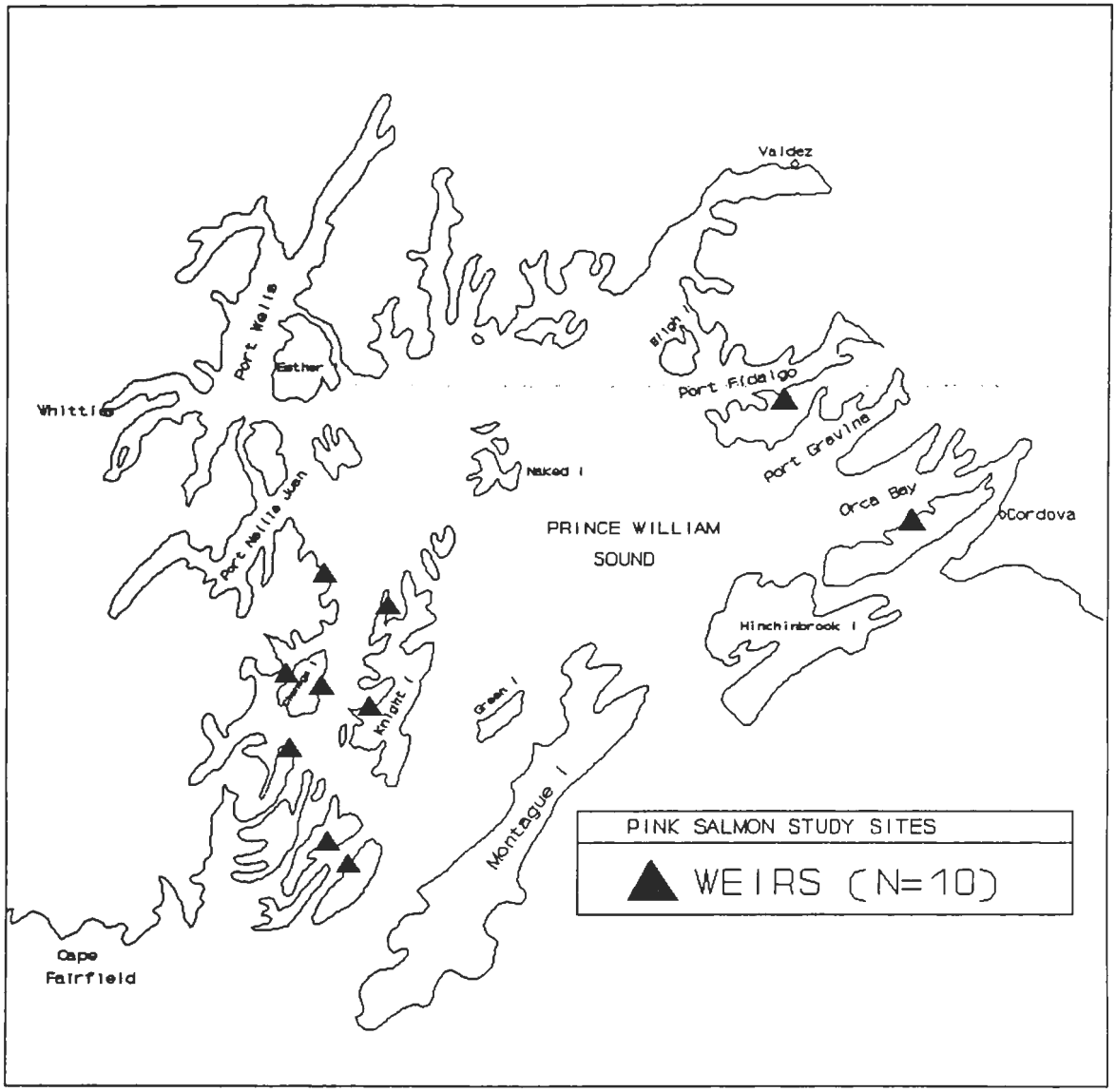

FIGURE 2. Streams proposed for weir, ground survey, and stream life studies in 1992.

Tide zones will be marked in June, prior to the return of spawning pink salmon. The location of tide levels 1.8, 2.4, 3.0, and 3.7 m above mean low water will be measured from sea level using a surveyor's level and stadia rod. Sea level at each site will be referenced to mean low water with site specific, computer generated tide tables which predict tide heights at five minute intervals. Tide zone boundaries will be delineated with color-coded steel stakes; the 3.7 m boundary will be delineated with a large orange float which will be visible to aerial surveyors. Field camp crews will conduct daily ground surveys of intertidal and upstream portions of streams with weirs (Figure 2). Live and dead pink salmon will be counted in standard intertidal and upstream zones in each stream. During each survey the following data will be recorded:

1. anadromous stream number and name (if available);
2. latitude and longitude of stream mouth;
3. date and time (24 hour military time);
4. tide stage;
5. observer names;
6. counts of live and dead salmon by species and tide zone (0.0-1.8m, 1.8-2.4 m, 2.4-3.0 m, and 3.0-3.7 m above mean low water and upstream);
7. weather, visibility, lighting, and other survey conditions.

All data will be recorded on standard forms. Maps will be improved and modified during surveys to show spawner distribution within each zone and the upstream limit of spawning. Counts of live and dead salmon will be made for the five tide zones (the intertidal zones < 1.8 m, 1.8-2.4 m, 2.4-3.0 m, 3.0-3.7 m above mean low water and the upstream zone) from the 1.8 m tide level to the limit of upstream spawning on all 10 streams during daily surveys. Tide stage will be monitored continuously and survey times and direction will be adjusted accordingly. If the tide stage at the time of the walk is at or below the 1.8 m level, the stream walk will begin at the stream mouth and progress upstream.

The mouth or downstream limit of the stream has been defined as the point where a clearly recognizable stream channel disappears or is submerged by salt water. Salmon seen below the downstream limit will be included in stream mouth estimates and noted as a comment on the data form. If the intertidal portions of the stream above the 1.8 m level are submerged at the time the walk begins, the crew will go to the upstream limit of the walk, proceed downstream, and end the survey at the time predicted for the tide to be at or below the 1.8 m level. The upstream limit of a walk will be determined by the presence of natural barriers to salmon passage (i.e., waterfalls), by the end of the stream, or by the upstream limit of spawning. The upstream limit of spawning will be marked on U.S. Geological Survey color aerial photos of each stream following each survey.

For counts of live and dead salmon on moderate size streams with a single channel, crew members will walk together but independently count live salmon in each intertidal zone. Crew members will individually enter their counts on mechanical hand tallies. A maximum of three replicate counts may be made in each zone at the request of either observer. Upstream counts in a single channel will be similarly conducted at convenient stopping points (i.e. log jams or other clear markers). For large braided or branched streams, each crew member will count separate channels or upstream forks. To avoid confusion with counts of live salmon, counts of dead salmon will be recorded on the return leg of the stream walk. Only salmon that have died since the previous count will be counted as dead in daily surveys. To prevent duplicate counts between surveys, tails and tags of all dead pink salmon observed will be removed. To avoid perpetuating counting biases within a counting crew, personnel will be rotated between crews daily. Whenever possible, crew members will not be assigned the same streams on succeeding days.

Stream-life Studies

All 10 streams in the ground survey program are included in a stream life study (Figure 2). Average stream life of pink salmon in these streams will be estimated using data from daily ground surveys. On the 10 streams with weirs a second, independent estimate of stream life will be made using tagging methods similar to those described in McCurdy (1984) and Helle et al. (1964). A third independent estimate of stream life will be made at these 10 streams using daily weir data and carcass counts from daily ground surveys.

For the tagging study, pink salmon will be captured with beach seines at stream mouths and tagged with Peterson disks. Tags will be uniquely colored to represent day of tagging and uniquely numbered to identify individual salmon. Each week 120 pink salmon will be tagged from each of 8 streams. At the other 2 streams, which are largest streams in the study, 200 tags will be applied weekly. If fewer than the desired number of pink salmon are available, all captured pink salmon will be tagged. Numbers of tagged live and dead pink salmon observed by ground survey crews each day will be recorded by color and tide zone on standard forms. Whenever possible, individual tag numbers will be recorded for tagged live pink salmon and tags will be recovered from carcasses.

DATA ANALYSIS - 60B

Data analysis procedures are similar or identical to those used in NRDA F/S 1. These procedures have been thoroughly evaluated through the NRDA peer review process and approved by the Management Team. Report format will follow that established by the Management Team. Reporting style and conventions will otherwise be in

accordance with the department's Division of Commercial Fisheries style manual.

Total Escapement Enumeration Data

Total escapement at weir sites will be the sum of daily counts of pink salmon which pass through the weir. The number of live pink salmon present in the stream on any date i (L_i) will be the difference between the cumulative count of live pink salmon on that date and the cumulative count of carcasses on that date.

$$L_i = \sum_{t=1}^{i} W_t - \sum_{t=1}^{i} D_t \quad , \tag{15}$$

where i = serial day of weir operation;
t = day of weir operation;
W_t = live pink salmon passed through the weir on day t;
D_t = count of dead pink salmon in the stream on day t.

These estimates will be used to validate corresponding counts from aerial and ground surveys.

Adjustment of Aerial and Ground Counts

Stream types will be defined from characteristics of study streams with weirs. Classification will be based on stream size, extent of upstream and intertidal spawning habitat, and other characteristics including water clarity and extent of forest canopy. These characteristics will be used to classify all other streams in the aerial and ground survey programs. Daily aerial and ground counts on streams with weirs will be adjusted for bias using the regression of aerial survey counts to live pink salmon in the stream on day i. Adjustment factors for streams with weirs will be applied to aerial and ground counts from streams without weirs having similar stream characteristics.

Stream-life Data

Tagging data will be used to calculate stream life values for individual pink salmon as:

$$S = J_r - J_t \quad , \tag{16}$$

where J_t = julian date when the live tagged pink salmon was first observed entering the stream channel from the milling area at the mouth;
J_r = julian date of tag recovery from the dead pink salmon.

Stream life estimates for each stream and weekly strata will be the average for individual pink salmon in the strata. The stream life estimate for the season will be the average of strata estimates. Stream life estimates within weekly time strata will be averaged across all streams to examine time trends in stream life.

Another mean stream life estimate for each stream will be calculated as the difference between the mean date of abundance of new arrivals of live pink salmon in the stream and the mean date of abundance of daily dead counts as follows:

$$S = \frac{\sum D_i J_i}{\sum D_i} - \frac{\sum [((L_i - L_{(i-1)}) + D_i) J_i]}{\sum [(L_i - L_{(i-1)}) + D_i]} , \qquad (17)$$

where i = survey number;
L_i = number of live pink salmon observed on survey i;
D_i = number of dead pink salmon observed on survey i;
J_i = Julian date of survey i.

For streams with weirs, a third estimate of mean stream life based on daily counts of live pink salmon passed the weir and daily dead counts in the stream will be as follows:

$$S = \frac{\sum [(J_i - J_{(i-1)}) \sum (W_i - D_i)]}{\sum W_i} , \qquad (18)$$

where i = serial day of weir operation;
J_i = Julian date;
W_i = live pink salmon passed through the weir on day i;
D_i = count of dead pink salmon in the stream on day i;
S = stream life (in days).

If observations for day i are missing, total live pink salmon in the stream on day i ($\Sigma(W_i - D_i)$) will be linearly interpolated.

If significant differences occur in stream life estimates between streams or time strata, stream and week specific stream life estimates will be applied to similarly stratified aerial and ground observations when estimating escapements using the geometric method (see below).

Escapement Estimates Based on Aerial Survey Data

Annual spawning escapement estimates (E) for pink salmon within each surveyed stream will be made using a geometric approach similar to that described by Johnson and Barrett (1986):

$$E = \frac{\sum \left[(J_i - J_{(i-1)}) L_i - \frac{(J_i - J_{(i-1)})(L_i - L_{(i-1)})}{2} \right]}{S} , \quad (19)$$

where i = survey number;
j = stream category;
J_i = julian date;
L_{ji} = survey estimate of live pink salmon in the stream adjusted for stream category j survey bias on survey i;
S = stream life (in days).

If the maximum daily survey of live pink salmon in the stream exceeds the total escapement estimate based on the geometric method, the maximum daily survey count will be treated as the total escapement.

Escapement estimates for streams not included as historic index streams (U) will be calculated as follows:

$$U = \sum R_k P , \quad (20)$$

where k = stream number;
R_k = escapement estimate for randomly selected and typically unsurveyed stream k for which escapement is calculated by applying the geometric method (equation 5) to aerial survey data;
P = proportion of total spawning streams represented by the group of randomly selected unsurveyed streams.

Escapement Estimates Based on Ground Survey Data

Ground survey counts will be summarized by species, stream, survey date, zone, and observer for all 10 streams in the study. Spawning escapement to streams surveyed from the ground will be estimated using the geometric method described for aerial survey data.

Frequently, survey counts (L_i) will be replicated as paired observations from two observers walking in tandem. The escapement estimate for a section walked in tandem will be the mean of the observations. The variance will be estimated using all replicates for the section. A one-way analysis of variance will be used to test for differences between replicate observations from separate observers. In instances where the maximum daily sum of live and dead pink salmon in a stream exceeds the total escapement estimate for the stream based on the geometric method, the maximum daily sum of live and dead pink salmon will be the total escapement estimate.

DELIVERABLES - 60B

Semi-weekly escapement estimates from aerial surveys and daily counts from weirs and foot surveys will be summarized for the ADF&G salmon management biologists. Stream life and surveyor bias estimates will be incorporated into algorithms used to estimate current and historic escapements from aerial results. Revised historic escapement estimates and migratory timing curves for streams in the aerial survey index program will be compared with current year data to assess escapement performance and the success of management strategies.

A report will be completed in February, 1993.

SCHEDULES AND PLANNING - 60B

The field work portion of this project is tentatively scheduled for completion in 1993. The schedule outlined below is for the 1992 field season and subsequent reports.

Data Collection, Analysis and, Reporting Schedule

Planning, outfitting, data collection, analyses and reporting of results for the 1992 field season will proceed as follows:

March 1-30 June 1992
: Planning, hiring, purchasing supplies and equipment for field season.

July 1-September 15, 1992
: Weir installation and operation, ground surveys, and stream life studies. Inseason data entry of weir, ground survey, and aerial survey data. Analysis of inseason data and consultation with ADF&G Division of Commercial Fisheries management personnel concerning management decisions regarding oil impacted stocks.

September 15-November 30, 1992

Completion of post-season computer data entry and editing.

September 15-December 30, 1992
Completion of preliminary post-season data analysis and progress report.

December 15-February 29, 1993
Finalize post-season data analyses and completion report for 1992 season.

Sample and Data Archival

All project operational plans, data logs, field notebooks, as well as original copies of draft and final reports will be kept in locked file storage in the Commercial Fisheries Division and Oil Spill offices in Cordova.

Weir data, ground survey, tagging, and tag recovery forms will be labeled with a three part alpha-numeric code unique to each data type, stream, and date. At the end of each day, forms will be carefully edited and the code for each will be recorded in a data collection log maintained by each field crew. As forms are logged they will be initialed by the crew member doing the log-in procedures for that day. Any biological samples collected will similarly be coded as to sample type, sampling site, and date. All data and samples collected will be remitted to the Cordova ADF&G office on a weekly schedule according to standard chain of custody procedures. Data collection log numbers, date sent and the initials of the person sending, will be recorded in a the field data camp data transmission log. Data received in Cordova will recorded in a data and sample transmission log which will show the codes assigned to each form and sample at each field camp as well as the date received and the initials of the receiver.

Original data forms for each data type and stream will be stored in separate, labeled three ring binders in the Oil Spill Impact, Assessment, and Recovery (OSIAR) office. Backup photocopies of the data will be stored in corresponding binders in the ADF&G Commercial Fisheries Division office in Cordova. All samples will be placed in locked storage and sent to the appropriate processing laboratories or centralized storage facilities when appropriate. Standard chain of custody procedures will be followed when any data or samples are remitted from the custody of project personnel in Cordova.

All data will be edited for errors immediately upon receipt in Cordova and then entered into a microcomputer database in R:BASE format. The R:BASE database will be accompanied by full documentation including a description of all columns, tables, and applications. Backup copies of the database will be updated after every data edit or update and placed in locked, fireproof storage in the

OSIAR and Commercial Fisheries Division offices. A complete log of data entries, edits, and archives will be maintained by project personnel which will reflect the alpha numeric data form codes, the date of entry or editing, and the initials of the person performing these functions.

MANAGEMENT PLAN - 60B

The Principal Investigator (PI) for the project is a Fisheries Biologist III with the Alaska Department of Fish and Game. The PI will be responsible for writing project operational plans, administering project budgets, quality control of data collection, supervising data analyses, and writing final reports. The PI will be assisted by a Fisheries Biologist II Project Leader (PL) who will hire project personnel, supervise day to day project operations, maintain data quality, assist in data analyses, and coauthor final reports. The PL will be assisted by two Fisheries Biologist I's. One of these assistants will be in charge of installing weirs and camps, weir operations, and remote camp logistics. The other assistant will supervise data collection activities in the ground survey and stream life studies. Each weir camp will be manned by two people, one of whom will be partially funded by NRDA Study F/S #3 for recovery of adult salmon bearing coded-wire tags. Each crew will have one Fisheries Technician III as crew leader. The remainder of each crew will be Fisheries Technician II's. Each day, two persons on each crew will tend the weir and conduct the ground survey, stream life, and tag recovery activities on the stream with a weir. The other two crew members will conduct ground survey, stream life, and tag recovery activities on streams without weirs. The consulting Biometrician II will review all operational plans, project reports, and be responsible for all statistical products and statistical reporting.

Project Logistics

Most weir and camp materials were purchased in the Spring of 1991 with funds from NRDA F/S 1. Any additional required materials will be purchased in the Spring of 1992 with restoration funds. The ADF&G R/V Montague will transport materials to the weir sites in June of 1992. Weirs and camps will be installed at ten sites (Figure 2) in the last week of June. Weir operations, ground surveys and, stream life studies will begin on July 1.

Weirs will be supplied semi-weekly by the R/V Montague or as needed by fixed wing aircraft. The PL and the assistant project leaders will visit each camp on a weekly schedule to oversee weir and camp operations, collect completed data forms and heads from tagged fish, answer questions from field crews, and monitor the data quality of data collected. The project leader or the assistant project leaders will maintain twice daily radio schedules with weir camps. During radio schedules, weir crew will transmit weir counts

and stream walk counts to the Cordova office and transmit any other information or requests essential to camp operations. Data collected each week will be edited and entered into an R:BASE database in Cordova by a Fisheries Technician III. The PI and the PL, in consultation with the OSIAR Biometrician, will update escapement estimates based on aerial and ground survey data and weir counts. These analyses will be completed daily and the results will be passed on to the ADF&G Division of Commercial Fisheries Prince William Sound Area Management Biologist. In consultation with the PI, the PL, and other ADF&G fisheries management and research staff, the Area Management Biologist will use these results to make inseason fisheries management decisions.

PERSONNEL QUALIFICATIONS - 60B

Fisheries Biologist III Principal Investigator - Samuel Sharr

Mr. Sharr received a Bachelor of Science degree in biology from the University of Washington in 1968. He has been a research biologist for ADF&G since 1979 and has worked on Prince William Sound salmon and herring since 1981. He assumed his present position as the ADF&G, Division of Commercial Fisheries, Biologist III, Prince William Sound Area Fin Research Project Leader in 1986. In this capacity, Mr. Sharr has in the past been in charge of all salmon and herring research conducted by the Division of Commercial Fisheries in Prince William Sound. His involvement with the Prince William Sound salmon escapement aerial survey program dates from the early 1980's. Mr. Sharr has supervised a total evaluation of historic aerial and ground survey data and has designed an R:BASE database for inseason escapement analyses. Mr. Sharr wrote the original operational plans for NRDA F/S 1,2 and, 3 and has been the Principal Investigator for those projects since their inception.

Fisheries Biologist II Project Leader - Dan Sharp

Mr. Sharp has a Bachelor of Science in Fisheries from the University of Idaho and has been employed by ADF&G since 1982. As a biologist for the ADF&G Susitna Hydroelectric Project Mr. Sharp gained valuable experience in a wide variety of techniques to enumerate salmon escapements and estimate migratory timing. His experience includes operation of weirs, sonar counters and wheels, as well as tagging studies of juvenile and adult salmon. Mr. Sharp has been the Fisheries Biologist II Project Leader for the tagging portion of NRDA F/S 3 since its inception in 1989. In 1991 Mr. Sharp also assumed responsibility for adult escapement enumeration and stream life studies (NRDA F/S 1 and RS 9).

Fisheries Biologist I Assistant Project Leader - Roger Dunbar

Mr. Dunbar has a Bachelor of Science in Wildlife Management from the University of Alaska and worked for ADF&G Division of Commer-

cial Fisheries in Bristol Bay for 10 field seasons. He was a Fisheries Biologist I for NRDA F/S 1 in 1991. In that position he helped supervise the installation and operation of 10 adult pink salmon weirs in Prince William Sound and assisted in daily supervision of ground survey and stream life study crews.

Biometrician II - Brian G. Bue

Brian Bue has a Bachelor of Science in Biology and a Bachelor of Science in Fisheries from the University of Alaska, Fairbanks. He also possess a Masters degree in Fisheries with an emphasis on quantitative studies from the University of Alaska, Fairbanks. Brian has worked with the Alaska Department of Fish and Game from 1974 through present in many capacities. He has worked as a consulting biometrician on oil spill damage projects since the first days of the Exxon Valdez spill.

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BUDGET - ($K)

	60A	60B	60AB
Salaries	$812.5	249.4	1,061.9
Travel	15.0	17.2	27.2
Contractual	38.1	54.6	92.7
Supplies	20.5	30.9	51.4
Equipment	18.2	57.5	75.7
Subtotal	$904.3	409.6	1,313.9
General Administration	124.6	41.2	165.8
Total	$1,023.9	$450.8	1,479.7

RESTORATION PROJECT NUMBER 73

Study Title: Harbor Seal Restoration Study

Lead Agency: ADF&G

PROJECT JUSTIFICATION

The harbor seal restoration project will be funded during 1992 to cover project closeout costs. Closeout funds will be used to complete spring 1992 field work and to prepare a final report of harbor seal restoration study activities.

Scheduled field work will entail attaching satellite transmitters to approximately ten harbor seals in Prince William Sound. They will be used to monitor their movements and hauling out and diving behavior until they cease to function and/or fall off during the annual molt in August. As indicated in all previous proposals and budgets for this project, satellite transmitters and data acquisition time for spring 1992 field work have already been procured with 1991 funds. This was necessitated by the three-month lead time required for transmitter manufacture and the requirement that satellite time be committed in January-February.

The final report will present and analyze data from harbor seals that were satellite-tagged in 1991 and 1992 as part of this restoration study. This will include analyses of movements and diving and hauling out patterns; an evaluation of changes in harbor seal distribution and abundance following the Exxon Valdez oil spill in light of these results; the potential application of diving and movements data to design and interpretation of aerial monitoring surveys; and recommendations for further study. In order to allow ample time for analysis of 1992 data, the final report will be completed by December 31, 1992.

	BUDGET ($K)
Salaries	$11.6
Travel	2.5
Contractual	5.0
Supplies	1.7
Equipment	1.2
Subtotal	$22.0
General Administration	2.9
Total	$25.0

RESTORATION PROJECT NUMBER 103 A,B,C,D

Study Title: Recovery Monitoring of Intertidal Oiled Mussel Beds in Prince William Sound and the Gulf of Alaska Impacted by the Exxon Valdez Oil Spill

Lead Agency: NOAA

Cooperating Agencies: ADF&G, NPS, USFWS

INTRODUCTION - R103A

The highest oil concentrations in animals or sediments in 1991 were found in mussels and underlying substrates from oiled mussel beds in Prince William Sound (Babcock, 1991 status report on oiled mussel beds). The oiled mussel bed study of 1991, supported by agency funds, exposed a potential serious pathway of oil to predators higher in the food chain. However, the study was cut short by weather and funds before the geographical extent of oiled mussel beds in Prince William Sound could be determined. Analyses on a limited number of samples indicated that the oil concentrations within the underlying substrates were higher than the oil in the mussels and that the oil in the substrates was not weathered, rather surprising since these samples were collected more than two years after the spill.

The primary goal of this study is to determine the geographical extent of oiled mussel beds in Prince William Sound, the intensity of oil remaining in mussels and the underlying organic mat. This study will provide chemical data to assess the possible linkage of oiled mussel beds with continued injury to harlequin ducks, oystercatchers, juvenile sea otters, and river otters. On the surface, the high concentrations of oil in mussels from oiled mussel beds appears to be a possible link (cause) for continued reproductive failure of harlequin ducks in the western Prince William Sound, injury to oystercatchers, and higher than normal mortalities of juvenile sea otters-- all feed heavily on mussels.

This study proposes a secondary goal, with minimal logistics costs, that will determine the chemical and biological recovery of these oiled beds without further treatment and the recovery with some mechanical treatment. This information is critical in deciding if future clean-up or removal of mussels is appropriate.

Oiled mussel beds will pose a significant and controversial management problem. Treatment, in the form of cleaning, will be difficult and removal will by unpalatable to some people. Some biologists fear the impacts of removal of large quantities of mussels to the food availability to some species, even if the mussels are oiled. Other biologists fear the impacts of oiled

mussels from the oiled beds on sensitive life stages and reproductive events dependent on specialized behaviors. Partial removal of the beds (removal of strips), to allow water circulation and access to the substrates below packed mussel beds may remove oil and permit biodegradation to occur at faster rates. The stripping study will evaluate the feasibility of this action on the chemical and biological recovery of the mussels.

The biological impacts of oiled mussel beds on mussels are unknown at this time. Coastal Habitat Study Number 1A does include random transects into mussel beds, but it is unlikely that many oiled mussel beds were within their randomized design. Furthermore, the chemical analyses from their studies will not be available to evaluate the chemical differences between oiled and non-oiled mussel beds. This study will collect samples to determine biological impacts of the oiled beds on mussels while on site for the primary function of collecting samples for chemical analyses. Mussels fill an important ecological niche and food source. There is a need to understand the impacts of oiled mussel beds on mussel biology.

Biological impacts will be measured on mussels by measuring byssal thread production, condition indexes, and reproduction indexes. All measurements will be from samples collected in the field, but measurements will be made back at Auke Bay Laboratory. All samples will be collected while sampling for the primary objective, geographical extent of oiled mussel beds and assessing their recovery. Several studies report reduced byssal production by mussels from hydrocarbon (HC) impacted areas and in experimental HC exposures. These measurements can assess physiological impact, and can assess biological recovery if rates change after treatments. Reproduction and condition indexes will measure the long-term health of a mussel bed.

This project consists of two primary goals: (1) determine the geographical extent of oiled mussel beds by sampling 30-50 sites within Prince William Sound, and (2) determining the chemical and biological recovery of mussels and oiled mussel beds at a limited number of oiled and non-oiled sites. The second goal will require two short follow-up samplings in 1992, and will require the analyses of samples from 1991 that have not yet been analyzed.

This project is relatively large, but it did not exist during the Damage Assessment process. Preliminary identification of potential sites will be provided by Alaska Department of Environmental Conservation (ADEC). Sampling will occur during other projects. Ultraviolet (UV) screening will be used to select samples for detailed analyses by gas chromatography/mass spectrometry (GC-MS).

OBJECTIVES - R103A

Objective 1. Determine the intensity and geographic extent of oiled mussel beds in Prince William Sound.

Justification - This study, with input from the spring shoreline survey by the response agencies (ADEC, US Coast Guard and Exxon), will determine the geographical extent of oiled mussel beds and will define the magnitude of this problem in Prince William Sound. Ultraviolet (UV) screening of byssal mat substrates for oil will reduce the analytical costs considerably, and will permit large numbers of samples from many sites to be analyzed. GC/MS analyses will determine the relationship between oil contamination in mussels with substrates and will permit an evaluation of the degree of weathering of the sample along with absolute concentrations of specific compounds.

Objective 2. Determine variation and correlation of HC concentrations in mussels with substrate HCs within oiled mussel bed sites.

Justification - This study will probably confirm the hypothesis that severely contaminated mussels are restricted to heavily contaminated underlying substrates, and that mussels adjacent to the oiled beds are not impacted and probably do not need any treatment. All logistics are within the primary objective to determine geographic extent of oiled mussel beds.

Objective 3. Determine the chemical and biological recovery of mussels and oiled mussel beds without treatment (natural recovery) and with treatment (treatment proposed is partial removal of mussels and substrate to enhance natural flushing of hydrocarbons from contaminated beds).

Justification - This part of the study will probably confirm that oiled mussel beds are slow to recover from HC contamination, by comparing data from oiled mussel beds in 1991 and 1992, and will explore the possibility of enhanced recovery by removing small strips of mussels within a bed.

Objective 4 and 5. See R103B

Objectives 6 and 7. See R103C

Objectives 8 to 12. See R103D

METHODS - R103A

Objective 1. Mussels, byssal substrates and sediments from 30-50 sites within Prince William Sound will be sampled. Potential sites with oiled mussel beds will be identified during the spring shoreline survey and by studies associated with harlequin ducks,

oystercatchers, and sea otters. Sampling will be repeated at sites that showed high HC in 1991.

UV analyses of approximately 200 byssal mat substrates from 30-50 sites will determine the geographic extent of oiled mussel beds and relative intensities of contamination. The GC/MS analyses of selected samples of mussels, byssal mat substrates, and sediments from 10-15 sites will be analyzed after screening by UV, and will determine absolute concentrations of HC, and the relationship of HC contamination levels between each medium. The GC/MS analyses of 18 samples from 3 control sites will be sampled for comparison, and can be related to historic HC contamination changes. Sixty-five samples collected in 1991 from oiled mussel beds remain to be analyzed by GC/MS.

Objective 2. Variation and correlation of HC concentrations within two mussel beds will be determined by randomly sampling mussels, substrates, and sediments within each bed and adjacent to oiled mussel beds. The ultraviolet screening of samples will be valuable here because of the high number of samples required for site distribution of HCs.

Objective 3. The treatment will strip one area in three heavily oiled mussel beds and one control mussel bed. Stripped areas (≈30 cm wide) will be perpendicular to the water line. Stripping will remove the mussels and immediate underlying byssal thread/substrates. Excess mussels and substrates will be disposed of in an acceptable and legal manner.

A. Chemical Recovery. Mussels and substrates will be sampled 30 days later and at the end of the season at varying distances from the stripping. Changes in HC concentrations will be compared with samples taken between the initial sampling and an untreated oiled mussel bed. All substrates will be screened for hydrocarbons by UV, and selected samples will be analyzed by GC/MS. These stripped areas will also be examined to determine the stability of mussels at edges of strips, the movement of adults onto stripped areas, and the settling of juveniles on the strips. The initial edges of the strips and/or mussels at strip edge will be marked; marked mussels will be checked at 30 days and at the end of the season.

B. Biological Recovery. Biological parameters to measure recovery in mussels can include byssal thread production, general condition, and reproductive condition. Samples for histological examination will be taken, but no histological processing will start in the first year.

Recovery of byssal production in impacted mussels from contaminated substrates will be tested by collecting mussels from the three heavily impacted beds (the stripped beds) and three non-impacted mussel beds. All mussels will be collected and transported to Auke Bay Laboratory in one day. Mussels will be glued to plates and

suspended in clean seawater on the second day, and time zero will begin on day 3 (48 hours post collection). Byssal thread production will be measured at 24 hours, 7 days and 30 days to determine rates of recovery. If there are significant differences in byssal production between mussels from heavily oiled mussel beds and non-oiled beds, a second series of byssal trials will be conducted to determine if recovery of byssal production capability occurs following stripping.

C. General Condition. Condition indices of mussels sampled for hydrocarbons and reproductive condition will be determined using methods developed for mussels by NRDA studies Subtidal 3 and CH1B (dry tissue weight/shell volume).

D. Reproductive Condition. Mussels will be collected at the six byssal sites in March, May, June, July, and August (three oiled mussel beds, three non-oiled mussel beds). A rough gonadal index will be calculated for each mussel by determining mantle dry weights and total dry weights. Some samples from each site may be examined histologically to determine gonadal developmental stage.

DELIVERABLES - R103A

The following reports are anticipated:

1. Interim report: Geographic extent of oiled mussel beds in Prince William Sound based on UV screening.....Nov 1, 1992

2. High concentrations of hydrocarbons in mussels and underlying substrates two and three years after the Exxon Valdez oil spill.....April 1993

3. Relationship of HC in mussels from contaminated substrate types three years after the oil spill.....April 1993

4. Contamination recovery of mussels from oiled mussel beds where contaminated mussels and underlying substrates were removed in strips to increase natural flushing of the beds.....April 1994

5. Biological impacts of oiled substrates on mussels three and four years after the oil spill.....April 1994

6. Tech Memo: Oil contamination in mussels from oiled mussel beds in Prince William Sound and the Kenai Peninsula, a geographic look with relative intensities.....October 1994

7. Final Report: 6 months after HC analyses are completed.

SCHEDULES & PLANNING - R103A

A. Data and Report Submission Schedule

ACTIVITY	TIME FRAME
Field Sampling	March - August '92
Reproductive	March, May, June, July, August '92
Stripping	initial May, checks June, August'92
Byssal trials (ABL)	May-July '92
Data Compilation	March '92-fall '93
Biological	March - August '92
Hydrocarbon	May '92-fall '93
Data Analyses	April '92 - winter '93
Report Preparation	
Status	Nov.'92
Final	Spring '94

B. Sample and Data Archival

Samples, field notes, data and reports will be retained at Auke Bay Lab by the principal investigators. Samples will be collected, handled and held under protocol established by the NRDA process.

C. Management Plan

Overall Manager, Report Preparation.....GS-14
Field Logistics, Study design, Report Preparation..GS-12
GS-9
Field Work, Study design.....GS-11
Field Work..... GS-7

D. Logistics

Field logistics in Prince William Sound are a major cost of this study, and cooperation with the spring beach survey will contribute to reduced costs. A ADEC vessel will be used during the initial stripping. The initial sampling of 30-50 sites will consume approximately 80% of the logistics costs. About 20% of the logistics cost will be consumed in re-visiting heavily impacted sites, with and without treatment, to get a time course in sampling which will permit examination of chemical and biological recovery. There will be two short trips to 6 sites after the initial stripping (30 day, end of summer). Additional reproductive samples from 6 sites will be collected and mussel beds surveyed for stripping during the March 92 NRDA cruise to pick up mussels and sediment traps (Subtidal 3). A skiff will be used in Auke Bay to service the byssal trial site.

E. Analytical Logistics

Screening substrates by UV will cost about one tenth the cost of a sample analyzed by GC-MS. Using UV screening procedures will permit many analyses of substrates from a large number of sites, with follow-up GC-MS analyses on "selected" samples. The relative UV determinations will be calibrated relative to the GC-MS. The cost for analyses of approximately 250 GC-MS samples to be analyzed (including samples from 1991), and about 400 - 500 samples screened by UV is about $250 K.

RESTORATION PROJECT 103B

Study Title: Recovery Monitoring of Intertidal Oiled Mussel Beds in the Gulf of Alaska Impacted by the Exxon Valdez Oil Spill

Lead Agency: NPS

Cooperating Agency: NOAA

INTRODUCTION - R103B

The presence of contaminated mussel beds along the outer Kenai Peninsula and the implication of their presence (through the continual oiling of mussels and linkage to higher birds and mammals) is of concern to several governmental agencies. With the cooperation of the NPS, ADEC, and ADNR, NOAA will survey the geographical extent and intensity of oiling at mussel beds at sites along the Kenai Peninsula.

In concert with the examination of contaminated mussel beds outside of Prince William Sound, the persistence and fate of Exxon Valdez oil at selected sites along National Park coastline will be examined, since the continued presence of the oil affects the scientific and recreational values and wilderness characteristics of National Park lands. These values and characteristics are clearly stated in both Alaska National Interest Land Conservation Act (1980) and the Wilderness Act (1964). Surveys conducted in 1991 indicate that oil continued to persist in the Kenai Fjords and Katmai National Parks, and that fresh-looking mousse and sheening were observed in many locations, despite the predictions that this would not occur beyond the first year after the oil spill. The presence of oil may further contaminate biological resources, including mussel beds. Objective 5 will address these concerns.

The two parts of R103B are linked by addressing the continued presence of oil outside the Prince William Sound area and implications for further contamination to higher order consumers. Also, mussel beds and boulder areas that are associated with the persistence of oil are similar because they both provide a structural heterogeneity that has allowed for the entrapment of oil and has apparently slowed the weathering of that oil.

OBJECTIVES - R103B

Objective 4. Determine the geographical extent and intensity of petroleum hydrocarbon contamination of mussel beds at sites outside of Prince William Sound, along the Kenai and Alaska Peninsula and in the Kodiak region.

Objective 5. Document, quantitatively and qualitatively, the location, persistence and fate of oil from the Exxon Valdez along the Kenai Fjords and Katmai National Park coastlines.

LOGISTICS and ANALYTICAL COSTS - R103B

All field support and logistics will be minimized by close coordination between NPS and NOAA/ABL. ABL costs for R103B consist of labor and travel costs associated with collection, and analytical costs. The NPS portion consists of extended logistics, vessel charter, sampling and additional analytical costs.

The analytical costs will be minimized by using UV screening of sediments and substrates, then selected mussels, substrates, and sediments will be analyzed by GC/MS.

RESTORATION PROJECT 103C

Study Title: Potential Impacts of Oiled Mussel Beds On Higher Organisms: Harlequin Ducks and Black Oystercatchers

Lead Agency: USFWS

Cooperating Agency: NOAA, ADF&G

INTRODUCTION - R103C

The high concentrations of unweathered crude oil found in some mussel beds in Prince William Sound during 1991 has raised questions regarding the impact of this oil on higher organisms. The species of concern include black oystercatchers, harlequin ducks and juvenile sea otters, all of which are known to include mussels as a relatively large portion of their diet. Harlequin ducks are apparently not reproducing in Western Prince William Sound, and weaning juvenile sea otters are suffering higher mortality as well. It is possible that these injuries are the result of exposure to petroleum hydrocarbons in oiled mussel beds. The goal of this study is to document exposure to and ingestion of contaminated mussels by direct observation of foraging activities, and by analysis of blood and feces of black oystercatchers.

Given the relatively large feeding range of sea otters and harlequin ducks, developing field studies that can provide useful information regarding exposure of these species to oiled mussel beds is difficult and would be very expensive. In contrast, breeding black oystercatchers establish a limited foraging territory in which they can be studied with relative ease. The researchers will study black oystercatchers in areas with oiled mussel beds to determine the extent to which these birds use oiled beds and are constantly exposed to oil. Blood and fecal samples will be collected from oystercatcher chicks which consume mussels collected by the adult birds. In addition, in cooperation with the Alaska Department of Fish and Game, blood and fecal samples will be collected from harlequin ducks captured in Western Prince William Sound.

The data from these studies will provide an indication of potential exposure of black oystercatchers and harlequin ducks to oil from mussel beds in Prince William Sound. Given the methods and financial resources available to address this question, however, it will not be possible to determine with certainty the degree to which oiled mussel beds are injuring higher organisms.

OBJECTIVES - R103C

6. Identify potential for exposure of higher organisms to petroleum due to foraging in or around oiled mussel beds by review of relevant NRDA studies, scientific literature, and GIS data.

7. Document exposure to and ingestion of contaminated mussels by direct observation of foraging activities and by analysis of blood and feces.

METHODS - R103C

Objective 6: Identify potential for exposure of higher organisms.

The first step in assessing the impact of oiled mussel beds on higher organisms is to determine the potential for key higher species to be exposed to oiled mussel beds. This will be accomplished by reviewing existing data from NRDA studies (including GIS layers), and the scientific literature. The first goal of this review is to document the species that utilize mussel beds and identify known foraging ranges for key species in the Exxon Valdez oil spill area. These ranges can then be compared to known or suspected locations of oiled mussel beds to identify the potential for exposure. Additional evidence will be sought from other ongoing restoration science studies (e.g., harlequin duck: R71) that indicate use of oiled mussel beds by key species.

An ad hoc review of existing information has already been accomplished in 1991. This review has suggested the species of concern are black oystercatchers, harlequin ducks, and river and sea otters. The review of existing information called for in this study will not duplicate the ad hoc effort but will complete and document the review to make sure that all relevant information has been identified and analyzed.

The second part of this review is to gather information regarding the impact of the oil spill on mussel mortality, and mussel density in oiled and unoiled locations. The results of the Coastal Habitat Study will be among the sources reviewed for this information.

Objective 7: Document exposure to and ingestion of contaminated mussels by direct observation of foraging activities and by analysis of blood and feces.

The review of existing data (Objective 6) will provide information regarding potential field sites for the foraging study. Optimal field sites would contain oiled and unoiled mussel beds, and the foraging area for harlequin ducks, black oystercatchers and sea otters. However, the relatively small population of harlequin ducks in Western Prince William Sound, and the relatively large

foraging areas used by harlequin ducks when they are not reproducing, will make it difficult to locate suitable field sites to conduct foraging studies. Similarly, any attempts to study sea otter foraging will be exceedingly difficult because of the mobility of sea otters (A. Doroff, personal communication).

In contrast, breeding black oystercatchers establish a limited foraging territory in which they can be studied with relative ease. Consequently, foraging studies will be limited to black oystercatchers.

Black Oystercatcher Foraging Study

Sampling Methods

The vast majority of breeding black oystercatchers arrive in Prince William Sound in April. The presence of breeding pairs will be noted during the May cruise described under Objective 1 of Part 1 of this study. (One of the criteria for selection of oiled sites for field work will include the location of sites relative to known or likely foraging areas of black oystercatchers). From these observations, and in combination with review of existing information, it should be possible to develop a set of black oystercatcher foraging territories that contain oiled mussel beds.

When a nesting pair is discovered, its location will be marked on a map for subsequent visitation. Subsequent visits will be used to determine the extent of the foraging territory. Once the foraging territory is delineated, mussel densities will be determined and samples will be collected for hydrocarbon analysis. Densities of mussels will be determined by randomly placing three 20x30 cm quadrats in each meter of tidal fall in foraging territory, following the Standard Operating Procedures of the Coastal Habitat Study. Density of prey can influence the choice of patches by intertidal predators (Marsh 1986) and may be an important covariable in discerning effects due to oil. Similarly, prey diversity may influence the taking of mussels (Morrell et al. 1979). Therefore, all individual invertebrates will be counted and placed into 5mm size classes. Barnacles, Fucus and filamentous algae cover also will be estimated for each quadrat.

Foraging behavior observations of adult oystercatchers will be conducted on 10 territories each on impacted and non-impacted sites. Observations periods will begin 2 hours before low tide and end 2 hours after low tide. Observations will begin when a bird first arrives at the foraging site. Time intervals from the start of the foraging bout and between each successful prey attack will be recorded. When the focal animal discovers a prey item, the species and size of the prey taken will be recorded. These variables will also be recorded for unsuccessful attacks. Size determination of mussels taken by oystercatchers is determinable in the field (Andres 1991; Cayford and Goss-Custard 1990). However,

it may be necessary to train observers and calculate observer differences in estimating size if numerous observers are involved. Observer differences can be tested using oystercatchers models and a variety of prey sizes. Conversion of shell lengths to biomass can be accomplished using length-weight regressions previously calculated for oystercatcher prey items (Andres 1991). Data on condition index in oiled and unoiled sites (from Part 1 of this study) will be examined to determine if separate length-weight regressions are needed for oiled and unoiled sites.

A field test will be conducted to determine if birds can discriminate between oiled and unoiled mussels by presenting a platter of mussels (de-shelled, 35mm) to nesting adults. Treatment mussels will be taken from an oiled mussel bed, or soaked in weathered crude oil for 15 minutes. These mussels will be presented to adult oystercatchers along with similar-sized unoiled mussels.

The proportional use of prey sites in oiled and unoiled sites will be determined. In oiled sites, will birds switch sites more frequently or use more sites within their feeding territory? Difference in diet diversity will also be examined among sites. Will birds supplement contaminated mussels with other foods? (This can be measured by direct observation and shell collection at nest sites.) Answering these questions will provide important information regarding the extent to which oystercatchers are dependent upon mussel beds for food. This knowledge will help predict the impact on black oystercatchers of restoration strategies that involve disturbing or destroying mussel beds.

Analytical Methods

These data can be used to test the differences in the foraging rate (items/time), foraging bout length, total foraging time, biomass intake and success rate between populations foraging on impacted and non-impacted sites. Model-based and sample-based statistical procedures can be used to determine the likelihood of the differences being attributed to oil effects. Sample-based procedures (randomization, boot-strapping) may be particularly appropriate since using these procedures makes no assumption about the birds studied being a random sample. If model-based procedures are used, a covariance model incorporating prey density, shoreline type and prey assemblage diversity with impact would probably be required.

Analysis of Blood and Feces

It is possible to document exposure of birds to petroleum hydrocarbons by sampling blood and fecal matter. Leighton et al. (1983) detected Heinz-body hemolytic anemia 3-6 days after exposure of herring gull and Atlantic puffin nestlings to various crude oils (including Prudhoe Bay crude oil). Analysis of blood chemistry in birds (Hunt, 1987) exposed to crude oil has been conducted.

Petroleum hydrocarbons will also be present in fecal matter of birds that ingest crude oil (Fry, in preparation).

Analysis of hydrocarbons in the blood of sea otters in Prince William Sound has also been conducted on animals brought to rehabilitation centers and animals caught in the wild. Heavily-oiled otters in the rehabilitation centers exhibited total hydrocarbon concentrations in the blood of 20-800 ppm (William et al., 1990), whereas the highest concentrations in the blood of wild otters from Western Prince William Sound was only 1.6 ppm (mean=0.3 ppm) (Bellachey et al., 1991). In addition, there were no significant differences in the concentration of petroleum hydrocarbons between otters in oiled and unoiled areas of Prince William Sound. Given that the USFWS will be collecting blood samples in the summer of '92 and will be continuing their analysis of blood samples from previous years, it is unlikely that a small amount of additional blood sampling from otters will be very valuable. Consequently, blood and scat analyses will be limited to the two key birds species, harlequin ducks and black oystercatchers.

Sampling Methods

Feces: Bird Feces will be sampled according to the method of Fry (personal communication). Birds will be placed in teflon-lined boxes on a wire shelf until they defecate. Feces samples will be collected in Whirlpak bags and kept cold until return to the laboratory.

The collection of fecal samples from harlequin ducks for hydrocarbon analysis will be conducted by ADF&G as part of the harlequin duck restoration study. The best subjects for sampling black oystercatchers will be the chicks. They spend their entire life in the vicinity of the nest-site and are totally dependent upon food brought by adults from the local foraging territory. A total of 25 samples from each bird species will be collected for analysis.

Blood: 10cc of blood will be taken from birds using a syringe. The blood will be injected into a container with a cork stopper containing a pre-measured quantity of methylene chloride, and kept cold until return to the laboratory. Blood samples from otters will be collected in a similar fashion. A total of 15 blood samples from each species will be collected for analysis.

Analytical Methods

Whirlpak bags containing feces samples will be emptied in the laboratory, and rinsed with distilled water. Feces samples will be extracted with methylene chloride. UV fluorescence analysis will be conducted to test for the presence of hydrocarbons in the blood and feces samples. For selected samples showing high UV fluorescence, GC/MS analysis will be conducted to identify the specific petroleum hydrocarbons in the sample.

Limitations of Methods

Determining exposure to the hydrocarbons from blood and feces requires sampling relatively soon after ingestion. Fecal samples will only reflect hydrocarbon ingestion for 24-48 hours, and birds exhibiting Heinz-body anemia begin to recover after 7 days. Consequently, it is possible that analysis of blood and feces may not produce evidence of exposure if the animals sampled have not recently ingested hydrocarbons. This is unfortunate, as small amounts of weathered crude oil (2ml) have been shown to cause reproductive effects in birds (Fry et al., 1986). This year, blood and feces samples will be collected and kept frozen for future analysis at a later date if it is determined to be appropriate.

It may not be possible to determine the precise source of any hydrocarbons detected. GC/MS analysis allows identification of hydrocarbons as Prudhoe Bay crude oil. However, metabolism of hydrocarbons may make determinations difficult, particularly if a relatively long time has elapsed between ingestion and sampling.

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RESTORATION PROJECT 103D

Study Title: Oiled Mussel Beds - River Otter Component

Lead Agency: ADF&G

Cooperating Agencies: NOAA, USFWS

PROJECT JUSTIFICATION - 103D

River otters (Lutra canadensis) in Prince William Sound have been impacted as a result of the Exxon Valdez oil spill (Faro et al. 1991 status report on river otters). Mussels (Mytilus spp.) have been recovered from scats of river otters (unpublished data) and mussels reported in the diet of river otters (Solf, 1989). In 1991 the highest oil concentrations found in Prince William Sound animals or sediments were from mussels and substrates underlying oiled mussel beds (Babcock, 1991 status report on oiled mussel beds). River otters are a species with a documented sensitivity to a number of aquatic pollutants (Table 1) so a connection between contaminated mussels and documented sub-lethal impacts is reasonable.

Table 1. Published literature indicating river otters are especially sensitive to pollutants in aquatic systems.

PESTICIDES	HEAVY METALS	CESIUM-137	PCB'S
Clark et al. 1981	Clark et al. 1981	Clark et al. 1981	Clark et al. 1981
Halbrook et al. 1981	O'Connor and Nielson 1981	Halbrook et al. 1981	Halbrook et al. 1981
Henney et al. 1981	Sheffy and Amant 1982		Henney et al. 1981
	Wren et al. 1980		
	Wren 1984, 1985		

River otters utilize land for many of their life functions but feed exclusively from aquatic habitats, placing them directly at risk to remaining Exxon Valdez oil. Although some feeding may occur in fresh water, in Prince William Sound (Faro et al. 1991 status report on river otters) and Southeast Alaska (Larsen 1983,

Woolington 1984), marine populations are dependent on a diet of fish, gastropods, and bivalves. Foraging occurs in shallow water at depths typically occupied by mussel beds. The river otter's sensitivity to pollutants and their high position on the food chain are factors that allow them to serve as an indicator species for the presence of hydrocarbon toxicity in the ecosystem. Unlike other species that may directly or secondarily acquire hydrocarbons from mussels, river otters have smaller home ranges and remain year round in close proximity to contaminated mussel beds.

This study will use nonlethal methods to obtain data on the health of river otters and their diet. River otters will be live captured during the spring breeding season when they are most vulnerable to capture. Trapping will occur in oiled habitat in close proximity to mussel beds providing data for interpretation with other information from the oiled mussel bed study. The home range of captured river otters should include one or more contaminated mussel bed. For control data, some animals will also be caught in an area with mussel beds present but not exposed to oil. Captured animals will be briefly immobilized, measured and a blood sample drawn. Procedures used will be approved by the Animal Care and Use committee under the authority of the University of Alaska Fairbanks. River otters will be released in the vicinity of their capture site when recovered from the immobilizing agent. These techniques were employed in 1991 with no known loss of animals.

Blood samples will be analyzed from components that reflect physiological stress in individual animals. These data will be compared to control data as well as to data obtained in 1990 and 1991. Weights and measurements will be compared between "control" and "oiled" data and between years.

River otter scats will be collected in the two intensive study areas (Esther Passage control area and Herring Bay/Lewis Bay oiled area) established for the impact assessment study. These samples will be examined to identify the "species" that are present. Data analysis will compare the 1992 diet in the two study areas and test for differences or similarities to dietary information from 1989 and 1990 on oiled and unoiled areas.

When gathering scat materials from the intensive study areas, information on the current use of latrine sites by otters will be recorded. Site use data for 1991 and 1992 in the 2 areas will be compared.

OBJECTIVES - R103D

8 - To test for (α = 0.05) sub-lethal effects of hydrocarbon toxicity on river otters by examining blood components.

9 - To determine if the body mass of adult river otters is significantly different (α = 0.05) in oiled and unoiled habitats and has changed through time.

10 - To test (α = 0.05) for differences in food habits of river otters before and after the oil spill on the oiled study area.

11 - To test (α = 0.05) for differences in food habits of river otters on oiled and control study areas.

12 - To determine if latrine sites use by river otters are similar between oiled and non-oiled study areas.

METHODS - 103D

Methods developed during the three years of the impact assessment study will be employed in 1992. Trapping areas will be keyed to the presence of oiled mussel beds under study by the oiled mussel bed study. The intensive oiled study area will have mussel beds also under study. Results of the mussel bed study will be incorporated into evaluation of river otter data.

Obj. 8, 9 - River otters will be captured in the vicinity of oiled mussel beds also under study. Proposed trapping areas with oiled habitat are Knight, Eleanor, and Naked Islands. Control animals will be captured at Unakwik Inlet. River otters will be live captured at latrine sites located close to the shore line. Modified Hancock live traps and drugging boxes to hold river otters, as described by Melquist and Hornocker (1979) will be used. Weather permitting, traps will be checked at least mornings and evenings. Traps will be monitored with trap transmitters that signal when the trap has sprung. River otters will be held only so long as necessary to obtain body measurements, draw blood, and recover from the immobilizing agent. Animals will then be released at their original capture site.

Standard procedures will be used to collect and process blood in the field. An Animal Care and Use document under the independent authority of the University of Alaska Fairbanks will be in effect.

Obj. 10, 11 - River otter scats will be collected from permanently marked latrine sites (113 sites in unoiled and 131 sites in oiled) located in the intensive study areas. Sites will initially cleared of scats in June and then revisited and cleaned two or three times during the summer. Collection procedures will be those established for the oil impact assessment study. All scats from a site will be placed in a single plastic bag and labeled with the date,

location, and number of scats collected. Samples will then be frozen until they prepared for analysis.

Scats (or subsamples from latrine sites) will be placed in nylon stockings, placed in a modified clothes washer, and washed. Samples will be air dried and then sealed in plastic bags prior to analysis.

Each sample will be examined under a dissecting scope and food items identified to the lowest possible taxonomic order. Random subsamples also will be examined to assure that important species are not overlooked. Food items will be from reference materials developed for the impact study. Additionally, keys to otolith (Morrow 1979), scales (Lagler 1974), mammal hair (Adorjan and Kolenoskey 1969, Day 1966) and bird remains and feathers (Chandler 1916) will be used. Identical analysis procedures will be used for oiled and control samples.

Obj. 12 - All permanently marked latrine sites in the two intense study areas will be visited in late summer and recent use by river otters recorded. A site will be considered abandoned if 1) No recent river otter scats are found and 2) growth of herbaceous vegetation or branch gall from the overstory that would be easily removed by river otter use were prevalent on trails and main site areas. The sites will be evaluated by the same personnel who evaluated river otter use in 1991. Additional observation on site use will be made concurrent to the 1992 capture program.

DATA ANALYSIS - 103D

Obj. 8, 9 - Values for river otters exposed to oil will be compared to those of nonexposed river otters and to values obtained in 1990 and 1991 by the river otter impact assessment study. Differences in haptoglobin levels will be tested with multi-response permutation procedures using "Blossom" statistical software (Biondini et al. 1988, Zimmerman et al. 1985). Differences in river otter length and body mass between seasons will be examined with a Kruskal-Wallis test (Zar 1984). Regression lines of length-mass relationship will be compared according to Neter, et al. (1985).

Statistical analysis of blood values and morphometrics of river otters will include a multivariate t-test (Hotelling's T2) to examine difference (α = 0.05) in animals between oiled and unoiled areas. Bonferroni tests for *a posteriori* comparisons of individual variables will follow.

Obj. 10, 11 - Because of differential digestibility of prey and variable rates of passage through the gut, volumetric measures of prey remains in river otter feces are meaningless. Consequently, analysis will be confined to the occurrence of prey "species" in latrines samples. A "species" is defined as the lowest taxonomic order that an item can be assigned. Data will be compared between oiled versus control area, and through time - 1989, 1990, and 1992. Results will be expressed in terms of percent and latrines with food items, and percent of total food items (Bowyer et al. 1983).

Obj. 12 - Latrine site abandonment will be tested ($\alpha = 0.05$) with a log-likelihood (G-test).

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BUDGET ($K)

		R103A NOAA	R103B NPS	R103C USFWS	R103D ADF&G	R103 TOTAL
Salaries	$	109.0	13.7	36.6	75.0	234.3
Travel		29.8	4.0	6.5	6.0	46.3
Contracts		329.6	27.5	0.0	74.0	431.1
Supplies		15.2	2.2	45.0	4.4	66.8
Equipment		2.3	0.0	28.0	0.0	30.3
Other		3.2	0.5	0.0	0.0	3.7
Subtotal	$	489.1	47.9	116.1	159.4	812.5
General Admin.		35.5	4.0	5.5	16.5	61.5
Total	$	524.6	51.9	121.6	175.9	874.0

RESTORATION PROJECT NUMBER 104A

Study Title: Archaeological Resource Protection: Site Stewardship

Lead Agency: USFWS

Cooperating Agencies: ADNR, USFS

INTRODUCTION

The purpose of this project is to create an archaeological site stewardship program. The Exxon Valdez oil spill and associated clean-up have resulted in an increased public knowledge of archaeological resources in the oil spill area. The greater visibility of site locations brought on by oil spill activities has resulted in higher rates of looting and vandalism of these resources (Archaeology Resources Damage Assessment Study Number 1). Local site stewardship will be a powerful tool in deterring such a trend.

Site stewardship is the recruitment, training, coordination, and maintenance of a corps of local interested citizens to watch over threatened archaeological sites located within their home districts. Local citizens' groups and Native Corporations will be brought into the project as cooperators to facilitate communications and operations. Successful models for such programs already exist.

This project is technically feasible. The Arizona State Historic Preservation Office has conducted a very successful site stewardship program for years. The Kodiak Area Native Association has already demonstrated its feasibility in coastal Alaska.

Long-term site observation by local residents is a desirable method of assisting in the protection of threatened archaeological resources. Change over time is a far stronger indicator of impact than can be obtained through one-time or even occasional observation. Lost information from injured sites is essentially irretrievable. This project will enable us to reduce the magnitude of the ongoing impacts and helps restore site integrity and protection.

OBJECTIVES

The objectives are to reduce or eliminate archaeological site looting and vandalism through the following measures:

1. Develop an information program for the general public concerning both the site stewardship program and the importance and sensitivity of archaeological resources.

2. Recruit, educate, and involve local people to protect the archaeological resources in their areas.

METHODS

Data collection under this project will consist of assembling narrative reports from site stewards. Information from these reports will include dates and times of observation of sites; physical descriptions of the condition of the sites; photographs; and specifics of any apparent impacts, including the presence of persons involved in site looting. Photographic equipment will be given to site stewards to assist in the documentation. Site stewards will be provided with existing documentation of known sites in their areas and will also be asked to provide information about any other sites known to them, or subsequently discovered by them, for addition to the data base.

Routine reports will be routed to the project coordinator for compilation and all data will be maintained in the files of the project coordinator and be available to all participating agencies. The project coordinator will be responsible for passing this information to landowners or managing agencies. Any observations of current vandalism will also be provided immediately to agency resource protection personnel.

Current situation reports will be provided to involved agencies on a regular basis throughout the year; this will include notification of law enforcement bodies where appropriate.

The training program will be developed by education personnel and archaeological staff at the U.S. Fish and Wildlife Service. Individual agency archaeological staff will also assist the project coordinator in recruitment, training, and quality control of volunteer stewards.

Local site stewards' activities will be primarily confined to those areas in which they find themselves in the course of their normal activities. Mechanisms will be developed to provide transportation assistance (e.g., providing additional boat gas). Other assistance or nominal compensation may be considered to improve effectiveness. Logistical arrangements for the project coordinator and other agency staff will be arranged through the agencies or on commercial carriers. Logistical arrangements for site stewards attending training sessions will be coordinated by the project coordinator. Wherever possible, local arrangements will be facilitated by Native and/or local government groups in conjunction with this project.

The project coordinator will also oversee quality control of volunteer stewards' work. Quality control will be accomplished by conducting joint field visits with local site stewards, archaeolog-

ical and/or resource protection staff, and a representative of the project coordinator.

DATA ANALYSIS

The data analysis requirements of this project component are quite modest and will involve simple statistical analyses. The project coordinator will compile information from the various agency sources, including tabulation of results.

DELIVERABLES

In 1992, deliverables will include the complete training program and public information program described under methods, including preparation of information packages for site stewards. Recruitment of site stewards will be completed as of March 1, 1993.

The project coordinator will prepare a final report.

SCHEDULES AND PLANNING

1. (1992) Develop and complete a training program for local site stewards, including development of a comprehensive information package.

2. (1992) Develop an information program for the general public concerning both the site stewardship program and the importance and sensitivity of archaeological resources; conduct a series of local meetings to inform the public about the site stewardship process and to solicit public input into the design of the program.

3. (1992) Recruit a corps of local site stewards in coastal communities.

4. (February 1993) Complete final report.

PERSONNEL QUALIFICATIONS

Archaeologist GS-12
Charles Diters - M.A. Anthropology Brown University, specialist in Alaska archaeology, has functioned as Regional Archaeologist with USFWS for the last ten years.

Archaeologist Range 18L
Charles Holmes - Ph.D. Anthropology, Washington State University, specialist in the archaeology of southcentral Alaska, Special Projects Archaeologist in ADNR Office of History for the last

fifteen years acting as principal investigator for National Science Foundation grants and archaeological contracts.

Education Specialist GS-11, to be determined.

Archaeologist GS-9
Debra Corbett - MA University of Alaska, Fairbanks, specialist in Alaskan archaeology, particularly southwest Alaska and the Aleutians. (And/or substitute to be determined.)

BUDGET ($K)

		USFWS	USFS	ADNR	TOTAL
Salaries	$	30.1	2.4	47.2	79.7
Travel		8.2	2.0	5.2	15.4
Contracts		40.5	0.0	0.0	40.5
Supplies		4.9	0.0	0.0	4.9
Equipment		5.7	0.0	0.0	5.7
Subtotal	$	89.4	4.4	52.4	146.2
General Administration		5.4	0.5	7.1	13.0
Total	$	94.8	4.9	59.5	159.2

RESTORATION PROJECT NUMBER 106

Study Title: Technical Support Study for the Restoration of Dolly Varden/Cutthroat Trout

Lead Agency: ADF&G

PROJECT JUSTIFICATION

This closeout budget represents the cost for preparation of a final report for the data collected in this project through 1991.

	BUDGET ($K)
Salaries	$27.6
Travel	0.0
Contractual	2.0
Supplies	1.0
Equipment	0.0
Subtotal	$30.6
General Administration	4.3
Total	$34.9

3. BUDGET

SUMMARY BUDGET TABLES

III. 1992 *EXXON VALDEZ* ANNUAL WORK PLAN BUDGETS

PROJECT		PROPOSED 3 MONTH COST[1,2]	PROPOSED 12 MONTH COST[1,2]
A. Damage Assessment Closeout			
AW1	Surface Oil Maps	10.4	17.0
ARC1	Archaeological Survey	100.8	248.8
B2	Boat Surveys	13.9	48.5
B3	Murres	42.5	75.7
B4	Eagles	32.6	60.6
B6	Marbled Murrelets	16.2	24.8
B7	Storm Petrels	7.5	7.5
B8	Kittiwakes	7.5	7.5
B9	Pigeon Guillemots	18.0	18.0
B11	Harlequin Ducks	22.9	22.9
B12	Shorebirds	13.2	20.7
CH1A	Coastal Habitat	828.5[3]	2,358.5[4]
CH1B	Hydrocarbons in Mussels	14.2	51.4
FS1	Spawning Area Injury	48.3	64.3
FS2	Pre-emergent Fry	22.7	29.3
FS3	Coded-Wire Tags	45.6	126.7
FS4A	Early Marine Salmon	56.0	145.2
FS4B	Juvenile Pinks	24.9	119.4
FS5	Dolly Varden	21.2	22.2
FS11	Herring Injury	144.7	303.6
FS13	Clams	30.1	40.8[5]
FS28	Run Reconstruction	60.1	250.6
MM1	Humpback Whales	0.0	17.3
MM2	Killer Whales	1.7	33.3

[1] Cost in thousands of dollars.
[2] Starting March 1, 1992.
[3] Number is approximate.
[4] A placeholder of $3,021,500 was initially approved pending completion of project review. A proposed project cost of $2,358,500 was developed upon completion of project review.
[5] For analysis of 1989 & 1990 growth data. Approval for additional work at an additional cost of $65,500 may be requested depending on the results of growth analysis.

PROJECT		PROPOSED 3 MONTH COST	PROPOSED 12 MONTH COST
MM6	Sea Otters	92.0	199.7
TM3	River Otter & Mink	67.8	74.0
ST1A	Subtidal Sediments	32.6	103.5
ST1B	Subtidal Microbial	12.8	17.1
ST2A	Shallow Benthic	37.4	109.8
ST2B	Deep Water Benthos	11.8	10.7[6]
ST3A	Caged Mussels	10.9	39.1
ST3B	Sediment Traps	40.4	50.9
ST4	Fate and Toxicity	8.6	52.6
ST6	Rockfish	0.0	16.6
ST7	Demersal Fishes	16.8	60.4
	SUBTOTAL	1,914.6	4,849.0
B. Damage Assessment Continuation			
FS27	Sockeye Overescapement	154.8	583.0
FS30	Database Management	47.5	202.5
ST5	Shrimp	13.3	22.7[7]
ST8	Sediment Data Synthesis	39.1	205.6
TS1	Hydrocarbon Analysis	388.8	1,028.3
TS3	GIS Mapping & Analysis	102.9	375.2[8]
	SUBTOTAL	746.4	2,417.3
C. Restoration: Technical Support			
R92	GIS Mapping & Analysis	29.4	125.5[8]
	SUBTOTAL	29.4	125.5
D. Restoration: Recovery Monitoring			
R11	Murres	192.6	316.7

[6] PI needs to resolve technical issues raised by peer reviewers. Approval for project completion, at an additional cost of $76,900, may be requested pending resolution of issues.

[7] Amount for final report. Approval for additional field work, at an additional cost of $67,900, may be requested depending on final report results.

[8] Placeholder. Final number to be developed following program approval by the Trustee Council.

PROJECT		PROPOSED 3 MONTH COST	PROPOSED 12 MONTH COST
R60C	Pink Salmon Egg/Fry	187.1	389.9
R90	Dolly Varden	91.5	91.5
R102	Coastal Habitat	165.0[3]	485.6[9]
	SUBTOTAL	636.2	1,283.7
E. Restoration: Implementation Planning			
R105	Instream Survey	74.6	348.1
	SUBTOTAL	74.6	348.1
F. Restoration: Manipulation/Enhancement			
R113	Red Lake Restoration	0.0	55.9
	SUBTOTAL	0.0	55.9
G. Restoration: Habitat Protection Planning			
R15	Marbled Murrelets	185.0	419.3
R47	Stream Habitat Survey	76.4	399.6
R71	Harlequin Ducks	130.6	424.5
	SUBTOTAL	392.0	1,243.4
H. Restoration Management Actions			
R53	Kenai Sockeye	66.2	674.2
R59	Genetic Stock ID	100.7	320.9
R60AB	Pink Salmon	154.1	1,479.7
R73	Harbor Seals	25.0	25.0
R103	Oiled Mussels	270.6	874.0[10]
R104A	Site Stewardship	46.7	159.2
R106	Dolly Restoration	34.9	34.9
	SUBTOTAL	698.2	3,567.9
	TOTAL	4,491.4	13,890.8

[9] A placeholder of $604,100 was initially approved pending completion of project review. A proposed project cost of $485,600 was developed upon completion of project review.

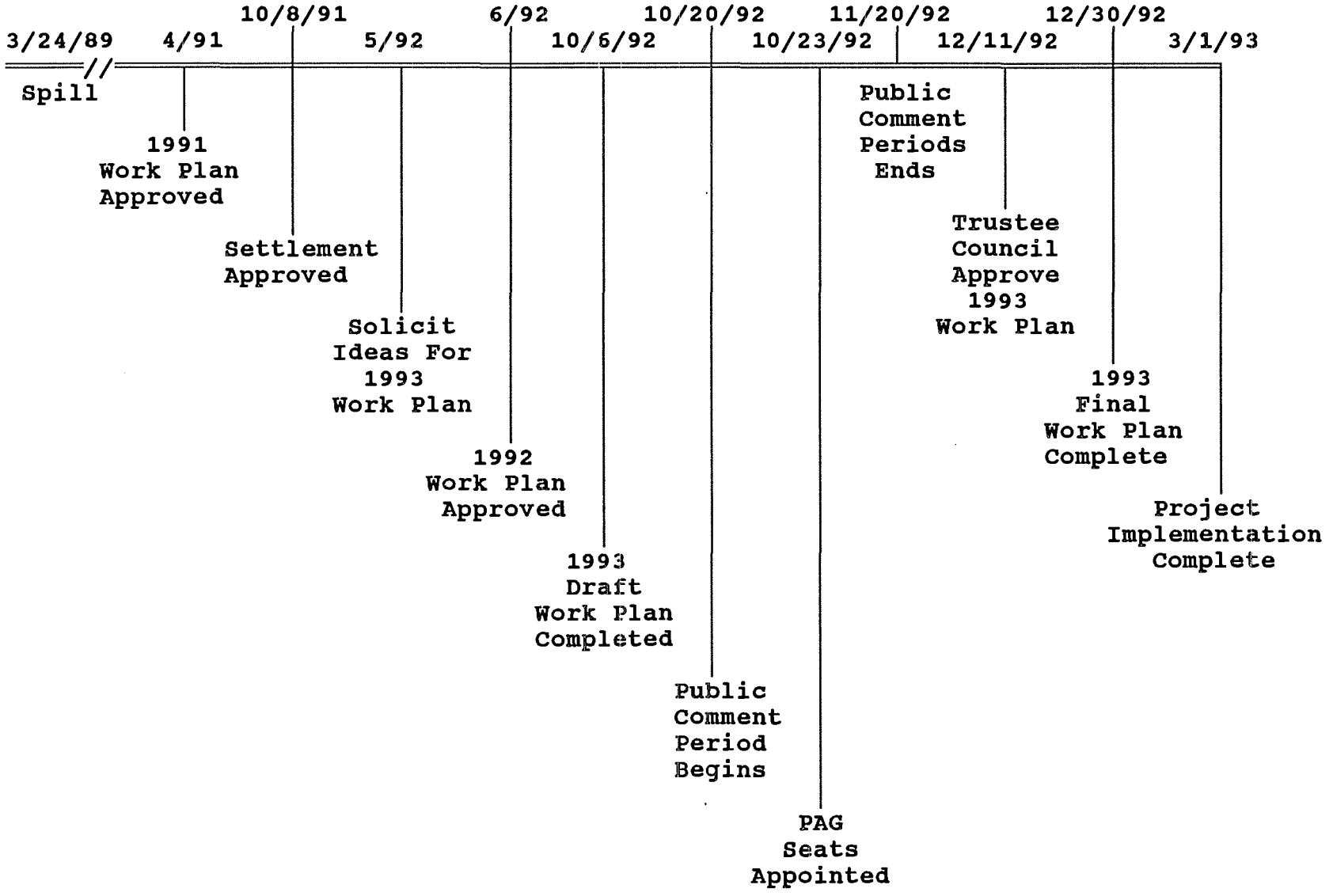
[10] A placeholder of $825,000 was initially approved pending completion of project review. A proposed project cost of $874,000 was developed upon completion of project review.

4. ACRONYMS AND ABBREVIATIONS

4. LIST OF ACRONYMS AND ABBREVIATIONS

ABL	Auke Bay Laboratory
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ANOVA	Analysis of Variance
CTD	Conductivity/Temperature/Depth
CWT	Coded Wire Tag
DBMS	Database Management System
DEC	Department of Environmental Conservation (Alaska)
DNA	Deoxyribonucleic Acid
DNR	Department of Natural Resources (Alaska)
ESI	Environmental Sensitivity Index
FRED	Fisheries Rehabilitation, Enhancement, and Development Division
F/S	Fish/Shellfish
FWS	Fish and Wildlife Service (US)
FY	Fiscal Year
GC-MS	Gas Chromatography - Mass Spectrometry
GIS	Geographic Information System
GPS	Global Positioning System
GSI	Genetic Stock Identification
HC	Hydrocarbon
HSRG	Habitat Spill Response Group
MDL	Method Detection Limits
MFO	Mixed-function Oxidase
MM	Marine Mammal
mtDNA	Mitochondrial DNA
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRDA	Natural Resources Damage Assessment
OSIAR	Oil Spill Impact Assessment and Recovery Office
PCA	Principal Components Analysis
PHC	Petroleum Hydrocarbon(s)
PI	Principal Investigator
PL	Project Leader
QA/QC	Quality Assurance/Quality Control
RNA	Ribonucleic Acid
RT	Restoration Team
SOP	Standard Operating Procedure
ST	Subtidal
TS	Technical Services
UAF	University of Alaska Fairbanks
UCI	Upper Cook Inlet
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	Ultraviolet
WAN	Wide Area Network

MILESTONES - 1993 WORK PLAN



ASSUMPTIONS FOR PREPARING THE DRAFT 1993 WORK PLAN

- **Budget for all federal projects in Draft 1993 Work Plan to Office of Management and Budget by August 31, 1992**

- **Since Restoration Plan will only be completed in Draft form it should take a conservative approach (Time Critical)**

- **Emphasis for selecting 1993 projects:**

  + **Damage Assessment Closeout projects - continue as highest priority. New and continued Damage Assessment projects will be limited to further evaluating injury that is not understood to a degree necessary to provide restorative action or document new injury**

  + **Restoration Monitoring - many projects deferred from 1992 to 1993 or later years. More projects may be conducted in 1993 than in 1992**

  + **Restoration Manipulation and/or Enhancement - may be more projects than proposed in 1992 plan**

  + **Restoration Habitat Protection and/or Acquisition - anticipate continuation or wrap-up of the three 1992 projects. Identifying important habitats and habitat-related services will be a high priority for 1993**

- **Trustee Council recognizes strong public support for habitat protection/acquisition, may protect habitats**

  + **Restoration Management Actions - largest category of restoration projects for 1993**

  + **Technical Support - some projects expected**

- **Greater demands and restoration needs could result in broader program scope**

- **Draft work plan and budget includes funds for projects, Restoration Team, Administrative Director, etc.**

- **Endowments should be considered**

IDEAS RECEIVED

- One-page idea sheet
- 463 idea sheets received mid-June 1992
  - \+ Agencies 2/3
  - \+ Public 1/3
- 358 ideas remained after duplicates and comments removed

CRITICAL REVIEW

- **Key Criteria approved by Restoration Team (project must pass all three)**

  1. Compliance with terms of settlement (link to injury)

  2. Technically feasible

  3 Compliance with laws, regulations, policies

- **Legal Council reviews decision for Criteria #3**

  Specific Criteria

  1. Damage Assessment

  + **Reject all 1992 Closeouts**

  + **New or Continuation only if injury present and inadequately described**

  2. Restoration

  + **Has restoration endpoint**

  + **Time critical**

  + **Lost opportunity**

  + **No long-term commitment**

- **Completeness**

  + **Logical combinations**

  + **Gaps**

PROJECT DEVELOPMENT

- **55 projects remained after critical review process**
- **Brief project descriptions (3-pagers) and detailed budgets developed**
- **Peer review conducted under auspices of Chief Scientist**
- **Restoration Team makes recommended changes, votes on individual merits of projects**
- **Projects revised**
- **Chief Scientist comments on package**
- **Restoration Team votes on priorities**
- **All projects presented to Trustee Council**
    - + **Those with 5-6 votes from Restoration Team represent Restoration Team recommendations**

TRUSTEE COUNCIL DECISIONS

- **Review Package of 55 in Public Meeting with:**
  - + **Restoration Team recommendations**
  - + **Chief Scientist recommendations**
- **Trustee Council removes five**
- **Decides remaining 50 should go out for public review in Draft Plan**

EXXON VALDEZ OIL SPILL

1993 DRAFT PROPOSED FIELD PROJECTS

Votes by Category	Total	RT Recommendation
Damage Assessment	2	2
Restoration Monitoring	11	11
Restoration Management	13	12
Restoration Manipulation/ Enhancement	12	9
Habitat Protection	7	6
Technical Support	5	3
Totals	50	43

Votes By Type	Total	
Fish	15	14
Shellfish	2	0
Birds	10	8
Mammals	7	7
Subtidal/Intertidal	3	3
Human Resources	5	5
Habitat Protection	7	7
Technical Support	6	4
Totals	55	48

The types list "double counts" projects which include work with more than one type; e.g. birds & mammals.

WHERE DO WE GO FROM HERE?

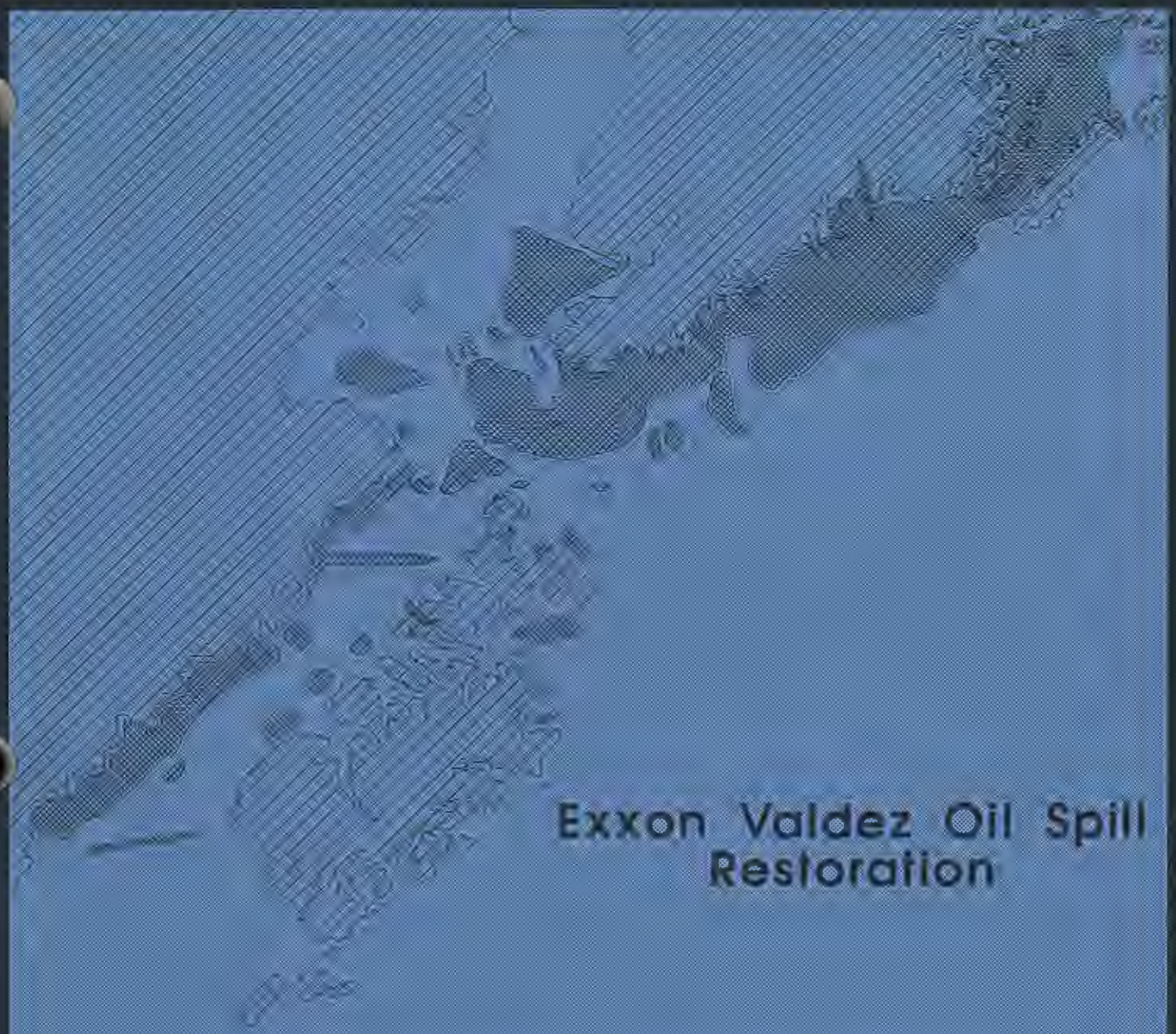
- **Current Status**
  - + **Some projects assigned to agencies, others contracted to public**
  - + **36 projects primarily to agencies**
  - + **14 projects primarily contracted out**
  - + **About 50 % of funds to agencies; remainder to private sector**
  - + **Draft Plan (projects only) $40,426,800 (includes $20,000,000 for Habitat Protection)**
  - + **Restoration Team Recommendation (projects only) $35,815,200 (includes $20,000,000 for Habitat Protection)**
- **Public Comment Period October 20 - November 20**
- **TC will consider public comments, PAG advice, recommendations of RT and Chief Scientist before making decisions on 1993 projects. Decisions due on December 11.**

IMPLEMENTATION

- **Develop detailed project descriptions or Request for Proposals**
- **Request and receive court funds for 1993**
- **Issue contracts or initiate agency projects**
- **Monitor project performance**

DOCUMENTS RELEVANT TO 1993 WORK PLAN

- **Notebook of all original ideas**
- **Notebook of all project evaluation sheets and Restoration Team recommendation**
- **Voting record tables**
- **Draft 1993 Detailed Budget Book**
- **1993 Draft Work Plan (Blue Book)**
- **Fate of ideas tables**



Exxon Valdez Oil Spill Restoration

1993 Draft Work Plan

Prepared by:
Exxon Valdez Oil Spill Trustees
645 'G' Street
Anchorage, Alaska
99501
(907) 278-8012

October 1992

State of Alaska: Departments of Fish & Game, Law, and Environmental Conservation
United States: NOAA, Departments of Agriculture and Interior

Dear Reviewer:

In the fall of 1991, the United States of America and the State of Alaska settled their claims against the Exxon Corporation and Exxon Shipping Company for natural resource and service damages from the *Exxon Valdez* oil spill. Monies provided by the settlement will be used to restore, enhance, replace, rehabilitate or acquire equivalent resources and services in Prince William Sound and the Gulf of Alaska. The undersigned three State and three Federal Trustee Council Representatives, in consultation with the public, are responsible for determining how restoration funds are to be spent in accordance with the Memorandum of Agreement and Consent Degree dated August 28, 1991.

The Federal and the State Trustees are developing a Restoration Plan for the injured resources and services. In April 1992, the *Exxon Valdez* Oil Spill Trustees prepared Volume I: Restoration Framework which provides background information and proposed guidelines for future planning efforts. The Trustees in April 1992, also prepared Volume II: 1992 Draft Work Plan which proposed activities that were important to undertake in 1992 prior to the development of a Restoration Plan.

A Draft Restoration Plan and associated Draft Environmental Impact Statement (EIS) are presently being developed and have not been completed. Therefore, the Trustees are preparing a 1993 Draft Work Plan which proposes activities to be undertaken in 1993 prior to the completion of the Final Restoration Plan and Environmental Impact Statement.

The 1993 Draft Work Plan is intended to elicit comments and suggestions from you and continue the public "scoping" process for environmental analysis under the National Environmental Policy Act (NEPA). NEPA Compliance will be completed on each 1993 proposal, and the 1993 and 1992 activities will be addressed in the Restoration Plan and EIS.

We invite your comments on the 1993 Draft Work Plan. The issues identified on the tear sheets in the 1993 Draft Work Plan are intended to facilitate but not limit your comments and suggestions. Written comments, in order to be considered during the development of the final 1993 Work Plan, must be received by November 20, 1992, at the following address:

Exxon Valdez Oil Spill Trustee Council
645 G Street
Anchorage, Alaska 99501

Questions concerning this document or its distribution should be directed to the Oil Spill Public Information Center, 645 G Street, Anchorage, Alaska 99501, or you may call (907) 278-8008.

We appreciate your interest and look forward to your participation in this important process.

Sincerely,

Date 9.21.92 Date 9/21/92

CHARLES E. COLE
Attorney General
State of Alaska

MICHAEL A. BARTON
Regional Forester
Alaska Region - USDA Forest Service

Date 9/21/92 Date 9-21-92

CARL L. ROSIER
Commissioner
Alaska Department of Fish and Game

CURTIS V. MCVEE
Special Assistant to the Secretary
U.S. Department of the Interior

Date 9/21/92 Date 9-21-92

JOHN A. SANDOR
Commissioner
Alaska Department of Environment Conservation

STEVEN PENNOYER
Director, Alaska Region
National Marine Fisheries Service

COMMENT SHEET
EXXON VALDEZ RESTORATION
DRAFT 1993 WORK PLAN

You are invited to share your ideas and comments on the Draft 1993 Work Plan.

Public comments on this document will assist the Trustee Council as decisions are made on which of the proposed projects will be conducted in 1993. As you develop your comments on the 1993 draft work plan, please also address the following questions:

- The Restoration Plan will not be completed prior to the 1993 field season. The Restoration Plan is a primary means for the public to help the Trustee Council prioritize expenditures of restoration funds. In light of that, should the Trustee Council: (1) limit restoration actions only to those projects that are time critical or would otherwise be a lost opportunity; (2) also include some limited restoration projects that are not time-critical; or (3) implement a large-scale restoration program prior to the completion of the Restoration Plan?

- Do you believe there are other projects that directly address injured resources or services that are not contained in this document? If so, please identify the project(s)?

- Do you believe the proposed projects contained in this document are appropriate in terms of their scope and level of funding? Please explain what, if anything, you would change and the basis for such change.

- How would you prioritize the proposed projects and your additional recommended projects (if any)?

You may use this tear sheet to present your views or attach additional sheets.

Please address your comments to:

Draft 1993 Work Plan Comments
Exxon Valdez Trustee Council
645 "G" Street
Anchorage, Alaska 99501

Comments must be postmarked by November 20, 1992

COMMENTS

You are invited to share your ideas and comments with the Trustees.
Please use this tear sheet to present your views on the 1993 Draft Work Plan.
You may send additional comments by letter regarding the 1993 Draft Work Plan.

If needed, use the space on the back or attach additional sheets. Please fold, staple, and add a postage stamp. Thank you for your interest and participation.

Additional Comments:

----------(fold here)----------Return Address:

_____

_____

_____

Place
Stamp
Here

Exxon Valdez Oil Spill Trustee Council
645 G Street
Anchorage, AK 99501

Attn: 1993 Draft Work Plan

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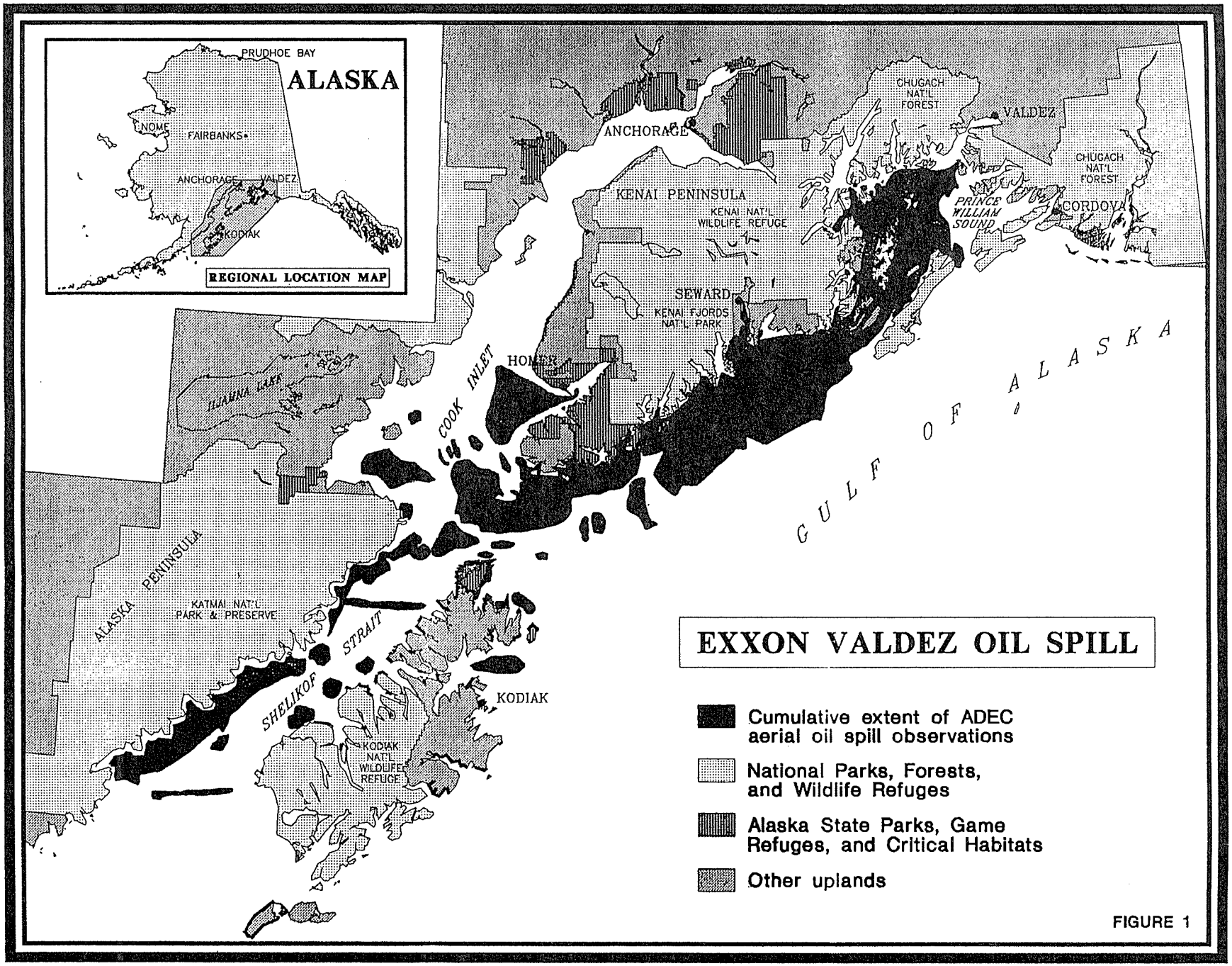
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ANCHORAGE
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VALDEZ
CHUGACH NAT'L FOREST
KENAI PENINSULA
KENAI NAT'L WILDLIFE REFUGE
PRINCE WILLIAM SOUND
CORDOVA
SEWARD
KENAI FJORDS NAT'L PARK
HOMER
COOK INLET
ILIAMNA LAKE
GULF OF ALASKA
ALASKA PENINSULA
KATMAI NAT'L PARK & PRESERVE
SHELIKOF STRAIT
KODIAK
KODIAK NAT'L WILDLIFE REFUGE
EXXON VALDEZ OIL SPILL
Cumulative extent of ADEC aerial oil spill observations
National Parks, Forests, and Wildlife Refuges
Alaska State Parks, Game Refuges, and Critical Habitats
Other uplands

FIGURE 1

Introduction

The March 24, 1989 grounding of the T/V *Exxon Valdez* in Alaska's Prince William Sound caused the largest oil spill in U.S. history. Approximately 11 million gallons of North Slope crude oil moved through the southwestern portion of the Prince William Sound and along the coast of the western Gulf of Alaska (see map, Fig. 1). The spill injured fish, birds, mammals, and a variety of other forms of marine life, habitats, and resources, and the services these resources provide.

On September 25, 1991, the State of Alaska, the United States and Exxon Corporation agreed to settlement terms of $900 million for civil damage claims arising from the *Exxon Valdez* oil spill. On October 8, 1991, the U.S. District Court approved this settlement. The funds will be received by a joint trust fund over a ten year period and will be administered by the State and Federal Trustees. The spending guidelines for the civil settlement monies are set forth in the Memorandum of Agreement and Consent Decree that was filed in the United States District Court for the District of Alaska, United States vs. State of Alaska, A91-081 CIV ("Memorandum of Agreement"), and approved and entered by United States District Judge H. Russel Holland on August 28, 1991. Through this agreement the United States and the State of Alaska resolved their claims against each other and agreed to act as co-trustees in the collection and joint use of all natural resource damage recoveries resulting from the *Exxon Valdez* oil spill.

The Memorandum of Agreement provides that the governments shall jointly use such monies for purposes of "restoring, replacing, enhancing, rehabilitating, or acquiring the equivalent of natural resources injured as a result of the Oil Spill and the reduced or lost services provided by such resources . . . " Under the Memorandum of Agreement the state and federal trustee agencies are to administer the restoration and injury assessment activities and to include public involvement as an integral part of the restoration process. The *Exxon Valdez* Trustee Council (representing the Trustees) is composed of six members, three Federal and three State of Alaska, representing the following trustee agencies - the United States Departments of Agriculture and Interior, the National Oceanic and Atmospheric Administration, the Alaska Department of Environmental Conservation, Alaska Department of Fish and Game, and the Alaska Department of Law. The Restoration Team which is directed by the Trustee Council and is composed of representatives of the Trustee agencies, oversees the administration of restoration activities and makes recommendations to the Trustee Council. A Public Advisory Group has now been established, a charter written, draft operating procedures produced and all seventeen members have been selected by the Trustee Council. There are members representing twelve interest groups and five members chosen from the public-at-large. There are also two *ex officio* members representing the State of Alaska Legislature. This group will advise the Trustee Council on planning, evaluating, and implementing restoration activities and the remaining injury assessments; developing a restoration plan; and allocating restoration funds.

A comprehensive Restoration Plan is being developed that will describe the preferred options to be used to restore the natural resources and services injured by the oil spill. A draft plan will be released to the public and the Public Advisory Group for comment. After analysis of all responses, a final Restoration Plan will be adopted that will outline the work to be performed. Prior to completion of the Restoration Plan, certain projects will need to be implemented that address injured resources and services and are time critical or present a lost opportunity if not conducted in 1993. The Trustee Council prefers to defer funding many restoration projects pending completion of the Restoration Plan in 1993, to maximize public input on restoration

priorities. The Restoration Team has recommended to the Trustee Council that some projects which would be included in any set of preferred restoration options should be implemented as part of this work plan to expedite restoration of the spill-affected area. The 1993 Draft Work Plan is comprised of projects of these types and some continuing assessment studies.

On September 21, 1992, the *Exxon Valdez* Trustee Council directed that the 1993 Draft Work Plan, contained herein, be distributed for public review and comment. This document contains descriptions and budgets of projects that are proposed to be conducted during the last nine months of the 1993 federal fiscal year which ends September 30, 1993. **The Trustee Council has not indicated which of these projects they believe should be conducted in 1993, but are relying on public comment and scientific peer review to assist their decisions. There is a thirty-day public review period from October 20 to November 20, 1992. All correspondence that concerns these projects and is postmarked by November 20 will be copied and distributed to the Trustee Council. Your opinion is important and will be considered when the Trustee Council meets on December 11, 1992 to decide which projects are to be conducted in 1993.**

Public comment on this document will assist the Trustee Council as decisions are made on which of the proposed projects will be conducted in 1993. As you develop your comments on the draft 1993 work plan, please also address the following questions:

- The Restoration Plan will not be completed prior to the 1993 field season. The Restoration Plan is a primary means for the public to help the Trustee Council prioritize expenditures of restoration funds. In light of that, should the Trustee Council: (1) limit restoration actions only to those projects that are time critical or would otherwise be a lost opportunity; (2) also include some limited restoration projects that are not time-critical; or (3) implement a large-scale restoration program prior to the completion of the Restoration Plan?

- Do you believe there are other projects that directly address injured resources or services that are not contained in this document? If so, please identify the project(s)?

- Do you believe the proposed projects contained in this document are appropriate in terms of their scope and level of funding? Please explain what, if anything, you would change and the basis for such change.

- How would you prioritize the proposed projects and your additional recommended projects (if any)?

This year suggestions from the public were requested to assist in developing ideas for projects to be conducted in 1993. Some 450 ideas were received by the *Exxon Valdez* Trustee Council. The project ideas were synthesized by and evaluated by the Restoration Team working in conjunction with the Trustee Council chief scientist and peer reviewers. Some ideas were developed into project descriptions (which appear in this volume). Some were rejected as inappropriate uses of the settlement funds, and some were deferred until a Restoration Plan has been developed. After the project descriptions were prepared, the Restoration Team with the assistance of the chief scientist and peer reviewers screened the proposals for technical merit and made recommendations to the Trustee Council on which projects should be included in the 1993 Draft Work Plan. Though legal review of some ideas was requested and received, some concerns

remain with a few projects or components of projects. Joint state and federal legal review is proceeding concurrently with public review and may result in further changes to the Work Plan.

Inclusion in this draft plan is not an indication that any of these projects will ultimately be approved. It does indicate that the Trustee Council is very interested in public comment concerning these proposed projects. As noted above, there are legal constraints on the use of settlement funds including a limitation on the expenditure of funds to the restoration and enhancement of injured resources and services. Although there are sufficient funds available to restore resources and services injured by the spill, there are not sufficient funds available to conduct all of the studies and projects which have been suggested and to acquire all of the habitat already proposed, and thus there must be a prioritization of restoration activities to be conducted in 1993. The Trustee Council has the responsibility to restore resources and services injured by the *Exxon Valdez* oil spill. As stated above, under the terms of the Memorandum of Agreement, restoration is a combination of activities. The Trustee Council recognizes the need to carefully weigh the mix of available restoration options to ensure development of the best restoration program for Alaska. Public comment will assist the Trustee Council in development of that program.

The proposed 1993 program includes damage assessment and restoration projects to be carried out in the last nine months of the 1993 federal fiscal year. Damage assessment projects are those necessary to complete or support the orderly completion of Natural Resources Damage Assessment (NRDA) studies that began after the *Exxon Valdez* oil spill. Restoration projects form two major groups. The first will provide timely information necessary to support subsequent decisions about restoration options for injured resources. The second restores the resources or the service provided by these resources. Categories of restoration projects described in the 1993 Draft Work Plan are recovery monitoring, implementation planning, manipulation/enhancement, habitat protection planning and acquisition, management actions, and technical support.

This volume contains: (1) a description of administrative and project support functions and budgets; (2) descriptions and budgets for field projects; (3) a description of the management structure (including the Restoration Team) which administers these projects; (4) a summary of the known oil spill-related injuries (Appendix A); and (5) evaluations of the proposed projects by the Chief Scientist (Appendix B).

The 1993 Draft Work Plan is the fifth of a series of plans prepared by the State and Federal Trustees for the *Exxon Valdez* oil spill. Previous plans include:

- State/Federal Natural Resources Damage Assessment Plan for the *Exxon Valdez* Oil Spill, August 1989
- The 1990 State/Federal Natural Resource Damage Assessment and Restoration Plan for the *Exxon Valdez* Oil Spill
- The 1991 State/Federal Natural Resource Damage Assessment and Restoration Plan for the *Exxon Valdez* Oil Spill
- The *Exxon Valdez* Oil Spill Restoration 1992 Draft Work Plan

Each of these previous plans contains descriptions of the projects that were conducted in each of those years.

Tables which outline the fate of each idea submitted and the detailed project budgets are available for public viewing at:

Oil Spill Public Information Center
645 G Street
Anchorage, Alaska 99501
(907) 278-8008
800-478-7745 (Alaska)
800-283-7745 (outside Alaska)

Copies have also been placed at the following libraries and teleconference sites:

LIBRARIES

A. Holmes Johnson Memorial
Library
319 Lower Mill Bay Road
Kodiak, AK 99615
(907) 486-8686

Alaska Dept. of Fish & Game
Habitat Division Library
333 Raspberry Road
Anchorage, AK 99518-1599
(907) 267-2314

Alaska State Library
Government Publications Services
P.O. Box 110571
Juneau, AK 99811-0571
(907) 465-2910

Cordova Public Library
P.O. Box 1170
Cordova, AK 99574
(907) 424-6667

Minerals Management Service
Library
949 East 36th Ave., Room 603
Anchorage, AK 99508
(907) 271-6435

University of Alaska - Fairbanks
Elmer E. Rasmuson Library
310 Tanana Drive
Fairbanks, AK 99775
(907) 474-7481

U.S. Fish & Wildlife Service
1011 East Tudor Road
Anchorage, AK 99503
(907) 786-3358

Alaska Dept. of Environmental
Conservation Library
410 Willoughby Ave.
Juneau, AK 99801-1795
(907) 465-5006

Alaska Resources Library
U.S. Bureau of Land Management
222 West 7th Ave, #36
Anchorage, AK 99513-7589
(907) 271-5025

Auke Bay Fisheries Lab
Marine Fisheries Service Library
11305 Glacier Highway
Juneau, AK 99801-8626
(907) 789-6010

Kuskokwim Consortium Library
Pouch 1068
Bethel, AK 99559
(907) 543-4516

University of Alaska - Anchorage
Consortium Library
3211 Providence Drive
Anchorage, AK 99508
(907) 786-1800

U.S. District Court Library
222 West 7th Ave., Box 31
Anchorage, AK 99513-7586
(907) 271-5655

Valdez Consortium Library
P.O. Box 609
Valdez, AK 99686
(907) 835-4632

Z.J. Loussac Library
Alaska Collection
3600 Denali Street
Anchorage, AK 99503-6093
(907) 261-2975

TRUSTEE COUNCIL TELECONFERENCE SITES

Chenega Bay Volunteer Teleconference Center
Box 60
Chenega Bay, AK 99574

Cordova Volunteer Teleconference Center
Cordova City Hall
Cordova, AK 99574
(907) 424-6200

Fairbanks Legislative Information Office
119 Cushman Rd., Suite 101
Fairbanks, AK 99701-2879
(907) 452-4448

Juneau Legislative Information Office
Goldstein Bldg., Suite 314
130 Seward St.
Juneau, AK 99801-2197
(907) 465-4648

Homer Teleconference Center
126 W. Pioneer, #4
Homer, AK 99603
(907) 235-7878

Kenai Peninsula Legislative Information Office
3482 Kalifornsky Beach Rd., Suite A
Soldotna, AK 99669-9728
(907) 262-9364

Kodiak Legislative Information Office
112 Mill Bay Rd., Kodiak Plaza Bldg.
Kodiak, AK 99615-6431
(907) 486-8116

Seward Volunteer Teleconference Center
Seward Public Library
Seward, AK 99664
(907) 224-3646

Tatitlek - IRA Council Office
General Delivery
Tatitlek, AK 99677
(907) 325-2311

Valdez Legislative Information Office
Room 13, State Court and Office Bldg.
121 Hazelet
Valdez, AK 99686
(907) 835-2111

City of Whittier
P.O. Box 608
Whittier, AK 99683
(907) 472-2337

PROPOSED 1993 PROJECT BUDGET SUMMARY

The budget summary table which follows lists only those budgets for *Exxon Valdez* restoration projects which are currently proposed for the last nine months of the federal fiscal year 1993. The funding period for projects is being changed from an oil year which cycled from March 1 to February 28 annually, to the federal fiscal year which runs from October 1 to September 30. Projects currently being conducted were approved earlier as part of the 1992 Work Plan and are funded through February 28, 1993. This volume does not address projects which were previously approved in the 1992 Work Plan. There is a portion of the 1993 fiscal year budget which, because it was already approved in the 1992 Work Plan, does not appear in the table of proposed projects which follows.

Projects in the table are grouped to show those which the Restoration Team is recommending that the Trustee Council include in the 1993 Work Plan. The projects included in the last grouping received less support from the Restoration Team but are still being considered by the Trustee Council and it is therefore important to review these potential costs as well. The Administrative Director's Office and Restoration Team Support projects are allocated between direct field support and process support. Pending public input on other new projects, the projects included in this table constitute the only projects currently under consideration for implementation in 1993.

PROPOSED 1993 PROJECT BUDGET SUMMARY
EXXON VALDEZ OIL SPILL RESTORATION
1993 Federal Fiscal Year 1-Oct-92 to 30-Sep-93

Project Number	Project Title	Agency		Proposed 1-Mar-93 30-Sep-93	
	RESTORATION PROJECTS (Recommended by Restoration Team)				
93002	Sockeye Salmon Overescapement	ADF&G		$714.6	
93003	Salmon Egg to Pre-emergent Fry Survival	ADF&G/NOAA		$686.0	
93004	Genetics, Documentation, Enumeration, & Preservation of Pink Salmon	ADF&G		$899.1	
93005	Cultural Resource Information, Education and Interpretation	USFS/ADNR/DOI-NPS		$399.4	
93006	Site Specific Archaeological Restoration	DOI-NPS/ADNR/ DOI-FWS/USFS		$259.1	
93007	Archaeological Site Stewardship Program	ADNR/USFS/ DOI-FWS/DOI-NPS		$194.6	
93008	Archaeological Site Patrol and Monitoring	DOI-NPS/ADNR/ DOI-FWS/USFS		$297.8	
93009	Public Information, Education and Interpretation	USFS		$316.7	
93011	Develop Harvest Guidlines to Aid Restoration of River Otters & H. Ducks	ADF&G		$11.2	
93012	Genetic Stock Identification of Kenai River Sockeye Salmon	ADF&G		$300.6	
93015	Kenai River Sockeye Salmon Restoration	ADF&G		$732.6	
93016	Chenega Bay Chinook & Silver Salmon	ADF&G		$25.9	
93017	Subsistence Food Safety Survey & Testing	ADF&G/NOAA		$360.6	
93018	Enhanced Management for Cutthroat Trout/Dolly Varden in PWS	ADF&G/USFS		$285.3	
93022	Murre Decoy/Playback Facility/Colony Monitoring	DOI-FWS		$281.0	
93024	Restoration of Coghill Lake Sockeye Salmon Stock	ADF&G/USFS		$191.9	
93025	Montague Island Chum Salmon Restoration	USFS		$81.5	
93028	Restoration of Wetlands	USFS		$82.1	
93029	Prince William Sound Second Growth Management	USFS		$62.0	
93030	Red Lake Restoration	ADF&G		$77.2	
93031	Red Lake Mitigation	ADF&G		$153.7	
93032	Cold Creek Pink Salmon Restoration	ADF&G		$36.1	
93033	Harlequin Duck Restoration	ADF&G		$717.9	
93034	Pigeon Guillemot Recovery	DOI-FWS		$165.8	
93035	Black Oystercatchers/Oiled Mussel Beds	DOI-FWS		$107.9	

11-Sep-92

Amounts shown are in thousands of dollars.

PROPOSED 1993 PROJECT BUDGET SUMMARY
EXXON VALDEZ OIL SPILL RESTORATION
1993 Federal Fiscal Year 1-Oct-92 to 30-Sep-93

Project Number	Project Title	Agency		Proposed 1-Mar-93 30-Sep-93	
	RESTORATION PROJECTS (Recommended by Restoration Team) (Continued)				
93036	Oiled Mussel Beds	NOAA/DOI-NPS		$404.8	
93038	Shoreline Assessment	ADEC/ADNR/USFS NOAA/DOI/ADF&G		$520.7	
93039	Herring Bay Experimental & Monitoring	ADF&G		$507.5	
93041	Comprehensive Monitoring	NOAA		$237.9	
93042	Killer Whale Recovery	NOAA		$127.1	
93043	Sea Otter Demographics & Habitat	DOI-FWS		$291.9	
93045	Marine Bird/Sea Otter Surveys	DOI-FWS		$262.4	
93046	Habitat Use, Behavior, & Monitoring of Harbor Seals in PWS	ADF&G		$230.5	
93047	Subtidal Monitoring	NOAA/ADEC/ADF&G		$1,000.8	
93051	Habitat Protection: Stream Habitat Assessment	USFS/ADF&G/ DOI-FWS		$1,179.8	
93053	Hydrocarbon Database	NOAA		$105.5	
93057	Damage Assessment GIS	ADNR		$67.5	
93059	Habitat Protection Workshop	USFS		$42.3	
93060	Accelerated Data Acquisition	USFS		$43.9	
93061	New Data Acquisition	USFS/ADNR		$535.0	
93062	Restoration GIS	ADNR		$138.4	
93063	Anadromous Stream Surveys	ADF&G		$59.4	
93064	Imminent Threat Habitat Protection*	ADNR/FED (To Be Determined)		$20,000.0	
93AD	Administrative Director's Office (Direct Project Support)	ADEC/ADNR/USFS/ DOI		$576.4	
93RT	Restoration Team Support (Direct Project Support)	ADEC/ADNR/USFS/ NOAA/DOI/ADF&G		$2,042.8	
	RESTORATION PROJECTS SUBTOTAL			$35,815.2	

11-Sep-92

Amounts shown are in thousands of dollars.

*Actual amount for interim habitat protection will be determined by the Trustee Council following imminent threat analysis.

FORM 1A PROJECT SUMMARY

PROPOSED 1993 PROJECT BUDGET SUMMARY
EXXON VALDEZ OIL SPILL RESTORATION
1993 Federal Fiscal Year 1-Oct-92 to 30-Sep-93

Project Number	Project Title	Agency	Approved 1-Oct-92 28-Feb-93	Proposed 1-Mar-93 30-Sep-93	Total FY 93
	ADMINISTRATION PROJECTS (Recommended by Restoration Team)				
93AD	Administrative Director's Office	ADEC/ADNR/USFS/ DOI		$1,293.7	
93FC	Financial Committee	ADEC/ADNR/USFS/ NOAA/DOI/ADF&G		$105.5	
93RT	Restoration Team Support	ADEC/ADNR/USFS/ NOAA/DOI/ADF&G		$618.2	
	ADMINISTRATION PROJECTS SUBTOTAL			$2,017.4	
	RESTORATION & ADMINISTRATION PROJECTS TOTAL (Recommended by Restoration Team)			$37,832.6	
	RESTORATION PROJECTS (Not Recommended by Restoration Team)				
93010	Reduce Disturbance Near Murre Colonies	DOI-FWS		$56.8	
93014	Coded Wire Tag Quality Assurance	ADF&G		$94.8	
93019	Chugach Region Village Mariculture Project	ADF&G		$589.1	
93020	Bivalve Shellfish Hatchery and Research Center	ADF&G		$55.7	
93026	Fort Richardson Hatchery Water Pipeline	ADF&G		$3,617.0	
93050	Update Information on Sources Relevant to EVOS Affected Resources	ADNR		$10.2	
93052	Identification of Bald Eagle Habitat	DOI-FWS		$188.0	
	RESTORATION PROJECTS TOTAL (Not Recommended by Restoration Team)			$4,611.6	

11-Sep-92

Amounts shown are in thousands of dollars.

ADMINISTRATION AND PROJECT SUPPORT

A. Administration-General

It is the intent of the Trustee Council to make use of existing agency administrative structures to keep administrative costs to a minimum. Each of the Trustee agencies already has administrative, personnel and financial management systems that will be used to the maximum extent possible for this purpose. Each project is assigned to a lead agency to provide oversight and the necessary financial structure. Administrative costs include the following:

1. Office of Administrative Director - The budget for the Administrative Director includes salaries, benefits, travel, office space, supplies, printing costs, contractual services, utilities, and other such items as may be necessary for efficient operation of the Trustee Council, Restoration Team, Restoration Planning Work Group, the Public Advisory Group and other working groups as needed.

2. Restoration Team - The budget for the Restoration Team includes personnel related costs, travel, contractual items, commodities, equipment and other miscellaneous items to support the respective Trustee agency personnel. Each Trustee agency has one representative per the approved Trustee Council and Restoration Team operating procedures.

3. Financial Committee - The membership of this Committee is comprised of three State and three federal representatives. The committee reports directly to the Trustee Council and is responsible for developing fiscal procedures, adherence to the procedures, and ensuring overall fiscal standards for accountability, and efficiency. The budget for this standing committee includes personnel related costs, travel, contractual items, commodities, equipment and other miscellaneous items to support the respective Trustee agency personnel.

4. Public Advisory Group - The Public Advisory Group consists of 17 members, plus two ad-hoc members from the State Legislature, representing 12 principal interest groups and five members from the public-at-large. The administrative support for the Group shall be provided by the Administrative Director's Office. The role of this group is to provide advice to the Trustee Council and Restoration Team on such items as the annual work plans, budgets and the Restoration Plan. The budget includes travel, per diem and administrative support expenses.

Specifically with regard to this document, the Public Advisory Group will receive the 1993 Draft Work Plan for review prior to their first meeting in late October. The Public Advisory Group will advise the Trustee Council with respect to decisions relating to the planning, evaluation, and allocation of available funds, the conduct of injury assessments and restoration activities.

5. Work Groups

A. Public Participation - Five of the six Trustee agencies are represented on this Work Group. Personnel related costs and travel are the only costs. This Group's tasks include: (1) review the public information/public participation elements of the draft Restoration Plan; (2) define the goals, objectives and strategies of public participation; (3) facilitate and review public information materials; and (4) define new public information products which need to be created to improve the communication with the public. These tasks are expected to be completed by March 1, 1993.

B. Management* - This group assists the Administrative Director in the operation of the *Exxon Valdez* Restoration Office and will: (1) develop the annual budget; (2) assist in building and support staff operation; (3) assist in budget oversight; (4) assist in the preparation of quarterly and annual reports; and (5) develop policy and procedures for the Restoration Office. Costs include personnel related costs, travel and per diem. This Group is funded through September 1993 on an as-needed basis.

*This Work Group was formerly called the Process Work Group

B. Project Support

1. Chief Scientist & Peer Reviewers - The Trustee Council and the project principal investigators need access to the best possible scientific knowledge and understanding concerning injured resources and services. This information has been provided continuously by the chief scientist and expert peer reviewers since early in the injury assessment process started in 1989. It is essential that this expertise be retained on an upon-request basis to provide the unbiased scientific review and continuity essential to perform the best possible scientific work. The budget proposed is for personnel related costs and travel and per diem through September 30, 1992.

2. Work Groups

A. 1994 Work Plan - The objective of this work group is to develop a 1994 Work Plan through a process of public solicitation of proposals, analysis and evaluation. Personnel related costs, travel, per diem and printing are the costs involved. A draft work plan is scheduled to be completed in the spring of 1993 and a final before October 1993.

B. Cultural Resources - The two objectives for this Group are to: (1) review and screen 1994 study/proposals to ensure Archeological Protection Act Section 106 compliance; and (2) provide the 1994 Work Plan Work Group with interagency cultural resource proposals. Budget figures cover personnel-related costs. This is a small work group that will be used sparingly throughout 1993.

C. Graphic Information System (GIS) - The two main objectives of this Group are to: (1) review and approve requests for GIS data sets and mapping products; and (2) provide oversight on GIS products and projects. Budget costs include personnel, travel and per diem. The group is used sparingly and will function at least through September 1993 to provide support to the proposed 1993 GIS activities.

D. Environmental Compliance - The objectives for this Group are to: (1) review proposed 1993 and 1994 project proposals and study plans to ensure compliance with the National Environmental Policy Act, the Alaska Coastal Zone Management Act and other applicable laws and regulations; (2) draft the record of decision for the Restoration Plan; and (3) oversee the National Environmental Policy Act analysis of the draft and final Restoration Plan. The members represent four Trustee Agencies with a budget reflecting a contract with Walcoff & Associates to prepare a draft and final Environmental Impact Statement. Costs include agency-related personnel, travel, per diem and printing costs. The Work Group will have a reduced role after the Final Environmental Impact Statement consisting of providing project-related National Environmental Policy Act compliance support.

E. Restoration Planning - The three main objectives of this full-time Work Group are to: (1) develop a draft Restoration Plan by March 1993; (2) synthesize and review public comments on the draft Restoration Plan; and (3) prepare a final Restoration Plan by October 1993. All Trustee agencies are involved with this group with costs reflecting printing costs, contracts, agency personnel costs, equipment, travel and per diem and commodities. This Group will disband upon completion of a final Restoration Plan.

F. Habitat Protection - This Work Group has many objectives related to restoration through habitat protection such as the development of an imminent threat analysis process, characterization of essential habitats linked to injured resources and services, and compilation of existing data sources and identification of needed data. All Trustee agencies are involved. Budgets reflect personnel, travel and per diem costs. This standing committee will be crucial to the development of a comprehensive habitat protection plan as an integral part of the Restoration Plan and will be funded as needed through September 1993.

1993 Administrative and Restoration Team Support Budgets

ITEM	ADEC	ADF&G	ADNR	USDI	USDA	NOAA	TOTAL
ADMIN DIR.	333.1	0.0	0.0	0.0	823.2	0.0	1,156.3
FINANCE	17.2	13.3	19.7	12.9	23.9	17.7	104.7
REST. TEAM	156.5	89.9	91.8	47.7	83.7	109.5	579.1
PAG	0.0	0.0	0.0	155.9	0.0	0.0	155.9
PUBLIC PART.	0.0	0.0	0.0	5.3	0.0	0.0	5.3
MANAGEMENT	26.0	0.0	0.0	0.0	0.0	7.8	33.8
SUBTOTALS	532.8	103.2	111.5	221.8	930.8	135.0	2,035.1
CS/PEER R.	0.0	0.0	576.4	0.0	0.0	0.0	576.4
1994 WP	83.3	78.0	66.5	56.7	95.4	40.8	420.5
CULT. RES	0.0	0.0	4.8	3.2	3.0	0.0	11.0
GIS	0.0	13.5	3.1	2.8	4.2	6.5	30.1
ENV. COMPL.	0.0	23.2	0.0	23.7	254.8	14.5	316.2
RPWG	244.4	98.9	70.0	38.5	136.9	81.3	670.0
HAB. PROT.	88.1	48.7	186.3	29.8	208.4	33.8	595.1
SUBTOTALS	415.8	262.3	907.1	154.7	702.7	176.9	2,619.5
TOTALS	**948.6**	**365.5**	**1,018.6**	**376.5**	**1,633.5**	**311.9**	**4,654.6**

PROJECT DESCRIPTIONS AND BUDGETS

INTRODUCTION

There are 50 projects currently under consideration in the 1993 Draft Work Plan. Though more were originally developed as brief project proposals, several have been combined by the Restoration Team and others were removed from the draft work plan by the Trustee Council. Unlike previous years, projects have simply received a numerical designation that has no relationship to category or type of project. To facilitate finding an individual project, projects are listed in numerical order rather than being grouped by related projects. Sockeye projects, for example, are numbered 93002, 93012, 93015, 93024, 93030, and 93931. Please refer to the Table of Contents for more information.

Projects were developed from ideas submitted both by the public and by agencies. Similar ideas were typically combined and then either developed into brief project descriptions, identified as inappropriate for settlement funding or deferred until development of the Restoration Plan. Tables have been prepared which enable interested parties to track the evolution of ideas. They are available at the locations listed in the introduction to this book.
Each project description is followed by a brief budget. More detailed budgets are also available for examination at the same locations as the idea tables.

The project descriptions that follow are being sent out by the Trustee Council for public review and comment. These comments will be used by the Trustee Council at their December 11, 1992 meeting when decisions will be made on funding individual projects. A joint federal and state legal review will concurrently be conducted to ensure that these projects are allowable within the terms of the settlement Memorandum of Agreement and Consent Decree (United States v. State of Alaska, Civil Action No. A91-081 CV), and all other applicable state and federal laws and regulations.

During the examination and discussion of projects by the Restoration Team, a set of these projects emerged which clearly had broad Restoration Team support as defined by the Team's operating procedures (available upon request). This set was presented to the Trustee Council on September 21, 1992 as the Restoration Team's recommended suite of projects to be conducted in 1993. Without taking action on the recommended list, the Trustee Council then added project 93042, Recovery Monitoring of Prince William Sound Killer Whales to this list of preferred projects. Other projects received less support, but all projects except those deleted by the Trustee Council are contained within this draft Plan for public comment. **Projects appearing in the preferred list will not automatically be included in the 1993 Work Plan nor will those not appearing in this list be automatically excluded. YOUR OPINION is very important. The Trustee Council has not and will not make final decisions on projects until they have reviewed public and legal comments.** The first list that follows displays the Restoration Team's preferred projects to be included in the 1993 work plan. The second list displays projects that received less Restoration Team support. Projects that do not appear in either of the following lists were combined with other projects or deleted from consideration by the Trustee Council.

Restoration Team List of Preferred Projects

Project Number	Project Title
93002	Sockeye Overescapement
93003	Pink Salmon Eggs to Pre-Emergent Fry Survival in Prince William Sound
93004	Documentation, Enumeration, and Preservation of Genetically Discrete Wild Populations of Pink Salmon Impacted by EVOS in Prince William Sound
93005	Cultural Resources Information, Education and Interpretation
93006	Site-Specific Archaeological Restoration
93007	Archaeological Site Stewardship Program
93008	Archaeological Site Patrol and Monitoring
93009	Public Information, Education and Interpretation
93011	Develop Harvest Guidelines to Aid Restoration of River Otters and Harlequin Ducks
93012	Genetic Stock Identification of Kenai River Sockeye Salmon
93015	Kenai River Sockeye Salmon Restoration
93016	Chenega Chinook and Coho Salmon Release Program
93017	Subsistence Restoration Project
93018	Enhanced Management for Wild Stocks in Prince William Sound, Special Emphasis on Cutthroat Trout and Dolly Varden
93022	Evaluating the Feasibility of Enhancing Productivity of Murres by Using Decoys, Dummy Eggs, and Recordings of Murre Calls to Simulate Normal Densities at Breeding Colonies Affected by the EVOS, and Monitoring the Recovery of Murres in the Barren Islands
93024	Restoration of the Coghill Lake Sockeye Salmon Stock

93025	Montague Island Chum Salmon Restoration
93028	Restoration and Mitigation of Wetland Habitats for Injured Prince William Sound Fish and Wildlife Species
93029	Prince William Sound Second Growth Management
93030	Red Lake Restoration
93031	Red Lake Mitigation for Red Salmon Fishery
93032	Pink and Cold Creek Pink Salmon Restoration
93033	Harlequin Duck Restoration Monitoring Study in Prince William Sound and Afognak Oil Spill Areas
93034	Pigeon Guillemot Colony Survey
93035	Potential Impacts of Oiled Mussel Beds on Higher Organisms: Contamination of Black Oystercatchers Breeding on Persistently Oiled Sites in Prince William Sound
93036	Recovery Monitoring and Restoration of Intertidal Oiled Mussel Beds in Prince William Sound and the Gulf of Alaska Impacted by the EVOS
93038	Shoreline Assessment
93039	Herring Bay Experimental and Monitoring Studies
93041	Comprehensive Restoration Monitoring Program Phase 2: Monitoring Plan Development
93042	Recovery Monitoring of Prince William Sound Killer Whales Injured by the EVOS Using Photo Identification Techniques
93043	Sea Otter Population, Demographics and Habitat Use in Areas Affected by the EVOS
93045	Surveys to Monitor Marine Bird and Sea Otter Populations in Prince William Sound During Summer and Winter

93046	Habitat Use, Behavior and Monitoring of Harbor Seals in Prince William Sound
93047	Subtidal Monitoring: Recovery of Sediments, Hydrocarbon - Degrading Microorganisms, Eelgrass Communities, and Fish in the Shallow Subtidal Environment
93051	Habitat Protection Information for Anadromous Streams and Marbled Murrelets
93053	Hydrocarbon Data Analysis, Interpretation, and Database Maintenance for Restoration and NRDA Environmental Samples Associated With the Exxon Valdez Oil Spill
93057	Damage Assessment GIS
93059	Habitat Identification Workshop
93060	Accelerated Data Acquisition
93061	New Data Acquisition
93062	Restoration GIS
93063	Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Anadromous Fish
93064	Imminent Threat Habitat Protection

List of Projects Receiving Less Restoration Team Support

Project Number	Project Title
93010	Reduce Disturbance Near Murre Colonies Showing Indications of Injury from the EVOS
93014	Quality assurance for Coded Wire Tag Application in Fish Restoration Projects
93019	Chugach Region Village Mariculture Project
93020	Bivalve Shellfish Hatchery and Research Center
93026	Fort Richardson Hatchery Water Pipeline
93050	Update: Restoration Feasibility Study #5 (Identification and Recordation of Information Services Relevant to Land and Resources Affected by the EVOS)
93052	Identification and Protection of Important Bald Eagle Habitats

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93002

Project Title: Sockeye Overescapement

Project Category: Damage Assessment

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: U.S. Fish and Wildlife Service

Project Term: October 1, 1992 to September 30, 1993

INTRODUCTION

A. Background on the Resource/Service

The sockeye salmon resources of Kodiak Island lakes affected by overescapement comprise approximately 20% of the Kodiak Island long-term commercial sockeye salmon harvest. The Kenai River sockeye salmon lakes affected by the *Exxon Valdez* oil spill (EVOS) are the major income producers for commercial fishermen in Cook Inlet. Sockeye salmon spawn in lakes associated with river systems. Adult salmon serve an important role in the ecosystem, providing food for marine mammals, terrestrial mammals, and birds. Additionally, carcass decomposition serves to charge freshwater lake systems with important nutrients. Juvenile salmon, which rear in lakes for one or two years, serve as a food source for a variety of fish and mammals. Sockeye salmon are also an important subsistence, sport, and commercial species. The ex-vessel value of the commercial catch of sockeye from these lake systems has averaged about $42 million per year since 1979, with the 1988 catch worth $115 million. Sockeye salmon returns to the Kenai River system support some of the largest recreational fisheries in the State.

B. Summary of Injury

Commercial fishing for sockeye salmon in 1989, was curtailed in upper Cook Inlet, the outer Chignik districts, and the Kodiak areas due to presence of oil in the fishing areas from the EVOS. As a result, the number of sockeye salmon entering four important sockeye-producing systems (Kenai/Skilak, Chignik/Black, Red, and Frazer Lakes) and two less important lake systems (Akalura and Afognak or Litnik lakes) greatly exceeded levels that are thought to be most productive.

Overly large spawning escapements may result in poor returns by producing more rearing juvenile sockeye than can be supported by the nursery lake's productivity (Kyle et al. 1988). In general, when rearing fish abundance greatly exceeds the lake's carrying capacity, prey (zooplankton) are altered by changes in species and size composition (Mills and Schiavone 1982, Koenings and Burkett 1987, Kyle et al. 1988) and concomitant effects on all trophic levels can occur (Carpenter et al. 1985). Because of such changes, juvenile sockeye growth is reduced, mortality increases, larger percentages holdover for another year of rearing; and the poor quality of smolts increases

marine mortality. Where escapements are two to three times normal levels, the resulting high juvenile densities crop the prey resources to the extent that more than one year is required to return to normal productivity. Rearing juveniles from subsequent brood years suffer from both the poor quality of forage and from the increased competition for food by holdover juveniles (Townsend 1989; Koenings and Kyle 1991). This is the brood year interaction underlying cyclic variation in the year class strength of anadromous fish. Smolt production from the Kenai River in 1991 was extremely low as was production of smolt from Red Lake. In the spring of 1992, the Kenai River smolt estimates dropped by another order of magnitude, suggesting severe declines in sockeye salmon returns in future years. Counts of smolt migration in Red River (on Kodiak Island) were relatively higher in 1992, but still insufficient to provide an average return for this system. The effects of overescapement can cause continued adversity because of multiple-year impacts on the zooplankton community or other critical juvenile life-history habitat components. Consequently, damage assessment studies require continuation until the juvenile sockeye salmon habitat is restored or naturally recovers.

C. Location

The studies will be conducted on the Kenai Peninsula include the Tustumena and Kenai River lake systems. In addition, studies will continue on Kodiak Island to assess the damage to the Red Lake system with Upper Station Lake acting as a control.

WHAT

The goal of these studies is to determine the impacts of the overescapement of 1989 that was associated with fishery closures due to the EVOS. The studies have specifically focused on Red Lake and the major rearing lakes of the Kenai River system. Study activities include the enumeration of smolt production and sampling of smolt population characteristics, and monitoring of subsequent adult returns from these systems as well as measuring the changes in the rearing habitat of the effected lakes and nearby unaffected lake systems. A secondary benefit of these studies may be to provide insight as to what, if anything, can facilitate rapid recovery of these systems.

The specific objectives of these studies are as follows:

A. Estimate the number, age, and size of sockeye salmon juveniles rearing in selected freshwater systems.

B. Estimate the number, age, and size of sockeye salmon smolts migrating from selected freshwater systems.

C. Determine effects of large escapements resulting from fishery closures caused by the EVOS on the rearing capacity of selected nursery lakes through:

1. Analysis of age and growth of juveniles and smolts
2. Examination of nutrient budgets and plankton populations.

D. In addition, evaluation of diel vertical migration induced by sockeye salmon predation on subsequent growth and survival of juvenile sockeye will be made. Also, assessment of the role of egg-bearing copepods as an essential diet component of sockeye salmon juveniles in glacial lakes will be conducted.

WHY

Before any mitigation and restoration of sockeye salmon in the effected lakes can be undertaken, the extent and cause of damage needs to be established. The resource in question has major implications for the commercial fishing industry on Kodiak Island and in Cook Inlet, where sockeye salmon provide the major source of income. In addition, heavy use of the Kenai River by subsistence, personal use, and sport fishermen have much importance to the Alaskan economy.

To restore lost resources it is essential that a clear understanding of damages be assessed. In the case of overescapement, a lake may require many years to recover, as the extent of damage may persist. Thus, to prevent recurrence and compounding damage, and to expedite natural restoration of the system, an understanding of the mechanism is essential.

HOW

From early May to early July, two inclined plane traps will be operated daily in the outlet stream of Red Lake about one mile below the lake's outlet. The catch will be counted by species, and sockeye smolts will be sampled daily for age, length, weight, and condition factor. Each week, 500 sockeye smolts will be marked (biologically inert dye), and released about 0.5 mile above the traps to determine trap efficiency. A similar operation will occur at Upper Station Lake which is the study control. This project will also provide support for the assessment conducted by FRED Division (fall fry townetting) of pre-smolt sockeye rearing conditions (biomass and growth data) in Red and Upper Station Lakes.

On the Kenai River, expanded smolt enumeration is proposed for the lower river through increased marking and recovery effort. In addition, coded wire tagging of smolts is proposed on the Moose River and a smolt project is planned for the Russian River system.

Limnology studies will continue on Upper Station and Red lakes on Kodiak, the major lakes of the Kenai River (Skilak and Kenai lakes), and on Tustumena Lake which is the control for the Kenai system. In addition, an optical plankton counter will be used to assist in determining the effects of predator-induced diel vertical migration in Skilak Lake. These studies will be coupled with expanded tow netting on Skilak and Kenai Lake to obtain juvenile sockeye salmon specimens throughout their rearing cycle in freshwater. Water quality and physical measurements from all of the lakes will continue to be monitored. Disease screening of fish specimens is also planned.

ENVIRONMENTAL COMPLIANCE

None of the proposed projects are intrusive. They involve collection of data and do not affect fish and wildlife populations or their habitat.

WHEN

The studies are continuous and will most likely continue beyond the end of the upcoming fiscal year (September 30, 1993). The studies will terminate when the sockeye salmon populations or their habitat recover to pre-spill conditions. Progress reports and interim findings will be released annually in a progress report issued in late November. Major discoveries are issued through news releases or through scientific publication.

BUDGET ($K)

	ADF&G
Personnel	$ 440.1
Travel	7.8
Contractual	115.9
Commodities	51.2
Equipment	25.5
Capital Outlay	0.0
Sub-total	$ 640.5
General Administration	74.1
Project Total	$ 714.6

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93003

Project Title: Pink Salmon Egg to Pre-emergent Fry Survival in Prince William Sound.

Project Category: Damage Assessment/Restoration Monitoring

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: National Marine Fisheries Service (NOAA)

Project Term: March 1, 1992 to July 30, 1995

INTRODUCTION

Each year approximately one-half billion wild pink salmon fry emerge from the streams of Prince William Sound (PWS) and migrate seaward. Adult returns of wild pink salmon to PWS average from 10-15 million fish annually. These huge outmigrations of wild pink salmon and subsequent adult returns play a major role in the PWS ecosystem. Both juveniles and adults are important sources of food for many fish, birds, and mammals. Adults returning from the high seas also convey needed nutrients and minerals from the marine ecosystem to estuaries, freshwater streams, and terrestrial ecosystems. Wild pink salmon also play a major role in the economy of PWS because of their contribution to commercial, sport, and subsistence fisheries in the area.

Up to 75% of pink salmon spawning in PWS occurs in intertidal areas. In the spring of 1989, oil from the *Exxon Valdez* oil spill (EVOS) was deposited in layers of varying thickness in intertidal portions of many western PWS streams utilized by spawning salmon. Pink salmon eggs and fry rearing in these intertidal areas appear to have been adversely affected by the oil. Salmon egg mortalities were 70%, 65%, and 115% higher in oiled streams than in comparable and nearby unoiled streams in 1989, 1990, and 1991. Differences between oiled and unoiled streams in 1989 and 1990 were confined to intertidal spawning areas and may be attributed to direct lethal effects of oil. Large differences observed across all tide zones in 1991 may be the consequence of damage to germ cells of the adults which originated from the 1989 brood year when egg and larval exposures to intertidal oil were greatest. A consequence of this genetic damage may be persistent functional sterility and reduced returns per spawner for populations from oiled streams.

The proposed damage assessment and resource monitoring study will consist of field and laboratory studies conducted in western PWS and additional laboratory studies at the National Marine Fisheries Service (NMFS) Research facility at Little Port Walter in southeastern Alaska. The majority of project funds will be spent to support the portion of the project located in PWS and will contribute to the local economy of Cordova. Results of the project will direct future restoration efforts for pink salmon and may impact future harvest management strategies in PWS fisheries.

WHAT

The project will continue to monitor egg mortalities in the oiled and unoiled wild pink salmon streams previously studied, examine stream characteristics unrelated to oiling which may partially or completely explain observed mortality differences, and provide laboratory verification that field results observed for eggs in 1989, 1990 are consistent with lethal effects of oil contamination of intertidal pink salmon spawning habitat. The laboratory verification experiment will also test the hypothesis that oil contamination during
incubation can result in functional sterilization of exposed animals at sexual maturity and may explain the persistence of higher egg mortalities observed in all tide zones of oiled streams in 1991.

The specific objectives of the project are as follows:

A. Estimate the density, by tide zone, of eggs and pre-emergent fry in 31 streams using numbers of live and dead eggs and fry.
B. Estimate egg mortality and overwinter survival of pink salmon eggs in the oiled and unoiled streams among the 31 sampled.
C. Determine whether the increased pink salmon egg mortalities observed in oiled streams in 1989, 1990, and 1991 can be attributed to the physical characteristics of the study streams.
D. Determine survival, genetic damage, hydrocarbon uptake, mixed function oxidase activity, and sublethal teratogenic effects from long term exposures to oil in each of two exposure groups:
    1. Green eggs to eyeing, and
    2. Green eggs to swim-up.
E. Determine survival, genetic damage, hydrocarbon uptake, and mixed function oxidase activity from long term exposures of juvenile pink salmon fed oil-contaminated food.
F. Determine growth characteristics from each exposure group from juvenile stage to maturity.
G. Assess whether differences exist among exposure groups with respect to fecundity, fertilization rate, genetic damage, and sublethal teratogenic effects in the second generation progeny through swim-up.
H. Compare lab study with field observations:
    1. Determine if the elevated egg mortalities in 1989 and 1990 were potentially caused by oiling in the environment.
    2. Determine if the elevated egg mortalities in oiled streams in 1991 were potentially caused by genetic damage to 1989 eggs.

WHY

Information from this study will provide resource managers insight to the magnitude and persistence of damages sustained by wild pink salmon due to EVOS. Efforts to restore damaged pink salmon populations depend upon the ability to identify sources of reduced survival and to monitor their persistence. Information on the potential of oil exposures causing genetic damage is needed so spawning escapement goals can be reevaluated and adjusted if necessary. Verification

of the genetic hypothesis would also provide the first evidence that reproductive capacity of fish exposed to chronic or acute sources of oil pollution would be compromised.

HOW

A. Field Studies

A systematic sampling program stratified by stream and tide zone will be used to collect egg and fry density and survival data from 11 oiled and 14 unoiled sites sampled previously in *NRDA* Fish/Shellfish Study 2, *Injury to Salmon Eggs and Fry in PWS.* Sampling will consist of egg-digs conducted in late September and early October, and fry-digs conducted in mid-March. Egg and pre-emergent fry data will be summarized by date, stream, level of hydrocarbon impact, stream zone, and number of live and dead eggs and fry. Density estimates will be used to assess adult spawning success. Relative numbers of live and dead eggs and fry will be used to test for continued reductions in survival in oiled streams.

B. Laboratory Study 1

Intra-stream crosses will be made using within stream pools of randomly combined gametes from six oiled and six unoiled streams from southwestern PWS. Eggs from the crosses will be incubated through hatching in a controlled laboratory environment. Egg mortalities will be compared for all crosses. Crossing results will be compared to results from field studies to determine the effect of stream characteristics on egg mortality differences previously observed between oiled and unoiled sites.

C. Laboratory Study 2

This study consists of three experiments. The first will examine the effects of six levels of intertidal gravel oil contamination and two durations of exposure on responses to various life history stages of cultured eggs and fry. Responses measured in the first generation will include survival to eyeing, survival to emergence, hydrocarbon uptake, survival to maturity, growth to maturity, and fecundity. Responses measured in the second generation will include fertilization rate and number of defective progeny. Samples for use in genetic analyses will be collected from first generation eyed eggs, emergent fry, juveniles, and mature adults. Genetic analyses will include flow cytometry methods and examination of metaphase germ cells. Second generation eyed eggs and emergent fry will be similarly sampled. The second experiment will determine if cultured fish fed oiled food for 6 weeks experience genetic damage and reduced gamete viability. Treatments will consist of 6 concentrations of oil in the feed (1 control and 5 different oil levels). Biological responses to be measured between emergence and the first 6 weeks of feeding will include growth, survival, hydrocarbon concentration, chromosome damage, and MFO incidence. Subsequent response measurements will include growth to maturity, fecundity, fertilization rate and number of defective progeny. Flow cytometry samples and samples for examination of metaphase cells will be taken after the first 6 weeks and will mirror those taken in the first experiment. The third experiment will determine if there is evidence of differential gamete survival to emergence between ten randomly paired families of cultured fish for five different treatment regimes. The treatments will be a combination of oiling concentrations from study 1

(Ci) and duration of exposure as follows:

1. Control,
2. C_2 through eyeing,
3. C_2 through emergence,
4. C_4 through eyeing, and
5. C_4 through emergence.

The fertilized gametes from ten randomly selected pairs of pink salmon (family) will be divided into aliquots, each aliquot will be randomly assigned one of the five treatments (3 aliquots per treatment). Ten family groups will be created and assigned in this manner. Individual aliquots will be incubated in pipe incubators and all fish culture practices will be randomized between families. Families will be incubated until emergence when they will be inspected, counted, and terminated.

ENVIRONMENTAL COMPLIANCE

Egg and pre-emergent fry sampling will require an ADF&G Title 16 permit and an ADF&G biological collections permit. Transport of wild gametes to the PWSAC hatchery will require an ADF&G Fish Transport Permit for each stock and a Permit Alteration may be required to rear and incubate the wild eggs at the AFK Hatchery.

WHEN: August 1993 - Interim Report 1 including: instream egg density and survival results, intrastream crossing results, first generation doses response results for eggs and fry.

August 1994 - Interim Report 2 including: update of Interim Report 1,First generation doses response results through year 1.

Final Report - July 1995

BUDGET ($K)

	ADF&G	NOAA	TOTAL
Personnel	$ 192.7	$ 117.9	$ 310.6
Travel	11.4	10.0	21.4
Contractual	83.0	116.0	199.0
Commodities	21.5	54.0	75.5
Equipment	0.0	19.0	19.0
Capital Outlay	0.0	0.0	0.0
Sub-total	$ 308.6	$ 316.9	$ 625.5
General Administration	34.7	25.8	60.5
Project Total	$ 343.3	$ 342.7	$ 686.0

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93004

Project Title: Documentation, Enumeration, and Preservation of Genetically Discrete Wild Populations of Pink Salmon Impacted by EVOS in Prince William Sound.

Project Category: Restoration Monitoring and Management Action

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: U.S. Forest Service

Project Term: March 1, 1993 to June 30, 1995

INTRODUCTION

Historically, approximately five-hundred-million wild pink salmon fry emerged from streams throughout Prince William Sound (PWS) each year to migrate seaward. Adult returns of wild pink salmon averaged from 10 to 15 million fish annually. These returning wild-stock adults play an important role in the total Prince William Sound ecosystem; they convey essential nutrients and minerals from the marine ecosystem to estuaries, freshwater streams, and terrestrial ecosystems. Both juveniles and adults are important sources of food for many fish, birds, and mammals. Wild pink salmon also play a major role in the economy of PWS because of their contribution to commercial, sport, and subsistence fisheries in the area.

Wild-stock pink salmon suffered both direct lethal and sublethal injuries as a result of the Exxon Valdez oil spill (EVOS). Pink salmon embryos and alevins suffered increased mortality, diminished growth, and a high incidence of somatic cellular and genetic abnormalities as a result of spawning ground contamination and rearing in oiled areas. Wild stocks most impacted by the *Exxon Valdez* oil spill (EVOS) are also subject to excessive exploitation in mixed stock fisheries of western PWS which are targeting on large hatchery returns. Also, in 1989 the commercial harvest of pink salmon had to be shifted away from the hatchery and wild stocks in the oiled areas to target only the wild stocks in eastern Prince William Sound. This resulted in overharvest and depletion of these stocks evidenced by general run failures of stocks in the northern and eastern portions of Prince William Sound in 1991.

Furthermore, coded-wire tag recovery results from NRDA F/S Study 3 indicate that damaged wild salmon streams located on hatchery stock migratory corridors in western PWS experience a high incidence of genetic interchange as a result of straying from the burgeoning hatchery populations. Ample evidence in the literature suggests that hatchery fish are ill

adapted to wild conditions and that genetic interchange between hatchery and wild stocks may lead to reduced fitness of wild stocks. The combined effects of oil damage, excessive harvest, and genetic burden on wild fish may result in an overall reduction in population size, genetic diversity, and fitness of PWS salmon populations.

The proposed damage assessment and resource monitoring study will consist of field studies conducted from Cordova and laboratory studies in Anchorage. The majority of the funds support PWS field studies and will contribute to the local economy of Cordova. The project may result in altered harvest management strategies in PWS fisheries and will contribute to the natural recovery process for PWS pink salmon populations.

WHAT

Depending upon results from 1992, this project will monitor the recovery of damaged wild streams through timely and accurate estimates of wild pink spawning escapements, quantify the extent of hatchery stock staying into wild salmon streams, and examine the genetic structure of representative salmon populations from throughout PWS, measuring both within and between population diversity. Genetic sample sites will include those which tagging results indicate are highly susceptible to hatchery straying (see Restoration Science project R60) in order to better clarify putative EVOS impacts on hatchery/wild-stock interactions.

Fisheries managers will use escapement data inseason to enact harvest management strategies which insure that sufficient fish escape fisheries to spawn in streams damaged by EVOS. Data on straying rates will be used in conjunction with genetic data to develop alternate hatchery production strategies and develop criteria for wild-stock sanctuary areas where straying is minimal or does not occur. An understanding of the population genetics of affected pink salmon populations will also be used to guide restoration management decisions including those regulating commercial harvest. Genetic monitoring and risk assessment are also required to evaluate any supplemental restoration programs in a manner similar The Northwest Power Planning Council currently uses such a monitoring and evaluation program for their supplemental restoration program.

The specific objectives of the project are as follows:

1. Estimate straying rates of hatchery and wild stocks of pink salmon through systematic sampling of spawner carcasses in approximately 50 streams in PWS.
2. Monitor the recovery and status of pink salmon stocks through total weir enumeration of intertidal and upstream spawning escapements in eight streams which are representative of streams injured by the oil spill.
3. Define the genetic structure of pink salmon stocks in the EVOS-affected area in order to better direct harvest management decisions made for restoration purposes on a stock-specific rather than species-specific basis.
4. Provide information needed for genetic risk assessment and genetic monitoring of supplementation programs (e.g., as a result of Study R105) to guide stock-specific restoration and enhancement.

WHY

The most cost effective method for restoring injured wild pink salmon populations to their pre-spill condition is through modification of the human uses which affect their natural recovery. Commercial harvest is the major factor controlling wild pink salmon spawning escapement and reproductive success. The ability to impose stock-specific management on the commercial fishery and reduce fishery exploitation of oil impacted wild stocks is vital to their restoration. One of the most important pieces of information for stock-specific management of fisheries is timely and accurate escapement data which this project will supply.

The importance of pink salmon in the PWS ecosystem is predicated upon their abundance and their diverse spatial and temporal distribution. Genetic interchange between hatchery and wild fish may lead to reductions in the overall fitness and population size of wild stocks and will most certainly alter historic spatial and temporal abundance of wild pink salmon in the PWS ecosystem. The status of wild salmonid populations was a concern prior to the oil spill and the documented damage to these populations further increases the concern and the need to understand the underlying population structure and amount of gene exchange among populations. Reproductively isolated populations are by definition self-recruiting--the adults generally do not stray to repopulate depleted areas. Therefore, basing management decisions on known population structure is critical to facilitate successful restoration of reproductively isolated units.

Hatchery supplementation of wild pink salmon stocks cannot be contemplated without knowledge of the underlying population structure (see State of Alaska Genetic Policy). To do so would put the unique adaptive advantages of the wild stocks at risk. The same population genetic data will provide a baseline for possible mixed-stock fishery analysis (e.g., see Restoration Science Project R59) and possible genetic marking. Genetic marks are now used to manage the harvest of Fraser River pink salmon, for example, and such techniques may ameliorate the hatchery/wild-stock management problems exacerbated by the EVOS.

HOW

Adult salmon will be counted through weirs at eight streams where outmigrating fry were enumerated and coded-wire tagged, and where adults were counted in previous years. Weir crews will perform daily ground surveys of intertidal and upstream portions of the weired streams and at ten additional streams. At weekly intervals they will also apply Peterson disk tags to fish as they enter weired streams. During daily foot surveys crews will enumerate live and dead pink salmon, record Peterson disk tag recoveries from dead fish, and record the number of carcasses with missing adipose fin denoting the possible presence of a coded-wire tag. Heads from adipose clipped carcasses will be removed and sent to a centralized laboratory for tag extraction and decoding. Paired aerial and weir data will be used to calibrate aerial estimation procedures and estimate observer bias. Weir data, daily counts of live and dead fish, and results of Peterson disk tagging studies will be used to estimate average stream life for streams in the PWS aerial survey program. Improved stock specific estimates of spawning escapements combined with commercial catch contribution data will allow fisheries managers to accurately assess the impacts of the harvest management strategies on impacted stocks.

Pink salmon populations sampled during the escapement enumeration project represent a small percentage of the over 900 anadromous spawning populations in Prince William Sound. To better document the full extent of hatchery staying this project will expand tag recovery efforts in approximately 50 important spawning streams throughout PWS. Tag recoveries will be accomplished through multiple ground surveys during periods of peak salmon returns. Tag recovery sampling will be identical to the sampling at weired systems.

Tissue samples for baseline genetic data will be taken from 100 fish from two hatcheries and from spawned-out fish in 18 of the 50 streams sampled for straying. Both early and late stocks and intertidal and upstream-spawning stocks will be included among the 18 sampled. Heart, liver, and muscle tissue and aqueous humor will be removed from each individual sampled, frozen immediately on liquid nitrogen, and returned to Anchorage for storage at -80° C. Results of genetics samples will be used to define the genetic structure of pink salmon populations in PWS and identify reproductively isolated populations. Results of coded-wire tag recovery data will be analyzed and used in concert with genetic data to identify areas with no evidence of straying which could be designated as genetic sanctuaries which could be protected by future management actions and hatchery release strategies. Those oiled areas with documented high levels of straying should be monitored to examine the long term effects of straying and the resultant wild/hatchery salmon hybridization on the overall fitness of wild populations.

Genetic data will be collected using the techniques of allozyme protein electrophoresis on all samples and restriction fragment length polymorphism (RFLP) analysis of mitochondrial DNA (mtDNA) on a subset of samples. These procedures are well-established and currently being conducted in the genetics laboratory of ADF&G. As appropriate, data will be merged into the state and federal interagency coast-wide databases.

ENVIRONMENTAL COMPLIANCE

ADF&G has Title 16 permits for all of the proposed intertidal weirs. Corps of Engineers' permits are not required since none of the weirs are on navigable waters. All sampling on weired and unweired systems is covered by ADF&G biological collection permits. None of the proposed camps or structures are permanent nor will they permanently alter the study sites in any way. All weirs, camp structures, and equipment will be removed from study sites upon completion of the project.

WHEN

December 1993	-	Interim Report 1 including: Summary of weir counts, live and dead counts, stream life estimates, aerial surveyor bias estimates by stream, and hatchery straying rates by hatchery and stream for 1993.
December 1994	-	Interim Report 2 including: Summary of 1994 escapement and straying data and comparison of 1993 and 1994 results. Escapement and straying data analyses will be in the same format as 1993 report and including a comparison of 1993 and 1994 results.
June 1995	-	Final Report

BUDGET ($K)

	ADF&G
Personnel	$ 550.1
Travel	8.0
Contractual	168.5
Commodities	57.0
Equipment	33.0
Capital Outlay	0.0
Sub-total	$ 816.6
General Administration	82.5
Project Total	$ 899.1

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93005

Project Title: Cultural Resources Information, Education and Interpretation

Project Category: Management Action

Project Type: Archaeology

Lead Agency: United States Department of Agriculture, Forest Service

Cooperating Agencies: U.S. Department of Interior, National Park Service; Alaska Department of Natural Resources

Project Term: January 1, 1993 to September 30, 1993

INTRODUCTION

The *Exxon Valdez* oil spill affected cultural resources in the oil spill affected area. These resources are ethnographically within the Alutiiq, or Pacific Eskimo, area. Known sites in the region contain information from as long as 8,000 years ago to the early 20th century A.D. These sites are the non-renewable source of date which are the basis of knowledge about past peoples and their relationship to the marine and terrestrial animals, plants, and other natural resources of the area.

One of the most significant injuries to cultural resources as a result of the *Exxon Valdez* oil spill was vandalism and looting resulting from increased visibility and knowledge of site locations. Mitigation of this injury involves education of the public about the valuable cultural heritage information preserved in these archaeological sites, and the losses which result from the unscientific digging and looting of sites.

The proposed mitigation measures will occur for the most part in oil spill affected communities. Increased circulation of existing brochures and posters is proposed for Anchorage, communities in Prince William Sound, on the Kenai Peninsula, and on Kodiak Island. These same communities will be included in Alaska Archaeology Week activities, the expansion of which would be coordinated in Anchorage. Several projects will be developed locally and made available to communities both within the oil spill area and throughout the state. These include the proposed portable cultural resources exhibits, public service announcements, educational videos, curriculum developed to state educational standards, and educational pamphlets to be distributed through museums, visitor centers, tour operators, and other public outlets. Local groups will be organized and promoted in oil spill affected communities to involve interested amateurs in archaeology under professional guidance. Curriculum development will occur primarily in the communities of southcentral Alaska, and secondarily state-wide through the Department of Education and individual school districts.

WHAT

The overall goal and purpose of these projects it to educate the public to the value and finite nature of cultural resources, thereby effecting value and behavioral changes so that future site looting and vandalism is minimized or ended. In the process, damage that has occurred to archaeological sites as a result of the oil spill will be ameliorated. This will be accomplished through the following:

A. Development and distribution of brochures, public service announcements, and videos concerning the heritage value of cultural resources in the oil spill area.
B. Development, construction, and circulation of 6 portable exhibits on the cultural resources of the oil spill area.
C. Design, production and implementation of curriculum for elementary through high school and teacher training is proposed. This effort will be coordinated with local, State and Federal agencies, private institutions, and other interested parties.
D. Expansion of Alaska Archeology Week and associated activities.
E. Organization and promotion of local amateur groups interested in cultural resources.
F. Interpretation of cultural resources at sites on National Forest and State Parks.

WHY

Although some vandalism and looting of archaeological sites had occurred prior to the oil spill, the increased number of people in the area during clean-up activities and the increased knowledge of site locations led to a higher rate of vandalism of known sites. Because it is impossible to reverse this increase of knowledge about cultural resources, an educational response is necessary concerning the significance and proper treatment of archaeological sites. These educational projects will develop a stewardship ethic reflecting an appreciation for cultural resources, and will enable individuals to be directly involved in furthering the understanding of the prehistory of Southern Alaska.

HOW

Several agencies will cooperate in achieving the desired education results.

A. A Department of Interior National Park Service (NPS) archaeologist will arrange for production and distribution of additional copies of existing ARPA publications and posters, and will design and supervise the production and circulation of the six traveling cultural resource exhibits. This archaeologist will arrange an expansion of the Alaska Archaeology Week program to include oil spill affected communities and will prepare, with the assistance of a Visual Information Specialist, three public service announcements concerning cultural resources.

B. Three archaeologists working for the Alaska Department of National Resources (ADNR) will develop new cultural resource pamphlets to distribute to the public, as well as a script for a 15-20 minute video about the value of archaeological sites. The actual video will be produced under contract. Most importantly, the archaeologist will organize and promote, in oil spill affected communities, groups interested in local archaeology. In connection with these groups, the archaeologists will develop activities which involve amateurs in archaeological work under the guidance of professionals.

C. The Kodiak and Kenai Peninsula State Parks offices will develop and present programs for school-age children on the importance of protecting cultural resources, and will contract to develop visitor exhibits.

D. Under USDA Forest Service contract a curriculum will be developed by an individual or agency who will be responsible for design, production and dissemination, working cooperatively with Forest Service, NPS, ADNR, Native organizations and other interested parties. Summer institutes will be the venue for teacher training and materials development, to be followed by field testing of materials in classrooms. Subsequent summer institutes will emphasize rewriting of the curriculum, with finalization envisioned by the fifth institute. Teachers who have been trained and have field-tested material will become trainers of other teachers within districts and at institutes.

ENVIRONMENTAL COMPLIANCE

Development of curriculum, publications, and videos is categorically excluded from documentation in an environmental impact statement or environmental analysis.

WHEN

A. Curriculum Development Time Line

01/01/93 - 04/01/93 -	Develop contract/ Award contract.
04/01/93 - 09/30/93 -	Contact agencies and institutions/ Identify and collect instructional materials.
10/01/93 - 02/27/94 -	Plan with cooperative agencies the core Elementary Curriculum Outline/ Prepare advertisements/ Initiate contact for contracted persons.
07/01/94 - 08/31/94 -	Conduct the summer institute and prepare for field testing.
09/01/94 - 12/31/94 -	Coordinate the field testing and oversee the administering of testing of classroom participants.

B. Pamphlets

07/01/93 -	Drafts of four pamphlets complete
08/01/93 -	Final pamphlets complete
09/15/93 -	Pamphlets printed

C. **Video**

06/01/93 - Draft
07/01/93 - Final

D. **Local Workshops**

05/01/93 - Activity schedule set
06/01/93 - 08/31/93 - Local group activities
09/30/93 - Report on activities

BUDGET ($K)

	USFS	USNPS	ADNR	TOTAL
Personnel	$ 73.7	$45.6	$ 99.1	$ 218.4
Travel	6.5	0.0	11.0	17.5
Contractual	0.0	66.0	30.0	96.5
Commodities	3.2	23.0	1.3	27.5
Equipment	0.0	0.0	0.0	0.0
Capital Outlay	0.0	0.0	0.0	0.0
Sub-total	$ 83.4	$ 134.6	$ 141.9	$ 359.9
General Administration	11.0	11.5	17.0	39.5
Project Total	$ 94.4	$ 146.1	$ 158.9	$ 399.4

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93006

Project Title: Site-Specific Archeological Restoration (Interagency)

Project Category: Restoration Management Actions

Project Type: Archeology

Lead Agency: National Park Service

Cooperating Agencies: Alaska Department of Natural Resources; Department of Interior, Fish and Wildlife Service; Department of Agriculture, U.S. Forest Service

Project Term: Five years for restoration action component; 10 years for monitoring component January 1, 1993 to December 30, 2002

INTRODUCTION

A two-phase archeological restoration assessment of all existing and accessible oil spill response documentation has revealed that there is solid evidence for substantive injury to 24 known archeological sites that can be directly linked to the *Exxon Valdez* oil spill event. The sources of injury include oiling, oil spill beach cleanup actions, and vandalism. Of these three identified sources, cleanup activities and vandalism appear to have resulted in the most clear-cut cases of injury to archeological sites (e.g. loss or destruction of diagnostic artifacts, illegal excavation, disturbance of human remains). The effects of oiling are more problematical, but the available evidence indicates that oil penetration impairs the ability of radiocarbon samples to yield accurate dates and may alter archaeologically-relevant soil chemistry.

In June 1992 the Trustees convened a multi-agency panel of experts in the archeology of the oil spill region chaired by Martin McAllister, the nation's foremost expert in archeological restoration. This panel gave thorough review to all available oil spill injury data and arrived at the following conclusions:

1. Nineteen known archeological sites had been injured by cleanup activities or vandalism related to the oil spill event.

2. A total of 10 known sites had been affected by moderate to heavy oiling (5 of which are also among the 19 sites injured by cleanup and vandalism).

3. Based on the total known sites and projected archeological sites in the oil spill pathway supplied by the Exxon Company contractors and a special Trustee-sponsored GIS/statistical study by the State University of New York, it is estimated that:

    a. A total of 112 archeological sites suffered substantive injury from oil spill cleanup or vandalism tied to the oil spill event.

b. A total of 59 archeological sites were subjected to moderate to heavy oiling during the oil spill event (at least half of these sites also number among the 112 sites affected by other sources of injury).

Note: These numbers represent the most conservative, statistically-derived estimate of injury endorsed by the "McAllister Panel." The next-lowest estimates put forward by Dr. Al Dekin's injury study are 338 and 155, respectively; statistically valid estimates, but based on what appear to be less valid assumptions about the nature and distribution of injury.

The purpose of this project is to conduct site-specific restorative actions at injured archeological sites on federal or state lands within the oil spill pathway. Guidance for the proposed work is drawn from Section 14 of the Archeological Resources Protection Act (ARPA). None of the planned work duplicates previous studies; it is based on a careful review of the results of earlier injury investigations.

WHAT

The goal of this project is to ameliorate injury to archeological sites that were impacted by oiling, oil spill cleanup, or vandalism as a direct result of the *Exxon Valdez* oil spill event. The measures include the following:

1. Full damage examination and analysis of the injured sites.

2. Recovery analysis and curation (and where appropriate, repatriation) of any remaining archeological resources that were exposed or disturbed by oil spill related injury.

3. Data recovery to compensate for the loss of important archeological information at injured sites and/or the stabilization and physical repair of disturbed areas within injured sites.

WHY

Archeological sites constitute a category of finite, non-renewable resources managed by the state and federal governments for the public benefit. These resources represent a major part of the cultural heritage of the United States and injury to resources of this type results not only in the loss of important scientific data about the human past but in an irrevocable diminution of our nation's historic patrimony. The restorative measures proposed herein are designed to either repair physical injury or reduce the loss of important archeological information caused by injury. Physical repair includes such actions as restoring trampled protective vegetation at a site or filling in a looter's hole. Data recovery is used to recover what bits of information can be salvaged from the area of an illegal excavation--in a sense, restoring to the public what information has been potentially lost by means of scientific investigations. If restorative measures are not taken; current signs of vandalism may provoke further vandalism, disturbed archeological soils will most likely result in accelerated erosion of archeological fabric, and altered artifact patterns and contaminated radiocarbon samples will probably play subtle havoc with future archeological

interpretations in the region--one of Alaska's richest but least known archeological zones. In recognition of the archeological importance of the area, the National Park Service has already committed a majority of its funds under a five-year National Archeological Survey project to conduct a sample survey and evaluation of coastal sites in Kenai Fjords and Katmai. Other participating agencies lack a similar funding source, but they are committed to do what they can to increase survey coverage of the area.

HOW

The first step in this project will be to conduct site-specific restoration assessments at sites with documented injury, but where there is insufficient detail upon which to determine appropriate treatment (19 sites). The second step will be to carry out the indicated restorative action--either physical repair and/or data recovery. In many cases, the anticipated restoration treatments will be limited in scope and difficulty and the necessary restorative actions will be taken immediately upon completion of the assessment. A few may require carefully- planned return visits. This portion of the work will be carried out in a two-year split (1993 and 1994) to permit sufficient time for planning larger and more complex restorative measures and to take advantage of corrective feedback from the first year of the project.

A concurrent restoration assessment, coordinated with the first, will address long-term injury resulting from oiling. Ten known sites that have been exposed to moderate to heavy oiling will be monitored for a period of 10 years to determine the effect of oil on radiocarbon samples, archeological soil chemistry, and protective site vegetation. Research assessments of this type are specifically authorized by Section 14(c) of ARPA when the nature and level of injury to archeological sites remains uncertain or problematic. The results will alert future researchers to any skewing effect the oil may have on archeological soil or radiocarbon specimens and make land managers aware of any residual threats to archeological sites (e.g., alterations or reductions in protective vegetative cover). The 10 sites selected for monitoring include 5 from the list of 19 sites with evidence of injury attributable to cleanup or vandalism and 5 additional sites that have been oiled, but presently have no documentation of other injury. These 5 sites bring the total number of known injured sites to 24, the number mentioned at the beginning of this proposal.

After completion of the assessment and treatment of previously-known injured sites in 1994 the work could be expanded in 1995 to discover additional injured sites, assess the nature and extent of the injury, and carry out appropriate treatment. The favored approach will be a "find and restore strategy." A problem-oriented research design will be developed to guide this inventory. The search will employ a stratified-random survey methodology to target the effort toward the most likely zones to contain injured archeological sites in need of treatment. Continuation of the oiling assessment and the start of this work will depend on an interim review of the results from the first two years of the project and the express approval from the Trustee Council to proceed.

The results of all project work will be published in both technical and popular formats. As they become available, pertinent findings will be fed into the stewardship, site protection monitoring, and public education projects. The research and restorative actions will follow the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation. The Division of Polar Research, National Science Foundation, is recommended as the most appropriate source and coordinator for peer review of the project.

ENVIRONMENTAL COMPLIANCE

The proposed project is a categorical exclusion from the National Environmental Policy Act but subject to the provisions of the Historic Preservation Act, the Archeological Resources Protection Act, and the Native American Graves and Repatriation Act. The project will be carried out in conformance with the consultative processes and standards demanded by these legislative mandates.

WHEN

January 1 to June 1, 1993	Consultation under the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act; preparation of work plans and research designs.
June 1, 1993	Start of field work for restoration assessment and oil monitoring projects.
December 30, 1994	Completion of restoration assessment for known injured sites.
June 1, 1995	Start of fieldwork for discovery, assessment, and treatment of additional archeological sites.
December 30, 1997	Completion of restoration assessments and treatment actions for additional injured sites.
December 30, 2002	Completion of oil monitoring project.

BUDGET ($K)

	USNPS	USFWS	USFS	ADNR	TOTAL
Personnel	$ 9.1	$ 14.9	$ 10.6	$ 48.6	$ 83.2
Travel	7.7	10.4	7.2	8.5	33.8
Contractual	84.9	3.0	5.3	14.5	107.7
Commodities	1.1	1.2	1.0	3.9	7.2
Equipment	1.2	1.8	1.2	2.9	7.1
Capital Outlay	0.0	0.0	0.0	0.0	0.0
Sub-total	$ 104.0	$ 31.3	$ 25.3	$ 78.4	$ 239.0
General Administration	7.3	2.6	2.0	8.2	20.1
Project Total	$ 111.3	$ 33.9	$ 27.3	$ 86.6	$ 259.1

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93007

Project Title: Archaeological Site Stewardship Program

Project Category: Management Action

Project Type: Archaeology

Lead Agency: Alaska Department of Natural Resources

Cooperating Agencies: U.S. Forest Service, Department of the Interior; National Park Service; Department of the Interior, Fish and Wildlife Service

Project Term: January 1, 1993 to January 15, 1994

INTRODUCTION

A. Background and Summary of Injury

The late prehistoric residents of the Prince William Sound, Kenai Peninsula, Kodiak Island and Alaska Peninsula areas oriented their subsistence activities to marine resources, and large numbers of archaeological sites occur along the coast in the area affected by the *Exxon Valdez* oil spill. Due to tectonic activity in this region, some archaeological sites which were once on dry land now occur in the intertidal zone, and 24 or more sites were directly oiled or disturbed by cleanup activities following the spill. In addition to these direct effects on archaeological resources, the spill brought hundreds of people into the spill area for response and damage assessment thereby increasing public knowledge of the locations of archaeological sites. Looting and vandalism of sites in the spill area has increased. Vandalism of archaeological sites is often caused by individuals that are interested in artifacts but are unaware of the damage caused by removing artifacts or disturbing the site. Vandalism results in the irretrievable loss of information from damaged sites. Vandalized sites cannot be returned to their original condition, and the most effective counters to vandalism are public education and increased oversight of the sites.

Site stewardship is the recruitment, training, coordination and maintenance of a corps of local interested citizens to watch over nearby archaeological sites. Site stewardship programs in Arizona, Arkansas and Texas have successfully reduced the incidence of vandalism of archaeological sites. A stewardship program for the area affected by the *Exxon Valdez* oil spill was initiated in 1992, and this proposed project would continue that program.

B. Location

In 1993, stewardship programs will be instituted using residents of Kodiak, Homer and Chenega. In subsequent years, the program will expand to include other communities in the spill area.

WHAT

A. Goal

The goal of the Program is to reduce or eliminate vandalism at archaeological sites in the area affected by the *Exxon Valdez* oil spill.

B. Objectives

1. Recruit and train local residents to protect the archaeological resources in their areas.

2. Obtain agreements with private landowners and agencies with land management responsibilities to participate in the stewardship program.

WHY

A. Benefit to Injured Resources/Services

This proposed project will benefit archaeological sites by preventing their destruction through vandalism. Archaeological sites in the area affected by the *Exxon Valdez* oil spill that were not directly oiled are nevertheless subject to continuing injury related to the spill due to increased public knowledge of the sites. This project will benefit an injured resource by preventing further injury.

B. Relationship to Restoration Goals

This proposed project meets the Trustee Council goal of restoring the environment to its pre-spill condition through management action.

HOW

A. Methodology

The stewardship program is based on functioning programs in Arizona and Texas. The program will be managed by the Alaska Department of Natural Resources, Office of History and Archaeology (SOHA) with assistance from the U.S. Fish and Wildlife Service, the U.S. Forest Service, and the National Park Service during the early phase of program development. The SOHA will have ultimate management responsibility for the stewardship program. The SOHA will employ a State Coordinator to coordinate and administer the network of site stewards and steward coordinators. The U.S. Fish and Wildlife Service, U.S. Forest Service and National Park Service will assist in the implementation of the program. These federal agencies will also cooperate with the SOHA in continued operation of the program.

Agencies with land management responsibilities in the spill area, including the U.S. Forest Service, National Park Service and U.S. Fish and Wildlife Service, and private landowners interested in participating in the stewardship program will enter into agreements with the SOHA. The program will employ volunteers to watch assigned sites and report any changes or

disturbances to the sites. A local coordinator, also a volunteer, will guide day to day efforts and recruit and train new stewards. Local coordinators will also make recommendations on future actions to land owners and the State Coordinator. The State Coordinator will provide overall direction for the program. Land owners and managers will identify sites for monitoring, help select and train stewards, and provide technical advice and assistance.

B. Coordination with Other Efforts

The stewardship program will continue the current stewardship project effort begun in 1992. This program will complement the archaeological site monitoring proposal submitted by the National Park Service. The stewards, with their intensive level of site observations, will be a valuable supplement to patrols by monitoring teams. The monitoring teams will, in turn, provide the professional and legal expertise to act on damage reports from stewards. The stewardship program will also complement the Public Education proposal submitted by the U.S. Forest Service. Stewards could assist in public education outreach programs by giving lectures and talking in classrooms in their local areas.

ENVIRONMENTAL COMPLIANCE

This proposed project is a non-intrusive study that appears to qualify for a categorical exclusion from the requirements of the National Environmental Policy Act.

WHEN

January - February 1993	Prepare/print 1993 training materials/handbooks
Winter 1993	Develop agreements with landowners and agencies
March 1993	Train stewards
Sping/Summer 1993	Stewards in place
Fall 1993	Compile reports from stewards
January 1994	Submit Status Report

In subsequent years, additional areas within the spill area will be included in the program. Training materials will be modified as needed.

BUDGET ($K)

	ADN	USFWS	USNPS	USFS	TOTAL
Personnel	$ 52.0	$ 21.4	$ 4.4	$ 16.3	$ 94.1
Travel	8.5	6.0	4.0	6.0	24.5
Contractual	33.5	5.0	2.5	5.0	46.0
Commodities	2.0	2.6	1.5	2.5	8.6
Equipment	4.0	2.2	0.0	0.0	6.2
Capital Outlay	0.0	0.0	0.0	0.0	0.0
Sub-total	$ 100.0	$ 37.2	$ 12.4	$ 29.8	$ 179.4
General Administration	8.5	3.2	0.7	2.4	14.8
Project Total	$ 108.5	$ 40.4	$ 13.1	$ 32.2	$ 194.2

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93008

Project Title: Archaeological Site Patrol and Monitoring

Project Category: Restoration Management Actions

Project Type: Archaeology/Cultural Resources

Lead Agency: National Park Service

Cooperating Agencies: Department of the Interior, U.S. Fish and Wildlife Service; Department of Agriculture, U.S. Forest Service; Alaska Department of Natural Resources

Project Term: May 5, 1993 to March 1, 1997

INTRODUCTION:

The *Exxon Valdez* oil spill and associated cleanups have resulted in an increased public knowledge of archaeological resources in the oil spill area. The greater visibility of site locations brought on by oil spill activities has resulted in higher incidence rates of looting and vandalism to these resources (An Evaluation of Archaeological Injury Documentation, *Exxon Valdez* Oil Spill, NPS, DNR).

The purpose of this project is to ameliorate the impact of these higher rates of archaeological looting and vandalism. This will be accomplished by utilizing agency archaeologists and resource protection personnel who will conduct public contact patrols and archaeological site monitoring along the coastlines in the *Exxon Valdez* oil spill area. The agency teams will work in their respective areas making contact with the public and informing them of the values of protecting archaeological sites and the federal and state statutes that require this protection. The teams will also monitor selected segments of the coastline for signs of looting or vandalism that may require additional management or law enforcement action.

WHAT

The goal of this project is to reduce or eliminate archaeological site looting and vandalism through the following measures:

1. Create greater public awareness of the value of archaeological resources and the laws protecting them.

2. Create an agency presence and demonstrate agency interest in archaeological resources to discourage and prevent future vandalism in the oil spill area.

3. Identify areas most vulnerable to looting and vandalism that will require further law enforcement action.

4. Track the geographical and temporal variation in the incidence of looting and vandalism in order to take the appropriate protective measures.

5. Increase the efficiency and effectiveness of archaeological resource protection among the involved agencies.

WHY

Before the oil spill, archaeological resources were, practically speaking, protected by their unknown locations. Unfortunately, it is impossible to reverse the expanded knowledge of these resources gained by the public as a direct result of the spill and cleanup activities. Therefore, it is necessary to offset this knowledge of the resource with a positive presence by the agencies and additional effort to spread the message that these resources are protected by state and federal laws.

HOW

The agency teams will consist minimally of an archaeologist and a resource protection specialist. The interdisciplinary team approach is essential to the success of this project. The teams will make active contact with the public that utilizes the target coastal zones and inform them of the values of protecting archaeological sites and the federal and state laws that require this protection. They will also monitor selected segments of the coastline for signs of looting or vandalism that may require further management or law enforcement action and refer the information to the appropriate agency for action. Site patrol and monitoring will give priority to known problem areas where looting has already occurred or where sites are known to be at risk as identified in the archaeological resource damage assessment study, recently completed.

Standard resource protection and archaeological data collection practices will be employed. Successful programs for cooperative multi-agency patrol and monitoring projects have been developed in the American Southwest, and the National Park Service (NPS) has an incipient program in place in Alaska. Detailed field notes, photographs or video tapes, and all patrol reports, including a log of all public contacts, will be kept by the field teams.

The bulk of the project funding for this component will be distributed among the participating agencies for field personnel salaries, for supplies, and for flight time, fuel, etc., to supplement existing site patrol and monitoring efforts, or establish them where necessary. Augmenting existing agency efforts is the most cost-effective approach. The three federal agencies and the state already have existing patrol capabilities in the oil spill zone. The purpose here is to expand those capabilities to cover the affected archaeological sites. In addition, the NPS has used ARPA law enforcement funds from Washington for the last two years to expand the patrolling capabilities of several seasonal rangers in Katmai National Park to cover archaeological resources.

The technical lead for this component will be the National Park Service which has expertise in this area, including a well-developed archaeological resource protection and training program. An archaeologist with a law enforcement commission will act as project coordinator and the regional law enforcement specialist will act as a technical advisor to the program. Both will serve as trainers for field personnel.

Project Descriptions

The overall management of the project will be done by the project coordinator in consultation with the project technical advisor and the agencies. The project coordinator will ensure that there is uniformity among the agencies in carrying out the project, will act as the liaison among agencies, and will recommend the most efficient use of project resources.

The project coordinator will act as the project information officer and maintain all project records, including a copy of all field notes, patrol reports, photographs, and other records or data collected by field personnel. The project coordinator will also consolidate and analyze this information to produce an annual report for the project, and make recommendations for future efforts. Data will be maintained in the files of the project coordinator and will be made available to all participating agencies.

Uniform training for field personnel is essential to the success of this project, and will be conducted by the project coordinator and the technical advisor with input from the agencies. A nationally recognized expert on archaeological resource protection will be brought from Duluth, Minnesota for the training session. All field personnel must attend the project training, to be held at the beginning of each field season, before they will be allowed to participate in the project. Training will consist of orientation to the project, archaeological resource protection training, resource familiarization, and public education and contact techniques.

To ensure uniformity and comparability of observations and data collection, the project coordinator and the technical advisor will periodically review individual agency operations, including field evaluations. Issues of safety and logistics will be handled by individual agencies.

A plan of operations must be filed by each participating agency for each year. An annual report will be required from each agency, including a status report on the targeted sites. The project coordinator will prepare an annual report for the entire project which compiles and analyzes the data collected by each agency for that year, and make recommendations for the following year's effort.

This project will be coordinated with the archaeological site stewardship program currently administered by the US Fish and Wildlife Service, and with any other archaeological restoration projects approved by the Trustees.

ENVIRONMENTAL COMPLIANCE

The proposed project is a categorical exclusion from the National Environmental Policy Act.

WHEN

The duration of the full project will be three to five years, depending on the level of documented site damage.

May 1, 1993	Agency Operating Plans for 1992 Field Season Due
June 1 to June 5, 1993	Field Personnel Training in Anchorage
June 8 to August 27, 1993	Field Work
November 16, 1993	Agency Annual Reports and Copies of Field Data Due
March 1, 1994	Project Annual Report Due and Distributed to Agencies and Trustees.

Similar schedules would be implemented for following years.

BUDGET ($K)

	USNPS	USFWS	ADNR	USFS	TOTAL
Personnel	$ 41.0	$ 14.8	$ 48.3	$ 14.8	$ 118.9
Travel	10.7	2.3	2.3	2.3	17.6
Contractual	29.9	29.2	29.2	29.2	117.5
Commodities	0.0	5.5	5.5	5.5	22.0
Equipment	0.0	0.0	0.0	0.0	0.0
Capital Outlay	0.0	0.0	0.0	0.0	0.0
Sub-total	$ 87.1	$ 51.8	$ 85.3	$ 51.8	$ 276.0
General Administration	6.1	2.2	9.3	2.2	19.8
Project Total	$ 93.2	$ 54.0	$ 94.6	$ 54.0	$ 297.8

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93009

Project Title: Public Information, Education and Interpretation

Project Category: Restoration Management Actions

Project Type: Education

Lead Agency: Department of Agriculture, Forest Service

Cooperating Agencies: Department of the Interior, National Park Service; Alaska Department of Fish and Game

Project Term: January 1, 1993 to September 30, 1997

INTRODUCTION

A. Background on the Resource/Service

This project will provide interpretive materials and experiences for communities, visitors, commercial and recreation users in the oil spill area about the *Exxon Valdez* oil spill and resultant research and restoration projects.

B. Summary of Injury

Numerous people in the PWS communities suffered adverse impacts from the spill. In a broader sense, many Americans felt injured by the effects of the spill on what they believed was one of the more pristine and beautiful areas of Alaska.

C. Location

The public information outreach will benefit all of Southcentral Alaska with an emphasis on the communities of Valdez, Whittier, Cordova, Seward, Homer, Kodiak, and the Municipality of Anchorage.

WHAT

A. Goal

1. To inform and educate the public on the effects and impacts of the *Exxon Valdez* oil spill, current research and restoration project activities.

2. To provide to the public an accurate/balanced view of existing conditions in PWS.

3. To interpret PWS and the Gulf of Alaska environment to the public to enhance their enjoyment and understanding of this area.

4. To enhance eco-tourism recreation opportunities and experiences through interpretation of the natural resources and environment.

B. Objectives

1. Development of a family of brochures on the oil spill impacted areas - the focus of the brochures will be on how the different subject areas were or were not affected by oil spill, and on educating recreationists and other users of the oil spill areas about minimum impact use to avoid further damage to injured resources. Subjects to be covered would include but not be limited to marine mammals, waterbirds, anadromous fish, plants, upland wildlife, intertidal life, cultural resources, history of PWS, upland birds, and recreational opportunities.

2. The development and production of a family of videos on the oil spill impacted areas. These will be short (5-10 minute) videos that can be used in visitor centers, in kiosks, taken to schools, public meetings or can be sent off as stand alone entities or as a combined package to whomever has a need for this type of information.

WHY

This project will provide to the public balanced and accurate information on the oil spill, injured and non-injured resources, and on restoration efforts. This project would tie into the restoration team's need to provide the public with information.

HOW

A public-affairs specialist (PAS) will be hired by the Forest Service in FY 1993 as overall coordinator for the approved projects. The PAS will report to the public affairs officer on the Chugach National Forest and be responsible for monitoring the progress of all projects and for their ultimate completion. Projects may be accomplished by agency (both state and federal) specialists or by contract. The project coordinator will also be responsible and accountable for all project budgets. Support services such as clerical help, purchasing, contracting and the execution of interagency agreements (if needed) will be provided by the Chugach National Forest Supervisor's Office. Close coordination with other agencies will be critical. The project coordinator will need to work closely with other appropriate cooperating state and federal agencies to ensure their active involvement. All of the projects will be accomplished through the efforts of a multi-agency team.

ENVIRONMENTAL COMPLIANCE

These projects are categorically excluded (FSH 1909.15, paragraph 26.la, item #4).

WHEN

		Start	Complete
A.	**Brochures (10)**	10/92	09/93
	Writing Script	01/93	04/93
	Design and Layout	04/93	07/92
	Printing	07/93	09/93
B.	**Video (1)**	01/93	09/94
	Footage Gathering	01/93	07/93
	Edit & Duplicating	07/93	09/93

BUDGET ($K)

	USFS
Personnel	$ 69.0
Travel	10.0
Contractual	205.0
Commodities	2.0
Equipment	6.0
Capital Outlay	0.0
Sub-total	$ 292.0
General Administration	24.7
Project Total	$ 316.7

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93010

Project Title: Reduce Disturbance Near Murre Colonies Showing Indications of Injury from the *Exxon Valdez* Oil Spill

Project Category: Management Action

Project Type: Birds

Lead Agency: Department of the Interior, Fish and Wildlife Service

Cooperating Agencies: None

Project Term: January 1, 1993 to September 30, 1993

INTRODUCTION

A. Background on the Resource/Service

Common and thick-billed murres were the species of higher vertebrates most frequently injured by the oil from the *Exxon Valdez* oil spill. These diving seabirds have continued to demonstrate abnormal breeding behavior and low reproductive output at several sites since the spill. Murres normally nest in dense aggregations, presumably an adaption which reduces the rate of predation of eggs and chicks. Social behavior within aggregations apparently is important in stimulating the onset of laying and there is a tendency for laying within aggregations to be relatively synchronous. Murres often respond to abrupt, loud noises by panic flights from nesting cliffs. They are especially prone to panic flights when they are not incubating an egg or brooding a chick. If a small percentage of the murres in an aggregation have laid and a panic flight occurs, eggs tend to be abandoned temporarily. In contrast, after a substantial proportion of birds have laid, incubating birds are more likely to remain with eggs even when non-breeders and pre-breeders fly. In most locations, eggs left unattended are taken by avian predators (e.g., gulls, ravens). If food is adequate and eggs are lost early in incubation, murres will relay about 14 days after eggs are lost. Nevertheless, a lower proportion of chicks fledge from second eggs than from first. The result of panic flights, especially when such flights occur during early incubation, is reduced productivity.

B. Summary of Injury

Over 100,000 murres were killed by the oil, and counts of birds at colonies within the trajectory of the oil indicated reduced populations after the spill. In the 3 years following the spill, remaining murres at colonies affected by the oil have initiated laying relatively late, if they laid at all, and reproductive output has remained lower than normal. Avian predators have been responsible for much of the egg loss. Murres in colonies where a high percentage of the individuals are failing to reproduce tend to be flighty at the slightest disturbance. As indicated above, panic flights, especially early in incubation, tend to reduce productivity for the colony. With reduced populations, it is important for remaining murres to produce recruits at a high

enough rate to cause recovery. Poor reproductive success following the spill has continued, and few young were produced during the breeding seasons of 1989-1991 to recruit to breeding populations in the future. If this continues, recovery to former population levels is unlikely.

C. Location

The project will attempt to reduce disturbance at the main murre colonies where evidence of injury has been recorded. These colonies are Ugaiushak Island and Puale Bay, located on the south side of the Alaska Peninsula near the downstream end of the spill trajectory; the Barren Islands, located near Homer between the Kenai Peninsula and Kodiak Island area; the Triplet Islands, located between Kodiak and Afognak Island; and the Chiswell Islands, located near Seward. This project will include education displays and efforts in Kodiak, Homer, Seward, and Chignik.

WHAT

A. Goal

The purpose of this project is to facilitate the recovery of murre colonies affected by the *Exxon Valdez* oil spill by reducing disturbance during the breeding season.

B. Objectives

1. Educate people who use areas near the murre colonies affected by the *Exxon Valdez* oil spill about the need to avoid disturbance to birds.

2. To enhance productivity of murres by reducing disturbance.

WHY

A. Benefit to Injured Resources/Services

Murre colonies within the trajectory of the spill were injured initially by loss of breeding birds. The lingering effect has been abnormal breeding behavior resulting in reduced reproductive success. This may be the result of a breeding population composed almost entirely of young inexperienced birds which may not have been present in 1989 when the oil-related mortality occurred. Reducing disturbance near breeding colonies during the breeding season should enhance productivity by diminishing the panic flights which leave eggs and chicks exposed to predators. Reducing disturbance bouts also may accelerate the return to an earlier nesting phenology by reducing the proportion of pairs that are forced to relay lost eggs. The timing of chick hatching is presumably timed to coincide with maximum food resources needed to successfully rear chicks. A return to more normal timing would therefore favor higher reproductive output and foster restoration of populations to former levels.

B. Relationship to Restoration Goals

There are few reasonable proactive approaches that will aid restoration of murres, but minimizing disturbance likely will result in increased hatching success of murre eggs. Further, if eggs laid early are not lost, the phenology of breeding events should return to a more normal schedule, one adaptive for maximum survival of young.

HOW

A. Methodology

The public education campaign would include development of a brochure, articles in community and industry newspapers and magazines (e.g., commercial fisherman), presentations to communities and industry groups, and automated slide shows at visitor contact centers at Homer, Kodiak, and Seward. Recommendations would be provided on how users may conduct activities in a less disturbing manner (e.g., ask halibut charter operators to gaff fish rather than shooting them to eliminate the loud noise). The targeted audience would include tour boat and fishing charter operators from Seward and Homer, and commercial fishermen from villages in the vicinity of colonies (e.g., Kodiak, Seldovia, Chignik, Seward). In addition, workshops for charter operators would be held, the Federal Aviation Agency would be contacted to try to get advisories out to pilots in these areas, and regular radio and television spots would be developed for use in selected communities. Although existing facilities, communication networks, and ongoing programs would aid accomplishment of the objective, one person would be hired specifically to perform the duties associated with this project.

B. Coordination with Other Efforts

This effort will compliment existing interpretive programs, and provide an opportunity to build understanding an appreciation for marine resources. An effort would be made to solicit aid from the National Park Service and Alaska Department of Fish and Game to disseminate information. Another restoration project, monitoring would provide a basis for judging the effectiveness of this project to minimize disturbance. Coordination with existing law enforcement programs will be a part of this project, but no new regulations are proposed initially. Not only murres but other colonial seabirds would benefit from reduced disturbance.

ENVIRONMENTAL COMPLIANCE

This is a non-intrusive project which appears to qualify for categorical exemption under NEPA.

WHEN

October 1992	Advertise for and hire a lead person
November to December 1992	Plan specific strategies for project and coordinate with cooperators
January to March 1993	Produce brochure, develop presentations, and schedule presentations
April to August 1993	Distribute information, make presentations
September 1993	Analyze program effectiveness, recommend modifications

BUDGET ($K)

	USFWS
Personnel	$ 35.0
Travel	9.0
Contractual	4.0
Commodities	2.0
Equipment	2.0
Capital Outlay	0.0
Sub-total	$ 52.0
General Administration	4.8
Project Total	$ 56.8

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93011

Project Title: Develop Harvest Guidelines to Aid Restoration of River Otters and Harlequin Ducks

Project Category: Management Actions

Project Type: Birds/Mammals

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Project Term: January 1, 1993 to September 30, 1993

INTRODUCTION

A. Background on Resource/Service

River otters (*Lutra canadensis*) and harlequin ducks (*Histrionicus histrionicus*) occur throughout the area impacted by the *Exxon Valdez* oil spill. Damage assessment studies of both species has documented injury and raised the possibility of long-term detrimental effects. Legal harvest of these species is continuing. This is a controllable source of mortality that should be applied as a restoration tool. However, that application cannot occur until harvest guidelines are developed and implemented that fully utilize injury assessment information. This project will develop those guidelines.

B. Summary of Injury

Otters forage in intertidal and subtidal zones that were heavily contaminated with oil. Analysis of bile and blood samples indicated hydrocarbons were accumulated and that toxic effects of oil are continuing. Oiled mussels eaten by otter are likely one source of continuing contamination. Home ranges of radio-collared animals were larger in oiled than non-oiled areas suggesting that oil contamination made it more difficult for them to find food. Body lengths, body weights and diet diversity were all lower in oiled areas, further substantiating indications of food problems. A population decline in the oiled area in 1991 was indicated by a high rate of latrine site abandonment (nearly 15%) as compared to non-oiled sites (less than 4%).

C. Location

More than 2,000 sea duck carcasses were recovered after the spill, including more than 200 harlequins. Harlequins use the intertidal and shallow subtidal zones most heavily affected by the spill. They feed on invertebrates, such as mussels, which showed continuing evidence of hydrocarbon contamination. Tissues from about 40% of harlequins sampled in the oiled area during 1989 and 1990 were contaminated with hydrocarbons, and about 33% of birds collected in the spill area were in poor body condition. In 1991, surveys indicated a harlequin population decline and near-total reproductive failure in oiled areas of PWS. Preliminary results of 1992 surveys suggested continuing reproductive failure.

WHAT

A. Goal

This project will recommend harvest guidelines to facilitate restoration of river otters and harlequin ducks in PWS.

B. Objectives for river otters are to:

1. Estimate number, composition and location of historical and current harvest.
2. Recommend seasons and bag limits that will facilitate restoration.

C. Objectives for harlequin ducks are to:

1. Recommend seasons and bag limits that will facilitate restoration.

WHY

Manipulation of seasons and bag limits to aid recovery of river otter and harlequin duck populations is likely the only restoration action possible over the next several years. Mortality from trapping and hunting could be reduced and recovery thereby accelerated. However, it must be clear that the benefit to injured species outweighs the loss of resource use opportunity for the public.

Other restoration actions, such as transplants or protection and enhancement of habitat will not be effective in the short-term because both species likely suffer continued exposure to petroleum hydrocarbons through ingestion of contaminated food. Moreover, it is possible that natural degradation of hydrocarbons in the environment over a long period of time is the only way to eliminate this food contamination.

Work proposed by this project will supplement normal management activities of ADF&G Division of Wildlife Conservation. It will allow formulation of harvest guidelines that consider restoration goals. Normal management activities for river otters and harlequins include at least four weeks of staff time devoted to collecting and analyzing harvest data, considering regulation changes, and implementing any season and bag limit changes that are approved. Those activities are supported by data entry services, travel funds, and facilities.

HOW

A. Methodology

1. River Otters.

The reliability of monitoring the use of latrine sites as an index to population trend will be evaluated. Literature will be searched and experts will be contacted to obtain opinions. If monitoring appears reasonable, it will be proposed as a continuation project.

Most harvest will be quantified by searching ADF&G furbearer sealing records. Additional harvest by local subsistence users that was not reported will be estimated using results of household surveys conducted by ADF&G Subsistence Division during 1992-93. Funding for those surveys is not requested as part of this proposal. All available information will be summarized by year beginning in 1985.

Harvest guidelines will be formulated by considering the restoration goal, population trend and harvest level. The goal is to restore the oil spill area to its pre-spill condition. Achieving it will require reversing an apparent downward population trend. The role of harvest mortality as a limiting factor will be estimated and guidelines formulated to insure that harvest facilitates recovery.

2. Harlequin Ducks.

Harvest and population data will be considered and harvest guidelines developed. The sport harvest data used will be very general in nature because specific information on harlequins in PWS has not been collected by management agencies. Existing subsistence harvest information is also non-specific. However, improved subsistence data is expected from household surveys that will be conducted by ADF&G Division of Subsistence during 1992-93. Population status information is expected from the harlequin duck restoration monitoring study (#93-033).

ENVIRONMENTAL COMPLIANCE:

No environmental assessment is required for this project.

WHEN

A. River Otter

November 1992	Make recommendation concerning emergency order changing 1992/93 trapping season.
March 1993	Evaluate reliability of latrine site monitoring as an index to population trends.
August - September 1993	Summarize harvest, make recommendation concerning an emergency order changing 1993/94 trapping season.

B. Sea Ducks

January 1993	Make recommendation on season and bag limits to Board of Game.

BUDGET ($K)

	ADF&G
Personnel	$ 6.6
Travel	0.5
Contractual	2.0
Commodities	1.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 10.1
General Administration	1.1
Project Total	$ 11.2

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93012

Project Title: Genetic Stock Identification of Kenai River Sockeye Salmon

Project Category: Restoration Management Actions

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish and Game

Project Term: January 3, 1992 to September 30, 1995

INTRODUCTION

A. Background on the Resource/Service

Fishing time in the Upper Cook Inlet area was affected in 1989 due to the presence of oil from the *Exxon Valdez* oil spill (EVOS). As a direct result, sockeye salmon (*Oncorhynchus nerka*) spawning in the Kenai River system exceeded optimal escapement goals by three times. This overescapement resulted in overproduction of sockeye salmon fry. The overabundance of sockeye salmon juveniles depleted invertebrate prey populations to the point that widespread juvenile mortality occurred during the winter-spring rearing period. Consequently, sockeye smolt outmigrations in the Kenai River have been severely reduced, and the number of adult sockeye salmon returning from the overescapement in the Kenai River system is expected to be well below minimum escapement levels. Starting in 1993, a large reduction, or closure of Kenai River sockeye salmon harvests may be necessary in an attempt to reach adequate escapements.

Sockeye salmon harvested from the mixed-stock fishery of Cook Inlet include fish from the Kenai, Kasilof, and Susitna Rivers. In order to effectively manage the harvest of EVOS-damaged stocks, Restoration Science Study R59 - Assessment of Genetic Stock Structure of Salmonids - was implemented. This study uses Genetic Stock Identification (GSI) techniques to identify Kenai River stocks in mixed stock Cook Inlet fisheries. Area managers will use this information to modify fishing areas and openings in order to facilitate the harvest of surplus Kasilof and Susitna River stocks while protecting the EVOS-damaged Kenai River stocks.

Restoration of Kenai River sockeye stocks will benefit subsistence, sport, and commercial fishermen in coastal communities throughout Cook Inlet, from Homer north through Anchorage to Tyonek. In 1992 nearly 10,000 families obtained subsistence permits to harvest salmon in UCI, most targeting Kenai River sockeye salmon. The most recent statistics indicate that nearly 100,000 sport anglers fished the Kenai River for salmon in 1990, spending $38 million in 1986 dollars. Forty percent of those anglers were from out of state. Of the 1,323 permits licensed to commercial fish in UCI, 80% are fished by state residents with the remaining predominantly from Pacific Coast states. Average ex-vessel value (1987-1991) of the UCI commercial salmon harvest was $ 67.8 million.

WHAT

Contingent upon the funding in 1992, the Alaska Department of Fish and Game (ADF&G) will continue to develop a comprehensive genetic database of sockeye salmon stocks in Cook Inlet. In 1992 ADF&G began collecting baseline genetic data from 28 subpopulations from the Kenai, Kasilof, and Susitna Rivers. Beginning in 1993, samples from the Cook Inlet commercial harvest will be analyzed to estimate the composition of the fisheries. This information will enable area managers to identify Kenai River fish occurring in the mixed-stock commercial fishery and thus harvest surplus stocks of sockeye salmon while providing protection to EVOS-damaged stocks destined for the Kenai River. The specific objectives are the following:

1. Refine and expand the allozyme database to include all significant spawning stocks contributing to mixed-stock harvests of sockeye salmon in Cook Inlet.
Initiate the development of DNA marker detection in sockeye salmon to test for expanded resolving power.

2. Obtain genetic data each week from samplings of the various mixed-stock fisheries occurring in 1993 - 1995.

3. Use Genetic Stock Identification (GSI) algorithms to estimate the proportion of Kenai River stocks in mixed stock fisheries so that managers may modify area and time of harvest in order to protect these damaged stocks while targeting surplus Kasilof River and Susitna River stocks. Estimates will be provided within 48 hours post-fishery.

WHY

Attempts to use stock identification to manage harvests of Cook Inlet sockeye salmon in the past have relied on scale growth patterns. However, the accuracy of the scale technique alone has not been reliable, and it is insufficient to permit the in-season protection of the EVOS-damaged Kenai River stocks. GSI techniques rely on genetic variation to discriminate between populations of organisms. This method has recently been applied as an in-season fisheries management tool, and it has proven to be extremely effective for allocating and adjusting the harvest of fish stocks intercepted in mixed-stock fisheries such as those that occur in Cook Inlet. Once a data base has been established, GSI techniques should provide a mechanism for in-season management on a stock-specific basis. This will allow managers to control the harvest of Kenai River sockeye salmon and facilitate their recovery.

HOW

A comprehensive baseline genetic database will be developed for all sockeye salmon stocks contributing to Cook Inlet fisheries. Additional sockeye salmon will be collected from approximately 20 baseline subpopulations each year (1993-1995). Sites will be chosen to supplement those being collected during the 1992 field season. Mixed stock fishery samples will be collected from every drift net fishery occurring during the July fisheries (1993-1995). Muscle, liver, heart, and eye tissue will be taken from individual fish and examined by protein electrophoresis (allozyme analysis) for discriminating gene markers. Genotypic and allelic frequency estimates will be calculated from allozyme electrophoretic data for each baseline and mixed-stock sample at every gene locus examined and will be used to identify discrete spawning populations. Stock components of mixed fishery samples will be estimated using a conditional

maximum likelihood algorithm. Fishery composition estimates will be available within 48 hours following the fishery so that management decisions can be based on the actual composition of the fisheries.

ADF&G will also screen representative individuals for DNA-level markers. Total genomic DNA will be extracted and amplified through PCR (polymerase chain reaction) techniques utilizing various mitochondrial and nuclear primers. Restriction analyses as well as sequencing studies will be performed. Maximum likelihood simulation studies will be performed to test the additional resolution that could be provided by the DNA-level data. DNA data will be collected from the fishery samples as scientifically and logistically feasible.

ENVIRONMENTAL COMPLIANCE

Collecting permits will be obtained as required.

WHEN

June - Sept. 1992	Baseline & Mixture sample collections/coordination with project R53
July - Dec. 1992	Laboratory analyses of baseline and model mixtures
Jan. - April 1993	Laboratory analysis of baseline populations and annual report
July - Sept. 1993	Laboratory analyses of mixtures; numerical analyses of stock structure; modeling for 1993 mixture analyses
Oct. 1993 - Sept. 1994	Baseline analyses, in-season analyses, annual report
Oct. 1994 - Sept. 1995	Baseline analyses, in-season analyses, finalnitoring of Prin

BUDGET ($K)

	ADF&G
Personnel	$ 149.1
Travel	12.0
Contractual	30.0
Commodities	45.0
Equipment	40.0
Capital Outlay	0.0
Sub-total	$ 276.1
General Administration	24.5
Project Total	$ 300.6

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93014

Project Title: Quality Assurance for Coded-Wire Tag Application in Fish Restoration Projects

Project Category: Technical Support

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Project Term: January 1, 1993 to December 31, 1993

INTRODUCTION

This project will maintain high quality coded-wire tag (CWT) application and CWT data tracking for EVOS restoration projects. The target species are pink, chum, and sockeye salmon. The *Exxon Valdez* oil spill (EVOS) injured wild pink and chum salmon eggs and fry. Various amounts of oil were deposited in intertidal spawning habitats in Prince William Sound (PWS) where up to 75% of the spawning occurs. Salmon eggs deposited in 1989 and all subsequent years have been contaminated and direct egg mortality has been documented. The growth and survival of juvenile salmon during the early marine period was reduced by oil contamination in 1989. Recently suspected genetic damages resulting from oil contamination in spawning beds may further reduce the productivity and fitness of wild salmon populations for many years to come. Sockeye salmon rearing lakes on Kodiak Island and elsewhere were damaged when fisheries were closed allowing large numbers of spawners to escape into rearing lakes. The resulting large fry populations overgrazed the resident fry food resources in the lakes causing a reduction in lake carrying capacity. The benefits of this project will be realized in the communities of Kodiak, Anchorage, Whittier, Valdez, and Cordova which support important sport and commercial fishing industries in the region.

WHAT

The goal of this project is to establish and maintain high quality CWT application and data tracking procedures within EVOS restoration projects. The project will achieve the following objectives:

1. Interface CWT application database with CWT recovery databases being developed for restoration projects,
2. Implement appropriate quality control standards, tag application, and data tracking procedures for CWT application within EVOS restoration projects and provide technical assistance to staff involved with CWT application,
3. Review data from CWT application projects at the end of the season to insure that quality control standards, tag application, and data tracking procedures are maintained, and
4. Conduct a pilot project to develop a methodology to quantify CWT placement in pink salmon fry and incorporate into CWT application database.

WHY

Coded-wire tagging is currently used in several fishery "management action" and "resource manipulation and enhancement" projects. Management action projects utilize CWT data to (1) direct fishing effort away from damaged wild salmon, and (2) inventory and evaluate the effects of straying hatchery salmon on wild salmon populations. Manipulation and enhancement projects utilize CWT as a tool to evaluate project success. Failure to assure proper CWT application procedures and data tracking may seriously compromise the quality of CWT programs, confound interpretation of CWT data, and reduce the success of EVOS restoration projects. This project is designed to maintain high quality CWT application and data tracking procedures to insure that this stock separation tool provides the expected results.

Coded-wire tagging is a very effective tool for marking large numbers of juvenile fish if high quality tag application and data tracking procedures are maintained. All CWT programs are based on the assumption that tagged fish are representative of untagged fish. Poor tag application and fish handling procedures will result in a violation of this assumption by (1) reducing the growth and survival of tagged fish, or (2) reducing the fishes' ability to home accurately to its stream of origin. Standard methods must be used during the application process to minimize damage to tagged fish, insure good tag placement, properly estimate number of tagged fish, number of untagged fish, tag mortality, tag retention, and number of good fin clips. This project will benefit all restoration projects that involve coded-wire tagging (e.g., Red Lake Salmon Restoration, Restoration of Coghill Lake Sockeye, Inventory and Effects of Straying of Hatchery Pink Salmon on Wild Pink Salmon Populations in PWS, Montague Island Chum Salmon Restoration) by insuring maintenance of quality control standards and interfacing of CWT application and recovery databases. Technical assistance will be provided to private groups that will use CWT to evaluate restoration program success (e.g., Chenega Chinook and Coho Stocking).

Poor tag placement is the most likely cause of reduced growth, survival, and homing ability in tagged fish. There is documented damage to the olfactory nerve in chum salmon fry tagged with CWT. Good placement is particularly important to maintain when tagging pink salmon fry because of their small size. Each year approximately one million CWTs are applied to pink salmon at five private nonprofit hatcheries in PWS. Recovery of these marked fish in hatchery broodstock and common property and cost recovery harvests is essential for effective management of hatchery and wild salmon populations. Recovery of CWT fish is currently being used to evaluate the effect of straying hatchery salmon on damaged wild salmon populations in PWS. A program to quantify CWT placement in pink salmon is needed to insure that variations in placement between tag codes do not confound interpretation of straying data.

HOW

This project will establish and maintain high quality CWT application and data tracking procedures within all EVOS restoration projects. The project will initially focus on a review of existing CWT quality control and tag application procedures. Sample sizes and procedures currently used to estimate tag mortality, tag retention, and fin clip quality will be evaluated and adjusted if necessary. The existing CWT application database will be interfaced with developing CWT recovery databases. Standard quality control, tag application, and data tracking procedures will be implemented. Documents detailing these procedures will be distributed to government and

private groups responsible for CWT application in various EVOS restoration projects. Each CWT application site will be visited periodically to answer questions and insure that CWT quality standards are being followed. Each restoration project involving CWT will prepare a report describing the methods and results from each field season. CWT reports will be reviewed for consistency with quality standards and recommendations will be developed for further improvement of the program.

A pilot study will be conducted to collect data needed to design a program to quantify CWT placement in pink salmon fry. Samples of tagged fry (n=200) will be collected from randomly selected tag groups/codes of pink salmon. Fry tissues will be cleared with a sequential treatment of formaldehyde and potassium hydroxide solution. A computer image analysis system will be used to quantify tag placement within the head of each fish relative to a reference line drawn between the eyes. Histological analyses will be conducted to determine the degree of olfactory nerve damage in fish exhibiting poor tag placement. The data obtained from the study will be used to estimate sample sizes and costs associated with quantification of tag placement.

ENVIRONMENTAL COMPLIANCE

This project will not have a direct impact on any environmental parameters.

WHEN

This project will take place during FY93. Project activities will occur throughout much of the year.

Jan. - Feb.	Review and revise CWT quality control standards and interface CWT application database with CWT recovery databases
Feb. - June	Collect samples for tag placement study and assist restoration project staff involved with CWT application
June - July	Review data from CWT application projects
July - Sept.	Process samples from tag placement study and analyze data
Oct. - Nov.	Prepare annual report

BUDGET ($K)

	ADF&G
Personnel	$ 68.4
Travel	3.8
Contractual	10.3
Commodities	1.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 83.5
General Administration	11.3
Project Total	$ 94.8

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93015

Project Title: Kenai River Sockeye Salmon Restoration

Project Category: Restoration Management Action

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Project Term: January 3, 1992 to September 30, 1996

INTRODUCTION

Sockeye salmon *Oncorhynchus nerka* which spawn in the Kenai River system were injured by the *Exxon Valdez* oil spill. Reduced fishing time in the Upper Cook Inlet area due to the oil spill caused sockeye spawning escapement levels in the Kenai River system to exceed the desired amount by three times. The biological impact of the oil spill on Kenai River sockeye salmon stocks is expected to be serious. Data collected by NRDA Fish/Shellfish Study 27, *Sockeye Salmon Overescapement*, showed greatly reduced survival estimates of juvenile sockeye salmon during the winter-spring rearing period. The large escapement appears to have produced more rearing juvenile sockeye salmon than could be supported by nursery lake productivity. In general, when rearing salmon abundance greatly exceeds lake carrying capacity, the species and size composition of prey resources are altered, which, in turn, affects all trophic levels. Because of such changes, juvenile sockeye growth is reduced and freshwater mortality is increased. Greater numbers of fry remain in the lake for another year of rearing. Competition for a limited food supply reduces condition of surviving fry. Marine mortality is increased because of poor condition of outmigrating smolts.

Limiting sockeye salmon fry production by closely regulating the number of spawning adults is the best way to restore the productivity of these rearing areas. However, the number of adult sockeye salmon returning from the 1989 overescapement may be so low that a reduction or closure of Kenai River sockeye may be necessary starting in 1993 in an attempt to reach adequate spawning escapements.

This project consists of increased monitoring and management of the sockeye salmon stocks in the Kenai River and Upper Cook Inlet (UCI) north of Anchor Point. The project will benefit subsistence, sport, and commercial fishermen in coastal communities throughout Cook Inlet, from Homer north through Anchorage to Tyonek. In 1992 nearly 10,000 families obtained subsistence permits to harvest salmon in UCI, most targeting Kenai River sockeye salmon. The most recent statistics indicate that nearly 100,000 sport anglers fished the Kenai River for salmon in 1990, spending $38 million in 1986 dollars. Forty percent of those anglers were from out of state. Of the 1,323 permits licensed to commercial fish in UCI, 80% are fished by state residents with the remaining predominantly from Pacific Coast states. Average ex-vessel value (1987-1991) of the UCI commercial salmon harvest was $ 67.8 million.

WHAT

A. Goal

The goal of this project is to restore Kenai River sockeye salmon stocks injured by the oil spill. This will be accomplished through improved stock assessment capabilities, more accurate regulation of spawning levels, and modification of human use. Restoration of Kenai River sockeye salmon stocks will be achieved when average fry, smolt, and adult production can be maintained at pre-spill levels. Prey resources of rearing lakes must also be restored to normal levels (This will be monitored under another restoration study, which will be based on information obtained from NRDA Fish/Shellfish Study 27).

B. Objectives

Specific objectives of this proposal are as follows:

1. Improve stock identification capabilities by combining parasite and genetic stock identification information with available scale growth data to provide statistically reliable estimates of Kenai River stocks in the mixed stock fishery of Upper Cook Inlet (UCI)

2. Increase the accuracy and precision of escapement monitoring by supplementing hydroacoustic equipment used in the Kenai River, and

3. Provide more accurate estimates of abundance of Kenai River sockeye salmon within UCI through hydroacoustic assessment techniques.

WHY

More intensive management is necessary to restore affected stocks to pre-spill levels and maintain them at those levels until the populations stabilize. This project will help restore those stocks by providing the information needed to properly manage human uses. Intensive fisheries management will temporarily reduce human pressure on these injured stocks to speed their recovery. As a means of minimizing impacts on the fisheries, existing fisheries may need to be restricted or redirected to alternative sites. For Cook Inlet this will relieve pressure on what are anticipated to be small runs to the Kenai River in the next several years without shutting down other UCI fisheries.

HOW

A. Stock Identification

Stock identification studies used to regulate human use of UCI sockeye salmon have, in past years, relied on scale growth patterns. The accuracy and precision of this technique has varied considerably from year to year. Kenai stocks typically dominate the total return and their scale patterns are generally distinct enough to provide some separation from other stocks. However,

when runs to other systems are more abundant (as may occur in 1993-1995) separation of Kenai stocks will be much more difficult. Improvements in stock identification procedures will be necessary to identify the contribution of Kenai River sockeye salmon to the total run accurately in this situation. Recent work by ADF&G, in cooperation with National Marine Fisheries Service staff, has shown that parasite occurrence can be used to improve estimates of stock contribution during the fishing season. The combination of scale patterns, parasites and genetic stock identification techniques (Restoration Science Study Number 59) will greatly increase the accuracy of UCI stock assessment estimates.

Sockeye salmon escapements into major drainages of Upper Cook Inlet were sampled for genetic, parasite, scale and otolith characteristics in 1992. During 1993, 20 additional baseline populations will be sampled and mixed-stock samples will be collected from the commercial drift gillnet fishery. Stock composition of mixed stock fishery samples will be estimated using scale pattern analysis, parasite data, genetic data, or a combination of all three. Stock resolution will be enhanced by using several kinds of biological marker data simultaneously. Typically a maximum-likelihood estimation procedure for a mixture problem with learning samples has been used to combine these data. The principal components of this project are sample collection, transportation to genetic laboratory facilities (for preparation by Restoration Study Number 59) and real time stock composition modeling necessary for inseason resource management decisions.

B. Escapement Monitoring

Bendix Corporation side-scan hydroacoustic equipment has been used since 1976 to count adult sockeye salmon entering the Kenai River to spawn. Lack of Bendix replacement parts and the inability to purchase new Bendix counters will compromise our future ability to provide escapement estimates. Accuracy of estimates would be greatly enhanced through use of newer, more technically advanced equipment. Evaluation of new equipment in 1992 will result in selection of the most appropriate replacement system. Funding for purchase of replacement equipment was authorized in 1992. ADF&G will conduct continuous operations with both the old Bendix equipment and the new equipment on both banks of the Kenai River during a three week period in 1993 to encompass the peak of the sockeye salmon run. This will provide a measure of quality assurance that will allow comparison of data previously collected using only the Bendix device to that collected using new equipment. Use of the Bendix is expected to be unnecessary in subsequent years.

C. Offshore Assessment Program

Sockeye salmon returning to UCI are captured with a drift gill net at a series of stations between Anchor River and Red River delta. Estimates of the total sockeye salmon return are made several times during the season by estimating expected total test fishery catch per unit of effort for the season and catchability of sockeye salmon in the test fishery calibrated by the commercial drift gillnet fishery. Analysis of historical data indicates that existing sampling effort and catch has not been proportional to abundance. Calibration by the commercial fleet is not guaranteed for future reduced run sizes. In 1992 hydroacoustic equipment and techniques were evaluated by a contractor experienced in marine salmon investigations to supplement the existing program. Anticipated results include: (1) operating parameters of the hydroacoustic system used, (2) real

time estimates of fish density, (3) fish distribution across the transects, and (4) definition of run timing models and total return estimates. In 1993 a hydroacoustic survey will be conducted to provide a real-time estimate of adult sockeye salmon in UCI. Placement and duration of transects needed for the 1993 survey will be based on 1992 results to provide an appropriate level of precision and accuracy for an abundance estimate of sockeye salmon. This is to include appropriate species composition estimates of fish targets. Purchase of offshore hydroacoustic equipment will be necessary in order to meet these goals.

ENVIRONMENTAL COMPLIANCE

A Corps of Engineers Section 10 or 404 permit, State of Alaska Title 16 permit, and a finding that this project is consistent with the Alaska Coastal Zone Management Plan may be required.

WHEN

Four additional years will be required to meet project objectives. Adult returns from the injured 1989 brood year will occur during 1993-1995, but information on the 1990, 1991, and 1992 brood years will also be needed to monitor recovery of the system. Adult returns from the 1992 brood year will not be observed until 1996.

Events and Milestones for 1992-1993

Aug. 1992	Begin to evaluate results of escapement monitoring, purchase new equipment and design escapement monitoring for 1993.
Jan. 1993	Begin to evaluate results from the offshore hydroacoustic investigation and design a survey for 1993.
April 1993	Results of baseline genetic sampling due to evaluate accuracy and precision of stock composition modeling and set sample design and sample size goals for 1993.
May 1993	Award contract for the offshore hydroacoustic survey in UCI to begin in July.
June 1993	Begin field work: fishery sampling and escapement monitoring begin in July, and escapement sampling for stock identification baselines through September.
Sept. 1993	Interim Report to include (1) performance of stock composition modeling with scale, genetic, and parasite data, (2) estimates of adult sockeye escapement in the Kenai River, and (3) offshore hydroacoustic estimates of sockeye salmon.

BUDGET ($K)

	ADF&G
Personnel	$ 271.0
Travel	15.5
Contractual	270.5
Commodities	36.0
Equipment	81.0
Capital Outlay	0.0
Sub-total	$ 674.0
General Administration	58.6
Project Total	$ 732.6

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93016

Project Title: Chenega Chinook and Coho Salmon Release Program.

Project Category: Manipulation and Enhancement

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish and Game

Project Term: January 1, 1993 to December 31, 2003

INTRODUCTION

A. Background

Due to the oil spill, salmon stocks were impacted. Subsistence as well as sport and commercial fisheries were disrupted. Traditional usage of fish stocks and fishing grounds by the Chenega Village residents was lost. This project will help to restore lost subsistence fishing and establish alternate subsistence fishing opportunities.

B. Injury

As a result of the Exxon Valdez Oil Spill, subsistence harvest of salmon and other resources was disrupted.

C. Location

Fish production at W. Noerenberg (WHN) Hatchery at Esther Island in PWS. (This is the preferred site if production can be accomplished without major modifications). Fish will be released and harvested in the vicinity of Chenega Village in southwestern Prince William Sound, at Deadend Bay.

WHAT

A. Goal

To replace subsistence resources by permitted releases of chinook and coho salmon at designated sites near Chenega village from stocks of Prince William Sound Aquaculture Corporation (PWSAC) Wally Noerenberg Hatchery near Esther Island.

B. Objectives

Produce 50,000 chinook salmon smolts at the W. Noerenberg Hatchery for transport and release at site(s) near Chenega Village

Hold and feed the smolts in net pens at the release site for 2 weeks before they are released.

Harvest approximately 1500 adult chinook salmon when they return (Assume 3% survival rate; 4 years before all year classes are represented).

Produce 50,000 coho salmon smolts for transport, holding, feeding and release near Chenega Village.

Harvest approximately 2500 adult coho salmon annually (assume 5% survival rate; annual return beginning 1 year after first release).

WHY

A. Benefit to Injured Resouce/Service

These projects will restore and improve subsistence salmon harvests that were lost because of the Exxon Valdez Oil Spill.

B. Relationship to Restoration Goals

Results from this project will help to restore lost subsistence fisheries. (Restoration Options: replace lost subsistence use (Management of Human uses) 18 (Resource Manipulation), 30 (Other) related to hydrocarbon contamination of subsistence foods.

HOW

A. Method

1. Smolts will be utilized from existing production lots and raised to smolt stage at the W.H.N. Hatchery.

2. Smolts will be transported by barge to the designated sites.

3. Smolts will be held and fed in net pens for 2 weeks before release to improve survival and imprinting.

4. Adults will be harvested when they return.
   Chinook Salmon: broodstock - from hatchery stock.
   Coho Salmon: broodstock - from donor stock near the release site.

All plans will be reviewed by the PWS Regional Planning Team (RPT) and by the Fish Transport Permit (FTP) process and will comply with the ADF&G Fish Genetics Policy.

B. Other Efforts

This project will provide an alternate source of food for subsistence use and reduce the need for reliance on wild stocks that were injured by the oil spill.

ENVIRONMENTAL COMPLIANCE

This project will be reviewed by the NEPA Process, the PWS RTP, and the ADF&G FTP review before it is implemented.

WHEN

Jan.	1993	Plans are reviewed by the NEPA process, PWSAC, and the PWSAC RPT.
June	1993	First chinook smolts transported, penned, fed, and released.
Oct.	1993	Coho salmon broodstock screening and selection.
June	1994	First "adult" (jack) returns of chinook salmon.
Oct.	1994	First coho salmon eggs are taken from the designated location.
June	1995	First coho salmon smolts are released.
Aug.	1996	First coho salmon adults return.
June	1996	First complete complement of all chinook salmon age classes return.

Each year, smolts will be released in June (or late May).

BUDGET ($K)

	ADF&G
Personnel	$ 2.5
Travel	0.0
Contractual	21.5
Commodities	0.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 24.0
General Administration	1.9
Project Total	$ 25.9

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93017

Project Title: Subsistence Restoration Project

Project Category: Restoration Management Actions

Project Type: Subsistence

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: National Oceanic and Atmospheric Administration

Project Term: January 1, 1993 to September 30, 1995

INTRODUCTION

A. Background on the Resource/Service

Subsistence use of fish and wildlife constitute a vital natural resource service that was injured by the *Exxon Valdez* oil spill. Data collected by the Alaska Department of Fish and Game's Division of Subsistence has demonstrated this injury.

B. Summary of Injury

Annual per capita subsistence harvests declined dramatically (from 12 to 77 percent decline as compared with pre-spill averages) in ten of the communities in the path of the spill during the first year after the event. While some of these communities' harvests demonstrated a limited recovery in the second post-spill year, harvest levels in other affected communities showed no signs of recovery. Concern over the long-term health effects of using resources from the spill area, a loss of confidence on the part of subsistence hunters and fishermen in their own abilities to determine if their traditional foods are safe to eat, and a perceived reduction in available resources, all contribute to the reduced harvest levels.

C. Location

This subsistence restoration project will involve the following communities: Chenega Bay, Tatitlek, Cordova, Valdez, Nanwalek, Port Graham, Seldovia, Kenai, Seward, Larsen Bay, Karluk, Old Harbor, Akhiok, Port Lions, Ouzinkie, Kodiak City, Chignik Lake, Chignik, and Chignik Lagoon.

WHAT

A. Goal

The goal of the project is to restore the subsistence use of fish and wildlife damaged by the *Exxon Valdez* Oil Spill. Community meetings will be held in order to identify and map the specific areas and resources of continued concern to subsistence users. These meetings will provide a

comprehensive, final opportunity to identify these concerns. Data obtained in these meetings will provide prioritization and locations of sites to the Alaska Department of Environmental Conservation's 1993 spring shoreline survey, Restoration Project 93018, in order to focus treatment efforts if necessary. Samples of subsistence foods will be collected from harvest areas identified during the mapping.

C. Objectives

Community representatives will assist in site selection, as well as the collection of samples. The samples will be analyzed for the presence of hydrocarbon contamination. The results of the tests, along with findings from other damage assessment and restoration studies, will be interpreted by the Oil Spill Health Task Force, and reported to the communities in an informational newsletter and community visits. This information will assist the Trustee Council in making decisions concerning restoration, enhancement or replacement of lost subsistence resources and uses. In addition, some mitigation of lost subsistence use will be provided by making funds available to communities to support travel to harvest areas away from oiled sites or to areas where resources have not been depleted. As further mitigation, funds will be made available to support subsistence food sharing programs between communities.**

WHY

The Oil Spill Health Task Force has had some success in conveying the message that most subsistence foods are safe to eat. However, concerns about long-term effects remain. Also, limited public access to the damage assessment studies has created the impression in most communities that the task force did not base its conclusions on a complete assessment of all data. This project provides the opportunity to put information from the damage assessment into context. This will help to empower the people in the impacted communities to make informed decisions and encourage those who are so inclined to return to using more subsistence resources. It would also restore the communities' abilities to pass on skills and knowledge associated with using subsistence foods.

Making information from subsistence users part of the restoration process will facilitate the recovery of subsistence use areas, the importance of which might otherwise be missed. There is a need in these communities to actively participate in restoration of the environment. This project would provide for this involvement.

The project answers the need to continue to monitor the risks to human health from the oil spill. This is consistent with the goal of restoring human services of the natural resources damaged in the oil spill. It also addresses the need to restore the natural resources and the services these resources previously provided to subsistence users.

HOW

By involving subsistence users in decisions affecting mitigation, and the monitoring, enhancement and replacement of the natural resources, we can accelerate the recovery of the resources subsistence users rely upon. This involvement, combined with effective communication of information concerning the safety of the resources should cause subsistence harvests to begin to approach pre-spill levels, and reduce anxiety about their use.

The Division of Subsistence will use the results of a joint study currently being conducted with the U.S. Minerals Management Service in 15 communities impacted by the *Exxon Valdez* oil spill to determine the communities where concern continues to exist, as well as the nature of that concern. Similar activities were suggested by the Bureau of Indian Affairs

** If this portion of the project is not within the scope of the settlement agreement and is eliminated, it would reduce the cost of the project by 53.5 thousand dollars.
for inclusion in 93017. These were seen as duplicative with the MMS/ADF&G study and therefore not included in 93017. As a member group of the Oil Spill Health Task Force, the Division of Subsistence will continue to ensure coordination with that group.

The details of the subsistence research being undertaken by the Department of the Interior as part of the Chenega Bay settlement are not available due to the litigation sensitive nature of the work. Nevertheless, the Department of Fish and Game has been assured by Regina Sleater, an attorney of the U.S. Department of the Interior, that there is minimal overlap between the ADF&G study and the DOI study. In addition, the results of the Interior study will be available in December 1992 and 93017 will be able to build upon--rather than overlap with--the Interior project.

ENVIRONMENTAL COMPLIANCE

This project is categorically excluded under NEPA guidelines.

WHEN

January 1 - May 31, 1993	Community meetings to map areas and species of concern
June - July 1993	Coordinate with DEC shoreline assessment to verify oiling information
June 1993	Collect subsistence food samples for testing (two months for analysis)
August 1993	Informational newsletter issued
September 1993	Collect subsistence food samples for testing
November 1993	Informational newsletter issued
December 1993	Collect subsistence food samples for testing
February 1993	Informational newsletter issued
March 1994	Collect subsistence food samples for testing
May 1994	Informational newsletter issued
June - July 1994	Coordinate with DEC shoreline assessment to verify oiling information
June 1994	Develop plan for additional cleanup/mitigation of oil
September 1994	Develop plan for enhancement/replacement of resources
May 1995	Coordinate with DEC shoreline assessment to verify oiling information

Note: there will be ongoing communication with subject communities throughout the duration of the project, with visits to communities as needed.

BUDGET ($K)

	ADF&G	NOAA	TOTAL
Personnel	$ 78.5	$ 65.2	$ 143.7
Travel	30.0	0.0	30.0
Contractual	135.5	0.0	135.5
Commodities	0.8	17.3	35.4
Equipment	0.0	0.0	18.1
Capital Outlay	0.0	0.0	0.0
Sub-total	$ 244.8	$ 82.5	$ 327.3
General Administration	21.3	12.0	33.3
Project Total	$ 266.1	$ 94.5	$ 360.6

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93018

Project Title: Enhanced Management for Wild stocks in Prince William Sound, Special Emphasis on Cutthroat Trout and Dolly Varden.

Project Category: Restoration Management actions

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: U.S. Department of Agriculture, Forest Service

Project Term: January 1, 1993 to September 30, 1994

INTRODUCTION

The status of many of the wild fish stocks and their habitats in the aftermath of the *Exxon Valdez* oil spill, are unknown. Numerous efforts have been conducted or initiated to evaluate effects of the oil spill on specific stocks and information exists scattered throughout various agencies on various aspects of some of these stocks. Higher mortality and slower growth rates for Dolly Varden and cutthroat trout was documented in oiled areas compared to non-oiled areas. Recreational fishing for Dolly Varden and cutthroat trout was curtailed by emergency closures and changes in sport regulations following the oil spill, likely resulting in faster recovery times for the stocks that were closed to sport fishing. In other parts of Prince William Sound (PWS), however, there is insufficient information on which to base population management actions for these two species. In addition, information to prioritized population and habitat management actions for most of the wild fish stocks in PWS is lacking or at least unconsolidated. Without appropriate information on which to base management action, injury may occur to other stocks due to overfishing or overly conservative regulations may be made which would unnecessarily restrict recreational sport fishing opportunities. Likewise, a readily accessible informational database is needed to identify appropriate strategies for protecting, maintaining and enhancing populations and habitat of wild stocks of fish in PWS.

Project personnel will operate weirs in Cordova, Valdez and western PWS at Eshamy Creek to sample outmigrating cutthroat trout and Dolly Varden. Where possible enumerations of other salmon smolts will be made. Concurrently, the Forest Service will construct a database of information on the wild stocks of cutthroat trout, Dolly Varden, coho salmon, pink salmon, and all other freshwater and anadromous fish in PWS. The combination of these two efforts will benefit all users who participate in sport fisheries in PWS by providing the means to assist resource managers in making prudent decisions regarding the viability and long term sustainable yield of all fish species in PWS.

WHAT

A. Goal

The goal of this project is to collect the information needed for the responsible management of populations and habitats of all fish species in PWS with a special emphasis on Dolly Varden and cutthroat trout. Resultant management actions will be prioritized toward recovery of depressed stocks of all species while assuring that anglers can fish for Dolly Varden and cutthroat trout where stocks are healthy enough to withstand fishing pressure.

B. Objectives

The Alaska Department of Fish and Game (ADF&G) objectives are as follows:

1. Determine the abundance of anadromous Dolly Varden and cutthroat trout over 200 mm in length outmigrating from Eyak Lake, McKinley Lake, Robe Lake and Eshamy Lake for both 1993 and 1994.

2. Obtain length compositions of the 1993 and 1994 outmigrations of Dolly Varden and cutthroat trout over 200 mm in length from Eyak Lake, McKinley Lake, Robe Lake and Eshamy Lake such that the composition is within ± 5% of the true value 95% of the time.

3. Estimate mean length and age for anadromous cutthroat trout that overwintered in Eyak Lake, Mckinley Lake, and Eshamy Lake such that the estimate is within ± 10mm of their true value 90% of the time.

The U.S. Forest Service (USFS) objectives are as follows:

4. Compile existing information on all freshwater and sea-run fish stocks in PWS in a readily available computerized format that will be made available to all interested resource management agencies.

WHY

The goal of this project is to collect the information needed to develop management strategies which will provide for the responsible management of wild fish stocks and their habitats in PWS, with special emphasis on Dolly Varden and cutthroat trout. Restoration project R 106, which was funded in 1991, provided preliminary information about the distribution of Dolly Varden and cutthroat in PWS and the adjoining CRD. Numerous other studies on other fish species have been conducted since the oil spill and much information prior to the oil spill on fish stocks in PWS exists scattered among various agencies and researchers. Information on where populations exist, their significance (e.g., biological, commercial, recreational cultural), habitat limiting factors, susceptibility to disturbance and potential impacts to populations and habitats are needed to adequately prioritize management actions. The availability of all this information in a readily accessible computerized format will increase the effectiveness of the Forest Service and other resource managers in the maintenance of population diversity in PWS.

Cutthroat trout and Dolly Varden population information is currently lacking for many sites in PWS. Two of the overwintering populations which will be studied in 1993 and 1994 are those of Eyak and McKinley Lakes. Both of these lake systems currently support popular sport fisheries; however, abundance and length composition for these populations is not known. Therefore we don't know how much fishing pressure either population can sustain. Furthermore, logging activities are planned for the Eyak Lake drainage. Population data from this site prior to logging will be useful in assessing the impacts of logging on these populations. Robe Lake was selected for evaluation because of the habitat restoration opportunities that exist at this site. This drainage once supported active sport fisheries for salmon and Dolly Varden. However, the lake has physically deteriorated in the last 20 years, and we don't know is what the lake currently supports for terms of fish. Because this site has the possibility of replacing lost fishing opportunity we feel that population research at this site is warranted. Eshamy Lake was a NRDA treatment site for Dolly Varden and cutthroat trout. We believe that monitoring at this site be continued in order to gauge the recovery of populations that were exposed to oil. Abundance and length parameters for the populations of the four sites will be studied for two consecutive years to obtain accurate estimates. These estimates, along with the information gained from NRDA F/S 5 and R 106 will be used to form a regulatory package for Dolly Varden and cutthroat trout fisheries in PWS that will be presented to the Alaska Board of Fisheries in 1996.

HOW

To estimate abundance of sea-run cutthroat trout and Dolly Varden, all emigrating fish over 200 mm in length, passing through weirs placed on the four streams and rivers, will be counted during the spring outmigrations for both species. To obtain length compositions for overwintering stock, all fish over 200 mm in length will be measured to the nearest 1 mm. To obtain estimates of mean length at age, three scales will be removed from all cutthroat trout emigrating through the weirs. Age will be determined by examination of the scales.

All existing information, including the results of the Dolly Varden and cutthroat trout field portion of this project, will be compiled by a contractor, hired and directed by Forest Service personnel. The contractor will work closely with individuals from the ADF&G, USFWS, NMFS and USFS researchers, and individuals who have information on wild fish stocks in PWS. A computer database will be developed using ORACLE software and will operate in a MS-DOS environment.

ENVIRONMENTAL COMPLIANCE

Title 16 permits will be obtained for each weir that is installed.

WHEN

January 1 - March 31, 1993	-	Operational plan will be written, materials purchased, crews will be hired and the Eyak River weir will be constructed.
January 1 - February 15, 1993	-	Contract for FS database will be written.
February 15 - April 15, 1993	-	Contract will be advertised
April 15 - June 30, 1993	-	Field Season
April 30, 1993	-	Contract will be awarded
May 1 - September 1, 1993	-	Database structure developed and start collecting information.
July 1 - September 1, 1993	-	Data entry, editing, and analysis. Cutthroat trout scales will be aged.
September 30, 1993	-	Preliminary Report
January 1 - March 31, 1994	-	Operational plan written, materials purchased and crews will be hired.
Sept. 1, 1993 - Sept. 1, 1994	-	Continued data compilation and computer database construction
April 15 - June 30, 1994	-	Second field Season
July 1 - September 1, 1994	-	Data entry, editing, and analysis. Cutthroat trout scales will be aged.
September 30, 1994	-	Database completed and installed on Forest Service computer.
September 1 - October 1, 1994		Final Report will be written.

BUDGET ($K)

	ADF&G	USFS	TOTAL
Personnel	$ 143.0	$ 5.0	$ 148.0
Travel	7.0	0.0	7.0
Contractual	35.5	50.0	85.5
Commodities	16.5	0.0	16.5
Equipment	0.0	0.0	0.0
Capital Outlay	0.0	0.0	0.0
Sub-total	$ 202.0	$ 55.0	$ 257.0
General Administration	24.0	4.3	28.3
Project Total	$ 226.0	$ 59.3	$ 285.3

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93019

Project Title: Chugach Region Village Mariculture Project

Project Category: Restoration Enhancement

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish & Game

Cooperating Agencies: Chugach Regional Resources Commission

Project Term: October 1, 1992 to September 30, 1996

INTRODUCTION

This project involves the culture of bivalve shellfish for use as a subsistence food and for economic development in Native villages of the Chugach Native Region. There are five Native villages in the region; Eyak, adjacent to Cordova; Tatitlek, in northern Prince William Sound; Chenega Bay, in southwest Prince William Sound; and Nanwalek and Port Graham, both of which are located on the southwestern tip of the Kenai Peninsula. All these villages will participate in this project. Shellfish have long comprised a significant subsistence food resource for these villages. This resource also has commercial potential for mariculture. A pilot commercial mariculture project underway near the Chenega Bay village in 1989 was aborted because of the oil spill.

The March 1989 *Exxon Valdez* oil spill adversely affected the waters and beaches utilized by the villagers. The oil spill affected the longstanding reliance of Chugach Native villages on the productivity of the marine habitat for their livelihood and traditional lifestyle.

Shellfish resources in the oil spill affected were affected in two ways. First, the sheltered habitats that were most hospitable to shellfish were also most protected against Prince William Sound's natural cleansing action. Oil spill residues tend to persist in contaminated shellfish habitats. The National Oceanic and Atmospheric Administration estimated that oil could remain in sheltered, low energy areas for twenty years or longer. Regardless of the action taken to remove the oil from shellfish beds, it will be a long time before these shellfish could be considered fit to eat. Second, the tendency of shellfish to accumulate, concentrate and store toxic contaminants such as polycyclic aromatic hydrocarbons (PAHS) compounds this habitat injury. An active approach to replace lost resources is needed.

The upshot is that the oil spill badly eroded community confidence in the healthfulness of this subsistence shellfish stock. It also arrested initial efforts to explore the commercial feasibility of shellfish mariculture. Thus, the oil spill has given special impetus and urgency to ongoing efforts to initiate Native-sponsored shellfish mariculture projects. Mariculture is a feasible and cost-effective means to conserve, repair and enhance the natural productivity of the renewable resource base.

WHAT

The broad long range goal of the village mariculture project is to strengthen the villages' economic well-being and self-sufficiency through the culture of shellfish stocks for subsistence and commercial harvest.

Three specific project sub goals are identified to implement the long range goal to strengthen Chenega Bay and Tatitlek's economies and economic self-sufficiency:

1. Develop self-supporting village-owned and managed commercial mariculture enterprises.
2. Create new local opportunities for employment and earned income.
3. Restore/enhance traditional subsistence as a supplement to cash income.

Eyak, Tatitlek and Chenega Bay have already begun the process of establishing mariculture operations. The first-year project objective for these villages will be to complete the development of an initial mariculture facilities installation, initiate maintenance activities, and expand the mariculture training program for the villagers.

First-year objectives for English Bay and Port Graham will be to identify potential sites for mariculture operations and initiate permitting procedures required for mariculture development.

Objectives for the ensuing years of the project will involve establishing mariculture operations for Port Graham and Nanwalek, continued training, expanding production and continued market development.

WHY

This project will provide the villages of the Chugach Native region with a means to develop the local bivalve resource in a manner that provides some level of protection against manmade disasters such as EVOS. The local marine environment offers one of the very few opportunities available to theses villages for economic development. EVOS amply demonstrated how vulnerable marine resource development is to disasters such as the oil spill. As well as being an efficient way of utilizing the local marine environment, the mariculture techniques that will be utilized in this project will allow steps to be taken to protect the shellfish that are under culture from the effects of disasters such as EVOS. Such steps could include moving the shellfish to a safe area or sinking them in subtidal water.

The project is designed to provide a long term source of income and subsistence food. It will provide a means for the villagers to maintain their traditional lifestyle in the face of increased and sometimes conflicting use of the area of the Chugach region. The project has already gone through feasibility testing and is designed to will become self sufficient after the development stage which will take the next four years. Development will consist of purchase and installation of seed and equipment, training interested villagers in mariculture techniques, and setting up a management structure in each village to take over the project after the development stage.

HOW

The basic strategy for the village mariculture projects will be to concentrate initially on oyster

culture. The reasoning is that oyster seed is readily available for culturing, there is a good market for oysters grown in Alaska, and oysters have proven to be an acceptable substitute for local shellfish species (oysters are not indigenous to Alaska) for subsistence use. The objective will be to set up a mariculture operation in each village that will produce about 650,000 marketable oysters per year.

The feasibility of establishing mariculture projects in the Native villages of the Chugach Region has been tested extensively at both Tatitlek and Chenega Bay. As mentioned, both these villages have established mariculture feasibility operations with very encouraging results. In addition, data collected from the Port Graham/Nanwalek (English Bay) area and from potential sites in the vicinity of Eyak suggest the mariculture would be successful in these areas as well.

For those villages that already have permitted mariculture areas, the procedure will be to establish new oyster culture operations or increase existing operations to commercial production levels. A mariculture specialist will be retained to organize the operations in these villages, help put together village crews for training and initiate a training program that will run concurrently with the development of the mariculture operations. Mariculture development plans, required as part of the permitting process, will be followed in setting up and developing the culture sites.

For those villagers without permitted sites, initial efforts will concentrate on locating suitable sites and submitting permit applications. Criteria used for locating sites will include the presence of residual oil, the amount of tidal flow, level of protection from adverse weather, upland ownership and ease of access from the village. It may be that for some reason it is determined that mariculture is not practical or feasible for a particular village at this time. In this case the village will be dropped from the project.

In addition to oysters, there is good potential for the culture of clams and scallops as well as the availability of good markets for these products. Clams and scallops are also important for subsistence use. It is hoped that this project can investigate the potential for clam and scallop mariculture on the Chugach region. However, before that can be undertaken, a reliable source of clam and scallop seed needs to be established.

The bulk of the cost for this project will go to training village residents in mariculture and in establishing a management structure for each village. In order to have an effective program it will be necessary to maintain these aspects of the project. Some cost savings could be realized by reducing the amount of seed and culture equipment. However, this would result in village projects with inefficient levels of production. Obviously, reducing the scope of the project to include fewer villages would reduce the cost. It would be possible to reduce the overall cost of the project by up to 50% and still maintain some level of long term benefit.

ENVIRONMENTAL COMPLIANCE

To obtain a permit a mariculture site must meet the criteria set forth in the Corps of Engineers general permit for mariculture projects in Alaska (GP 91-7). They must also be in compliance with the local coastal zone management plan. An environmental impact analysis has not been necessary for permitted mariculture sites.

WHEN

For villages without permitted mariculture sites:

March 1 - March 30, 1993	Identify suitable sites
March 1 - April 30, 1993	Apply for mariculture permits
March 1 - March 30, 1994	Obtain permits

For villages with permitted sites:

Jan. 1 - Dec. 31, 1993	Organize village crew, set up training schedule and initiate training
Jan. 1 - Jan. 31, 1993	Order culture equipment and seed
March 1 - June 30, 1993	Install culture equipment and seed
March 1 - March 30, 1993	Initiate ongoing maintenance schedule for mariculture operations
Ongoing -	Continue training and maintenance

Second Year:

January 3, 1994	Order new seed
March 1 - June 30, 1994	Install new seed
July 1994 - ongoing	Sort out market sized oysters from first year seed and place in intertidal hardening area
August 1994 - ongoing	Begin to market oysters
Ongoing -	Training and maintenance

The remaining years of the project will concentrate on increasing production efficiency in order to bring each village operation to the 650,000 marketable oyster per year level, and to increase marketing effort and improve transport.

BUDGET ($K)

	ADF&G
Personnel	$ 7.5
Travel	0.0
Contractual	556.8
Commodities	0.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 564.3
General Administration	24.8
Project Total	$ 589.1

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93020

Project Title: Bivalve Shellfish Hatchery and Research Center

Project Category: Restoration manipulation and/or enhancement

Project Type: Fish and shellfish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Project Term: January 1, 1993 to September 30, 1993

INTRODUCTION

A. Background on the Resource/Service

Shellfish resources in the *Exxon Valdez* oil spill (EVOS) affected area were impacted in several ways. Most obviously, shellfish populations were damaged, destroyed and/or contaminated by the spill and/or subsequent cleaning activities.

B. Summary of Injury

Some bivalve shellfish populations were affected directly by the toxic effects of the spilled oil and subsequent cleaning. Still other populations were contaminated or were suspected to be contaminated to the degree that they were unfit for human consumption and/or were negatively affecting birds, mammals and other animals that fed upon those shellfish. Evidence indicates that natural cleansing is not proceeding well in some areas. The sheltered habitats most hospitable to shellfish were also those most protected from natural cleansing action. Oil spill residues continue to persist in these areas.

Native communities in the oil-impacted area were altered by the EVOS. Prior to the EVOS at least one mariculture feasibility study was under way (near Chenega Bay Village). This was terminated because of the spill. Replacement shellfish opportunities are reasonable expectations for impacted villages.

C. Location

The project involves two physical facilities. The proposed location for these facilities is in Seward, Alaska. A component of this study is to determine if that is the best location. Target locations for projects resulting from the operation of these facilities include Tatitlek, Chenega Bay, Eyak, Port Graham and Nanwalek.

WHAT

A. Goal

The goal of this project is to assess the feasibility of using aquatic farming technology to restore, replace or enhance bivalve shellfish populations in oil-affected areas and to mitigate the negative affects of the *Exxon Valdez* oil spill on native communities.

B. Objectives

The initial objectives of the project are to assess the feasibility of a shellfish production hatchery and a mariculture technical center to be used to restore, replace and/or enhance bivalve shellfish populations in oil-impacted areas. A report on the feasibility of the proposed facilities relative to potential uses will be generated from data collected during the year. Alternative configurations will be considered and analyzed. This initial study will also attempt to identify potential species and establish production goals for those species.

Native communities and organizations in the affected area would be involved from the outset in development of this project. Pending the results of the feasibility analysis, they would be the logical entity to operate the production shellfish hatchery.

If full funding for construction of the facilities is not realized from oil spill funds, additional funding sources will be required before they can be built. Though this would not affect the stated objectives, it would alter the project time frames and facility priorities

WHY

A. Benefit to Injured Resources/Services

Bivalve shellfish populations were severely impacted by the oil spill and by the cleanup efforts following. All of the affected populations were used to some degree by marine mammals, birds, fishes and in many cases for human subsistence. This project would provide the facilities and infrastructure to research techniques to restore, replace and/or enhance affected populations using shellfish hatchery and aquatic farm-based technology.

HOW

A. Methodology

Utilizing concepts already developed for the Seward shellfish hatchery and the ADF&G Mariculture Technical Center, a feasibility analysis of the project will be conducted. Engineering and biological expertise will be retained to conduct the analysis. If construction funds are later approved, direct restoration, replacement and/or enhancement of bivalve shellfish will be accomplished via an onshore production hatchery operated by the private sector using technology developed at a State-operated research center. The combination of the two facilities is necessary to accomplish the overall production objectives of this project because of the lack of technology for indigenous species.

Analysis of similar projects in other areas will be conducted. The information will be incorporated into the project design.

Evaluation and feasibility determinations of potential projects for restoration, replacement or enhancement of bivalve shellfish in more remote areas, but of import to marine mammals, birds and fish will also be accomplished.

B. Coordination with other efforts

During the process of needs assessment and feasibility analysis, necessary coordination of efforts needs will also be determined and analyzed. At this time ADF&G is aware of efforts by Alaska native groups to establish a shellfish hatchery and an aquatic farm industry in the oil-affected area. This project is supportive of and will be coordinated with those efforts to insure maximum efficiency and utility.

ENVIRONMENTAL COMPLIANCE

Project compliance with the National Environmental Policy Act (NEPA) will be assessed during the feasibility phase. Until project design and specifications are finalized, specific NEPA requirements cannot be determined. Aquatic farms are addressed under a Corps of Engineers' general permit (GP 91-7). If facilities are constructed, a determination of compliance with the Alaska Coastal Management Plan (ACMP) will be required. The required State and Federal permits will be identified and incorporated into the project planning process.

WHEN

The feasibility study will occur this budget year (1/1/93 - 9/30/93). The clam restoration/enhancement demonstration project will occur next budget year.

If the project is determined to be feasible and appropriate budgets realized, construction of the facilities will begin in 1993 (Oil Year 6). The facilities will be operational in 1994.

BUDGET ($K)

	ADF&G
Personnel	$ 37.6
Travel	8.0
Contractual	2.0
Commodities	2.4
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 50.0
General Administration	5.7
Project Total	$ 55.7

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93022

Project Title: Evaluating the Feasibility of Enhancing Productivity of Murres by using Decoys, Dummy Eggs, and Recordings of Murre Calls to Simulate Normal Densities at Breeding Colonies Affected by the *Exxon Valdez* Oil Spill, and Monitoring the Recovery of Murres in the Barren Islands

Project Category: Manipulation and Enhancement; Restoration Monitoring

Project Type: Birds

Lead Agency: Department of the Interior - Fish and Wildlife Service

Cooperating Agencies: None

Project Term: January 1, 1993 to December 31, 1993

INTRODUCTION:

A. Background on the Resource/Service

Murres were the species of higher vertebrates most heavily affected by the oil from the *Exxon Valdez* spill. These diving seabirds have continued to demonstrate abnormal breeding behavior and low reproductive output at several sites since the spill. Factors that normally result in increased breeding success of common murres are breeding in high-density concentrations and laying eggs in synchrony with neighbors. Being one of a crowd apparently reduces vulnerability to avian predators. Within a colony, birds in groups that breed early tend to be more productive than birds breeding later, and older birds tend to breed earlier and be more successful than young birds. Prior to laying, murres tend to be flighty. In cases where a small percentage of murres in a cluster have begun to incubate before others have laid, incubators tend to leave their eggs exposed to predators, joining the flock when panic flights occur. Nevertheless, as more birds lay there is a tendency for incubators, now apparently feeling safer with company, to remain with eggs when non breeders flush.

For reasons not yet fully understood, murres at colonies affected by the oil have not yet resumed normal breeding schedules. Apparently a relatively small proportion of birds have laid their eggs earlier than others, and egg predation by gulls has been high. Perhaps a substantial proportion of experienced breeders were killed in the spill so that the population now is composed of mostly young, inexperienced breeders. It is not well understood how crucial the presence of older birds is to the social facilitation of normal breeding, and it is possible that a shortage of experienced breeders is causing the abnormal timing and poor reproductive success. Another contributing factor could be reduced breeding densities, since populations were reduced by mortality of adults. The use of tape-recorded murre calls, placement of decoys, and dummy eggs could stimulate more normal breeding behavior.

B. Summary of Injury

Over 100,000 murres were killed by the oil, and counts of birds at colonies within the trajectory of the oil indicated reduced populations after the spill. In the 3 years following the spill, remaining murres at colonies affected by the oil have initiated laying up to 1 month late, if they laid at all, and reproductive output has remained much lower than would be expected. Three consecutive years of poor reproductive success is very unusual based upon other studies.

C. Location

Experiments would be conducted at murre colonies in the Barren Islands, located between the Kenai Peninsula and the Kodiak Archipelago.

WHAT

A. Goal

The purpose of this project is to evaluate the feasibility of using artificial means to stimulate normal breeding behavior, as measured by nesting chronology and success, in murres at colonies affected by the oil spill.

B. Objectives

1. Determine the feasibility of enhancing the breeding success of murres by using decoys, dummy eggs, and recorded murre calls.

2. Monitor the recovery of murres in the Barren Islands.

WHY

A. Benefit to Injured Resources/Services

If murres can be induced to resume nesting at normal dates and if predation were reduced, reproductive success should increase. Increased recruitment from birds produced at injured colonies is likely to provide the best opportunity for populations to recover from reductions caused by the *Exxon Valdez* oil spill. Pioneering from other colonies outside the spill area is not likely to contribute in a major way in the near future since murres exhibit a high tendency to return to their natal colonies to breed, especially if there are available nest sites. There would be available nest sites at colonies with reduced populations. The monitoring phase is essential to understand the results of the feasibility study and to assess the recovery of the colony as a whole following the oil spill. The underlying causes of the abnormal nesting behavior (e.g., delayed laying) are not yet understood, and monitoring data will provide the basis for testing various hypotheses. Understanding the impact of the oil spill may make it possible to minimize damage in future spills by directing clean up efforts appropriately. Moreover, documentation of the response of murres in the aftermath of the oil spill will provide a basis for predicting the extent of the injury from future spills.

B. Relationship to Restoration Goals

This project meets the Trustee Council goal of restoring the spill area to its pre-spill condition by providing information that could be used to develop a management action. If one or more of the experimental treatments prove to be feasible, it should be possible to implement the technique extensively enough to generate improved success for a portion of one or more colonies. At least for these portions, more young should be produced and ultimately begin the process of recovery to former population levels.

HOW

A. Methodology

Treatment and control plots would be selected at East Amatuli Light Rock and on Nord Island in the Barrens. Decoys, and solar powered sound players would be placed in selected locations prior to the arrival of murres on cliffs. It would be necessary to use technical climbing gear to accomplish the objective on Nord Island. Time-lapse cameras would be used to monitor plots on E. Amatuli Rock because access after murres have laid would disturb the birds.

B. Coordination with Other Efforts

The two subprojects included here are complimentary. Data from the monitoring program will be used to assess the effectiveness of this project, and a single project leader would guide both projects.

ENVIRONMENTAL COMPLIANCE

This is a non-intrusive project which appears to qualify for categorical exemption under NEPA.

WHEN

Jan. - April 1993	Plan and arrange logistics (e.g., boat charters), recruit seasonal employees, develop detailed study protocols, assemble field gear, purchase equipment
May 1993	Place decoys, players, dummy eggs, and time-lapse cameras in field
Jun. - August 1993	Conduct field studies
Sept. - Oct. 1993	Analyze data
Nov. - Dec. 1993	Write progress report
Dec. 15, 1993	Submit progress report

BUDGET ($K)

	USFWS
Personnel	$ 84.5
Travel	9.0
Contractual	126.0
Commodities	15.0
Equipment	25.0
Capital Outlay	0.0
Sub-total	$ 259.5
General Administration	21.5
Project Total	$ 281.0

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93024

Project Title: Restoration of the Coghill Lake Sockeye Salmon Stock

Project Category: Restoration manipulation and enhancement

Lead Agency: Alaska Department of Fish and Game (ADF&G)

Cooperating Agencies: U.S. Forest Service (USFS)

Project Term: January 1, 1993 to December 31, 1997

INTRODUCTION

This project will attempt to restore the natural productivity of Coghill Lake through use of established lake fertilization techniques. Coghill Lake is located on the eastern side of Port Wells in the northwest region of Prince William Sound (PWS). The Coghill Lake sockeye salmon stock historically supported important sport and commercial fisheries. Returns have declined in recent years from a historical average of 250,000 to only 25,000 in 1991. Damage assessment studies on juvenile salmon suggest that the *Exxon Valdez* oil spill contributed to the decline of the Coghill sockeye stock. Salmon migration patterns indicate that juvenile sockeye smolt from Coghill Lake likely migrated through oil-contaminated areas in western PWS. Juvenile salmon similar in size to Coghill smolts utilized oiled nearshore nursery habitats. The growth and survival of juvenile salmon utilizing these habitats was reduced by oil contamination from the *Exxon Valdez* spill. The Coghill Lake stock is presently at extremely low levels. Action must be taken to restore the stock before any further decline occurs. The communities of Anchorage, Whittier, Valdez, and Cordova will benefit from this project. Coghill Lake sockeye have been heavily utilized by sport fishermen traveling from Whittier by boat and from Anchorage by air. Commercial fishermen from all of these communities have historically fished the Coghill Lake sockeye salmon stock. Restoration of Coghill Lake sockeye salmon will further improve management of important sockeye and chum salmon stocks returning to hatcheries in western PWS.

WHAT

The goal of this project is to restore the natural productivity of Coghill Lake and the resident sockeye salmon population through use of established lake fertilization techniques. The USFS will apply fertilizer to the lake each summer for five years (the USFS has already purchased the fertilizer from another funding source). The ADF&G will conduct limnological and fisheries studies needed to monitor and refine the fertilization program. These studies will focus on the effects of fertilization on primary and secondary production and the growth and survival of juvenile sockeye salmon in the lake. The ADF&G component of the project will achieve the following objectives each year:

1. Determine the response of lake nutrient levels, primary and secondary production, and plankton species composition to lake fertilization

2. Monitor changes in water temperature, light penetration, and water level in the lake

3. Determine the habitats utilized by sockeye salmon fry at various lifestages

4. Determine if fry prey composition, growth, and overwinter survival changes in response to lake fertilization

5. Estimate the effect of fertilization on lake carrying capacity and smolt-to-adult survival, and

6. Develop recommendations for refinement of the lake restoration program.

WHY

This project will restore an important natural resource and resource service in the *Exxon Valdez* oil-spill area. Restoration of the Coghill sockeye stock will further provide natural resource services to replace those once provided by other injured stocks. Damage assessment studies on juvenile salmon suggest that the *Exxon Valdez* oil spill may have contributed to the decline of the Coghill sockeye stock. Lake fertilization techniques have been successfully applied in Alaska and elsewhere to restore the productivity of sockeye salmon rearing lakes. The production of sockeye salmon populations is closely linked to the productivity of lakes where the fish rear for one to three years. The availability of food in rearing lakes determines the growth and size of smolts that emigrate to sea. Smolt size in turn determines ocean survival and subsequent adult returns. The fry food resources in Coghill Lake are currently very low. As a result, the lake cannot support large numbers of fry, and the smolts are very small. Fertilization is needed to increase lake productivity and boost fry food abundance until natural nutrient input from salmon carcasses is restored.

HOW

Limnological sampling will be conducted twice each month at two stations. Dissolved oxygen concentrations will be measured from the surface to a depth of 40 M. Eight liter water samples will be collected from the 1m stratum, chemocline, and monimolimnion. Replicate vertical zooplankton tows will be taken using a 153-μm mesh conical net. Water samples will be analyzed for the following parameters: conductivity, alkalinity, calcium, magnesium, turbidity, total iron, filterable reactive phosphorus, total phosphorus, nitrate and nitrite, total Kjeldahl nitrogen, total nitrogen, and reactive silicon. Yearly phosphorus loading will be estimated. Euphotic zone depth and algal standing crop will be estimated. Zooplankton abundance will be estimated from triplicate counts of organisms in 1 ml subsamples. Zooplankton dry weight and biomass will be estimated by regression analysis using body length measurements on 10 individuals from each taxa. Light penetration will be measured at 1 m increments from the surface to a depth equivalent to 1% of the subsurface light. Water temperature in the epilimnion and water level will be continuously monitored by electronic recorders moored at 5, 15, and 25m depth.

The habitats used by sockeye salmon fry in the lake will be determined from visual surveys, beach seine and tow net catches, and hydroacoustic surveys conducted in June, August, and October. A 70-Khz echosounder will be used to determine the vertical distribution of fry in the lake during the day and at night. Twenty samples (n = 10) of 10 sockeye salmon fry will be collected from various habitats during each survey for later analysis of stomach contents and otolith growth.

Stomach analysis will be conducted on sockeye fry (n = 200) collected during each survey. Prey items in the stomach will be identified to the lowest possible taxonomic level. Prey body weight will be estimated by regression analysis using body length measurements on 10 individuals from each taxa. Stomach contents' weight will be estimated by the product of abundance and mean body weight for each taxa. Chi-square analysis will be used to test for differences (P = .05) in the proportion of stomach contents weight in each taxonomic group between three time periods. Analysis of covariance will be used to test for differences (P = .05) in stomach contents weight between three time periods.

Otolith microstructure analysis will be conducted on sockeye fry (n = 200) collected during each survey. Thin sections of the otoliths will be prepared using established methods. A computer image analysis system will be used to collect data from the otoliths. A modified Fraser-Lee back calculation procedure will be used to reconstruct fish growth histories during weekly time periods. Weekly growth estimates obtained from otoliths will be regressed against weekly mean water temperatures obtained from electronic temperature recorders. Analysis of covariance will be used to test for differences (P = .05) in temperature-specific growth between Coghill Lake sockeye and fish fed an excess ration. Comparison of regression slopes will be used to determine if fry growth in Coghill Lake is limited by food abundance. This information will be used to monitor the growth response of the fish to fertilization and determine the carrying capacity of the lake.

The overwinter survival of juvenile sockeye will be estimated from fall fry and spring smolt population estimates. Fall fry population size will be estimated with a 120-khz echosounder towed along 10 randomly selected transects. A mid-water trawl will be used in conjunction with the hydroacoustic surveys to determine species composition, age, and size of fish targets. Sockeye salmon smolts emigrating from Coghill Lake will be enumerated using incline-plane traps. The traps will be operated continuously from early May through June. The catch efficiency of the traps will be determined by mark/recapture analysis. Age composition and size will be estimated from a sample of 40 smolts collected each day. Chi-square analysis and analysis of variance will be used to test for differences (P = 0.05) in age composition and smolt size between years, respectively. A representative sample of smolts will be coded-wire tagged to enable later estimation of smolt-to-adult survival in the commercial fishery. The combined results from these investigations will be compiled in an annual report describing the success of the fertilization program and recommending refinements to the methodology.

ENVIRONMENTAL COMPLIANCE

An environmental assessment has been conducted to evaluate the various options for rehabilitating Coghill Lake and the resident sockeye salmon population. The assessment has concluded that a program of lake fertilization is the most appropriate method for rehabilitation in this case. Final approval of the environmental assessment is expected before the end of 1992.

WHEN

This project will be conducted over a five-year period which corresponds to the generation time for Coghill Lake sockeye salmon. Lake fertilization is expected to elevate lake productivity until carcasses from adult spawners can once again contribute significantly to the nutrient load in the lake. Project activities will take place throughout each year (Table 1).

May - June 1993	Enumerate outmigrant smolts and estimate smolt age and size
June - October	Apply fertilizer each week and conduct limnological sampling
June, Aug., Oct.	Determine fish habitat use and sample for otolith and stomach analysis
October	Estimate fall fry population size using hydroacoustic techniques
June - October	Conduct laboratory analyses of limnological, otolith, and stomach samples
October - Dec.	Analyze data and prepare annual report.

BUDGET ($K)

	ADF&G	USFS	TOTAL
Personnel	$ 104.7	$ 10.2	$ 114.9
Travel	1.3	5.4	6.7
Contractual	8.8	7.0	15.8
Commodities	14.0	0.7	14.7
Equipment	21.5	0.0	21.5
Capital Outlay	0.0	0.0	0.0
Sub-total	$ 150.3	$ 23.3	$ 173.6
General	16.3	2.0	18.3
Project Total	$ 166.6	$ 25.3	$ 191.9

EXXON VALDEZ OIL SPILL PROJECT PROPOSAL

Project Number: 93025

Project Title: Montague Island Chum Salmon Restoration

Project Category: Restoration Manipulation and/or Enhancement

Project Type: Fish/Shellfish

Lead Agency: Department of Agriculture, Forest Service

Cooperating Agencies: Alaska Department of Fish and Game

Project Term: October 1, 1992 to September 30, 1997

INTRODUCTION

Prior to the 1964 earthquake, Montague Island streams accounted for nearly 8% of the total chum salmon production in Prince William Sound. Habitat alterations caused by the uplift, combined with a number of environmental and man induced factors, led to the virtual extirpation of chums on the Island. While some of the Island's historic chum producing streams are thought to have stabilized over time to once again support chum salmon populations, others have been slow to recover. Many of the historic chum salmon producing streams were also moderate- to lightly oiled by the *Exxon Valdez* oil spill, which caused further degradation of chum salmon habitat, particularly in the inter-tidal spawning areas. There is also a lack of sufficient brood source to reestablish numbers of chums within Montague streams through natural straying and reproduction.

WHAT

A. Goal

The goals of the project are as follows:

1. To reestablish wild stock populations of chum salmon on Montague Island and maintain the genetic diversity of wild chum salmon stocks in Prince William Sound.

2. To provide mitigation to identified injured species through habitat restoration. Once the project is established, it could contribute an estimated 300,000 pounds of salmon annually to the common property fishery. Approximately 10 miles of stream habitat will be rehabilitated to provide excellent habitat not only for fish species, but many wildlife species as well. In addition, at least one artificial spawning channel will be created.

WHY

Chum salmon were not specifically studied to determine injury from the oil spill. However, chum salmon spawn in the same inter-tidal habitats as pink salmon which were studied and determined to be injured. Enhanced habitat will provide off-site mitigation for the more severely damaged areas of the Sound and replace pink and chum salmon runs injured by the oil spill. Montague Island remains as one of the best Prince William Sound locations for improving wild chum salmon production.

This project offers a means of minimizing impacts on fisheries within Prince William Sound by increasing chum salmon production. This meets the goals of restoration Option Number 2 (Intensify Management of Fish and Shellfish) and 18 (Replace Fisheries Harvest Opportunities by Establishing Alternative Salmon Runs. It also provides a means for implementing Restoration Option Number 11 (Improve or Supplement Stream and Lake Habitats for Spawning and Rearing of Wild Salmonids). The Forest Service has expertise in a variety of established techniques for salmonid habitat improvement.

HOW

A four-year cooperative chum fry stocking effort in the Chalmers river was completed in 1990. This stocking proved successful when more than 1,000 chums were observed returning to Chalmers river. Pending favorable spawning success of these fish, stocking efforts will be expanded to include all historic chum salmon producing streams on Montague Island. Cooperative work with the Alaska Department of Fish and Game and Prince William Sound Aquaculture Corporation will continue to identify a source for brood stock and eggs will be collected for culture by 1994.

During 1991, spawning habitat surveys were conducted at fourteen of the seventeen top historic chum salmon producing streams, using the Chugach National Forest standard methods for quantifying fish habitat within streams. During FY 92, the habitat assessments will be completed in the remaining three of the seventeen historic chum streams, using the same standard methods. Based on the information collected, recommendations will be made on possible habitat restoration projects for several of the chum salmon streams. These projects will be further evaluated in FY 92 for hydrologic feasibility, using the slope area method (USGS standards for data collection and analysis) and aerial photo interpretation. Projects will include instream structures in the form of large boulders, and log placements, spawning channel development, and riparian habitat management.

During FY 92, riparian forest habitat will be evaluated at three stream sites in the Port Chalmers area of Montague Island, using the R10 standard methods for assessment of plant associations within forested areas. Based on the data collected, a riparian forest prescription will be developed for each of the three streams in the Port Chalmers area. Riparian forest management will include tree planting and tree thinning of selected zones. Beginning in FY 93, forest riparian areas in the Montague Strait area will be developed for each of these streams, and silvicultural techniques will be applied during FY 94-Fy 97. Through effective silvicultural management these areas can be rehabilitated to provide excellent habitat not only for fish species, but many wildlife species as well.

ENVIRONMENTAL COMPLIANCE

Given the scope of the proposed activities for FY 93, a categorical exclusion would be appropriate. However, larger scale projects such as spawning channel development or instream work using heavy equipment may be developed based on information collected during FY 92 and FY 93 field seasons. These type projects will require environmental assessments and therefore will be evaluated on a project by project basis. Any environmental compliance documents will be budgeted in the program for FY 94 and FY 95 if funding is approved to continue.

WHEN

During FY 93, boulder and log placement will be completed in three streams in the Port Chalmers area. In addition, riparian habitat rehabilitation of 25 acres will be completed at the same streams.

Also, during FY 93, riparian forest assessment will begin at five stream sites in the Montague Strait area. Riparian forest management will begin at those sites in FY 94 and be completed by FY 97.

As fisheries and hydrologic assessments are completed in FY 92, projects will be developed for implementation in FY 95-97. Prior to implementation, design and NEPA documentation will be necessary in FY 93-94.

BUDGET ($K)

	USFS
Personnel	$ 46.8
Travel	18.2
Contractual	0.0
Commodities	2.0
Equipment	7.5
Capital Outlay	0.0
Sub-total	$ 74.5
General Administration	7.0
Project Total	$ 81.5

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93026

Project Title: Fort Richardson Hatchery Water Pipeline

Project Category: Restoration Enhancement

Project Type: Fish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Project Term: January 1, 1993 to June 30, 1994

INTRODUCTION

Overescapement of sockeye salmon occurred in the Kenai River as a result of the Exxon Valdez oil spill. This has led to a dramatic reduction in smolt survival.

The Fort Richardson Hatchery currently uses only 50% of available fish rearing space because the existing water supply is limited. Construction of a water pipeline to connect the Fort Richardson Hatchery to the Municipal water system would allow immediate doubling of fish production. This increased production would then be used to provide alternative sport fishing opportunities as early as 1994, thus reducing the impact caused by the loss of the Kenai River sockeye salmon sport fishery.

The increased production of rainbow trout and king, coho, and pink salmon resulting from this project would be released into lakes and streams throughout Upper Cook Inlet and on the Kenai Peninsula providing direct alternative sport fishing opportunities for severely impacted fishermen. Completion of this project would also increase hatchery dependability and reduce cost per unit of production so all areas served by the Fort Richardson Hatchery would indirectly benefit.

WHAT

The goal of this project is to provide alternative sport fishing opportunities to reduce the social and economic impact of the loss of the Kenai River sockeye salmon sport fishery. As a result of the expected closure of the Kenai sockeye salmon fishery it is estimated that at least 100,000 angler days will be lost each year. Increased production at the Fort Richardson Hatchery would ameliorate this loss.

Fish production objectives are as follows:

Species	Number	Size	Potential Angler Days
Rainbow Trout	250,000	100.0 g	50,000
King Salmon	800,000	15.0 g	25,000
King Salmon (catchables)	50,000	100.0 g	20,000
Silver Salmon	600,000	20.0 g	32,000
Pink Salmon	2,000,000	0.15 g	15,000

WHY

The decrease of sport fishing opportunities for sockeye salmon on the Kenai River would have significant social and economic impact on the Cook Inlet area. Over 335,000 angler days were spent in pursuit of salmon on the Kenai River in 1990. A major portion of this effort was directed toward sockeye salmon with an average annual harvest of 107,500 sockeye salmon valued at approximately $10,000,000.

The extremely low number of out-migrant smolts in 1991 and 1992 strongly suggests that sockeye salmon production in the Kenai River will be affected. It is possible that sockeye salmon fishing will be closed for a number of years starting in 1993. However, if immediate action is taken, the Fort Richardson Hatchery water pipeline project would provide alternative sport fishing opportunities during the years the Kenai River loses are expected to be most severe and would significantly reduce these impacts.

HOW

The main project objective would be met by constructing a water delivery system connecting the Municipal Water Utility with the hatchery. The main elements of this system include a cold water line running directly from the Municipal Water Plant to the hatchery and a second line that will provide heated water (via heat exchangers in the Sullivan Power Plant which is adjacent to the Water Plant) to accelerate fish growth.

An engineering feasibility study was completed in 1991 by F. Robert Bell and Associates. This study determined that this project was both technically and economically feasible. In a separate study the Anchorage Economic Development Corporation determined that this project would have a benefit/cost ratio of 2.8:1.

Fish cultural methodology will follow well established, standard Department of Fish and Game and FRED Division procedures and policies.

In the Fall of 1992, a peer review synthesis meeting will examine the proposed benefits and associated potential ecological risks of wild versus hatchery fish.

Construction permits will be required. They will be the responsibility of the contractor. The hatchery is on a military reservation. Access permits to the reservation may be required. This project may be required to meet requirements under Clean Water Act.

WHEN

If this project is approved by the Trustee Council, a minor amount of preliminary work would begin immediately. In cooperation with the Municipality we would solicit proposals for engineering and design for review so that an engineering firm could be hired as soon as an EIS was completed and funds were available. Major milestones are as follows:

Fall 1992	Project peer review synthesis meeting
January 1993	Environmental Impact Statement
January - March 1993	Public Review of EIS
March 1993	Contingent upon favorable public review and concurrence of the Trustee Council, design and construction funding is approved
March -- June 1993	Project design and engineering
April 1993	Collect rainbow trout eggs
June 1993	Award construction contract
July 1993	Collect king salmon eggs
September 1993	Collect coho eggs
January 1984	Water system on-line to support additional fish
June 1984	Release fish

ADDENDUM

1. The Municipality of Anchorage (which strongly supports this project) has an easement for this pipeline route; the corridor already contains an existing powerline.

2. After the pipeline is completed, the program will be partially operated by federal funding as it currently is; consequently, the NEPA public review process has been and will be followed before fish are released. This review process has been incorporated into the development of the ADF&G "Statewide Stocking Plan for Recreational Fisheries" (copy available upon request from FRED Div., Alaska Dept. of Fish and Game, 333 Raspberry Rd., Anchorage, AK 99518-1599). This document has been scheduled for review and updating in 1993. In addition, before any new release location is approved, it is also subjected to another ADF&G review process that addresses fish genetics, fish disease and fisheries management concerns (Fish Transport Permit or FTP process). Thus all releases are subject to both the federal NEPA and state FTP processes currently and will be in the future.

BUDGET ($K)

	ADF&G
Personnel	$ 30.0
Travel	0.0
Contractual	3,500.0
Commodities	0.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 3,530.0
General Administration	87.0
Project Total	$ 3,617.0

EXXON VALDEZ OIL SPILL PROJECT PROPOSAL

Project Number: 93028

Project Title: Restoration and Mitigation of Wetland Habitats for Injured Prince William Sound Fish and Wildlife species

Project Category: Restoration manipulation and/or enhancement

Project Type: Birds/mammals/fish

Lead Agency: Department of Agriculture, Forest Service

Cooperating Agencies: None

Project Term: January 10, 1993 to September 30, 1997

INTRODUCTION

Past events associated with the 1964 earthquake drained the 250 ha lake within the San Juan Bay Drainage on Montague Island. Since the uplift, periodic flooding occurs during periods of high, nearly continues rainfall or in combination with snow melt. With this altered water regime the uplifted lake is undergoing a rapid succession from a sedge/grass community to a spruce/hemlock community. At the same time, downcutting of the San Juan Creek has changed the character of the stream along a major portion of its course through the former lake bed. Pool habitats important for anadromous fish rearing have been reduced and adjacent sedge meadows are undergoing plant succession to shrub and forest communities. Opportunities exist for long term improvement of PWS waterfowl, furbearer and anadromous fish habitat within the stream and in the adjacent wet meadow zones.

WHAT

A. Goal

The purpose of this project is to restore the wetland habitats used by waterfowl, anadromous fish and furbearing species impacted by the oil spill in Prince William Sound.

B. Objectives

1. Maintain a wetland component by flooding the uplifted lake bed and reversing succession from a forested habitat type to an early succession grass/sedge community.
2. Create pools and ponds in riparian and flood plain areas to restore associated aquatic vegetation.

WHY

This project has the potential to improve habitat for waterfowl and anadromous fish by creating

wetlands. Some intertidal wetlands were injured by the *Exxon Valdez* oil spill. This project would provide an equivalent resource replacement for those injured wetlands. This project will implement restoration option number 11 (improve or supplement stream and lake habitats) and number 25 (protect or acquire upland forest and watersheds, established or extend buffer zones for nest birds) identified in the Restoration Framework Document.

HOW

This project will be accomplished through the following sequence of events:

1. Feasibility

This consists of conducting the following analyses:

A. Hydrologic analysis to determine subsurface flow regimes
B. Soils analysis to determine soils types and,
C. Channel morphology analysis. Monthly surveys will determine wildlife use of the area from spring through fall.

2. Inventory Existing Habitat

This will be accomplished by low-level aerial photography of San Juan Bay area. This will be coordinated with proposal number 29854. Vegetation surveys will be conducted to determine existing plant community type.

3. Project Design

After feasibility and inventory studies are completed, vegetation objectives will be established specific to the targeted species and engineering design will be completed to meet those objectives.

4. Environmental Analysis

An Environmental Analysis will be conducted prior to a decision for any action. The scope of the Environmental Analysis will depend on the result of public scoping and issues developed.

5. Implementation

If the decision is made to implement the recommended engineering design after the Environmental Analysis this project could be accomplished over the following three years.

6. Monitoring

Monitoring will continue for five years after completion of the project to determine if the vegetation objectives were met.

ENVIRONMENTAL COMPLIANCE

Given the scope of this project an Environmental Analysis will be required. The first year's work is design work only and is categorically exempt from formal documentation in an environmental analysis.

WHEN

The following is the proposed schedule:

Jan. 1 - Feb. 15, 1993	Hydrologic Analysis
June 1 - June 15, 1993	Fly for Low Aerial Photography
June 15 - June 30, 1993	Soils Analysis
April 1 - Oct. 1, 1993	Wildlife Surveys
June 1 - June 30, 1993	Engineering Data Collection
Sept.1 - Sept. 30, 1993	Project Design
Jan. 1 - April 1, 1994	Environmental Analysis
Jan. 1, 1994 - Dec. 1998	Implementation (project construction)
Jan. 1, 1994 - Dec. 1998	Monitoring

BUDGET ($K)

	USFS
Personnel	$ 44.1
Travel	18.0
Contractual	5.0
Commodities	0.0
Equipment	8.0
Capital Outlay	0.0
Sub-total	$ 75.1
General Administration	7.0
Project Total	$ 82.1

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93029

Project Title: Prince William Sound Second Growth Management

Project Category: Restoration Manipulation and/or Enhancement

Project Type: Birds/Mammals

Lead Agency: U.S. Department of Agriculture, Forest Service

Cooperating Agencies: None

Project Term: January 10, 1993 to September 30, 1997

INTRODUCTION

The Prince William Sound area has several watersheds on National Forest Lands where timber harvest occurred in the early 1970's. These harvest areas have removed a portion of the old-growth vegetation in the *Exxon Valdez* oil spill area. The second-growth vegetation present on these areas can now be managed to improve habitat for certain wildlife and fish species and accelerate the return to old-growth vegetative conditions. Habitat for old-growth dependent oil spill injured species such as river otter, marbled murrelet, and harlequin duck can therefore be improved.

WHAT

A. Goal

The purpose of this project is to provide mitigation through habitat enhancement to identified injured wildlife species in Prince William Sound.

B. Objectives

1. Maintain understory vegetation components throughout the successional stages of second growth.

2. Increase successional trends in key wildlife habitat areas to develop old growth structure. Approximately 2,500 acres of second growth habitat will be evaluated for enhancement opportunities.

WHY

This project has the potential to improve habitat for pink and chum salmon, harlequin duck, marbled murrelet river otter and bald eagle. These species were injured by the *Exxon Valdez* oil spill. This project falls within the category of habitat protection and acquisition and manipulation

of resources since the objective is to enhance habitats for injured species. This project will implement restoration option number 11 (improve or supplement stream and lake habitats) and number 25 (protect or acquire upland forests and watersheds, established or extend buffer zones for nesting birds).

HOW

This project will be accomplished through the following sequence of events:

1. Inventory existing data base.

   This consists of compiling existing data on Prince William Sound second growth, establishing date of harvest, and entering GIS data base.

2. Inventory existing habitat.

   This will be accomplished by low level aerial photography of all second growth sites and field sampling to determine existing vegetation community type and site potential.

3. Define vegetation objectives.

   After the second growth areas have been described, vegetation objectives will be established specific to the targeted injured species.

4. Site Prescription

   Prescriptions will be developed identifying recommended treatment to meet the vegetation objectives. Treatment options could consist of pre-commercial thinning at varied spacing to maintain understory vegetation throughout the rotation.

5. Environmental Analysis

   An environmental analysis will be conducted prior to a decision as required by the National Environmental Policy Act.

6. Implementation

   If the decision is made to implement the recommended treatment after the Environmental Analysis this project could be accomplished over the following three years.

ENVIRONMENTAL COMPLIANCE

Given the scope of this project an environmental analysis will be required. This years proposed work is survey and project design work only which is categorically exempt from documentation in an environmental analysis.

WHEN

The following is the proposed scheduled:

Jan. 1 - Feb. 15, 1993	Inventory Existing Data Base
June 1 - June 15, 1993	Develop Low Aerial Photography
June 1 - Sept. 1, 1993	Inventory Habitat
Sept. 1, - Sept. 15, 1993	Define Vegetation Objectives
Sept. 15 - Sept. 30, 1993	Write Site Prescriptions
Nov. 1, - March 1, 1994	Environmental Analysis
Contract 1994-1997	Implementation of Prescriptions

BUDGET ($K)

	USFS
Personnel	$ 34.2
Travel	6.0
Contractual	10.0
Commodities	0.0
Equipment	6.0
Capital Outlay	0.0
Sub-total	$ 56.2
General Administration	5.8
Project Total	$ 62.0

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93030

Project Title: Red Lake Restoration

Project Category: Restoration, Manipulation and/or Enhancement

Project Type: Fish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Project Term: January 7, 1993 to September 30, 1997

INTRODUCTION

Red Lake, located on the southwest side of Kodiak Island, has historically been one of the most consistent producers of sockeye salmon for Kodiak's commercial purse seine fishermen. The Department of Fish and Game's annual escapement goal for the system ranges from 200 to 300 thousand. Since 1980, the catch has ranged from 25,000 to 1.5 million with an average of 450,000. This fishery has had an average annual value to fishermen of about $2.2 million.

Careful management of the number of spawning fish is required to maintain this fishery at a high level. Young sockeye salmon spend at least their first year of life (up to 3 years) living and growing in lakes where they rely on microscopic-sized animals (plankton) for food. These animals, in turn, graze on tiny plants. If too many adult salmon spawn in the lake system, an overabundance of the young sockeyes will deplete their limited food source before they migrate to sea. When this happens, large numbers of young salmon die, survivors grow more slowly and smaller numbers migrate to the ocean to mature. So, large numbers of spawners in one year may result in an unusually small run in the next cycle.

In 1989, as a result of the *Exxon Valdez* oil spill, commercial salmon fishing was closed over most of Kodiak Island waters. The closure resulted in an escapement of 768,000 sockeye salmon into Red Lake, a 2.5 fold increase over the maximum desired. Data gathered showed low survival for the 1989 escapement year. Surveys showed low numbers of juveniles in the lake in the fall of 1990; and, in the spring of 1991, reduced number of migrant smolts were observed. This means that very low numbers of sockeye will return as four-, five-, and six-year olds in 1993, 1994, and 1995. It is anticipated that adult salmon return may be depressed to the extent that the escapement may fall below 150,000. If this happens during one or more of these years, supplemental production would be implemented immediately to restore the population.

If immediate actions are taken, we will have the capability to restore Red Lake sockeye salmon production. As a result of the oil spill, sockeye salmon returns are expected to be so low in 1993 and 1994 that minimum spawning population goals will not be achieved. If this were to happen, the productivity of this lake would be underutilized, and the fisheries would be seriously impacted in future years.

Restoration will involve taking a total of six million early run sockeye salmon eggs at Red Lake by August 30 each year. The eggs will be transported and incubated in a module at the Pillar Creek Hatchery in Kodiak. Fry will be reared until emergence and then released into Red Lake in May of each year.

The commercial purse seine fleet will benefit from this project as well as all associated fishing communities on Kodiak Island. The Red Lake sockeye fishery has historically provided a stable, significant source of income for Kodiak fishermen, consequently, restoration of this system is extremely important.

WHAT

Contingent upon the finding of a sockeye salmon synthesis meeting, this project is intended to supplement natural sockeye fry production in Red Lake with fry plants if escapement levels fall below minimum levels.

Project objectives are as follows:

1. Increasing the incubation and rearing capacity of Pillar Creek Hatchery to support additional Red Lake eggs and fry.

2. Collecting six million early run Red Lake sockeye eggs, beginning in 1993 and continuing through 1995, contingent upon Red Lake escapement falling below the minimum escapement goal of 150,000 by August 1.

3. Incubation of six million Red Lake sockeye eggs at Pillar Creek Hatchery with 90% survival from green to eyed eggs.

4. Rearing of approximately 5.4 million Red Lake sockeye fry at Pillar Creek Hatchery to the size of .25 grams with 90% survival.

5. Evaluating freshwater survival and the success of hatchery fry plants, by thermally marking otoliths of fry prior to stocking into Red Lake.

6. Stocking of approximately 4.9 million fed fry (.25 gram) into Red Lake with timing parallel to the period of wild stock recruitment.

7. Producing approximately 146,000 adult red salmon from annual fry plants (3% fry to adult survival).

WHY

The project restoration activity will result in restoration by allowing wild and cultured fry to enter the lake at the same period. A forecasted survival rate of 3% from fry to adult could result in 146,000 adults returning each year to the Red Lake system.

This project should be funded because immediate actions are needed to restore Red Lake sockeye salmon production if expected damage from the oil spill is realized. This damage is expected to result in weak return in 1993 and 1994, when minimum escapement goals may not be achieved. If this happens, the productivity of the lake would be underutilized and the fishery and economy would be seriously impacted in future years.

HOW

Pillar Creek hatchery will be modified by the addition of an incubation module and 24 Kitoi box incubators to allow receipt of Red Lake eggs. Additional raceways will be installed to short-term rear emergent fry. Net pens, frames, seines and other egg take gear will be purchased and staged in Kodiak in July each year, after the initial purchase in 1992. If escapement into Red Lake is below 150,000 by August 1 (beginning in 1993) an egg take will proceed. Eggs will be collected, with a goal of 6,000,000, in August and transported to Pillar Creek Hatchery for incubation. During incubation, between the eyed and hatched stages, eggs will b marked by thermally induce otolith banding. Fry will be reared in aluminum raceways until reaching a weight of.25 grams and then will be transported by float plane for release into Red Lake. Smolt samples will be collected via NRDA #27 smolt enumeration project and checked for marks to determine hatchery fry contribution and project success.

This project will be operated in close association with NRDA Study #27 which monitors the effects of the 1989 overescapement on the productivity of Red Lake. This monitoring will assist with forecasting returns and, in association with the ADF&G weir, will help coordinate this project's restoration activities. Also, Pillar Creek Hatchery enhancement and rehabilitation activities in other areas of Kodiak Island will provide technical assistance to this project.

Red Lake lies within the boundaries of the Kodiak National Wildlife Refuge. Other projects of this type on refuge lands have required an environmental analysis (EA) and a "finding of no significant impact." The EA will be completed prior to implementation of this project.

WHEN

July 1992 -	Jan. 1993	Purchasing incubators, raceways, pipeline, and plumbing
Jan. 1993 -	Feb. 1993	Purchasing egg take supplies
Nov. 1992 -	Dec. 1992	Annual project status report
Mar. 1993 -	June 1993	Preparation of PCH for receiving of eggs; incubator, raceways, and pipeline installation, egg take camp set up, supply ordering
July 1993 -	Aug. 1993	Egg take site preparation
Aug. 1993 -	Sep. 1993	Red Lake sockeye egg take and site breakdown
Nov. 1993 -	Dec. 1993	Annual project status report
Aug. 1993 -	May 1994	Red Lake sockeye incubation and rearing
May 1994 -	May 1994	Red Lake stocking

Repeat above sequence until end of project.

BUDGET ($K)

	ADF&G
Personnel	$ 32.3
Travel	0.9
Contractual	7.2
Commodities	14.8
Equipment	16.6
Capital Outlay	0.0
Sub-total	$ 71.8
General Administration	5.4
Project Total	$ 77.2

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93031

Project Title: Red Lake Mitigation for Red Salmon Fishery

Project Category: Restoration, Manipulation and/or Enhancement

Project Type: Fish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Project Term: January 10, 1993 to September 30, 1996

INTRODUCTION

Red Lake, located on the southwest side of Kodiak Island, has historically been one of the most consistent producers of sockeye salmon for Kodiak's commercial purse seine fishermen. The Department of Fish and Game's annual escapement goal for the system ranges from 200 to 300 thousand sockeye salmon. Since 1980, the catch has ranged from 25,000 to 1.5 million with an average of 450,000. This fishery has had an average annual value to fishermen of about $2.2 million and has reached as high as $10 million.

Careful management of the number of spawning fish is required to maintain this fishery at a high level. Young sockeye salmon spend at least their first year of life (up to 3 years) living and growing in lakes where they rely on microscopic-sized animals (plankton) for food. These animals, in turn, graze on tiny plants. If too many adult salmon spawn in the lake system, an overabundance of the young sockeyes will deplete their limited food source before they migrate to sea. When this happens, large numbers of young salmon die, survivors grow more slowly and smaller numbers migrate to the ocean to mature. So, large numbers of spawners in one year may result in an unusually small run in the next cycle.

In 1989, as a result of the *Exxon Valdez* oil spill, commercial salmon fishing was closed over most of Kodiak Island waters. The closure resulted in an escapement of 768,000 sockeye salmon into Red Lake, a 2.5 fold increase over the maximum desired. Data gathered showed low survival for the 1989 escapement year. Surveys showed low numbers of juveniles in the lake in the fall of 1990 and 1991; and in the spring of 1990, 1991, and 1992 reduced numbers of migrant smolts were observed.

The 1989 brood year failure could result in very low returns of sockeye salmon in 1993, 1994, and 1995. Minimum escapements may not be reached resulting in fishery closures and the purse seine fleet being displaced to other fishing areas. Fishing will not return to normal until several years after the numbers of outmigrating smolts have returned to normal. Therefore, if outmigrating smolt numbers are within the normal range in June and July of 1993, it will not be necessary to continue this project, though approved, because adequate numbers of adults for escapement goals and fisheries will be expected to return in the same years as the mitigation

fisheries this project would create. Conversely, until outmigration has been demonstrated to have returned to normal, it will be necessary to produce hatchery smolts for a mitigation fisheries.

This project will be undertaken at Kitoi Bay Hatchery where early run sockeye will be net pen-reared in brackish water for accelerated growth and released as age zero smolt. Returns from smolt releases will provide a fishery in Northeast Afognak district. The commercial purse seine fleet and associated business communities of Kodiak Island will have an opportunity to benefit from this project. Village residents of Afognak Island and other areas will also have increased subsistence fishing opportunities. The expected return of 4.8 million smolt released annually will be 100,000 sockeye. At a value of $1.00/pound and 5-pound average, the total value of the program is $500,000.

WHAT

A. Goal

Contingent upon the results of the sockeye salmon synthesis meeting, this project will be funded to provide an alternative commercial fishery to mitigate the impact of lost fishing opportunities as a result of very low returns of sockeye salmon in 1996 and beyond.

B. Objectives

The objectives of this project are as follows:

1. Modify existing incubation modules at Kitoi Bay Hatchery for receiving Afognak Lake sockeye eggs.

2. Collect 6 million early run sockeye salmon eggs from Afognak Lake and transport them to Kitoi Bay Hatchery.

3. Increase sockeye fry/smolt rearing capabilities at Kitoi Hatchery to accommodate 5 million fry/smolt.

4. Mark 10 - 15% of fry prior to net pen rearing for evaluation of returns, imprinting success and possible straying.

5. Net pen rear fry/smolt in brackish water to a target size of 4-5 grams and release by June 30.

6. Evaluate growth, diet and behavior of age zero smolt releases at Kitoi Bay until migration is complete.

7. Evaluate survival, imprinting and straying of returning adults in 1996 and 1997 by operating weirs at Little Kitoi, Paul's Bay; sampling at Afognak Lake weir; sampling at Little Afognak Lake.

WHY

If immediate actions are taken, alternative commercial sockeye salmon fishing opportunities can be provided beginning in 1996. The focus is to develop alternative fisheries in other areas where returns would be most manageable and wild stocks would be least affected. This proposal will mitigate the impact of the *Exxon Valdez* oil spill on future Red Lake commercial sockeye fisheries.

The Trustees should fund this project because immediate action is needed to offset the fishery losses due to overescapement of the 1989 brood adults.

HOW

Kitoi Bay Hatchery will be modified by the addition of an incubation module and incubation water disinfection capability. Six million early run Afognak lake sockeye eggs will be collected in August under sockeye culture guidelines, and transported by float plane to Kitoi Hatchery for incubation. After emergence and ponding in freshwater troughs, 10 -15% of the total sockeye fry will be marked by ventral fin clipping, prior to rearing in brackish water net pens. Marking quality will be monitored to assure valid marks. Following seawater challenge tests, fry (fingerlings) will be ponded into net pens in Little Kitoi Bay and reared to achieve 4 - 5 gram smolt with growth rate monitored on a weekly basis. Smolt will be released into Little Kitoi Bay after achieving target size and timed to parallel Afognak smolt outmigration timing. Once released, smolt movements will be monitored, samples will be collected for stomach content analysis and additional growth information. To evaluate returns from smolt releases as well as imprinting, a weir will be operated at Little Kitoi where escapement will be enumerated and age, sex and length data collected. Returning adults will be examined for marks. Also, the commercial harvest will be sampled in the same manner. Returning sockeye at Paul's Bay, Little Afognak, and the parent system at Afognak Lake will be sampled to assess possible straying. Paul's Bay will be weired and returns will be examined for marks as well as age, sex and length data collected. At Little Afognak, samples will be collected by beach seining and post spawning surveys. Samples will be collected and examined for marks at the Afognak River weir currently operated by ADF&G.

This project will be coordinated with NRDA F/S 27 which will continue damage assessment of Red Lake. Information from this study will determine the long term effects of overescapement, and the length that mitigation for fishing loss will be necessary. Also, a current zero check sockeye program in place at Kitoi will provide technical assistance in the mitigation project.

ENVIRONMENTAL COMPLIANCE

The following steps will be taken to comply with environmental regulations:

1. Completion of General Waterway/Waterbody application to be submitted to Habitat Division of ADF&G for the weirs at Little Kitoi and Paul's Bay.

2. Completion of Coastal Zone Consistency Review Questionnaire to be submitted to State of Alaska for both weired systems.

WHEN

Jan. 3, 1993 - Feb. 1, 1993	Permitting (FTP, Habitat)
Jan. 3, 1993 - Mar. 31, 1993	Kitoi modifications (incubation, rearing)
June 1, 1993 - July 1, 1993	Egg take preparation and supply orders
July 15, 1993 - Aug. 1, 1993	Egg take at Afognak Lake (6 million eggs)
Aug. 1, 1993 - Mar. 1, 1994	Incubation of eggs at Kitoi
Mar. 1, 1994 - Apr. 15, 1994	Marking of fry
Apr. 15, 1994 - May 30, 1994	Net pen rearing of fry
June 1, 1994 - June 15, 1994	Smolt released in Little Kitoi Bay
May 1, 1994 - Aug. 31, 1994	Adult weirs installed and operated at Little Kitoi and Paul's Bays
Sep. 1, 1994 - Oct. 1, 1994	Report writing

BUDGET ($K)

	ADF&G
Personnel	$ 59.4
Travel	0.7
Contractual	5.1
Commodities	16.8
Equipment	62.4
Capital Outlay	0.0
Sub-total	$ 144.4
General Administration	9.3
Project Total	$ 153.7

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93032

Project Title: Pink and Cold Creek Pink Salmon Restoration

Project Category: Restoration, Manipulation and/or Enhancement

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Project Term: January 10, 1993 to September 30, 1994

INTRODUCTION

This project will target Pink Salmon stocks (will also indirectly target Coho salmon at Cold Creek) at Cold and Pink Creeks on Afognak Island (see map). Pink Creek drains into Afognak River which enters Afognak Bay on southeast Afognak Island. Cold Creek drains into Danger Bay, adjacent to Duck and Izhut Bays on northeast Afognak Island. Restoration Study 105 surveyed these systems in 1992 to determine fishpass feasibility. A falls blocks pink salmon from reaching a potential spawning area in Pink Creek. Cold Creek has a steep gradient that blocks upstream migration at low to moderate water periods. Spawning area above the barrier at both Pink and Cold creeks has been determined to be of good to excellent quality and in sufficient quantity to support 3,000 and 9,000 spawners, respectively. Both systems currently have limited Pink Salmon production due to these barriers preventing access to spawning areas. Escapements to each of these systems have been limited to several hundred spawners each year.

Afognak Bay, Izhut Bay and other areas on northeast Afognak as well as Shuyak Island were oiled in 1989 and oil still remained in these areas in 1990. Resource damage assessment was not conducted in these areas, however, in Prince William Sound, damage to pink salmon eggs and juveniles has been documented under similar conditions of oil contamination.

This project will be undertaken at Pink Creek (252-342) and Cold Creek (252-331) which are located on Afognak Island. The benefits from this project will be realized by increased Pink (and Coho) returns to these systems, providing up to 17,000 (pinks) for commercial and subsistence harvest. The villages of Port Lions, Ouzinkie, and the City of Kodiak will benefit economically from this project through direct fishery receipts and all associated fisheries business enhancement.

WHAT

A. Goal

The goal of this project is to increase Pink salmon spawning capability, and overall pink salmon (and coho) returns, by enhancing fish passage above barriers in Pink and Cold creeks.

B. Objectives

The objectives of this project are as follows:

1. Evaluate pink salmon escapement and spawning distribution in Cold and Pink creeks.

2. Bypass barriers in Cold and Pink creeks by installing steeppass sections or cutting channels in substrate.

3. Evaluate fish passage through barrier bypasses by conducting peak spawning surveys.

WHY

This project will be an economical way to increase wild Pink and Coho stocks in specific areas contaminated by oil or areas in close proximity to impacted areas. In PWS, Pink salmon eggs and fry were injured by oil contamination. These injuries were documented in PWS. In the waters near Afognak and Shuyak Islands, similar impacts may have occurred. Since a significant amount of spawning area is presently unavailable to Pink (and Coho) salmon on these systems due to barrier falls, this project will realize a measurable benefit by making these areas available to spawning Pink salmon.

HOW

Initially prior to construction, a peak spawning survey would be conducted to define peak salmon distribution in Pink and Cold creeks. Bypass construction materials would be staged at each project site. Construction would require steeppass sections resulting in a 15-foot rise to bypass the barrier falls at both Cold and Pink creeks. Channels also would be cut leading into the upstream end of the steeppasses. Water diversion structures such as gabions, reinforced with steel pipe and rebar, would divert water into the channels and steeppasses. Cables would be anchored into the rock substrate to secure the steeppasses. This project would be evaluated by stream surveys during the peak pink salmon spawning period.

This project will be directly related to previous feasibility work conducted through Restoration Project 105. Feasibility stages of this project were defined through R105. In addition, Alaska Department of Fish and Game, FRED Division, in cooperation with Kodiak Regional Aquaculture Association operates other fishpass projects on Afognak Island. Efforts for this project will be assisted through technical assistance and offered by these ongoing projects.

MATCHING ELEMENTS

The Department of Fish and Game has already purchased from other funding sources the needed steep pass components which are valued at approximately $70,000.

ENVIRONMENTAL COMPLIANCE

The following steps will be taken to comply with environmental regulation:

1. Completion of General Waterway/Waterbody application to be submitted to Habitat Division of ADF&G for both Pink and Cold Creeks.

2. Completion of Coastal Zone Consistency Review Questionnaire to be submitted to State of Alaska for both creeks.

3. Compliance with any environmental land use regulations imposed by Afognak Natives (land owners) will be strictly adhered to.

WHEN

Nov. 1, 1992	-	Dec. 1, 1992	DSP
Jan. 1, 1993	-	Jan. 15, 1993	Habitat application Equipment order, steeppass
Feb. 15, 1993	-	Feb. 30, 1993	Fabrication Stage steeppass section
Mar. 15, 1993	-	Mar. 30, 1993	at sites Construction, steeppass
July 1, 1993	-	Aug. 1, 1993	installation
Aug. 15, 1993	-	Aug. 31, 1993	Peak spawning survey
Nov. 1, 1993	-	Dec. 1, 1993	Report writing Follow up construction
July 1, 1994	-	Aug. 15, 1994	modification
Aug. 1, 1994	-	Aug. 31, 1994	Final peak spawning survey
Nov. 1, 1994	-	Dec. 1, 1994	Final report writing

BUDGET ($K)

	ADF&G
Personnel	$ 21.3
Travel	0.0
Contractual	3.6
Commodities	2.3
Equipment	5.4
Capital Outlay	0.0
Sub-total	$ 32.6
General Administration	3.5
Project Total	$ 36.1

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93033

Project Title: Harlequin Duck Restoration Monitoring Study in Prince William Sound, Kenai, and Afognak Oil Spill Areas

Project Category: Restoration Monitoring

Project Type: Birds

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: National Park Service; U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration; National Marine Fisheries Service, Auke Bay Laboratory; Alaska Department of Natural Resources

Project Term: January 10, 1992 to September 30, 1995

INTRODUCTION

The *Exxon Valdez* oil spill (EVOS) significantly affected Harlequin Ducks (Histrionicus histrionicus). Not only was there direct mortality of at least 200 Harlequins in Prince William Sound (PWS), but there has been a nearly complete reproductive failure of residents of the western PWS oil spill area from 1990 to 1992. (No study was conducted in 1989). This is a significant and unexpected long-term effect. Because some Harlequins spend their entire lives in the oil spill area, where they breed, feed, and overwinter, it is possible to detect and study this impact of EVOS. (Non-resident Harlequins and other seaducks that over-winter in oiled areas may be similarly affected, but because they breed in areas remote from the spill, it is impractical to study them.)

Harlequins are intertidal feeding diving ducks. The Harlequin Duck population in the Prince William Sound, Kenai, and Afognak areas contains both residents and non-resident migrants. The residents breed along forested streams within a few kilometers of saltwater, molt in secluded bays and lagoons, and roost on offshore rocks. Broods are found with hens on saltwater in summer. Non-resident Harlequin Ducks which winter on the south coast of Alaska breed elsewhere on mountain streams. They arrive in the south coastal area in October and depart in May. Harlequin Ducks return to the same breeding and wintering areas year after year.

Breeding Harlequin Ducks were formerly distributed throughout PWS, including the oil spill area, with broods commonly observed in shoreline habitats (Isleib and Kessel, 1973; Isleib, pers. comm.). Subsequent to the oil spill, Harlequin Ducks have failed to breed in western Prince William Sound, and their population has declined in the oil spill area.

In contrast, these ducks reproduced normally in unoiled areas of Prince William Sound, and their population has remained stable. A few broods were found on the periphery of the EVOS area in 1991-92.

The reproductive failure of Harlequin Ducks in the oil spill area is postulated to be a chronic effect of petroleum exposure through contaminated intertidal food. Blue mussels (Mytilus) appear to be the most likely source of contamination. They are well known to concentrate and hold pollutants in their tissues. Restoration Study #103 has documented high concentrations of polynuclear aromatic hydrocarbons (PAHs) in mussel flesh, byssal thread mats, and underlying substrates in western PWS in 1992. Because Harlequin Ducks consume entire mussels, ingesting petroleum hydrocarbons in mussel tissue, on the shell surface, and in attached byssal threads and sediment, Harlequin Ducks collected in 1989-90 in western PWS and SW Kodiak contained oiled food items in their gullets and petroleum residues in liver tissue and bile. Experimental studies have demonstrated that single small doses of petroleum can cause reproductive failure in some seabirds. A search of the files of U.S. Coast Guard Federal On-Scene Coordinator indicated that approximately 130 blue mussel beds may retain EVOS oil in western PWS. However, field evidence collected in 1992 has shown additional previously unreported oiled mussel beds in PWS and along the Kenai coast. EVOS oil also remains associated with dispersed blue mussels in a number of sheltered locations currently under investigation. Damage Assessment studies of Harlequin Ducks through 1992 have been limited to Prince William Sound. Additional work is needed on Afognak and the Kenai coast. Extensive oiling of Kenai Fjords National Park is well documented, and there may be continuing injury to Harlequin Ducks occupying suitable habitat in this park unit.

WHAT

A. Goals

1. Study Harlequin reproductive failure in western PWS
2. Characterize Harlequin Duck nesting habitat on the outer Kenai coast and Afognak Island;
3. Determine whether there is reproductive failure elsewhere in the oiled area (Kenai coast and Afognak Island).

B. Objectives

1. Radio-track Harlequin Ducks to nest sites on the outer Kenai coast and Afognak
2. Determine the distribution of breeding Harlequins, using pair counts and brood surveys, in oiled and non-oiled areas
3. Compare characteristics of streams on which successful Harlequin reproduction is occurring in unoiled areas to those of similar streams, in both oiled and unoiled areas, having no Harlequin reproduction
4. Identify food items in Harlequin Ducks found dead during the oil spill
5. Obtain new information on movements of resident breeding and non-breeding Harlequins, including documentation of spring and summer habitat use, home ranges, foraging behavior and nest site selection
6. Determine petroleum residues in tissues of collected and live-trapped Harlequin Ducks
7. Determine the diet of collected Harlequin Ducks.

WHY

The ultimate goal of this project is the restoration of breeding Harlequin Ducks to the oil spill area. To achieve restoration requires the following:

1. Determine the geographic extent of the reproductive failure

2. Define habitat requirements to guide restorations, and

3. Determine whether hydrocarbon residues are currently present in Harlequins in order to clarify the link to persistent oil contamination. If the observed failure of reproduction is related to the contaminated food chain, remaining oil may need to be treated to make other restoration efforts more effective. In some cases these mussel beds remain grossly contaminated. Technical knowledge of habitat requirements of breeding Harlequin Ducks may prove valuable for habitat acquisition and mitigation measures, protection of non-Federal lands in National Park Service areas, development of marine sanctuaries, or other restoration actions.

HOW

ADF&G will use methodology developed during previous Harlequin Duck studies. The 1993 project will concentrate on nesting habitat characterization along the outer Kenai coast and Afognak Island but will also monitor the reproductive failure in PWS. The same metholodogy will also determine whether the reproductive failure extends outside PWS. The expanded geographical area will involve less survey intensity per unit area, but will include initial boat surveys for identification of pairs at stream mouths in late spring, followed by trapping of selected stream estuaries. Harlequin females flying to streamside nest sites in early summer will be mist-netted and radio-tagged. Using new radio telemetry techniques, nine Harlequin nests have been located in unoiled PWS 1990-91. The nests were located on steeply sloping stream banks in old growth forest. Nest sites, broods, and feeding areas on the Kenai coast and Afognak Island will be located by following the radio-tagged hens through the summer nesting and brood-rearing period. Brood count surveys will be conducted in shoreline habitats in late summer in western PWS and selected areas of the outer Kenai coast and Afognak Island. Breeding survey results from the oil spill areas will be compared to unoiled control areas on Afognak Island. As nests are located in the Kenai - Afognak area, habitat characterization work will be conducted at each site. Blood samples will be collected from breeding Harlequins in unoiled areas and from molting Harlequins in oiled areas. Blood and tissue samples may also be taken from collected ducks. Blood samples will be analyzed for normal blood parameters and presence of elevated levels of haptaglobins and interleukins. Tissue samples (fat, liver, bile) from 40 collected ducks from the Prince William Sound and Afognak oil spill areas will be analyzed for presence of petroleum hydrocarbons. Feather samples will be examined for presence of vanadium, a trace metal indicating petroleum exposure. Fecal samples from flightless birds trapped during the molt will be collected to determine presence/absence of recent petroleum exposure (i.e. through contaminated blue mussels) by means of fluorescence testing. The Harlequin diet will be studied by examination of gullet contents of Harlequin carcasses from the EVOS bird morgue in Anchorage. This project will coordinate with Restoration Study # 051 (Quantification of Stream Habitat for Harlequin Ducks from Remotely Sensed Data) to ground-truth aerial photographs and

satellite imagery in the PWS and Afognak areas. There is no financial or operational overlap with project #93051.

ENVIRONMENTAL COMPLIANCE

This project will comply with requirements of the National Environmental Policy Act. No environmental analysis is required to conduct this study, because it is a research project. State and Federal collecting permits will be obtained through regular procedures.

WHEN

This project will be conducted during 1993-1995. Field work will be completed each year by August 30. Report preparation will begin in September, and the annual progress report will be completed before January 30. Literature review and study plan revisions will be conducted during February. Preparation for field work will continue during March-April. Field work and camp set-up will begin in early May. Resident pair counts will be conducted in late May. Stream sampling, capture and radio-tracking of females will be carried out during June; radio-tracking non-breeders will continue until mid-July. Molt surveys will be carried out between July 15-August 15. Capture and blood sample of flightless molters will take place July 20-August 10. Brood counts will take place between August 15-September 1. Final Report Preparation will be between September 1, 1994-January 29, 1995.

BUDGET ($K)

(The Trustee Council, at the September 21, 1993 meeting, added an additional component identifying Harlequin duck habitat on the Kenai Peninsula, but directed that the budget figures for this component be identified separately.)

	ORIGINAL ADF&G	KENAI COMPONENT	ADF&G TOTAL
Personnel	$ 239.0	$ 59.0	$ 298.0
Travel	23.0	4.0	27.0
Contractual	156.8	105.0*	261.8*
Commodities	21.0	7.0	28.0
Equipment	20.0	20.0	40.0
Capital Outlay	0.0	0.0	0.0
Sub-total	$ 459.8	$ 195.0	$ 654.8
General Administration	46.8	16.3	63.1
Project Total	$ 506.6	$ 211.3	$ 717.9

* U.S. Department of Interior vessel may be available for the Kenai component of this project at no cost, resulting in a reduction in contractual costs of $ 50K.

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93034

Project Title: Pigeon Guillemot Colony Survey

Project Category: Habitat Protection and Acquisition

Project Type: Birds

Lead Agency: Department of the Interior, Fish and Wildlife Service

Cooperating Agencies: None

Project Term: January 1, 1993 to December 31, 1993

INTRODUCTION

A. Background and Summary of Injury

The pigeon guillemot (*Cepphus columba*), a diving seabird, feeds in nearshore waters and nests in numerous small colonies on rocky shores throughout the eastern North Pacific. The U.S. Fish and Wildlife Service began studies of pigeon guillemots at Naked Island in the center of Prince William Sound (PWS) during the late 1970s when oil tanker traffic began through the sound. These studies have provided baseline data for evaluating the effects of the spill on guillemots.

An estimated 2,000 to 3,000 guillemots were killed as a direct result of the *Exxon Valdez* oil spill. These birds may have represented as much as 10% of the cataloged pigeon guillemot population in the Gulf of Alaska, and 33% of the 1991 estimated PWS population. Pigeon guillemots are one of six seabird species that showed significantly greater declines in the oiled area of PWS. The PWS summer population has declined from over 15,000 in 1972 to 6,585 in 1991. At Naked Island, guillemot numbers declined more in oiled areas, and a complete colony census in 1992 showed continuing decline. Adults were contaminated internally, and unhatched eggs showed internal and external contamination in 1989 and 1990. On a daily basis throughout the summer, guillemots perch on intertidal and supratidal rocks at nesting colonies, and researchers have hypothesized that guillemots were, and continue to be, contaminated by shoreline oiling.

Knowledge of the distribution of guillemot colonies and of the number of birds breeding at these colonies is very limited. Because guillemots often represent only a small number of the birds nesting at large multispecies colonies, researchers typically only list guillemots as present, and good estimates of their numbers are not often made. In addition, guillemots nest at many locations where the other more abundant seabirds do not breed, thus the majority of guillemot colonies are missed completely.

Within the spill area, censuses specific for pigeon guillemots have been conducted only in very limited areas around Naked Island and Afognak Island (1992 only). Although Bird Study 2 provided a population estimate for PWS guillemots, these surveys were not designed to identify breeding colonies. Information on the location and degree of oiling at guillemot colonies would

identify areas where protection management actions might be appropriate or where additional cleanup could benefit guillemots.

B. Location

This project will be conducted in PWS with efforts focused primarily in the western sound.

WHAT

A. Goal

The goal of this project is to enhance recovery of pigeon guillemot populations injured by the *Exxon Valdez* oil spill. This goal will be accomplished by identifying important breeding areas for possible protection or additional cleanup.

B. Objectives

1. Identify and map pigeon guillemot colonies within the trajectory of the *Exxon Valdez* oil spill.

WHY

A. Benefit to Injured Resources/Services

This project will benefit injured pigeon guillemot populations by identifying and censusing guillemot colonies throughout the spill area. Important breeding areas must be identified to enable protective measures or land acquisition which will benefit guillemot restoration. Guillemots nest in crevices among supratidal talus, on cliffs, or in the cavities formed by the roots of trees at the forest/cliff edge. Guillemot nest sites are sensitive to logging operations or other shoreline developments, since they utilize forest edges and beach talus. Because guillemots tend to feed near their nest sites, adjacent foraging areas could also be impacted by such activities as logging, tailings from mining operations, intensive commercial fishing, barge or dredging operations, and recreation activities. Thus, foraging areas near large guillemot colonies might be included in a marine sanctuary system or be protected by an extended buffer strip.

B. Relationship to Restoration Goals

This project meets the Trustee Council goal of restoring the environment to its pre-spill condition by identifying management actions that will help restore an injured marine bird species.

HOW

A. Methodology

Pigeon guillemot colonies will be located and censused by cruising the shoreline when birds are at their colonies. The optimum time for locating colonies is prior to incubation, in May and early June, at 0400-0800 h or at high-tide. In PWS, three teams of two observers operating from 25-

foot boats will find colonies by cruising close to shore during the appropriate hours. About 60 km of shoreline can be covered per boat per day during appropriate hours, so that much of the west side of PWS can be covered in May and early June. Colony locations will be marked on topographic maps and lat/long recorded using the Global Positioning System. Colonies will also be censused. Habitat, nest accessibility and onshore oiling at each colony will be recorded.

B. Coordination with Other Efforts

This project will use existing distribution and abundance data collected by the PWS boat survey project (former Bird Study 2) to determine likely guillemot colony locations. This project will also share personnel and equipment with the proposed 1993 boat survey project (Project 93045), assuming both projects are approved. Data on colony locations will be added to the Catalog of Alaskan Seabird Colonies. The catalog, including updated information such as will be collected by this proposed project, will be used as a data layer for the oil spill area geographic information system being developed under proposed project 93060 (Accelerated Data Acquisition for Habitat Protection/Acquisition).

ENVIRONMENTAL COMPLIANCE

This project relies on non-intrusive methods and appears to qualify for a categorical exemption from the requirements of the National Environmental Policy Act.

WHEN

March - April 1993	Study Design and Logistical Planning
May - June 1993	Colony Census
Sept. - Dec. 1993	Data Analysis, Report

BUDGET ($K)

	USFWS
Personnel	$ 53.0
Travel	10.0
Contractual	55.0
Commodities	21.0
Equipment	15.0
Capital Outlay	0.0
Sub-total	$ 154.0
General Administration	11.8
Project Total	$ 165.8

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93035

Project Title: Potential Impacts of Oiled Mussel Beds on Higher Organisms: Contamination of Black Oystercatchers Breeding on Persistently Oiled Sites in Prince William Sound

Project Category: Restoration Monitoring/Restoration Manipulation

Project Type: Birds

Lead Agency: Department of the Interior, Fish and Wildlife Service

Cooperating Agencies: None

Project Term: January 1, 1993 to March 15, 1994

INTRODUCTION

A. Background

The Shoreline Assessment Program which has monitored the recovery of beaches impacted by oil from the *Exxon Valdez* spill has documented the existence of persistent oil contamination in dense blue mussel (*Mytilus edulis*) beds at more than 100 sites throughout western Prince William Sound (PWS). The oil has been trapped under the mussels in the byssal mats that anchor the mussels to each other and to the substrate. In this anaerobic environment, the oil has not degraded. Sheening from these beds has been observed, and aromatic compounds are still present.

The black oystercatcher (*Haematopus bachmani*) is a large shorebird that lives on rocky intertidal shores throughout the North Pacific. They nest in the open on rocky points and islets and rely on cryptic egg coloration and distractive behaviors to avoid predation of eggs and chicks. After hatching, adults feed their chicks until the chicks are capable of feeding themselves; the total length of this rearing period is unknown, but may last two or more months. During the early rearing period, the adults and chicks occupy a feeding territory in the vicinity of the nesting site. Black oystercatchers feed on a variety of intertidal mollusks, including mussels which form a significant portion of the diet of both adults and chicks. In PWS, oystercatchers favor gravel shorelines, and mussel beds embedded in sand/gravel beaches are an important foraging habitat. The mussel beds used by oystercatchers in PWS occur in low energy environments where oil persists. Because oystercatcher chicks are fed food items from a restricted area near their natal site, oystercatcher chicks are excellent subjects for monitoring how oil from the *Exxon Valdez* spill is affecting the physiology and reproduction of a higher vertebrate species. Because of their complete dependence on rocky intertidal areas and the importance of mussels in their diet, black oystercatchers can serve as an indicator species for assessing the condition of rocky intertidal habitats and the continuing presence of oil in such habitats.

B. Summary of Injury

Oil from the *Exxon Valdez* contaminated rocky shorelines used by black oystercatchers for feeding and nesting. Based on initial studies in PWS at Green Island, the oiling affected black oystercatchers by reducing the number of breeding pairs and by reducing egg volume. Subsequent studies demonstrated that oystercatcher chicks raised on oiled beaches, despite being delivered a larger biomass of food, grew slower than chicks raised on unoiled beaches. Based on studies with captive birds, ingestion of oil can decrease growth because energy that would otherwise be used for growth is used to fuel the metabolic processes that detoxify oil. The reduced growth rates of chicks raised at sites with persistent oil contamination is still occurring, suggesting continuing injury due to the presence of *Exxon Valdez* oil in rocky intertidal habitats.

C. Location

This study will be conducted in Prince William Sound. Study sites will include Montague Island (unoiled), Green Island (oiled) and Knight Island (oiled).

WHAT

A. Goal

The goal of this study is to determine whether black oystercatchers breeding on shorelines with persistent oil contamination in Prince William Sound are affected by their use of these habitats. This study will determine if there is a link between use of oiled mussel beds by oystercatchers and their reproductive success, as evidenced by chick growth rates and recruitment. This project will only be undertaken if the review of the results of the 1992 work indicates a need for further work on this species.

B. Objective

1. To determine if the continued persistence of hydrocarbons in mussel beds is being transferred to chicks via the food chain and is responsible for depressed growth rates.

WHY

A. Benefit to Injured Resources

This study will be beneficial to the restoration of black oystercatchers because the study will determine whether continuing injury or recovery is occurring at oiled sites. If recovery is not occurring, the study is designed to reveal whether a cause of the continuing injury to oystercatchers is use of oiled mussel beds for feeding. This study will identify specific mussel beds and their characteristics which result in the continuing injury to oystercatchers. These data could be used to identify sites needing additional treatment. Treatment of such sites will eventually benefit oystercatchers by returning their foraging areas to a normal condition.

B. Relationship to Restoration Goals

This study meets two Trustee Council restoration goals: restoration monitoring and restoration manipulation. This study will determine whether black oystercatchers are continuing to be adversely affected by persistent oil contamination. This information is necessary to plan meaningful restoration actions. This study will also identify areas with persistent contamination and document the effects of that contamination on a higher trophic level organism. These data could be used by the Trustee Council to identify specific areas needing additional treatment so that the contamination can be eliminated.

HOW

A. Methodology

Study methodology will follow previous study plans. From June to late August, study personnel will operate from field camps at Herring Bay, Knight Island, Montague Island, and Green Island. Chicks raised on Montague Island will serve as unoiled controls.

Chicks will be banded with individually-recognizable color bands when $\geq$7 days old and will be reweighed twice before fledging. At $\geq$25 days, blood samples will be collected from chicks. Fecal samples from chicks will be collected and analyzed to determine the presence of hydrocarbons (n=50).

Recruitment of young into the breeding population and overwinter survivorship will be determined by relocation of color-banded birds marked in previous years by this study (n=140+).

Samples of mussels from mussel beds used by black oystercatchers for feeding will be collected for hydrocarbon analysis by the NOAA oiled mussel bed project.

B. Coordination with Other Efforts

This study continues damage assessment and restoration projects on black oystercatchers in 1989, 1991 and 1992. As in 1992, the study will coordinate with the proposed NOAA oiled mussel bed study to ensure that oiled mussel beds used by oystercatchers are included in the NOAA sampling program. This study will also coordinate with the proposed harlequin duck study.

ENVIRONMENTAL COMPLIANCE

This study is a non-intrusive study primarily involving observations and infrequent handling of live birds. No birds will be collected. Samples of oystercatcher fecal material and food items will be collected for analysis of hydrocarbon content. This study appears to qualify for a categorical exemption from the requirements of the National Environmental Policy Act.

WHEN

March 1993	Hire Project Leader
March - May 1993	Logistical Planning
June 1, 1993	Commence Field Work
August 31, 1993	Complete Field Work
Sept. - Dec. 1993	Data Analysis
January 1994	Draft Report
March 1994	Final Report

BUDGET ($K)

	USFWS
Personnel	$ 38.0
Travel	4.0
Contractual	45.0
Commodities	7.0
Equipment	5.0
Capital Outlay	0.0
Sub-total	$ 99.0
General Administration	8.9
Project Total	$ 107.9

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93036

Project Title: Recovery Monitoring and Restoration of Intertidal Oiled Mussel Beds in Prince William Sound and the Gulf of Alaska Impacted by the *Exxon Valdez* Oil Spill.

Project Category: Restoration Monitoring and Restoration Manipulation

Project Type: Coastal Habitat

Lead Agency: National Oceanic and Atmospheric Administration

Cooperating Agencies: National Park Service; U. S. Fish & Wildlife Service; Alaska Department of Fish and Game; and Alaska Department of Environmental Conservation

Project Term: January 1, 1993 to December 31, 1997

INTRODUCTION

A. Background on the Resource/Service

The persistence of *Exxon Valdez* crude oil underlying some densely packed mussel (*Mytilus trossulus*) beds in Prince William Sound, Alaska, began to cause concern, 1991, among scientists from state and federal agencies. With the encouragement of the Restoration Team and the Trustee Council, staff from several agencies conducted a field survey and sampled mussels and underlying sediments from several sites in June of 1991. Subsequent sampling trips were conducted by NOAA in August and September of that year and several times to date in 1992.

Preliminary analytical data indicate total aromatic hydrocarbon concentrations as high as 470 ppm dry weight in sediments and 5.5 ppm dry weight in mussels. Natural recovery of oiled mussel beds appears to be minimal.

B. Summary of Injury

High concentrations of oil in mussels from oiled mussel beds may provide a source of continued exposure to petroleum hydrocarbons through ingestion by higher consumers. There may be possible linkage to 2 species of birds - harlequin ducks and black oystercatchers; and possibly river and sea otters. The presence of these contaminated beds is also of concern for human subsistence.

C. Location

Identified and verified oiled, densely packed mussel beds are located throughout the western and southwestern part of Prince William Sound. The National Park Service has also surveyed and sampled mussels and sediments from oiled sites along the Kenai Peninsula and proposes to continue the monitoring in 1993. NPS expects to extend the geographic area of site survey to the Kodiak area.

WHAT

A. Goal

The overall purpose of this project is to document continued bioavailability of petroleum hydrocarbons to consumers of contaminated mussels, and determine the rate of recovery of oiled mussel beds with and without manipulation. Restoration/recovery methodology will be tested to accelerate cleansing of oiled mussel beds.

B. Objectives

1.a. To measure recovery of petroleum hydrocarbon concentrations to background levels in mussel bed sites manipulated in 1992. This involves three sites treated by NOAA and two sites manipulated by ADEC in 1992; and additional sites if cleaning mussel beds is initiated by ADEC in 1993 under Project 93038. [NOAA]

b. To test the feasibility of new, minimally intrusive manipulative techniques at 3 oiled mussel bed sites within Prince William Sound; and to conduct restorative manipulations at selected sites in the Gulf of Alaska. [NOAA, NPS]

2. To measure natural recovery in levels of petroleum hydrocarbons in mussels and underlying sediments and oiled mussel beds identified and sampled in 1991 and 1992 and to sample mussel beds in areas newly identified by other agency field investigators. [NOAA, NPS]

3. To measure the physiological and reproductive injury of mussels, with and without treatment. [NOAA]

WHY

A. Benefit to Injured Resources/Services

This project will provide data on the efficacy of natural recovery processes and the efficacy of on-site cleaning or manipulation to hasten return to background levels.

Documentation of the level of hydrocarbons in oiled mussel beds or recovery of oiled mussel beds is necessary to evaluate continued linkage to injury seen in consuming species - harlequin ducks, black oystercatchers, river and sea otters; and, will provide necessary information for human subsistence purposes.

B. Relationship to Restoration Goals

If petroleum hydrocarbon concentrations remain high in these beds in 1993; further action may be necessary to minimize or eliminate these mussels as a pathway of oil being incorporated into the food chain of consuming mammals and birds. Recovery monitoring is necessary to insure that petroleum hydrocarbon levels in sediments and mussels have returned to background levels and are no longer a source of contaminated prey.

HOW

A. Methodology

Sampling of mussels and sediments for petroleum hydrocarbons will follow protocol established by NOAA and the NRDA process. NOAA's Auke Bay Lab has successfully established a fast screening method (UV Fluorescence) for sediment hydrocarbons. Using this technique, we have documented that hydrocarbon distribution within a heavily oiled mussel bed appears to be patchy and probably related to grain size of the sediment. Rapid turn around of hydrocarbon data allows targeting manipulative areas in a timely manner. Most sediment samples will be analyzed using this method and only selected sediment samples (mostly for method verification) and mussel samples (based on UV levels found at particular sites) will be analyzed by gas chromatography/mass spectroscopy.

Samples for histopathological analyses have been collected several times at manipulated and control sites in 1992 and we propose to process them and have them examined for anomalies, particularly precancerous conditions associated with long-term exposure to petroleum hydrocarbons. Data for condition and reproductive indices for mussels from selected sites will be calculated using accepted standard methods.

Byssal thread extrusion rates were measured in May 1992 and again in June 1992 in mussels from selected sites and data from these trials are currently being analyzed. Depending on results, we may again repeat this test in May 1993. Thread extrusion rates can be a sensitive indication of overall physiological health. These tests incorporate hydrocarbon depuration while mussels are exposed to clean seawater.

Maps will be produced showing within site variation of petroleum hydrocarbon concentrations at manipulated sites. These will show a time series to illustrate changes in concentrations at 30 days, 90 days and 1 year. Standard statistical analytical methods will be used on data and will be tested at the $P = .05$ level. Guidance here will come from that given by the NRDA peer reviewers.

B. Coordination with Other Efforts

Close coordination with principal investigators of species affected by ingestion of oiled mussels will be maintained to identify new areas of continued contamination.

ENVIRONMENTAL COMPLIANCE

This is a field research project in which routine data collection will take place which is limited in context and intensity. Consequently, this project is categorically excluded from being required to provide an Environmental Impact Statement or Environmental Assessment.

WHEN

Analytical Analyses: GC/MS analyses will be conducted at the completion of all NRDA samples still in the analytical queue. Selected mussel and sediment analysis are scheduled to begin in

December 1992 and expected to continue on an as needed basis through 1993. UV fluorescence screening will be done on an as needed basis. This technique produces data within 10 days. We estimate processing around 500 samples by this method in 1993.

Biological and physiological measurements and data from 1992 will be analyzed during Jan-Mar 1993.

Field work on manipulated sites is scheduled to occur during May with follow up evaluation at 30 days and at the end of the field season. Resampling of oiled mussel sites already identified and any new sites proposed by other agency field personnel will be sampled at a suitable low tide series - probably in late June. Some of this site sampling may be coordinated with the other trips.

BUDGET ($K)

	NOAA	USNPS	ADEC	TOTAL
Personnel	$ 126.0	$ 31.5	$ 0.0	$ 157.5
Travel	23.0	6.0	0.0	29.0
Contractual	70.0	45.0	0.0	115.0
Commodities	26.6	7.6	0.0	33.6
Equipment	34.0	4.0	0.0	38.0
Capital Outlay	0.0	4.0	0.0	4.0
Sub-total	$ 279.0	$ 94.1	$ 0.0	$ 373.1
General Administration	23.8	7.9	0.0	31.7
Project Total	$ 302.8	$ 102.0	$ 0.0	$ 404.8

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93038

Project Title: Shoreline Assessment

Project Category: Restoration Monitoring

Project Type: Coastal Habitat

Lead Agency: Alaska Department of Environmental Conservation

Cooperating Agencies: Trustee Agencies

Project Term: January 1, 1993 to September 30, 1993

INTRODUCTION

Shorelines treated during spill response activities need to be monitored to ensure recovery is proceeding at an acceptable rate and that winter storms have not brought subsurface oil to the surface. Shorelines treated in 1992 and other potentially oiled sites need to be evaluated to determine if the shorelines responded to treatment, or if additional treatment is required to restore resources and services. Technical experts with *Exxon Valdez* spill experience from the state and federal agencies along with the local communities will evaluate impacted shorelines for the presence of *Exxon Valdez* hydrocarbons. The evaluation will document the amount of remaining hydrocarbons and determine if the remaining oil impacts shoreline activities.

This project is divided into two phases. Phase 1 is the physical survey of selected shorelines. This project will use the assessment procedures developed and refined during the *Exxon Valdez* spill clean up. Agency surveyors and upland landowners will evaluate shorelines and determine if additional activities would be of net benefit to restore resources and services. Phase 2 is the restoration of land and resource uses, if necessary. Light duty restoration activities would be performed during and after the survey by the surveyors where feasible. Larger scale treatment work, if necessary, would be identified on work orders and restoration crews from Chenega, Port Graham or other areas would be hired to perform the identified work.

This project will assess *Exxon Valdez* impacted shorelines in Prince William Sound and the Gulf of Alaska. The principal areas are Knight, Latouche, Evans, Elrington, Green, and Disk Islands in Prince William Sound and Tonsina Bay, Windy Bay, and Chugach Bay in the Gulf of Alaska. These areas are in proximity to Chenega Village, Whittier, Port Graham, Seward and Homer.

WHAT

The overall purpose of the project is to ensure that shorelines have recovered sufficiently to facilitate normal shoreline activities. The project objectives are to assess the shoreline hydrocarbon concentrations and, where appropriate, to carry out necessary treatment either during the survey or following the survey using local work crews to perform the identified work.

The shoreline assessment will utilize the process developed and refined since the 1989 spill:

1. Survey shorelines for the presence of *Exxon Valdez* hydrocarbons.
2. Determine if resource uses are affected by hydrocarbons.
3. Perform light duty manual treatment to restore resource use if necessary and feasible.
4. Write work orders for local crews to treat the shoreline if necessary.
5. Document field activities.

WHY

This project will assess shorelines and determine if resources and services are still impacted and the need for additional treatment, if any. The public, land owners, and resource managers need to have current and accurate field information for operation and management. If resources are impacted and need to be restored, technical experts need to survey the sites and determine the best course of action to correct the problem and not cause further damage. Impacts on resources will be corrected and resource use will be restored. Public complaints about the presence of hydrocarbons can be assessed and addressed through the framework of this project.

Information collected by this project will assist Trustee Council review of other projects submitted for funding. This project will provide current, accurate information about shoreline conditions that will help with funding decisions for other activities. Accurate field information will be used by Restoration Team members to identify areas with persistent hydrocarbon concentrations that may slow restoration activities.

HOW

The Alaska Department of Environmental Conservation, in conjunction with the other Trustee Agencies and in consultation with the U. S. Coast Guard, will review the 1992 shoreline survey information and produce a list of subdivisions to be surveyed in 1993. This list will then be circulated to subsistence users by Project 93017 (Subsistence) and to land owners and resource managers to identify additional sites to be included on the 1993 survey. Agency personnel will review the proposed survey list and ensure that oiling conditions at each segment warrant an assessment. The survey list will be prioritized based on resources affected and projected oil concentrations. For planning purposes, we have assumed that 80 sites or less will be recommended for survey. After a final list is developed, the survey list will be sent to land and resource agencies for their approval and clearance to assess the sites.

Phase 1 is the physical survey of the shorelines. Agency technical experts and the upland owners will assess the shoreline segments and document oiling conditions. The survey team will be berthed on a vessel and use skiffs to access the shoreline. Float planes will provide logistics support. Previous *Exxon Valdez* surveys have used these logistics as the most cost effective and time efficient support structure. Agency representatives will be chosen for their environmental and habitat experience. Each person will have extensive *Exxon Valdez* spill experience. Surveys will be conducted daily during both low tide windows with appropriate weather and light conditions. Field information will be recorded on forms previously generated during *Exxon Valdez* surveys to facilitate comparison and familiarity of the existing databases.

Phase 2 is the restoration of resources and services, if necessary. Agency personnel with input from the landowner will determine if treatment is necessary based on established State and Federal standards. Such a determination would include consideration of the resources impacted by the oil, the area and concentration of remaining oil, the cost effectiveness and technical feasibility to treat the oil, the services such as subsistence provided by the shoreline segment, and a reasonable expectation that the treatment will not cause more damage than allowing the oil to remain in place. Such a determination would be made by the Agencies in consultation with the Chief Scientist. The State On-Scene Coordinator will resolve disagreements between Agencies. Any light duty restoration work that is determined to be necessary would be completed during and after the survey by the surveyors which have proven to be the most cost effective method of treatment. Additional restoration treatment would be identified with work orders and the treatment will be performed using local work crews. Necessary treatment would usually consist of hand labor using shovels, rakes, and bags. A determination of appropriate restoration activities, if any, to be done in oiled mussel beds would be based upon results from the 1992 mussel bed study (R-103), the 1993 spring survey of project 93036 (Monitoring of Oiled Mussel Beds), and other completed and ongoing damage assessment and restoration studies. Any treatment work done in oiled mussel beds will be conducted in conjunction with Project 93036 to ensure appropriate treatment methods are used and to monitor the effectiveness of treatment.

The need for shoreline treatment work, if any, in 1993 cannot be determined until the 1993 shoreline assessment is completed and the results of several damage assessment and restoration studies become available this winter and next spring. Because of the necessity of preplanning logistics support, we will assume limited treatment work will be necessary. If treatment is found not to be necessary, the logistics support will not be used, and the money will be returned to the Trustee Council for use in other restoration activities. If treatment is found to be necessary at a level greater than initially authorized, we will request additional funds from the Trustee Council to expand the effort.

Surveyors and work crews will be required to attend Hazwoper training.

Wastes generated during restoration activities will require treatment at approved facilities.

ENVIRONMENTAL COMPLIANCE

As in prior years, permits and notifications will be required by several permitting agencies. All permits will be obtained prior to commencement of field work.

WHEN

The duration of this project will be determined by yearly surveys of contaminated sites. The project will be recommended for termination as soon as conditions warrant. Funds expended in 1993 will be proportional to the amount of restoration work necessary. Unexpended funds will be returned for use on other projects in later years. If work is necessary in future years, milestones would be similar for each year. Costs would vary in future years due to the size of the survey and type of restoration activities.

January 15 - February 15, 1993	Solicit input from landowners and resource agencies on sites to be surveyed.
March 1, 1993	Produce final list of survey sites for Trustees.
March 7, 1993	Submit request for bids for vessel and float plane.
March 30, 1993	Receive approvals from land and resource agencies to access shoreline for survey and restoration activities.
April 15, 1993	Secure contracts for vessel and float plane.
May 15, 1993	Surveyors, landowner representatives, and work crews receive Hazwoper training.
June 1 - July 15, 1993	Perform survey.
August 15, 1993	Complete restoration activities, if any.
September 30, 1993	Complete report and documentation.

BUDGET ($K)

	ADEC	ADF&G	ADNR	USFS	USDOI	NOAA	TOTAL
Personnel	$ 147.1	$ 10.0	$ 10.0	$ 10.0	$ 10.0	$ 10.0	$ 197.1
Travel	6.0	0.0	0.0	0.0	0.0	0.0	6.0
Contractual	252.1	0.0	0.0	0.0	0.0	0.0	252.1
Commodities	16.5	0.0	0.0	0.0	0.0	0.0	16.5
Equipment	5.0	0.0	0.0	0.0	0.0	0.0	5.0
Capital Outlay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	$ 426.7	$ 10.0	$ 10.0	$ 10.0	$ 10.0	10.0	$ 478.7
General Administration	36.5	1.5	1.5	1.5	1.5	1.5	44.0
Project Total	$ 463.2	$ 11.5	$ 11.5	$ 11.5	$ 11.5	$ 11.5	$ 520.7

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93039

Project Title: Herring Bay Experimental and Monitoring Studies

Project Category: Restoration Manipulation and Enhancement, and Restoration Monitoring

Project Type: Fish and Shellfish

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Project Term: January 1, 1993 to September 30, 1996

INTRODUCTION

Marine intertidal communities were the largest single category of habitat affected by the *Exxon Valdez* oil spill. Experiments conducted at Herring Bay, Knight Island, and throughout the EVOS impact area since 1990 clearly indicate that one of the consequences of the oil spill and resultant clean-up activities was injury to intertidal algal and invertebrate populations, especially in the mid- to upper-intertidal zones. The dominant organism in this community is the seaweed *Fucus gardneri* which provides habitat and food for a variety of invertebrates. These invertebrates in turn serve as an important food source for marine mammals, birds, and fishes. This project is designed to examine the impact of oil on relationships between and among intertidal invertebrates and plants, to investigate means of restoring *Fucus* populations and to provide detailed monitoring of the recovery of intertidal communities over the long term.

A. Summary of Injury

Studies to date indicate that plants and animals living in the upper portion of the intertidal zone suffered extensive injury. In fact, data from 1991 show that some species were still declining in abundance. The upper intertidal is where oil was deposited on rocks and sediments during ebbing tides and where clean-up activities were focused. The dominant alga, *Fucus gardneri*, was greatly reduced in many of these areas, and experiments indicate that several years will be required for its recovery in the lower- and mid-intertidal zones. Recovery of this species in the upper intertidal will require an even longer period. Oil inhibits recruitment of *Fucus* and other algae, and *Fucus* does not recruit successfully onto the cleaned, bare rock surfaces. Grazers such as limpets were also reduced by the spill/clean-up and have been unable to recover, due to lack of food and shelter normally provided by the algae. Barnacles have recruited on oiled surfaces, even tar, but our studies show poor subsequent survival. Our data show some recovery in the mid- to lower-intertidal zone, but recruitment is not consistent between locations and years. Recruitment variability appears to have a greater impact on intertidal community structure in Alaska than at lower latitudes.

B. Location

The proposed restoration, monitoring, and experimental studies will be conducted in Herring Bay, Knight Island. Intertidal studies were initiated in Herring Bay in May 1990 and have continued through the 1992 season. Herring Bay was heavily oiled in 1989, and was a central area for cleanup efforts. The Bay was chosen for experimental studies because of its oiling history and proximity to non-oiled sites used as controls.

WHAT

A. Goals

1. To understand what factors limit and/or facilitate recolonization of the intertidal by algae, especially *Fucus*, and invertebrates such as barnacles, mussels, and limpets.

2. To provide controlled, long-term natural recovery monitoring of inter-tidal communities such that natural variability can be differentiated from oil/clean-up effects.

B. Objectives

1. Quantify recruitment rates, survivorship, and population dynamics of barnacles and other sessile invertebrate species on oiled, oiled and cleaned, and non-oiled substrates and at matched oiled and non-oiled sites.

2. Determine the recovery rate of important community members dependent upon other species reduced or eliminated by the spill, i.e., second-order impacts. And determine the recovery rates of species with poor dispersal capabilities, e.g., the predators *Nucella* and *Leptasterias*.

3. Quantify the population structure and population dynamics of *Fucus* in oiled, oiled-cleaned, and control sites to monitor and to project recovery rates, especially in the upper intertidal zone areas denuded by the oil spill/clean-up activities.

4. Develop techniques for restoring *Fucus* by reducing heat and desiccation stress with a biodegradable substratum.

WHY

A major goal of restoration is to ensure that "injured resources have been restored to their pre-spill baseline conditions." Many plant and animal species were damaged directly by the fresh crude oil of the EVOS and/or the subsequent cleanup activities. Previous work in Herring Bay has shown that some populations continued to decrease in 1991 (1992 data not in yet), suggesting continuing expression of the original impact or additional damage due to residual oil. Experimental studies on the impact of the oil spill on intertidal community structure and recovery dynamics have been conducted in Herring Bay since 1990 and should be continued. A long-term

monitoring commitment within Prince William Sound will provide several benefits, including (A) an understanding of the year-to-year variables that affect intertidal community structure, (B) an understanding of long-term consequences of an oil spill, and (C) establishing baseline data and an understanding of complex community structuring mechanisms at monitoring locations strategically located within Prince William Sound, should there be a future perturbation.

HOW

Population dynamics of *Fucus*, sessile invertebrates, and grazers (limpets) will continue to be quantified in established quadrats at oiled and unoiled sites. Recruitment of algae and invertebrates on tarred, cleaned, and control substrata will be determined, with and without grazing. The impact of grazing on algal recruitment and the role of algae in providing food or shelter on survival or recruitment of other species will be examined in enclosures and exclosures.

Growth rates of tagged *Fucus* plants will be determined. Studies will be continued on *Fucus* egg dispersal, survival, and recruitment at oiled and unoiled sites. Experiments will be conducted on the effects of substrata heterogeneity, herbivory, shading by *Fucus* canopy, and tide level on settlement and recruitment of *Fucus* embryos.

Data from the Damage Assessment studies in Herring Bay have shown that the recovery of damaged *Fucus* populations in rocky habitats on steep south-facing beaches has been very slow. The extent of this type of damage throughout PWS will be estimated using data contained in the Department of Natural Resources Oil Spill GIS database. New data on beach aspect and beach slope in PWS will be generated under a technical services contract to DNR. The GIS model to estimate the areal extent of damage will be developed by Coastal Resources Associates. Field verification of the model and data quality assurance will be conducted in Herring Bay and in nearby sheltered rocky intertidal habitats.

For the *Fucus* restoration study, we will use biodegradable erosion-control fabric that has been seeded with *Fucus* embryos. A series of tests will be conducted to determine the optimum fabric type, of the several varieties available, to maintain sufficient moisture for embryo survival, yet provide enough open space for light for the growth of juvenile plants. We will eliminate the potential problem of lack of natural settlement by seeding the fabric with *Fucus* embryos for adding fertile adult plants. Unseeded strips will be used to test whether embryo seeding is necessary. The cost effectiveness of this procedure for large-scale restoration will be assessed.

ENVIRONMENTAL COMPLIANCE

We anticipate that this project will be categorically excluded.

WHEN

Each year of the study, the field season will commence on a low-tide series in late April. Approximately two weeks will be required to record winter results and initialize experiments for the season. Three subsequent 10 day visits will be made to Herring Bay during the summer low tides. Our objectives will be to collect quantitative data from the experiments and to monitor our restoration efforts. Reports will be prepared by March 1 of each year.

BUDGET ($K)

	ADF&G
Personnel	$ 7.5
Travel	0.0
Contractual	478.7
Commodities	0.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 486.2
General Administration	21.3
Project Total	$ 507.5

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93041

Project Title: Comprehensive Restoration Monitoring Program Phase 2: Monitoring Plan Development

Project Category: Restoration Monitoring

Project Type: Monitoring

Lead Agency: National Oceanic and Atmospheric Administration

Cooperating Agencies: Alaska Department of Fish and Game; Alaska Department of Environmental Conservation; Alaska Department of Natural Resources; U.S. Department of Agriculture, Forest Service; U.S. Department of Interior, Fish and Wildlife Service; U.S. Department of Interior, National Park Service

Project Term: January 1, 1993 to September 30, 1993

INTRODUCTION

A. Background on the Resource

Resources to be monitored include affected floral and faunal assemblages as well as impacted substrates upon which they depend. Services arising from injured natural resources will also be monitored inclusive of, but not limited to, recreation, subsistence, and wilderness and intrinsic values. Finally, injured archaeological resources will be monitored.

B. Summary of Injury

The *Exxon Valdez* oil spill occurred just prior to the most biologically active season of the year. During the four-month period following the spill, critical life stages of algae, invertebrates, fish, birds, and mammals encountered the most concentrated, volatile, and potentially toxic forms of the spilled oil. While different species demonstrated varying levels of injury, sea otters and marine birds (common and thick-billed murres, sea ducks) were particularly hard-hit. Portions of 1200 miles of coastline were oiled resulting in impacts to intertidal and shallow subtidal resources. Oil reached shorelines nearly 800 miles from Bligh Reef, the site of the spill. Of continuing concern, resources are exposed to oil remaining in the intertidal zone or transported to the subtidal zone. Following the spill, recreational use of public lands and waters declined and archaeological resources along the shoreline also were injured. For a more detailed account of injuries to individual species, habitats and services, see Chapter IV of the *Exxon Valdez* Oil Spill Restoration Volume 1: Restoration Framework.

C. Location

Monitoring will be conducted on and in surface waters, on tidelands, and on adjacent uplands

including their watersheds in Prince William Sound and the Gulf of Alaska.

WHAT

A. Goal

This project will establish the design of the monitoring component of the Restoration Plan. The goal is to develop a comprehensive and integrated restoration monitoring program that will follow the progress of natural recovery, evaluate the effectiveness of restoration activities, and establish an ecological baseline from which future disturbances can be evaluated.

Implementation of this multifaceted program requires central coordination and management. To successfully implement an ambitious and wide-ranging program as contemplated, a high degree of organization is needed to create the design, to analyze, interpret and disseminate the data generated, and to assure that all aspects of the program are carried out as designed.

B. Objectives

This program will assist the Trustees in various organizational and coordination activities in support of developing a comprehensive, interdisciplinary and integrated program of restoration monitoring aimed at:

1. assessing the rate of natural (unassisted) recovery of injured resources and services;

2. evaluating the effectiveness of restoration activities, identifying where additional restoration activities may be appropriate, and determining when injury is delayed, and;

3. following the dynamics of other ecological components (those important in the food webs of injured species) to document long-term trends in the environmental health of the affected ecosystem.

To fulfill these objectives, a three-phase program is planned. Phase 1 is being conducted in early FY-93 and focuses on the development of a "conceptual" plan for monitoring[1]. Phase 2, which is the focus of this proposal, will be conducted over essentially the second-half of FY-93 and deals with developing the technical plans for monitoring. Phase 3 provides for management of the monitoring program following full implementation (FY-94 thru FY-2203).

WHY

Monitoring is necessary to assess the adequacy of natural recovery. Resources and associated services that are found to be recovering at an unacceptable rate may have to be reconsidered as candidates for restoration action. Likewise, resources and services that are found to be

[1] Environmental Protection Agency pass-through money in 1991.

recovering faster than anticipated may allow for an earlier completion of a restoration endpoint. Monitoring of important physical, chemical and biological properties will establish an environmental baseline for the affected ecosystem. This baseline then can be used to assess the anticipated effects of human activities and to improve our ability to manage affected resources and services over the long-term.

HOW

Phase 1:

In Phase 1, which is being conducted this year (1 September 1992 thru 31 January 1993), a consultant will be asked to assist the Trustees in developing a "conceptual" design for the required monitoring plan. This will provide for more technical planning in Phase 2, which is the focus of this proposal. The conceptual planning in Phase 1 will address but will not be limited to such issues as goals and objectives, what resources and services to monitor, what process is required for management, what relationships need be established with other monitoring programs in the spill zone, and how can monitoring be funded over the long-term. Phase 1 planning also addresses the need to identify which current cleanup, damage assessment and restoration science studies would best serve the purpose of the intended restoration monitoring program.

Phase 2:

In Phase 2 (1 January 93 thru 30 September 93), a consultant will again be asked to assist the Trustees. With an approved "conceptual" plan, the consultant will develop a "detailed" monitoring plan that will be presented as a "strawman" plan for review by technical experts at a workshop. This phase focuses on the technical requirements of an integrated monitoring plan and assumes a close working relationship with the Trustee agencies and contracted peer reviewers. It is further assumed that the Trustee agencies will implement monitoring once this phase of planning is completed and a Final Restoration Monitoring Plan is approved. Phase 2 will establish:

1. what the bounds (magnitude) of the monitoring effort will be;

2. the locations (fixed and rotating) where monitoring should be conducted;

3. a technical design for each monitoring component (e.g., sediments, invertebrates, fish, birds, mammals, and services [recreation, subsistence, aesthetics, etc.]) that specifies how and when data will be collected, analyzed, interpreted, and reported;

4. a data management system to support the needs of the Trustees and other decision makers, planners, researchers and the public. This assumes a system that facilitates a variety of retrieval and analysis functions and is flexible and expandable to meet new and changing needs;

5. a rigorous quality assurance program to ensure that monitoring data produces defensible answers to management questions and will be accepted by scientific researchers and the public;

6. cost estimates for each monitoring component;

7. coordination of this monitoring plan with other monitoring programs that may exist or be proposed; and

8. a strategy for review and update to ensure that the most appropriate and cost-effective monitoring methods are applied.

A workshop approach will be used to establish a model for specific technical requirements. The consultant will then work directly with representatives of the Trustee agencies and peer reviewers to produce definitive monitoring protocols. After completion of a Draft Restoration Monitoring Plan, a program of peer review will be organized and implemented. Subsequently, the draft plan will be issued for public review and comment.

It is proposed in Phase 2 that NOAA/NMFS will assist the Trustees in various organizational and coordination activities pursuant to developing the Draft Final Restoration Monitoring Plan. NOAA/NMFS will design and prepare the RFP to solicit services of a consultant to provide technical expertise. NOAA/NMFS also will design procedures for evaluating the resulting technical proposals and chair a proposal review committee to select a consultant. NOAA/NMFS with the assistance of the consultant also will design and implement a workshop to develop a framework for detailed monitoring protocols, a data management system, a QA/QC program, costs, and a review strategy, etc.

The Trustee agencies will be expected to attend the workshop and to work with NOAA/NMFS and the consultant to provide detailed input to the comprehensive monitoring plan.

Phase 3:

Following development of the Restoration Monitoring Plan, 1994 and beyond will be devoted to Phase 3 - monitoring and management, including audits, annual reviews, data management, and reports.

ENVIRONMENTAL COMPLIANCE

This activity should fall under a categorical exclusion within NEPA because this proposed project is essentially a planning exercise. This does not, however, obviate the responsibility for each Trustee agency to conduct additional NEPA reviews as various components of the comprehensive and integrated monitoring plan are implemented in Phase 3.

WHEN

Phase 1 planning begins 1 September 1992 and will essentially be complete 1 February 1993. Phase 2 planning which is the focus of this proposal will begin 1 February 1993 and essentially be complete 30 September 1993. Phase 3, a fully expanded and integrated monitoring program, will be implemented in the 1994 field season and will continue for the life of the Restoration Monitoring Program (FY-95 thru FY-2004).

BUDGET ($K)

	NOAA
Personnel	$ 79.0
Travel	15.0
Contractual	100.0
Commodities	15.0
Equipment	10.0
Capital Outlay	0.0
Sub-total	$ 219.0
General Administration	18.9
Project Total	$ 237.9

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93042

Project Title: Recovery Monitoring of Prince William Sound Killer Whales Injured by the Exxon Valdez Oil Spill Using Photo Identification Techniques

Project Category: Restoration Monitoring

Project Type: Marine Mammals

Lead Agency: National Oceanic and Atmospheric Administration

Cooperating Agencies: None

Project Term: July 1, 1993 to September 30, 2002

INTRODUCTION

A. Background

The killer whale, *Orcinus orca,* occurs in all oceans of the world. Population estimates, based on photo-identification studies, are available for 4 North Pacific regions (inland waterways of Washington, British Columbia, southeast Alaska, and Prince William Sound). Current killer whale population estimates for Prince William Sound are 11 resident pods (representing 245 whales) and eight transient pods (representing 52 whales). Of these killer whale pods, AB pod is the most often encountered pod in Prince William Sound. The resident killer whale pods of Prince William Sound are a valued wildlife resource contributing substantially to the wilderness, aesthetic, tourism, and recreational walues of the region.

B. Summary of Injury

The whales of Prince William Sound were studied intensively before the spill, and their social structure and population dynamics are well known. Damage assessment studies of killer whales involved boat-based photo-identification surveys in Prince William Sound. Photographs of killer whales were compared to the Alaska killer whale photographic database for the years 1977 to 1989 to determine the changes in whale abundance, seasonal distribution, pod integrity, mortality and natality rates.

One of the Prince William Sound pods, AB pod, had 36 whales when last sighted before the spill in September 1988. When sighted on March 31, 1989, seven days after the spill, seven individuals were missing. Six additional whales were missing from AB pod in 1990. Assuming that whales missing for two consecutive years are dead, the mortality rates for the AB pod were 19.4 percent in 1988-1989 and 20.7 percent in 1990-1991. The average annual mortality in AB pod in 1984 to 1988 was 6.1 percent. An additional whale was missing in 1991, but a calf was also born into the pod. The approximate calving interval of killer whales is four years, so some long-term effects may not be obvious for many years.

Several of the missing whales from AB pod were females which left behind juveniles; such abandonment of juveniles is unprecedented in killer whales. As a consequence, the social structure of AB pod has changed and significant mixing of maternal subgroups has been documented.

Killer whales, which may have died as a result of the oil spill, probably would have sunk and not been found by researchers. So, it has not been possible to directly link the missing whales of AB pod with the Exxon Valdez oil spill.

WHAT

A. Goal

The purpose of this study is to obtain photographs of individual killer whales occurring in AB pod and to document natural recovery. Photographs collected will be compared to the National Marine Mammal Laboratory's photographic database for the years 1989 to 1991 to determine if changes continue to occur in whale abundance, pod integrity, mortality and natality rates.

B. Objectives

1. Count the number and individually identify killer whales within AB pod.

2. Test the hypothesis that pre- and post-spill killer whale pod structure and integrity within AB pod have remained constant.

3. Determine killer whale reproductive rates and trends in abundance for AB pod within Prince William Sound.

WHY

Researchers have documented a decline in Prince William Sound's AB pod in 1989 and again in 1990. The AB pod has been the predominant resident pod of killer whales in Prince William Sound. It is important to pursue studying AB pod despite the difficulty of proving the link of injury to the Exxon Valdez oil spill because of its high intrinsic value as a wildlife resource of the Sound. Continued monitoring of the status of AB pod in Prince William Sound through photo-identification studies is required to document natural recovery of the injured population. The information gained from this work may lead to initiating additional actions to protect killer whales by protecting sensitive habitats, minimizing fishery interactions, reducing or redirecting other human-use impacts, and promoting public education.

Because killer whale recovery rates are essentially unknown (it may take 25-30 years or more), there is a clear need to continue monitoring population trends for killer whales in the spill area. Since the historical database was found inadequate to reliably predict killer whale movements or habitat requirements to support decisions to implement restoration options (habitat protection), additional habitat-use investigations (beyond satellite tagging) may be necessary in the future.

HOW

1. Personnel from the National Marine Mammal Laboratory (NMML) will develop and coordinate all killer whale research activities with this monitoring study. NMML has had extensive involvement in all phases of this research since 1989 and will provide the needed scientific continuity required for this research. Field studies will be conducted by NOAA and contract personnel who have recognized expertise in the study areas of concern. A shore-based camp (equipped with a suitable small boat for whale identification work) will be used in Prince William Sound to conduct photo-identification studies on killer whales from July to September 1993. Study areas will be similar to those worked when assessing injury to killer whales from 1989 through 1991. The camp would be fully self-contained with necessary items for safety and staffed by at least two biologists. For consistency in data collection, key personnel remain in the field throughout the study period.

   Weather permitting, field personnel will spend an average of 8 to 10 hours per day conducting boat surveys searching for AB pod. When encountered, other pods of killer whales should be photographed as well. Specific areas, known for whale concentrations, are investigated first. However, if reports of whales are received from other sources, those areas are examined. If AB pod is not located in "known" areas and opportunistic sighting reports are not available; a general search pattern is developed and implemented. Travel routes typically taken by AB pod will be surveyed. When whales are sighted, researchers stop further search efforts and approach the whales to collect photo-identification information. When whales are encountered, researchers select a vessel course and speed to approximate the animals' course and speed to facilitate optimal photographic positioning.

2. Association patterns of individual whales/maternal subgroups will be examined to evaluate the current social structure of AB pod. Whale association patterns will be compared to the three-year database available at NMML (1989-1991) to determine if changes have occurred in AB pod structure-and integrity.

3. Mortality (number of missing whales) and natality (number of births) will be calculated from the 1993 season through photo-identification studies. The 1993 vital rates will be compared to NOAA's historical database on Prince William Sound killer whales to determine trends in abundance.

ENVIRONMENTAL COMPLIANCE

This is a field research project in which routine data collection will take place which is limited in context and intensity. Consequently, this project is categorically excluded from being required to provide an Environmental Impact Statement or Environmental Assessment.

Permits required by the Marine Mammal Protection Act will be obtained prior to the field season.

WHEN

Apr. 1, 1993	Contract negotiation
Jun. 1, 1993	Select contractor
Jul. 15, 1993 to Sep. 15, 1993	Field research
Dec. 30, 1993	Draft report
Feb. 15, 1994	Final report

BUDGET ($K)

	NOAA
Personnel	$ 18.8
Travel	4.2
Contractual	89.0
Commodities	6.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 118.0
General Administration	9.1
Project Total	$ 127.1

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93043

Project Title: Sea Otter Population Demographics and Habitat Use in Areas Affected by the *Exxon Valdez* Oil Spill

Project Category: Restoration Monitoring/Restoration Habitat Protection

Project Type: Marine Mammals

Lead Agency: Department of the Interior - Fish and Wildlife Service

Cooperating Agencies: None

Project Term: April 1, 1993 to March 31, 1994

INTRODUCTION

A. Background on the Resource/Service

The sea otter (*Enhydra lutris*) is a well-known marine mammal species in Alaska. They historically occurred throughout coastal waters of the Pacific, but as a result of fur harvests in the 18th and 19th centuries, they came close to extinction. They have since increased in abundance and distribution, and presently are found in most coastal areas of southern Alaska. Sea otters prey on a variety of invertebrate species, including mussels, clams, crabs and sea urchins, and may have a strong influence in structuring prey populations.

B. Summary of Injury

Immediate losses of sea otters due to the *Exxon Valdez* oil spill probably ranged from 3,500 to 5,000 animals. Current sampling of sediments and sea otter prey items indicate exposure of otters to hydrocarbons may be continuing. The results of several NRDA studies indicate that this exposure, at a minimum, may be affecting sea otters at an organismic level and, at a maximum, may be affecting survival and therefore recovery of the population. Comparisons of post-spill sea otter surveys found no change in abundance between July 1990 and July 1991, with significantly lower densities in the oil spill area compared to non-oiled areas. The age distribution of sea otter carcasses recovered in oiled areas of Prince William Sound continues to reflect elevated mortality in prime-age sea otters, and a 1990-91 study determined the survival rate of weanling sea otters was significantly lower in oiled than nonoiled areas of PWS. This evidence, together with results from blood and contaminant analyses, suggests that the sea otter population within the spill zone may still be compromised by exposure to oil and that recovery to pre-spill levels is not occurring.

C. Location

The major focus of this project will be on sea otters in Prince William Sound.

WHAT

A. Goals

The overall goal of this project is to restore sea otter populations affected by the Exxon Valdez oil spill by determining what is limiting their recovery and identifying areas with high value for sea otter habitat within Prince William Sound for possible protection. Results from 1991 and 1992 preliminary studies on survey techniques will be evaluated prior to initiating 1993 surveys.

B. Objectives

1. Monitor the recovery of sea otters in oiled areas by determining their abundance, distribution and mortality
2. Construct a population model to evaluate the potential recovery of the sea otters
3. Identify patterns of habitat use
4. Identify and evaluate areas with high value of sea otter habitat within PWS for possible protection

WHY

Studies to date have determined that initial damages to the sea otter population were severe (a loss of 3,500 to 5,000 sea otters), and suggest that chronic damages to sea otters are also occurring, delaying recovery of affected populations. Through monitoring of affected populations and evaluation of patterns of habitat use, this restoration project will guide the development of strategies to aid in the recovery of the otters. The various project activities will enhance our understanding of the demographics of sea otter populations, and identify potential sites for protection of sea otter habitat. Protection of habitats important to sea otters (including foraging, pup rearing, pup weaning and haulout areas) will promote population recovery over the long-term as well as provide protection for other members of the nearshore marine community.

HOW

A. Methodology

In order to evaluate recovery of the sea otter population affected by the oil spill, annual monitoring will be undertaken. Since the spill, detailed data on population size has been collected primarily in the Prince William Sound portion of the spill area. Efficient standardized survey techniques to increase precision and accuracy of population estimates were being developed through RESTORATION FEASIBILITY PROJECT #3, which was conducted in 1991 but not in 1992. The project evaluated the feasibility of using a small float-equipped airplane (Piper P-18 super-cub) as a survey platform in a strip transect survey of sea otters. The design involves counting otters along transects according to a strict protocol and conducting "intensive searches" at pre-determined intervals to estimate the proportion of animals that remain uncounted (e.g., due to diving) during the strip count. Through the information gleaned in the feasibility project and subsequent work by the USFWS, this census technique can be implemented within Prince William Sound in 1993. Survey methodology will be field tested outside Prince William Sound in 1993, and an extended monitoring program may be implemented in subsequent years. In addition to

aerial surveys, mortality surveys (recovery of beach-cast carcasses) will be continued as part of this project. The mortality surveys will build on data collected over a decade in PWS.

A population model will be developed based on age structure and age specific reproduction and survival rates estimated from the carcasses recovered following the oil spill. Model parameters will be modified to reflect available information on post-spill population size, reproduction and survival rates (including data from a 1992-93 USFWS study on juvenile sea otter survival in PWS) to predict recovery rates under a range of assumptions, including those related to potential restoration or management strategies. Data collected in subsequent years will be used to refine and update the model and predictions. This work will be conducted cooperatively with Service personnel and other individuals having expertise in modeling sea otter populations.

The habitat evaluation component of the project will 1) utilize data from a 1992-93 USFWS juvenile survival study to develop a data base on sea otter movements and patterns of habitat use, 2) integrate this information with other sea otter data on distribution and abundance (pre- and post-spill), and 3) evaluate available data on commercial, recreational, and subsistence uses of PWS. Continuing efforts (planned for 1994-95) will utilize the data base compiled on habitat use patterns to identify and evaluate potential areas of high habitat value in PWS for protection.

B. Coordination with Other Efforts

To date, aircraft and boat surveys have not been conducted concurrently. Collection of survey data by both methods in 1993 would complement both projects by providing a basis for comparison of methods and continuity of data collection in subsequent years. Data from both surveys will contribute to the analyses of habitat use patterns.

ENVIRONMENTAL COMPLIANCE

This project does not involve capture or handling of sea otters, or any other methods that are intrusive. It appears to qualify for categorical exclusion under the National Environmental Policy Act.

WHEN

The first year of the project will be April 1, 1993 to March 31, 1994. The population and reproductive surveys will be conducted in the summer of 1993. Mortality surveys will be conducted in the late spring of 1993. The population modeling and evaluation of habitat use patterns do not involve field work. Data compilation and analyses for these components of the project will occur throughout the year. Progress reports for all components of the project will be produced by January 30, 1994, and "final" reports on 1993 activities will be produced by March 31, 1994. The identification of potential sites for habitat protection would occur in 1994-95. Monitoring of population recovery (through abundance, distribution, reproduction and mortality, and continued modeling) is planned as a long-term activity, extending through 2001 (pending availability of continued funding), or through recovery.

A. Milestones

April 93	Data compilation and entry; preparation for field work
April - Nov. 93	Compilation and analysis of existing data for habitat and population modeling work
May - Sept. 93	Field activities for population, reproductive and mortality survey work
Sept. 93 - Jan. 94	Data entry, analysis, report preparation
Jan. 30, 94	Annual Report due on progress to date
March 31, 94	Final Report on 1993 activities due

BUDGET ($K)

	USFWS
Personnel	$ 154.5
Travel	14.5
Contractual	50.2
Commodities	17.1
Equipment	27.5
Capital Outlay	0.0
Sub-total	$ 263.8
General Administration	28.1
Project Total	$ 291.9

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93045

Project Title: Surveys to Monitor Marine Bird and Sea Otter Populations in Prince William Sound during Summer and Winter

Project Category: Restoration Monitoring

Project Type: Birds, Marine Mammals (Sea Otters)

Lead Agency: Department of the Interior, Fish and Wildlife Service

Cooperating Agencies: None

Project Term: January 1, 1993 to March 15, 1994

INTRODUCTION

A. Background on the Resource/Service

The U.S. Fish and Wildlife Service conducted boat surveys of marine bird and sea otter populations in Prince William Sound in the early 1970s, the mid-1980s and in 1989, 1990 and 1991 following the *Exxon Valdez* oil spill. These surveys documented overall declines in Prince William Sound marine bird populations between 1972-1973 and the years after the spill for grebes, cormorants, northern pintail, harlequin duck, oldsquaw, scoters, goldeneyes, bufflehead, black oystercatcher, Bonaparte's gull, black-legged kittiwake, arctic tern, pigeon guillemot, marbled murrelet, Kittlitz's murrelet, and northwestern crow. For five of these species or groups--cormorants, harlequin duck, black oystercatcher, pigeon guillemot and northwestern crow--populations declined more in the oiled area than in the non-oiled area, suggesting an oil spill effect. Specific studies of three of these species--harlequin duck, black oystercatcher and pigeon guillemot--have corroborated the population changes found by the survey project. In addition, these studies have investigated how the reproduction and foraging ecology of these species have been affected by the spill. These studies have also examined hydrocarbon contamination in these species. Links between the oil spill and effects on these species are still being investigated.

Relative to sea otters, the boat surveys documented declines in sea otter density and abundance in shoreline habitats of Prince William Sound following the spill. The surveys also detected a continuing pattern of significantly lower sea otter densities in oiled coastal areas, suggesting that mortality or displacement of sea otters from these areas was considerable.

B. Summary of Injury

About 35,000 birds and 1,000 sea otters were recovered following the spill. Based on modeling studies using carcass, search effort, and population data, the total number of marine birds killed by the spill was between 300,000 and 645,000 birds, with the best approximation between 375,000 and 435,000 birds. The majority of birds killed were murres. The total number of sea otters killed by the spill in Prince William Sound was estimated to be between 3,500 and 5,000

otters. These estimates reflect direct mortality occurring in the first five months after the spill and do not include chronic effects or loss of reproductive output.

C. Location

This study will be conducted in Prince William Sound. The entire sound, including oiled and unoiled areas, will compose the study area.

WHAT

A. Goal

The purpose of this study is to obtain annual estimates of the summer and winter populations of marine birds and sea otters in Prince William Sound to determine whether species whose populations may have declined due to the *Exxon Valdez* oil spill are recovering.

B. Objectives

1. To determine distributions and estimate abundances, with 95% confidence limits, of marine birds and sea otters in Prince William during summer and winter.

2. To estimate trends in populations of marine bird species whose populations declined more in oiled areas than in unoiled areas of Prince William Sound since the early 1970s, specifically cormorants, harlequin ducks, black oystercatchers, and pigeon guillemots.

3. To support restoration studies on harlequin ducks, black oystercatchers, pigeon guillemots, marbled murrelets, other marine birds and sea otters by providing data on population changes, distribution and habitat use of Prince William Sound populations.

WHY

A. Benefit to Injured Resources/Services and Relationship to Restoration Goals

This study meets the Trustee Council restoration goal of restoration monitoring. Restoration of marine bird and sea otter populations will require population estimates to determine whether recovery is occurring or if declines are continuing. This project will benefit marine birds and sea otters by revealing species that show continuing injury due to the *Exxon Valdez* oil spill; this information is necessary to plan meaningful restoration actions.

This project will also provide valuable information on the distribution and habitat use of these species. Survey data from this project have been used for these purposes by investigators of harlequin ducks, marbled murrelets, black oystercatchers and sea otters. Survey methods are flexible enough to provide for collection of more detailed information (such as age class data) if such information is requested by investigators of those species.

HOW

A. Methodology

Boat surveys will be conducted using methods developed by NRDA Bird Study 2. Surveys will be conducted in March (winter) and July (summer) of each year. Surveys will be conducted using three 25-foot boats each staffed by an operator and two crew members. All three will serve as observers. Observers will record all birds and mammals within 100m of each side of the boat within survey transects, and whether the animal is in the water, on land or in the air. The survey window will extend approximately 40-50m ahead of and 100m above the moving boat, but will be extended for animals that exhibit strong avoidance behavior when the boat is more than 50m away (e.g., scoters, murrelets, harlequin ducks, harbor seals). Surveys will be conducted only when seas are less than two feet. Date and time of survey, and environmental variables including wind velocity and direction, air and water temperature, weather, observation conditions, sea state, tide, presence of oil, and presence of human activity will be recorded for each transect.

A stratified random sampling design using shoreline, coastal/pelagic and pelagic strata will be used. The current design is powerful enough to detect small population changes (e.g., 15%) for some species. Data collected previously will be used to improve the design for other species, possibly lowering costs at the same time. The size of individual blocks in pelagic and coastal/pelagic strata will be decreased, and blocks reselected, to decrease variances. Such alteration will not affect our ability to compare population estimates among years.

Analyses aimed at reducing survey variances, detecting population changes, and identifying habitat use and distribution will continue. Such analyses include exploration of post-stratification by habitat (using shoreline type or bathymetry to define habitats), examination of differences among observers' abilities to identify and count animals, and calculation of optimal sampling unit size and number of samples. Future analyses should include the effects of survey vessel disturbance and distance from the vessel on counts of different species.

B. Coordination with Other Efforts

This study will provide data on distribution and abundance of selected species for use by restoration study investigators (assuming these studies are approved). Proposed studies that would use data collected by this project include the following: sea otters, black oystercatchers, pigeon guillemots, habitat (marbled murrelet portion), murres, and habitat acquisition.

ENVIRONMENTAL COMPLIANCE

This study relies on observations from boats and is a non-intrusive study. Based on a review of the CEQ regulation 40 CFR 1500-1508, this study appears to be categorically exempt from the requirements of NEPA in accordance with 40 CFR 1508.4.

WHEN

This project will require, at minimum, 15 months to complete. Surveys are proposed to continue for several years. The need to continue the surveys on an annual basis, and the need to conduct both winter and summer surveys in each year, will be evaluated.

January 1	- March 1, 1993	Logistical Planning
March 1	- March 20, 1993	Winter Survey - data collection
April 1	- May 30, 1993	Data compilation
July 1	- July 20, 1993	Summer Survey - data collection
Aug. 1	- Sept. 15, 1993	Data compilation
Sept. 15	- Dec. 31, 1993	Data analysis
Jan. 1994		Draft Report
March 1994		Final Report

BUDGET ($K)

	USFWS
Personnel	$ 108.5
Travel	12.0
Contractual	80.0
Commodities	10.0
Equipment	30.0
Capital Outlay	0.0
Sub-total	$ 240.5
General Administration	21.9
Project Total	$ 262.4

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93046

Project Title: Habitat Use, Behavior, and Monitoring of Harbor Seals in Prince William Sound, Alaska

Project Category: Restoration Monitoring, Habitat Protection

Project Type: Marine Mammals

Lead Agency: Alaska Department of Fish and Game

Cooperating Agencies: National Marine Fisheries Service (NMFS)

Project Term: January 10, 1992 to September 30, 1995

INTRODUCTION

Harbor seals (*Phoca vitulina*) occur year-round in Prince William Sound (PWS) where they often haul out on rocks, reefs, beaches, and glacial ice. They pup, breed, molt, and feed in the Sound. During extensive surveys of PWS in 1991, 2,500-3,000 harbor seals were counted on haulouts. Another 1,700 were counted in the Copper River Delta and Orca Inlet. This under-estimates the population since some seals were in the water and some small haulouts were not surveyed. From 1984 to 1988, harbor seal numbers at trend sites in PWS declined by 43% for unknown causes. The decline continued in 1989-1990, exacerbated in oiled areas by the *Exxon Valdez* oil spill (EVOS); 1990 counts were 57% lower than in 1984. Following the oil spill, counts of harbor seals at oiled trend count sites declined by 35%, compared to 13% at unoiled sites, indicating a reduction of about 20% at oiled haulouts. It is likely that over 200 harbor seals were killed by the EVOS in PWS. Although molting surveys in 1991 suggested that numbers might be increasing, pupping counts were 10% lower in 1992 than in 1991. Whether there are long-term effects is unknown.

Harbor seals are important to residents of PWS for subsistence. In 1987-1989, they made up 13%-19% of the total harvest of subsistence foods in Tatitlek. In Chenega Bay in 1985-1986, harbor seals accounted for 27% of the total pounds harvested. Harbor seals are also watched by tourists and recreational users of PWS and they interact with and are incidentally killed in commercial fisheries. Like all marine mammals, they have special federal protection under the Marine Mammal Protection Act. If the current decline continues or if up-to-date population data are not available, harbor seals could be placed in a more restrictive legal classification.

The proposed study will take place in PWS. The information obtained will benefit residents of Tatitlek, Chenega Bay, and other PWS communities who use harbor seals for subsistence, and tourists and other recreational users by providing information on trends in abundance, biology of the seals, and insight into possible causes for the ongoing decline. Data will benefit PWS fishermen by ensuring that restrictive measures regarding incidental take of harbor seals are not implemented unnecessarily due to lack of data. Information contributed by this study may lead to management recommendations will ensure that human activities do not have further impacts on harbor seals.

WHAT

A. Goals

The goals of this study are as follows:

1. to monitor the abundance and trends of harbor seals in oiled and unoiled areas of PWS in order to determine trends in numbers since their decline following the EVOS; and

2. to characterize habitat use and hauling out and diving behavior of harbor seals so that important habitat can be identified and properly managed.

B. Objectives

The objectives are as follows:

1. to conduct aerial surveys of harbor seals at 25 trend count sites in PWS during pupping and molting in 1993 and 1994;

2. to compare data from surveys to data collected following the EVOS to determine whether seals are recovering; 3) to describe hauling out and diving behavior, and by inference, feeding behavior of satellite-tagged seals in PWS relative to date, time of day, and tide; 4) to describe use of and frequency of movements between haulouts; and 5) to determine movement patterns within PWS and between PWS and adjacent areas.

WHY

We cannot assume that the number of seals in oiled areas will return naturally to pre-spill levels. It is necessary to have current data to know whether seal numbers in PWS have stabilized or are continuing to decline. The proposed surveys will provide such information. To date, the data are equivocal: 1991 molting counts increased slightly but 1992 pupping counts declined. Molting counts in oiled areas were 30% lower in 1991 than they were in 1988 before the EVOS. By comparison, counts at unoiled sites were approximately the same in 1988 and 1991. Overall since 1984, there has been a decline of more than 50% in numbers that have left much of the harbor seal habitat in PWS vacant. Subsistence hunters and other local residents complain about the scarcity of seals and want to know why there has been a decline.

While count data are essential for monitoring trends in abundance, they are of little help in explaining the decline or designing conservation and management measures to facilitate recovery. There is no information on site fidelity, movements between sites, seasonal changes, habitats used for feeding, or feeding behavior. It is clear based on data from harbor seals that were satellite-tagged as part of a pilot EVOS restoration study that some seals in PWS make unexpectedly long movements in short periods of time, and that there is more interchange among seals in PWS and the Copper River delta than was anticipated. Areas of particular biological significance must be identified and appropriately managed to be able to aid recovery in any way

possible.

Under federal law, subsistence is the priority use of marine mammals. Data on seal abundance should be shared with PWS residents so that hunters can regulate their seal harvest to ensure that the harvest is sustainable. If data are not current and adequate to determine that subsistence takes and fisheries removals are sustainable, this could result in very restrictive incidental take regulations for PWS salmon fisheries. While it is not clear what caused the declines prior to the EVOS, there is little question that the EVOS compounded the decline. Consequently, post-spill monitoring must continue until residual effects of the EVOS are no longer evident. This project will complement other activities of NMFS on conservation and management of harbor seals.

HOW

We are proposing a two-year field study (1993, 1994) with final data analysis and reporting to take place in year three. Harbor seal abundance will be monitored by flying aerial surveys during pupping (June) and molting (August/September). A fixed-wing aircraft will be used to fly a survey of 25 trend count sites at an altitude of 500 feet. These 25 sites have been used for PWS harbor seal trend counts since 1984, including NRDA studies in 1989-1991. The observer will count all seals and photograph large groups. Pups will be counted separately in June. We will attempt to survey each site 7-10 times during a survey period to reduce statistical variance of the counts. Methodology and observers will be the same as those used in 1989-1991 NRDA studies. Several surveys will also be conducted of seals in the Copper River Delta to gain understanding of the relationship between seal counts in PWS and the Delta. Counts will be compared to data collected prior to and during the EVOS in order to document whether and how rapidly recovery in the oiled area occurs. Project investigators will travel to Chenega Bay and Tatitlek at least once each year to exchange information with village residents.

Satellite-linked time-depth recorders (PTTs) will be attached to 12 seals per year (6 each in spring and autumn) at a variety of locations in PWS in order to better evaluate geographical and seasonal differences in movements and behavior. Seals will be caught by in nets placed near haulouts and PTTs will be glued to their backs with epoxy resin. Each PTT will transmit signals to polar-orbiting satellites when the seal is hauled out or when it surfaces for a sufficient time. Sensor information will indicate when the animal is hauled out, and how deep and for how long it dives. PTTs will be shed during the annual molt in autumn. Pilot studies demonstrated that the project is feasible. During 1991-1992, PTTs were attached to eight seals and data were received for 3-67 days. Several seals made substantial movements within PWS and to the Gulf of Alaska and the Copper River Delta.

Aerial survey data will be analyzed using the trimean statistic as the measure of central tendency. Between-year comparisons of pup production and abundance during the fall molt will be done using a Repeated Measures Analysis of Variance (ANOVA) performed on the trimeans of site count data. Hypotheses will be tested using orthogonal contrasts derived from the specialized ANOVA. Data on geographic location and movements will be plotted by computer. Rates of movement and average lengths and depths of dives will be calculated depending on location, date, and size of the seal. Hauling out periods relative to tidal stage will be examined by analyzing sensor data that indicates whether the seal is on land or at sea.

ENVIRONMENTAL COMPLIANCE

No environmental analysis is required for this study. As required by the Marine Mammal Protection Act, ADF&G has been authorized under Permit No. 700 to instrument up to 100 harbor seals with PTTs during the period 1992-1995. No additional permits are required.

WHEN

This project will be conducted during 1993 and is proposed for 1994 also, with final report submission in either 1994 or 1995 depending upon whether the second year of field effort is conducted. Aerial surveys will be conducted during June and August/September of each year. Each survey period will be 7-14 days, depending on weather and tides. One of the investigators will visit Chenega Bay and Tatitlek once a year to discuss survey results with residents. Satellite tags will be attached during 10-14 day periods in May and September of each year. Because a lead time of 3-6 months is required to obtain PTTs, we will have to order PTTs by November of 1992 and 1993. Satellite data acquisition costs must be prepaid to Service ARGOS by February of each year. Data are received monthly and preliminary analysis will begin as soon as data diskettes are received. Final analyses cannot be completed until the PTTs have ceased to function (April-June 1995). A report of field activities will be submitted in letter form within 30 days following any field activity. Annual progress reports will be submitted by 31 December 1993 and 1994. A final report will be submitted by 30 September 1995. Results will be prepared for publication in a peer-reviewed journal.

BUDGET ($K)

	ADF&G
Personnel	$ 104.7
Travel	10.2
Contractual	46.7
Commodities	49.9
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 211.5
General Administration	19.0
Project Total	$ 230.5

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93047

Project Title: Subtidal Monitoring: Recovery of Sediments, Hydrocarbon-degrading Microorganisms, Eelgrass Communities, and Fish in the Shallow Subtidal Environment.

Project Category: Restoration monitoring

Project Type: Subtidal

Lead Agency: National Oceanic and Atmospheric Administration.

Cooperating Agencies: Alaska Department of Fish and Game; Alaska Department of Environmental Conservation

Project Term: March 1, 1993 to September 30, 1995

INTRODUCTION

A. Background on the Resource/Service

This project will monitor the recovery of subtidal sediments, hydrocarbon-degrading microorganisms, eelgrass communities, rockfish, and bottom fish from SHALLOW subtidal areas of Prince William Sound. An important component of this study is tracking the loss of oil from the environment and from organisms in the spill area.

Hydrocarbons were found in the shallow subtidal sediments and in species (rockfish, flounders) associated with the shallow bottom sediments. Investigators attempting to restore or monitor recovery of populations of shallow subtidal organisms following the *Exxon Valdez* oil spill will want to know what concentrations of petroleum hydrocarbons are present in sediments, and if they continue to contaminate the organisms and have sublethal impacts.

We anticipate that complete recovery to background levels of hydrocarbons in subtidal sediments in the Sound is likely to take several years.

B. Summary of Injury

Subtidal sediments have been found to be contaminated by oil at no fewer than 15 sites within Prince William Sound by June 1990. Hydrocarbon contamination of sediments had reached a depth of 20 m at least 8 sites. Evidence of hydrocarbon movement down-slope into subtidal sediments was detected by 1991; further oil movement to greater depths is suspected (from weathering, cleaning, etc.) but is unknown.

A few dead rockfish were found after the spill. Species exposure in rockfish and flounders (contaminated bile) was documented between 89-91, but not since. Eelgrass beds in oiled areas were affected by the spill. Persistence of hydrocarbons and their impacts on associated species were not examined in 1992, and the current status of recovery is unknown.

C. Location

All locations of the study will be in Prince William Sound (PWS; except for potential control sites outside PWS if needed). All projects within the study will sample the same oiled sites all of which were sampled in previous years. Five oiled and five reference sites will be studied intensively by all agencies cooperating in the project.

The oiled sites will include Herring Bay, Northwest Bay, Sleepy Bay, Snug Harbor, and Bay of Isles. The control sites will include Drier Bay, Lower Herring Bay, Moose Lips Bay, Olsen Bay, and Zaikof Bay. All sites were sampled repeatedly under the NRDA program. Sites will be sampled in June/July 1993 and 1994.

WHAT

A. Goal

Monitor recovery of sediments, hydrocarbon-degrading microorganisms, eelgrass beds, and shallow fish species in the subtidal environment.

B. Objectives

1. National Oceanic and Atmospheric Administration

    A. Determine Hydrocarbons concentration and composition in subtidal sediments in PWS by GC-MS (6 depths; 10 sites).

    B. Determine hydrocarbon movement down slope in three oiled bays (150 samples per bay, all from 0-20 meters) by fast screening UV-Fluorescence procedures.

    C. Determine changes in exposure of fishes to hydrocarbons by monitoring bile, MFO activity and histopathogical lesions in near-shore bottom fish.

2. Alaska Department of Environmental Conservation

    A. Measure the numbers of hydrocarbon-degrading microorganisms and their activity as an indicator of persistence of biodegradable oil in PWS sediments.

3. Alaska Department of Fish and Game

    A. Determine impacts and recovery of shallow eelgrass communities in western PWS that were impacted by the spill.

    B. Determine changes in exposure of fishes to hydrocarbons by monitoring bile, MFO activity and histopathogical lesions in Rockfish.

WHY

A. Benefit to Injured Resources/Services

The sediment hydrocarbons sub-project will determine the recovery of oiled sediments, if any, and the movement of subtidal oil, if any. The other sub-projects will determine if contamination continues in species, and if responses to contamination or impacts continues.

Management of species and habitats may be influenced by the level of recovery (e.g., no contamination or detectable responses would permit higher rates of harvest for target species). Information on rates of recovery of contaminated habitats and species is needed to protect those habitats and species.

HOW

A. Methodology

All of the sites proposed for sampling by this project were sampled by the cooperating agencies between 1989-91. None of the sub-projects proposed here were implemented in 1992. All sub-projects will use methods comparable to the methods they employed in 1989-91 to insure temporal comparability of the results. The project will be limited to 10 sites within PWS.

Specific methods vary considerably between sub-projects. Sediments will be collected primarily by divers (some grab samples will be taken at greater depths) and will be analyzed by GC-MS. All sediment samples will be screened using the UV-Fluorescent procedures developed for analyzing sediments from the mussel bed study. Details of the methods for monitoring biological impacts/contamination will be given in detailed study plans and will follow the methods used in previous years.

Chain of custody procedures will be followed after collection of all samples.

B. Coordination with Other Efforts

The sub-projects will coordinate closely with each other to insure concurrent sampling dates and similar stations between studies. Also, this project will coordinate with the mussel bed project, and will make use of the shoreline evaluations particularly to identify stations for the intense subtidal sampling at 3 oiled bays.

ENVIRONMENTAL COMPLIANCE

It is not anticipated that this study will have a significant effect on the environment and an Environmental Impact Statement or Environmental Assessment will not be necessary.

WHEN

All field work will be conducted in June/July 1993 and 1994. An interim progress report will be completed by 1 Dec. 1993 and 1994. Final reports for sub-projects with one field season will be completed by 1 May 1994; those for sub-projects with two field seasons will be completed by 1 May 1995.

BUDGET SUMMARY

All sub-projects are self-contained. Budgets include analytical costs, vessel-field logistics, university overhead, and final analyses/interpretation/write up.

Note: Because the summer field season occurs in the fourth quarter of the fiscal year, much of the sample analysis will fall in the first two quarters of the next fiscal year.

BUDGET ($K)

	NOAA	ADEC	ADF&G	TOTAL
Personnel	$ 230.6	$ 2.5	$ 38.1	$ 271.2
Travel	20.8	0.0	1.9	22.7
Contractual	185.0	62.4	313.0	560.4
Commodities	51.0	0.0	6.5	57.5
Equipment	9.0	0.0	0.0	9.0
Capital Outlay	0.0	0.0	0.0	0.0
Sub-total	$ 496.4	$ 64.9	$ 359.5	$ 920.8
General Administration	47.6	4.7	27.7	79.9
Project Total	$ 544.0	$ 69.6	$ 387.2	$ 1,000.7

EXXON VALDEZ OIL SPILL BRIEF PROJECT DESCRIPTION

Project Number: 93050

Project Title: Update: Restoration Feasibility Study #5 (*Identification and Recordation of Information Sources Relevant to Land and Resources Affected by the Exxon Valdez Oil Spill)*

Project Category: Technical Support

Lead Agency: Alaska Department of Natural Resources

Cooperating Agencies: None

Project Term: March 1, 1993 to May 31, 1993

INTRODUCTION

Restoration planning and implementation projects proposed to enhance and accelerate the recovery of areas affected by the *Exxon Valdez* oil spill require information on natural resources, land status, and damage assessment. In a previous study, Restoration Feasibility Study #5, DNR compiled information identifying available sources of information pertaining to land status, existing and proposed uses of both public and private lands, natural and cultural resource inventories, existing infrastructure, management plans, maps and other resource documents that were relevant to the restoration process. Since this project was completed in March 1991, much damage assessment and other ancillary information has become available. To facilitate the restoration process it is necessary to identify available damage assessment information, locate its source, determine its availability and evaluate its relevance within the context of restoration.

Information will be collected and added to an existing DNR database and be published as an Update to Restoration Feasibility Study #5, *Identification and Recordation of Information Sources Relevant to Land and Resources Affected by the Exxon Valdez Oil Spill.* This document would then be made available to Principle Investigators, Restoration Planners and the public.

WHAT

A. Goal

The goal of this project is to identify sources of existing information pertinent to the *Exxon Valdez* Oil Spill Restoration Process. Specific objectives include the following:

1. Identify location and source of damage assessment studies and update the existing document to reflect new information.

2. Identify the sources and locations of maps, management plans, and other resource documents pertaining to land status, public resources, land use patterns, ownership, existing and proposed land use, vegetation, fish and wildlife populations, habitat, recreational value, commercial resources and cultural resources.

3. Produce a selected bibliography identifying the source and location of reports, maps, scientific literature, management plans and studies relevant to the restoration process.

WHY

In order to properly plan for the design and implementation of appropriate restoration projects, it is necessary to review and make accessible existing information about land and resource status, damage assessment in the affected area, and existing and proposed land use. This information should be updated to reflect new and recently released damage assessment studies. The restoration team should consider updating this publication on a yearly basis to provide a complete body of knowledge for Restoration Planners, Principle Investigators and the public.

HOW

A survey of existing and ongoing damage assessment studies will be conducted as well as an update of previously compiled information published in Restoration Feasibility Study #5. Information collected will be added to the existing DNR database and an Update to Restoration Feasibility Study #5 will be published. Technicians collecting information for this study will coordinate with other agencies in order to provide a comprehensive survey of existing information.

ENVIRONMENTAL COMPLIANCE

The project qualifies for a categorical exclusion under the National Environmental Policy Act.

WHEN

The project will begin March 1, 1993 and be completed May 31, 1993.

March 1, - April 1, 1993	Survey damage assessment studies.
April 1, - May 15, 1993	Update RFS #5 database.
May 15, - May 31, 1993	Prepare database for publishing.

BUDGET ($K)

	ADNR
Personnel	$ 6.9
Travel	0.0
Contractual	1.5
Commodities	0.4
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 8.8
General Administration	1.4
Project Total	$ 10.2

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93051

Project Title: Habitat Protection Information for Anadromous Streams and Marbled Murrelets

Project Category: Habitat Protection and Acquisition

Project Type: Survey

Lead Agency: Department of Agriculture, Forest Service

Cooperating Agencies: Alaska Department of Fish and Game; Department of Interior, Fish and Wildlife Service

Project Term: October 1, 1992 to September 30, 1994

INTRODUCTION

This project will acquire detailed information on the locations and characteristics of habitats and services of injured resources so that habitat/protection or acquisition options can be evaluated. Data collection efforts will focus on anadromous fish and murrelets. Anadromous fish were affected by the oil spill in a number of ways: pink salmon had high egg and fry mortalities, reduced growth rates, and possible morphological abnormalities; sockeye salmon suffered poor smolt survival due to overescapement. Murrelet populations were impacted by initial mortalities and continue to be depressed.

This project will encompass lands throughout the spill-affected area.

WHAT

This project has two components:

1. Murrelet nesting habitat assessment; and,

2. Stream habitat assessment.

1. Murrelet Nesting Assessment

The purpose of this sub-project is to help restore murrelet populations injured due to the *Exxon Valdez* oil spill by providing information that could be used to protect, through acquisition or other means, murrelet nesting habitat. This sub-project will further characterize the nesting habitat of

marbled and Kittlitz's murrelets in the spill-affected area. Two objectives will be implemented to achieve this goal:

A. Determine habitat features that are reliable indicators of high density murrelet nesting areas in the spill-affected area.

B. Determine feasibility of using radio telemetry to determine nesting habitat of murrelets in the spill-affected area.

2. Stream Habitat Assessment

The stream habitat assessment project is intended to be a comprehensive survey of anadromous fish stream resources that will provide basic information needed to evaluate candidate lands for restoration, protection, enhancement or acquisition actions.

The project is composed of two sub-projects:

A. Stream Habitat Assessment Study: Surveying anadromous fish distribution and documenting the total number and extent of anadromous fish streams on candidate lands.

B. Stream Classification Study: Developing channel typing procedures that will allow comparative evaluations of stream habitat on private and public lands.

WHY

Marbled murrelets and anadromous fish, were injured by the oil spill. Murrelets nest in trees throughout the spill area but little is known about their nesting requirements. Work conducted in 1992 is providing some information on nesting requirements but additional information is needed before nesting habitat can be reliably determined. Any habitat protection applied to uplands for murrelets would be dependent on the ability to accurately estimate the quality and quantity of nesting habitat.

Anadromous fish, such as pink salmon were also injured by the oil spill. The surveying portion of the project will locate and map new anadromous streams within candidate lands that may require habitat protection. The stream classification study will provide a GIS based tool that will allow comparative evaluations of streams throughout the spill area. This component will also provide a level of information that can be expanded upon through additional field work should such information become necessary.

HOW

Based on results from the 1992 season, selected habitat types will be tested for predicted levels of murrelet activity, particularly behaviors indicating occupation of the habitat for nesting. Potential nesting areas will be surveyed using intensive dawn watches along elevational or distance-from-water gradients. Previously monitored high-density nesting areas will be surveyed to determine the relative level of murrelet upland activity for 1993. The U.S. Forest Service will

determine forest cover attributes (specifically, forest structure, volume and stand class as well as plant associations) for dawn watch sites within each survey area. These data will be used to determine the habitat characteristics of occupied and unoccupied sites. The study area for this portion of the project will include Prince William Sound (PWS) and areas outside PWS (Kenai Peninsula, Kachemak Bay, Afognak Island). The specific areas to be studied outside of PWS will be determined after results from 1992 field work are available.

Radio-telemetry could be a useful technique for determining the nesting areas of murrelets, however, capture methods, radio life-span and ability to track murrelets are still experimental. We propose to conduct a pilot study on capturing and tagging murrelets to determine the feasibility of using radio-telemetry to determine the nesting habitat of murrelets in the spill zone. Given the experimental nature of this work, we propose to conduct the study in Kachemak Bay, which is relatively accessible and has a high density of both murrelet species.

Streams within candidate private lands will be walked to determine the extent of anadromous fish habitat. Concurrent with the streams walks, information on channel types will be collected and entered into the stream classification study.

The stream classification study will use existing air photographs to classify streams within the spill area. Selected sites will be surveyed during the field season to verify and correct the maps. All the maps will be placed into an ARC-INFO based GIS.

ENVIRONMENTAL COMPLIANCE

The proposed project qualifies for a categorical exclusion under terms of the National Environmental Policy Act.

WHEN

Several of the planned project components are continuing studies previously funded by the Trustee Council. The general timelines for the individual components are as follows:

1. Stream habitat assessment: Present - September 1994.

2. Murrelet nesting habitat assessment: Present - September 1994

3. Stream channel typing: January - September 1994

BUDGET ($K)

	USFS	ADF&G	USFWS	TOTAL
Personnel	$ 260.7	$ 182.8	$ 98.2	$ 541.7
Travel	19.0	15.0	30.0	64.0
Contractual	190.0	101.0	86.0	377.0
Commodities	21.0	1.0	10.0	32.0
Equipment	42.5	1.5	14.0	58.0
Capital Outlay	0.0	0.0	0.0	0.0
Sub-total	$ 533.2	$ 301.3	$ 238.2	$ 1,072.7
General Administration	52.5	34.4	20.7	107.1
Project Total	$ 585.7	$ 335.7	$ 258.9	$ 1,179.8

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93052

Project Title: Identification and Protection of Important Bald Eagle Habitats.

Project Category: Restoration Habitat Protection and/or Acquisition.

Project Type: Birds

Lead Agency: U.S. Fish and Wildlife Service

Cooperating Agencies: None

Project Term: January 1, 1993 to September 30, 1995

INTRODUCTION

Bald eagles are closely associated with intertidal habitats. They use these areas for feeding, and they nest almost exclusively within 200 meters of the beach. The *Exxon Valdez* oil spill caused direct mortality to an estimated 800-900 bald eagles throughout the spill area and significant losses to productivity in Prince William Sound. This project would complete the nest inventory in Prince William Sound which was begun during damage assessment studies; nest tree marking and other habitat protection work would be undertaken cooperatively with landowners, emphasizing areas likely to be developed in the near future. Identification of important feeding or seasonal concentration areas may involve areas from the Kenai Peninsula to Cape Yakataga. Primary benefits would be to bald eagles and other species dependent on timbered, shoreline habitats in Prince William Sound. Secondary benefits would occur in areas outside Prince William Sound, which are deemed critical to bald eagles.

WHAT

A. Goal

The goal of this project is to identify and protect threatened or important bald eagle habitats to ensure the recovery of bald eagles from the *Exxon Valdez* oil spill, and maintain healthy bald eagle populations over the long term.

B. Objectives

1. Inventory and mark bald eagle nests, emphasizing areas likely to be developed.

2. Provide land managers with maps depicting locations of bald eagle nest sites on their lands.

3. Develop a list of lands that require additional measures to ensure protection, such as conservation easements or outright acquisition.

4 Monitor a sample of radio-tagged bald eagles to gain a better understanding of shoreline use for feeding and nesting, improve management guidelines, and to identify important concentration areas for bald eagles.

WHY

Bald eagle habitats within the spill area have been identified in development plans for timber, minerals, oil and gas, and other types of uses that may not be compatible with eagle nesting, feeding, and roosting requirements. Some threats to habitat are imminent, such as logging of which might be essential bald eagle habitat in Prince William Sound, Copper River Delta, Kenai Peninsula, Cape Suckling, and Afognak Island. The timely identification and protection of threatened habitats will enhance the recovery of bald eagles from the *Exxon Valdez* oil spill, and maintain healthy bald eagle populations over the long term.

This study will improve the rate of recovery and prevent further degradation of critical bald eagle habitat. Data acquired from this study will provide input for an overall habitat protection strategy for the spill area, which will benefit not only bald eagles, but any species dependent upon timbered shoreline, old growth forest, and intertidal or riparian areas. This study represents an essential step toward justifying and prioritizing specific lands for acquisition.

HOW

The study will have three main elements: (1) inventory and marking of bald eagle nest trees, (2) distributing maps of eagle nests to landowners and providing guidelines for protection of habitats, and (3) continuing to monitor a sample of eagles radio-tagged during the damage assessment study to document shoreline use and identify important concentration areas.

The first element will involve habitat reconnaissance by helicopter to locate bald eagle nests. These efforts would concentrate in areas not previously surveyed in Prince William Sound during damage assessment studies. Areas with nests would later be visited by boat to mark the tree and record the characteristics of the site. The location would be verified using a Global Positioning System (GPS) receiver. These data would be entered into the GIS database.

The second element would provide land owners with a map of nests on their lands and a copy of the regional guidelines for bald eagle management. Lands under imminent threat of logging would be targeted for initial reconnaissance and subsequent cooperative habitat protection work with landowners.

The third element of this project will involve monitoring a sample of radio-tagged adult and immature eagles to document habitat use throughout the year. Flights will be conducted weekly and specific locations will be mapped for individuals in each age group. These locations will be examined to determine the extent and types of habitats that eagles use as requirements for food and shelter shift throughout the year. Nests of tagged adults will represent an unbiased sample, which will be characterized to assess nesting habitat. Information will be gathered on concentration areas as they are observed, recording the location and cause of the concentration. Low level surveys will be conducted to determine the numbers of eagle using concentration areas.

Information acquired through this study will complement data collected during the damage assessment study on bald eagles. It will help identify important eagle habitats, and contribute to other efforts directed at assessing the relative value of certain habitat or specific areas to wildlife.

ENVIRONMENTAL COMPLIANCE

The proposed project is a non-intrusive study that appears to qualify for a categorical exclusion from the requirements of the National Environmental Policy Act.

WHEN

This project should be initiated immediately because 1) some lands containing high densities of eagle nests are targeted for logging in the immediate future, 2) this information is necessary to guide decisions on land acquisitions or other types of habitat protection, and 3) a huge investment in time, resources, and money was made to capture and radio-tag a large sample of bald eagles from 1989 to 1991, as part of the damage assessment process. A delay in initiating this project will result in the loss of these transmitters as their battery life is consumed, and a valuable investment will be wasted.

Monitoring of radio-tagged birds would be resumed as soon as funds are available, and continued weekly for 12 months. Contacts with landowners would begin during winter 1993. Nest surveys will conducted in May 1993. Tree marking, focusing on areas with the greatest threat of logging, would be conducted during the summers of 1993 and 1994. Mapping and GIS work will be accomplished during winters.

BUDGET ($K)

	USFWS
Personnel	$ 55.5
Travel	3.0
Contractual	89.0
Commodities	2.0
Equipment	25.0
Capital Outlay	0.0
Sub-total	$ 174.5
General Administration	13.5
Project Total	$ 188.0

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93053

Project Title: Hydrocarbon Data Analysis, Interpretation, and Database Maintenance for Restoration and NRDA Environmental Samples Associated with the *Exxon Valdez* Oil Spill

Project Category: Technical Support

Lead Agency: National Oceanic and Atmospheric Administration

Cooperating Agencies: None

Project Term: January 1, 1993 to September 30, 2000

INTRODUCTION

A. Background on the Resource/Service

The analytical expertise of this project was developed through rigorous performance criteria and quality control/quality assurance standards imposed on participating analytical labs during the damage assessment process. Several thousand environmental samples have been collected and analyzed for hydrocarbons in support of the *Exxon Valdez* NRDA effort, and it is anticipated that at least several hundred more samples will be collected and analyzed as part of Restoration efforts to evaluate the recovery of areas affected by the spill. The data from completed NRDA analyses are stored in a database at the Auke Bay Laboratory, where methods are under continuing development to distinguish samples containing oil from the *Exxon Valdez* oil spill from samples containing oil from other sources, and to determine the oil concentration and weathering status of *Exxon Valdez*-oiled samples. The results of these efforts provide numerical correlates that are directly related to oil, and that may be used by principal investigators (PI's) of other Restoration projects, by other governmental agencies, and by the public, to assess associations of observed biological effects with concentrations of *Exxon Valdez* oil. The purpose of the proposed project is to apply and extend these hydrocarbon interpretation methods to samples analyzed for the Restoration effort, and to insure the comparability of analytical and interpretive results with those of the NRDA effort.

B. Summary of Injury

This project provides technical support to other projects addressing injuries resulting from the *Exxon Valdez* oil spill. This project will provide fundamental interpretive services to all Restoration PI's, governmental agencies, and the public at large, and as needed.

C. Location

This project will be undertaken at the Auke Bay Laboratory in Juneau, Alaska.

WHAT

A. Goal

This project will support the measurement of other restoration projects performances with respect to achieving standards and success criteria of those projects. The goal of this project is to estimate the amount of *Exxon Valdez* oil that is present in environmental samples analyzed for hydrocarbons that are collected for the Restoration effort, such that the methods used and the results are comparable with those used for *Exxon Valdez* NRDA samples and to continue maintenance of results in a database for access by all appropriate parties. This project will not be responsible for archival and disposal of collected samples.

B. Objectives

1. Provide a statistically defensible basis for deciding which environmental samples analyzed for hydrocarbons contain oil from the *Exxon Valdez* spill;

2. Estimate the original concentration of *Exxon Valdez* oil in environmental samples that have been determined to contain *Exxon Valdez* oil;

3. Assess the weathering status of sediment hydrocarbon samples; and

4. Archive these results in a database extension of the NRDA database and as physical maps.

WHY

A. Benefit to Injured Resources/Services

This project will make possible the evaluation of the following:

1. the recovery of areas affected by the oil spill by identifying the amount of *Exxon Valdez* oil remaining, and

2. the association of continuing biological impacts of the spill with *Exxon Valdez* oil remaining in impacted areas.

B. Relationship to Restoration Goals

The Trustees should fund this project so that they can determine the extent of recovery (here defined as absence of *Exxon Valdez* oil) of areas oiled by the spill.

HOW

A. Methodology

Hydrocarbon data from environmental samples will be examined using pattern recognition techniques related to principal component analysis. The pattern of hydrocarbon measurements in a sample will be compared with the pattern in samples of pure and of weathered *Exxon Valdez* oil, and the pattern variance of known samples of weathered *Exxon Valdez* oil will be used to evaluate the likelihood that the pattern observed in an environmental sample could have derived from *Exxon Valdez* oil contamination. Samples with patterns that could likely have derived from *Exxon Valdez* oil will be presumed to contain *Exxon Valdez* oil, and the concentration of oil initially present will be determined after correction for weathering or biological alteration, by calculating the minimum concentration of *Exxon Valdez* oil necessary to explain the observed hydrocarbon pattern in the sample. Sample archival and database procedures will follow NRDA. NRDA and restoration databases will be merged and placed on a database server to facilitate data retrieval.

B. Coordination with Other Efforts

This project will provide basic, interpreted hydrocarbon results that will be of great use to all other projects that either monitor the persistence of *Exxon Valdez* oil in affected areas, or assess the biological effects of persistent *Exxon Valdez* oil. In addition, this project will promote consistency among published results by providing a uniform and consistent approach to hydrocarbon interpretation.

ENVIRONMENTAL COMPLIANCE

This is not a field study nor does it have any significant effect on the environment. Consequently, an Environmental Impact Statement nor Environmental Assessment need not be provided.

All federal, state, and local laws are followed in the management of chemical analysis.

WHEN

The project will continue as long as samples are collected and need interpretation. Restoration sample data will be interpreted as received. Therefore there is no set beginning or ending time. We intend to work with PI's to interpret and map their data to their needs on an ongoing basis. We anticipate this need to continue as long as restoration hydrocarbon samples are collected. We propose to interpret and analyze a set of data within several months of receipt.

BUDGET ($K)

	NOAA
Personnel	$ 82.9
Travel	6.2
Contractual	0.0
Commodities	4.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 93.1
General Administration	12.4
Project Total	$ 105.5

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93057

Project Title: Damage Assessment GIS

Project Category: Technical Support

Lead Agency: Alaska Department of Natural Resources

Cooperating Agencies: None (USF&WS considered separately)

Project Term: March 1, 1993 to September 30, 1993

INTRODUCTION

A. Background on Injured Resource/Service

This project provides a baseline information repository (shoreline, oiling, Environmental Sensitivity Index, shore type, ownership, salmon streams, bathymetry data) for statistical analysis and mapping in support of damage assessment projects scheduled for completion during this last budget period, and for final database and product documentation, repository storage, and distribution and dissemination.

WHAT

A. Goal

Complete statistical analysis and GIS mapping support for existing damage assessment studies, and provide a quality controlled and documented database of baseline information for restoration study use and data publication.

B. Objectives

Complete statistical reports and maps for shoreline assessment; produce updated land status maps and anadromous streams maps; deliver fully documented, digital GIS database of oil spill related themes for final public release, and for use by restoration and habitat acquisition projects; provide direct technical support to PI's on document graphics and maps. Workload and analysis based on those projects scheduled for completion by September 1993.

WHY

A. Benefit to Injured Resource/Service

Completing the damage assessment database of baseline information will provide restoration studies with information relevant to their projects: current ownership and designated use status, oiled areas, oiling change over time, beach treatment areas, geographic links to injury determinations, baseline information critical to habitat acquisition objectives.

HOW

A. Methodology

Complete major documentation project to prepare data layers for final publication. Quality control newly acquired data, and produce statistical reports and maps for the shoreline assessment study, against spring 91 and spring 92 data. Acquire current ownership data from various sources (BLM, DNR, USFS), synthesize data, produce most current land status maps, and distribute to damage assessment and restoration studies.

ENVIRONMENTAL COMPLIANCE

ADNR GIS is a technical service project, and is subordinate to the environmental compliance of the damage assessment projects supported.

WHEN

Data publication, ready for public distribution by August of 1993. Spring 91 shoreline data maps quality controlled, and produced spring 93. Produce shoreline maps and reports from spring 92 data within 3 to 4 months of receipt and quality control of data. Technical assistance to PI's subject to PI deadlines, all work complete by October 93.

BUDGET ($K)

	ADNR
Personnel	$ 53.0
Travel	0.0
Contractual	5.0
Commodities	1.5
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 59.5
General Administration	8.0
Project Total	$ 67.5

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93059

Project Title: Habitat Identification Workshop

Project Category: Habitat/Land Protection

Project Type: Technical Support

Lead Agency: Department of Agriculture, Forest Service

Cooperating Agencies: Alaska Department of Environmental Conservation; Alaska Department of Fish and Game; National Oceanic and Atmospheric Administration; Alaska Department of Natural Resources; U.S. Department of the Interior

Project Term: January 10, 1992 to September 30, 1993

INTRODUCTION

Public comment, to date, has overwhelmingly supported use of the Habitat Protection and Acquisition option as a method of preventing further harm to, and assisting the recovery of, natural resources and services injured by the oil spill. Numerous proposals or nominations of lands believed to be deserving of protection or acquisition were received from the public as FY 93 work plan proposals.

In response, where an imminent threat is determined to exist, this project accelerates important elements of the Habitat Protection and Acquisition option within the context of maintaining the integrity of the overall Restoration Planning process and accompanying compliance with NEPA and other legal and regulatory requirements. An imminent threat is defined as a change in land use which (1) is likely to foreclose restoration options, and (2) can reasonably be expected to occur before adoption and implementation of the Restoration Plan.

WHAT

A. Goal

The goal of this project is to identify those parcels of non-public lands within the oil spill affected area which contain critical habitats necessary for the recovery of natural resources and services injured by the oil spill and which are determined to be under imminent threat.

WHY

The Habitat Protection and Acquisition option is but one of a number of restoration tools being considered in the draft Restoration Plan scheduled for release for public review and comment in February 1993. A final Restoration plan is expected in May 1993. In the interim, protection of key parcels of non-public lands which contain critical habitats is needed to ensure that the Habitat Protection and Acquisition option is not foreclosed by events preceding Trustee Council adoption and implementation of a final Restoration Plan.

HOW

1. BY NOVEMBER 1, 1992 - The Habitat Protection and Acquisition workgroup, in cooperation with The Nature Conservancy, will conduct and document a series of workshops to be attended by scientists and other resource specialists for the purpose of (1) assessing the rate and degree of recovery of resources and services injured by the oil spill, and (2) identifying and characterizing the habitats associated with the recovery of injured resources or services.

2. BY NOVEMBER 1, 1992 - The Habitat Protection and Acquisition workgroup will identify those parcels of non-public land within the oil spill affected area which face an imminent threat.

If the threat analysis indicates that there is no imminent threat, further analysis of the nomination may be deferred to the more detailed evaluation process emanating from the Restoration Planning process.

ENVIRONMENTAL COMPLIANCE

This project, which is initial data gathering, is categorically excluded from formal documentation in an environmental impact statement or environmental analysis.

WHEN

The project will commence October 1, 1992. The initial imminent threat analysis is expected to be completed by January 1993. Each subsequent year lands will be evaluated for imminent threat and, if necessary and appropriate, protection tools will be applied.

BUDGET ($K)

	USFS
Personnel	$ 0.0
Travel	0.0
Contractual	39.5
Commodities	0.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 39.5
General Administration	2.8
Project Total	$ 42.3

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93060

Project Title: Accelerated Data Acquisition

Project Category: Habitat Protection

Lead Agency: U.S. Department of Agriculture Forest Service

Cooperating Agencies: Alaska Department of Environmental Conservation, Department of Interior, Alaska Department of Natural Resources, National Oceanic and Atmospheric Administration and Alaska Department of Fish and Game.

Project Term: October 1, 1992 to September 30, 1993

INTRODUCTION

This project, in cooperation with The Nature Conservancy, accelerates the collection, and compilation of existing resource data needed for evaluation of proposals for habitat protection and acquisition and for other restoration activities.

WHAT

A. Goal

Facilitate acceleration of the Habitat Protection and Acquisition option by collecting and organizing existing resource data needed to evaluate habitat protection and acquisition proposals and for other restoration activities.

WHY

A substantial amount of data on injured resources and services is essentially unusable in its present form due to the data being located in a variety of different federal and state agencies and in a variety of different and sometimes conflicting formats. A common data base usable by all of the Trustee Agencies is needed for these data to be most useful in analysis and identification of critical habitats in the spill affected area.

HOW

The Nature Conservancy, in cooperation with the Trustee Council Agencies and others, will complete collection and compilation of existing resource data from the oil spill affected areas into a data base having the following characteristics and "layers":

DATA BASE CHARACTERISTICS

The data base will be compatible with existing Trustee agency hardware and software. Database "layers" will include, but are not exclusive to the following:

DATA BASE "LAYERS"	SOURCE
Line graph (shoreline corrected post-earthquake)	DNR
Cities, towns, villages, roads	DNR (update with current
Land ownership (surface and subsurface; (2.5 acre resolution outside of built up areas)	DNR, FS, FWS, BLM, NPS
Hydrography (remote sensing update)	DNR, FS, USGS, FWS
Hypsography (elevation)	USGS, FS, DNR
Vegetation	FS
Anadromous streams	DFG, FS, DNR
Wildlife habitat	FWS, DFG, FS, NPS, NMFS
Shoreline oiling	DNR, DEC
Management boundaries, conservation units	DNR, FS, FWS, NPS
Easements	BLM, FS, DNR, FWS, NPS
Land use activities	DFG, COE, DNR, DEC, DGC
Bathymetry	DNR
Spruce Bark Beetle Infestation	DNR, FS

ENVIRONMENTAL COMPLIANCE

This project is categorically excluded from formal documentation in an environmental impact statement or environmental analysis under Department of Agriculture and Forest Service regulations.

WHEN

The project will start October 1, 1992 and be completed by January 31, 1993.

BUDGET ($K)

	USFS
Personnel	$ 0.0
Travel	0.0
Contractual	41.0
Commodities	0.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 41.0
General Administration	2.9
Project Total	$ 43.9

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EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93061

Project Title: New Data Acquisition

Project Category: Land/Habitat Protection

Lead Agency: U.S. Department of Agriculture Forest Service

Cooperating Agencies: Alaska Department of Environmental Conservation; Alaska Department of Natural Resources; Alaska Department of Fish and Game; National Oceanic and Atmospheric Administration; U.S. Department of Interior

Project Term: January 1, 1993 to September 30, 1993

INTRODUCTION

The purpose of this project is to acquire currently unavailable data needed for evaluation of proposals for habitat protection and acquisition and for other restoration activities.

WHAT

A. Goal

Fill gaps in existing data that are needed to evaluate habitat protection and acquisition proposals and for other restoration activities.

WHY

It is important that the Trustee Council be able to evaluate proposed habitat protection options in terms of the relative contribution that each option will have toward furthering restoration objectives. Existing data, though useful, may be inadequate for evaluation of habitat protection options - particularly long-term and acquisition.

HOW

BY JANUARY 1, 1993 - The Habitat Protection workgroup will evaluate the existing data base and determine additional data elements necessary for the base to be fully functional as an analytical tool for identifying and evaluating critical habitats being considered for protection. Specific projects to acquire needed data will then be developed and presented to the Trustee Council for approval as revisions to this project. Such projects may involve field data collection, remote sensing, digitizing or other techniques as appropriate.

WHEN

The project will start October 1, 1992 and be completed by January 1993.

COST

It is difficult to determine the cost of this project until such time as the evaluation of the existing data base is completed in April 1993. However, the necessity of collecting at least some additional data at a cost in the range of $500,000 is a reasonable probability.

The lead agency(s) and appropriate general administrative costs will be determined and approved by the Trustee Council when approving revisions to this project for collection of specific additional data.

BUDGET ($K)

	USFS	ADNR	TOTAL
Personnel	$ 0.0	$ 0.0	$ 0.0
Travel	0.0	0.0	0.0
Contractual	250.0	250.0	500.0
Commodities	0.0	0.0	0.0
Equipment	0.0	0.0	0.0
Capital Outlay	0.0	0.0	0.0
Sub-total	$ 250.0	$ 250.0	$ 500.0
General Administration	17.5	17.5	35.0
Project Total	$ 267.5	$ 267.5	$ 535.0

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93062

Project Title: Restoration GIS

Project Category: Technical Support

Lead Agency: Alaska Department of Natural Resources

Cooperating Agencies: None (USF&WS considered separately)

Project Term: March 1, 1993 to September 30, 1993

INTRODUCTION

A. Background on the Resource/Service

Alaska Department of Natural Resources (ADNR) is currently a major repository for EVOS damage assessment GIS data, most of which is highly relevant to restoration analysis and planning. ADNR GIS provides the most comprehensive, automated land status ownership data available. ADNR also has extensive experience dealing with the various land status implications that result from state and native selection rights, inholdings and access, and entitlement rights such as navigability and tidelands. ADNR GIS also has extensive experience providing the multi-thematic GIS analysis and mapping that will be required as habitat protection and acquisition becomes a central focus of the Restoration Team.

WHAT

A. Goal

Provide statistical and spatial analysis, and GIS mapping support for approved restoration projects. Products will be map series, data transmittal, and online query support. Consistent, current, and quality control repository services will be provided for this comprehensive geographic database.

B. Objectives

Acquire, convert, and process necessary incremental resource themes that must be integrated geographically to support restoration. For example, acquire slope/aspect data, perform needs analysis with PI, and perform the programming and data synthesis necessary to identify ideal habitats for *fucus* recovery. Provide maps and statistical analysis products, data repository services and data dissemination. Report to the Restoration Team GIS Review Committee.

WHY

A. Benefits

Using GIS for restoration project support will allow the most informed analysis of geographically dependent information. Using ADNR GIS will allow the current economies of highly specialized personnel, database access, system and project management to transition from the historic damage assessment themes to the restoration focus. ADNR has access to, both directly and through multi-agency contacts, land use planning and land cover databases. Complex restoration alternatives may be rapidly evaluated using a GIS approach.

HOW

A. Methodology

ADNR GIS will work directly with the PIs directing the approved Restoration projects to assess necessary GIS and analysis support. The Restoration Team has provided a tentative list of data themes required for *habitat protection.* These themes are referenced and evaluated below.

Line graph	-	Complete as of date.
Cities, towns, villages	-	Complete as of date.
Land ownership	-	Mostly complete as of date, precision and currency may need to be updated and revised to consider specific project needs.
Hydrography	-	Currently being completed, 1:63360, KAP area outstanding only.
Hypsography	-	Currently requested from USFS/USGS.
Vegetation	-	Currently have some land cover in the affected area, will require largest data gathering and acquisition process for restoration needs.
Anadromous streams	-	Currently integrating this information with the hydrography above. Some is complete, with the rest currently scheduled for completion.
Wildlife habitat	-	Some of this information is already available via damage assessment studies. Habitat information for uplands will need to be acquired, converted and processed; this work may require extensive effort.
Shoreline oiling	-	Complete as of date.
Easements	-	Complete for state lands, need to acquire for other lands, convert, and process.
Land use activities	-	Need to acquire, convert, and process from various sources.
Bathymetry	-	Complete as of date.

Additional approved Restoration projects that have high GIS potential are as follows:

Restoration of Second Growth Habitat for Wildlife in PWS
Harlequin Duck Restoration and Monitoring Study
Natural Recovery of Oiled and Treated Shoreline
Mussels and Sediments
Develop Harvest to Aid Restoration of Injured Terrestrial Mammals and Sea ducks

ADNR GIS will work with the GIS Review Committee of the Restoration Team to identify, analyze, and schedule all data acquisition, conversion, processing, and GIS production work. Additionally, ADNR GIS will work with CACI Building staff to design and implement an interactive GIS workstation environment to support immediate query needs of the Restoration Team. Analysis and representation of generalized data themes, such as vegetation, land use, and habitat, will be coordinated with and reviewed by the contributing agencies. This type of information coordination, in addition to work with the PIs, is anticipated with the USFS, ADF&G, USF&WS, native corporations, and ADEC. Other coordination efforts may be necessary to integrate broad resource agency information into PI studies.

ENVIRONMENTAL COMPLIANCE

ADNR GIS is a technical service project, and is subordinate to the environmental compliance of the restoration projects supported.

WHEN

ADNR GIS staff will continue to advise the Restoration Team on ongoing data acquisition and processing efforts that are projected to continue, or be initiated, in this seven month period. To the extent feasible, data acquisition that can be initiated before this period, for receipt and processing during this period, will be facilitated by ADNR GIS.

BUDGET ($K)

	ADNR
Personnel	$ 97.7
Travel	1.0
Contractual	12.0
Commodities	7.0
Equipment	6.0
Capital Outlay	0.0
Sub-total	$ 123.7
General Administration	14.7
Project Total	$ 138.4

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93063

Project Title: Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Anadromous Fish

Project Category: Restoration Manipulation and Enhancement

Lead Agency: Alaska Department of Fish and Game (ADFG)

Cooperating Agencies: U.S. Forest Service (USFS)

Project Term: March 1, 1993 to October 31, 1993

INTRODUCTION

This project will develop project designs for appropriate and cost-effective salmon spawning habitat restoration and enhancement projects. The *Exxon Valdez* oil spill injured wild pink and chum salmon eggs and fry. Various amounts of oil were deposited in intertidal spawning habitats in Prince William Sound (PWS) where up to 75% of the spawning occurs. Salmon eggs deposited in 1989 and all subsequent years have shown increasing egg mortality. Recently detected genetic damages resulting from oil contamination in spawning beds may further reduce the productivity and fitness of wild salmon populations for many years to come. This project will be undertaken in PWS where portions of the spawning habitat was injured. The benefits of the project will be realized in the communities of Whittier, Valdez, and Cordova which support the commercial fishing industry in the region.

WHAT

The goal of this project is to develop proposals and designs for appropriate and cost-effective instream habitat and stock restoration projects. The following objectives will be achieved:

1. Review existing literature and databases, determine preliminary restoration techniques for specific sites, and identify sites where field studies are needed,
2. Conduct field studies at specific sites to collect data needed to evaluate restoration techniques,
3. Compile available data and select the most appropriate fish restoration projects,
4. Collect additional field data if necessary to develop project design and cost estimates, and write proposals for specific projects, and
5. Estimate the total area of anadromous fish spawning habitat that was oiled in PWS.

WHY

This is an ongoing project currently evaluating various sites in PWS for application of established spawning habitat restoration and enhancement techniques. The project is essential to responsibly develop project proposals and designs to restore and replace damaged salmon spawning habitat. The project was initially funded in September, 1991 near the end of the field season in PWS.

Field activities in 1991 focused on evaluation of 41 sites for construction of fish passes and fry weirs. Field activities in 1992 are focused on evaluation of 15 sites for construction of spawning channels. The ADFG is currently installing standpipes and water temperature/level recorders at these sites to obtain data on groundwater stability and water temperatures. The equipment must be in place throughout the winter to determine minimum temperatures and water levels at each site. Additional funds in FY93 are essential to retrieve the equipment being placed in the field now, analyze data, and prepare project designs.

HOW

Fifteen potential spawning channel sites have been identified in PWS (Willette and Carpenter 1991). Standpipes and electronic water temperature/level recorders are currently being installed at these sites to evaluate groundwater stability and temperature. This equipment must be retrieved from the field in FY93. Data obtained from electronic water temperature/level recorders will be analyzed to evaluate groundwater stability and the probable rate of intragravel flow at potential spawning channel sites. The rate of intragravel flow is an important variable affecting egg-to-fry survival in salmon spawning beds (McNeil 1966).

Data collected from field surveys conducted in FY92 (Willette and Carpenter 1991) will be evaluated in FY93 along with data describing groundwater characteristics. Criteria outlined by Bonnell (1991) will be used to evaluate the suitability of specific sites for the construction of spawning channels. In addition, the estimated increase in fish production and the benefit/cost ratio of the proposed project will be considered. Additional field work may be required to collect engineering data needed to develop detailed project designs. All restoration survey efforts will be coordinated with local landowners and governments.

Literature Cited

Bonnell, R.G. 1991. Construction, operation, and evaluation of groundwater-fed side channels for chum salmon in British Columbia. In: Proceedings of the Fisheries Bioengineering Symposium, American Fisheries Society Symposium no. 10, pp. 109-124.

McNeil, W.J. 1966. Distribution of spawning pink salmon in Sashin Creek, Southeastern Alaska, and survival of their progeny. USFWS, Spec. Sci. Rpt.-Fisheries NO. 538.

Willette, T.M. and G. Carpenter. 1991. Survey and evaluation of instream habitat and stock restoration techniques for anadromous fish. Draft Status Report to the *Exxon Valdez* Oil Spill Trustees Council, 34p.

Willette, T.M. and G. Carpenter. 1991. Survey and evaluation of instream habitat and stock restoration techniques for anadromous fish. Detailed Study Plan (Oil Year 4). Submitted to *Exxon Valdez* Oil Spill Trustees Council, 12p.

ENVIRONMENTAL COMPLIANCE

The project qualifies for a categorical exclusion under the National Environmental Policy Act, because it does not involve any significant manipulation of biological resources or their habitats.

WHEN

This project will continue for five months in FY93. This will allow project staff sufficient time to retrieve equipment placed in the field in FY92, analyze data, collect additional engineering design data if necessary, and prepare detailed project proposals (Table 1).

Table 1: Summary of project activities in FY93.

Date	Activity
June	Retrieve standpipes and electronic water temperature/level recorders from 15 sites.
July	Compile and evaluate data, select sites for development of detailed project proposals.
August	Collect additional engineering data if necessary for project design.
Sept-Oct	Prepare detailed project proposals including engineering designs.

BUDGET ($K)

	ADF&G
Personnel	$ 29.3
Travel	0.3
Contractual	20.5
Commodities	3.5
Equipment	0.0
Capital Outlay	0.0
Sub-total	$ 53.6
General Administration	5.8
Project Total	$ 59.4

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Project Number: 93064

Project Title: Habitat Protection Fund

Project Category: Habitat/Land Protection

Project Type: Habitat Protection

Lead Agency: Alaska Department of Natural Resources (Federal agency to be determined)

Cooperating Agencies: Alaska Department of Fish and Game; National Oceanic and Atmospheric Administration; Department of Interior; Alaska Department of Environmental Conservation; U.S. Forest Service

Project Term: January 10, 1992 until completed

INTRODUCTION

Public comment, to date, has overwhelmingly supported use of the Habitat Protection and Acquisition option as a method of preventing further harm to, and assisting the recovery of, natural resources and services injured by the *Exxon Valdez* oil spill. Numerous proposals or nominations of lands believed to be deserving of protection or acquisition were received from the public as FY 93 work plan proposals.

In response, this project demonstrates a strong commitment on the part of the Trustees to accelerate important elements of the Habitat Protection process. The project would be conducted within the context of maintaining the integrity of the overall Restoration Planning process and accompanying compliance with NEPA and other legal and regulatory requirements.

WHAT

The goal of this project is to capitalize on available opportunities to provide protection for those parcels of non-public lands within the oil spill affected area which contain critical habitats linked to those natural resources and services injured by the oil spill. The initial focus of the effort will be on those parcels facing imminent threat, where the lack of protection could foreclose restoration opportunities.

WHY

The Habitat Protection and Acquisition option is but one of a number of restoration tools being considered in the draft Restoration Plan scheduled for release for public review and comment in February 1993. A final Restoration plan is expected in May 1993. In the interim, protection of key parcels of non-public lands which contain critical habitats is needed to ensure that the Habitat Protection and Acquisition option is not foreclosed by events preceding Trustee Council adoption and implementation of a final Restoration Plan. This will also allow the application of the full-spectrum of habitat protection actions ranging from moratorium to fee title. This fund: provides

the wherewithal to bring negotiations to closure when appropriate; exhibits good faith intent on the part of the Trustees; and allows access to monies without long delays.

HOW

1. BY NOVEMBER 15, 1992 - The Habitat Protection and Acquisition work group, in cooperation with The Nature Conservancy, will conduct and document a series of workshops to be attended by scientists and other resource specialists for the purpose of (1) assessing the rate and degree of recovery of resources and services injured by the oil spill, and (2) identifying and characterizing the habitats associated with the recovery of injured resources or services. This task is part of Project 93059.

2. ONGOING - The Habitat Protection and Acquisition work group will identify those parcels of non-public land within the oil spill affected area which face an imminent threat.

If the threat analysis indicates that there is no imminent threat, further analysis of the nomination may be deferred to the more detailed evaluation process emanating from the Restoration Planning process.

3. BY DECEMBER 1, 1992 - The Habitat Protection and Acquisition work group, through the Restoration Team, will request authority from the Trustee Council to negotiate protection on specific parcels.

4. FOLLOWING DECEMBER 1992 - The Trustee Council approves the results of the negotiations on specific parcels.

5. SUBSEQUENT TO #4 ABOVE - Additional evaluations (i.e. appraisals, biological surveys, title searches) of specific parcels will occur subsequent to Trustee Council approval of the negotiated terms.

WHEN

The project will commence October 1, 1992. There is no set completion date for the project because protection measures will vary depending upon the specifics of each parcel and negotiations may occur over multiple years.

ENVIRONMENTAL COMPLIANCE

Each habitat protection action will be evaluated to determine the level of environmental analysis and documentation necessary to comply with the National Environmental Policy Act (NEPA). It is expected that NEPA compliance for most contemplated protection measures would not exceed an Environmental Analysis level of documentation.

BUDGET ($K)

	ADNR	FEDERAL AGENCY (TBD)	TOTAL
Personnel	$ 0.0	$ 0.0	$ 0.0
Travel	0.0	0.0	0.0
Contractual*	10,000.0	10,000.0	20,000.0
Commodities	0.0	0.0	0.0
Equipment	0.0	0.0	0.0
Capital Outlay	0.0	0.0	0.0
Sub-total	$ 10,000.0	$ 10,000.0	$ 20,000.0
General Administration	0.0	0.0	0.0
Project Total	$ 10,000.0	$ 10,000.0	$ 20,000.0

* The actual amount for interim habitat protection will be determined by the Trustee Council following imminent threat analysis.

APPENDIX A:
SUMMARY OF INJURY

The *Exxon Valdez* oil spill occurred just prior to the most biologically active season of the year in southcentral Alaska. During the four-month period after the spill, seaward migrations of salmon fry, major migrations of birds, and the primary reproductive period for most species of birds, mammals, fish, and marine invertebrate species took place. The organisms involved in these critical periods of their life cycles encountered the most concentrated, volatile, and potentially damaging forms of spilled oil. Oil affected different species differently. Resources continue to be exposed to oil remaining in the intertidal zone, as well as to oil transported to the subtidal zone. The following general account summarizes the main results from the Natural Resource Damage Assessment studies carried out after the spill.

Oil spill injuries can be estimated in several ways: Dead animals, such as birds and sea otters, can be counted and used to estimate the total number of each species lost. Where carcasses are not found and counted, injuries to populations can be based either on comparisons before and after a spill, or between oiled and unoiled environments. Measurements of physiological and biochemical changes due to oil exposure provide further evidence that may support changes observed in populations. Because populations fluctuate from year to year and there are natural differences from place to place, the most accurate estimates of injury are those in which the exact population is known just before the spill and then after the injury occurred. Although scientists studying the effects of oil spills may carry out excellent studies under difficult conditions, there are always uncertainties, especially where good pre-spill population data are lacking.

The injuries summarized here may change as the results of additional sampling and data analysis become available. It is also possible that injuries to populations of long-lived species may not be manifested for some time.

Introduction

Following the spill, humpback whales, Steller sea lions, sea otters, harbor seals, and killer whales were studied. Field work on Steller sea lions and humpback whales was completed in 1990. Humpback whale studies included photo-identification of individual whales, estimations of reproductive success, and documentation of possible displacement of whales from their preferred habitat within Prince William Sound. Exposure of this species to oil was not observed, nor were tissues sampled and analyzed for hydrocarbons. The data do not indicate an effect of the spill on mortality or reproduction of humpback whales in Prince William Sound. However, in 1989 humpback whales were not seen in Lower Knight Island Passage, a preferred habitat.

Results from the sea lion study were inconclusive. Several sea lions were observed with oiled pelts, and petroleum hydrocarbons were found in some tissues. Determining if there was an effect of the spill on the sea lion population was complicated by seasonal movements of sea lions in and out of the spill area, an ongoing population decline and a pre-existing problem with premature pupping.

Based on several photo-identification censuses a significant number of killer whales are missing from at least one and possibly two pods in Prince William Sound. Changes also have been observed in killer whale distribution and social structure. Some male whales have drooping dorsal fins. The cause of the mortalities and fin problems is uncertain.

Injuries to harbor seals and sea otters, described below, have been more evident. Studies of these species are continuing.

Sea Otters

The population of sea otters in Prince William Sound before the spill was estimated to have been as high as 10,000. The total sea otter population of the Gulf of Alaska was estimated to have been at least 20,000. Statewide, the sea otter population is estimated at 150,000. As the oil moved through Prince William Sound and the Gulf of Alaska, it covered large areas inhabited by otters. Sea otters were particularly vulnerable to the spill. When sea otters become contaminated by oil, their fur loses its insulating capabilities, leading to death from hypothermia. Sea otters also may have died as a result of oil ingestion and perhaps inhalation of toxic aromatic compounds that evaporated from the slick shortly after the spill. The effects of oil were documented by repeated surveys of populations in the spill area, recovery of beach-cast carcasses, analysis of tissues for petroleum hydrocarbons and indicators of reduced health, tracking sea otters outfitted with radio transmitters (including those released from rehabilitation centers), and estimating total mortality from the number of sea otter carcasses recovered following the oil spill. These studies concentrated on developing an estimate of sea otter mortality in Prince William Sound and along the Kenai Peninsula, the populations believed to have been most affected by the spill. During 1989, 1,011 sea otter carcasses were recovered in the spill area, cataloged and stored in freezers. Of these, 876 otters were recovered dead from the field and 135 died in rehabilitation centers or other facilities. It is estimated that 3,500 to 5,500 sea otters died from acute exposure to the oil in the entire affected area.

Heavy initial and continuing long-term exposure to petroleum hydrocarbons may be resulting in a chronic effect on sea otters. Significantly elevated concentrations of petroleum hydrocarbons have been detected in intertidal and subtidal sediment samples within the spill zone in western Prince William Sound and in intertidal mussels and benthic marine invertebrates and staples of the sea otter diet. Analyses of blood from sea otters in 1990 and 1991 indicated slight but significant differences in several blood measures in exposed animals. For example, higher eosinophil counts, total hemocrits and hemoglobin concentrations occurred in males in western Prince William Sound, the area that was oiled, compared to males in the eastern Prince William Sound, the unoiled area, suggesting systemic hypersensitivity reactions. These changes are not sufficient to indicate that the individuals that were sampled had health problems likely to result in death.

Abnormal patterns of mortality are continuing in sea otters. Based on pre-spill data from Prince William Sound, very few prime-age sea otters (animals between 2 and 8 years old) die each year and most mortality occurs among otters less than two years old. In 1990 and 1991 a high proportion of carcasses of prime-age sea otters were found on beaches, suggesting a chronic effect of the spill on sea otters.

Results of boat surveys indicate continued declines in sea otter abundance within oiled areas in Prince William Sound. Pre-spill estimates of sea otter abundance in Prince William Sound were carried out in 1984 and 1985 using similar survey techniques. Comparisons of pre- and post-spill estimates of sea otter abundance show that sea otter populations in unoiled areas experienced a 13.5 percent increase in abundance, while sea otter populations in oiled areas underwent a 34.6 percent decrease. In addition, the post-spill population in the oiled area is significantly lower than the pre-spill estimate, indicating a real decline of 1,600 sea otters in Prince William Sound in the first year after the spill, and up to 2,200 in the first three years after the spill.

Pupping rates and survival of pups through weaning in 1990 and 1991 were similar in eastern and western Prince William Sound sea otter populations. Weaned sea otter pups with radiotags died at a faster rate in western than in eastern Prince William Sound (Figure 2). In contrast, survival of tagged adult female sea otters was significantly higher in western Prince William Sound than in eastern Prince William Sound.

Sea otters released from rehabilitation centers had higher mortality and significantly lower pupping rates than those measured in the wild population before the spill. Of the 193 sea otters released from rehabilitation centers, 45 were fitted with radio transmitters. As of July 31, 1991, 14 of these animals were still alive, 14 were known to be dead, and 16 were missing. One radio transmitter is known to have failed.

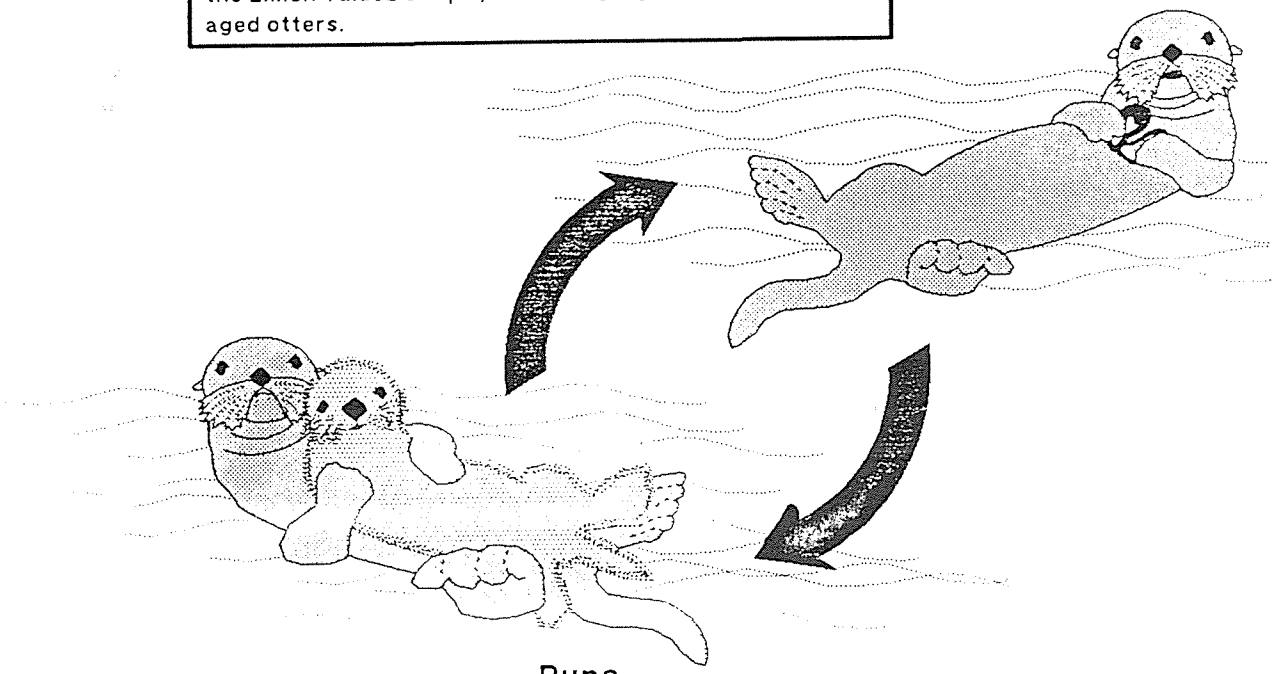
The observed changes in the age distributions of dying sea otters, continued declines in abundance, higher juvenile mortality, and higher mortality and lower

Sea Otters

Adults

Sea otters prefer shallow coastal waters with abundant molluscs and crustaceans for prey. Intertidal rocks and exposed beaches are used for haulout sites. Otters become sexually mature in 4 - 7 years. Most otters in Prince William Sound mate from September through October, but they are capable of breeding throughout the year.

INJURY: Heavy direct mortality of all age classes during the Exxon Valdez oil spill; continuing high mortality of prime aged otters.



Pups

Within Prince William Sound, most sea otter pups are born May through June. The single pup is dependent on its mother for 5 - 7 months. High quality, shallow habitats are used by female-pup pairs.

INJURY: High post-weaning mortality within the Exxon Valdez oil spill area.

Figure 2. Summary of the major injuries in relation to the life history of sea otters.

pupping rates suggest a prolonged, spill-related effect on the western Prince William Sound sea otter population.

Harbor Seals

Two hundred harbor seals are estimated to have been killed by the spill in Prince William Sound. Only 19 seal carcasses were recovered following the spill, since seals sink when they die. Population changes were documented by summer and fall aerial surveys of known haul-out areas. Toxicological and histopathological analyses were conducted to assess petroleum hydrocarbon accumulation and persistence and to determine toxic injuries to tissues. Severe and potentially debilitating lesions were found in the thalamus of the brain of a heavily oiled seal collected in Herring Bay, Prince William Sound, 36 days after the spill. Similar but milder lesions were found in five other seals collected three or more months after the spill. During 1989, oiled harbor seals were abnormally lethargic and unwary. Petroleum hydrocarbon concentrations in bile were 5 to 6 times higher in seals from oiled areas than in seals from unoiled areas one year after the spill. This indicates that seals were still encountering oil in the environment, were mobilizing fat reserves containing petroleum hydrocarbons, or both.

A complete census of harbor seals in Prince William Sound had not been conducted before the spill. However, trend index locations have been intermittently surveyed since the 1970s. Counts at the trend index sites declined by 40 percent between 1984 and 1988, with similar declines in what were subsequently oiled and unoiled areas. From 1988 to 1990, however, the decline at oiled sites, 35 percent, was significantly greater than at unoiled sites (13 percent). Trend surveys conducted in 1991 continue to indicate similar differences between oiled and unoiled areas, although mean numbers of seals in trend counts have increased since the spill. The increases in seals at unoiled sites have been significant, while those at oiled sites have risen only slightly. The first complete survey of Prince William Sound was completed during August 1991, resulting in a count of 2,875 harbor seals.

Killer Whales

Approximately 182 killer whales, forming nine distinct family units or "pods", used Prince William Sound before the spill. These whales were studied intensively before the spill, and their social structure and population dynamics are well known. Damage assessment studies of killer whales involved extensive boat-based surveys in Prince William Sound and adjacent waters. Whales were photographed, and the photographs were compared to the Alaskan killer whale photographic database for the years 1977 to 1989 to determine changes in whale abundance, seasonal distribution, pod integrity and mortality and natality rates.

The AB pod had 36 whales when last sighted before the spill in September 1988. When sighted on March 31, 1989, seven days after the spill, seven individuals were missing. Six additional whales were missing from the AB pod in 1990. Assuming that whales missing for two consecutive years are dead, the mortality rates for the AB pod were 19.4 percent in 1988-1989 and 20.7 percent in 1990-1991. The average annual mortality in AB pod from 1984 to 1988 was 6.1 percent. An additional whale was missing in 1991, but a calf also was born into the pod. The approximate calving interval of killer whales is four years. Accordingly, some long-term effects may not be obvious for many years.

Several of the missing whales from AB pod were females that left behind calves; such abandonment of calves is unprecedented in killer whales. As a consequence the social structure of AB pod has changed. Calves normally spend time with their mothers, but AB pod calves have been observed swimming with adult bulls. The occurrence of collapsed dorsal fins on two adult bulls after the spill is an indication of possible physiological injury. Very little is understood about the likely mechanisms of death from the spill. Various explanations, including oil exposure and other causes, continue to be explored. During the mid-1980s photographic evidence was obtained of bullet wounds in individuals in the AB pod, though there is no recent evidence of such shootings.

Another Prince William Sound pod, AT pod, is missing 11 whales. A subgroup of four AT pod members was photographed behind the *Exxon Valdez* three days after the grounding on Bligh Reef and three of these animals are among the missing AT pod whales. This is a transient pod and it is possible that the missing whales left the pod.

Terrestrial Mammals

Terrestrial mammals that may have been exposed to oil through foraging in intertidal habitats were studied. These species included brown bear, mink, black bear, Sitka black-tailed deer and river otters.

Brown bears forage seasonally in the intertidal and supratidal areas of the Alaska Peninsula and the Kodiak Archipelago. Preliminary analysis of fecal samples from brown bears in the spill area showed that some bears were exposed to petroleum hydrocarbons. High concentrations of petroleum hydrocarbon metabolites were found in bile from a yearling brown bear found dead in 1989. The normal rate of mortality in yearling cubs is close to 50 percent for the first two years, so it is uncertain if this death was due to oil or other causes.

Black bears also forage in the intertidal zone in the spill area and therefore could have been affected by the spill. No field studies were carried out, however, due to the difficulty of finding, collaring or otherwise investigating these animals in the dense underbrush that is their habitat.

Mink and other small mammals living in coastal areas may feed in and spend part or all of their time in the intertidal zone. When mink are sick or injured, they are known to crawl into inaccessible burrows or the brush. For this reason the effect of the spill on mink populations could not be determined. Also, information on pre-spill populations of mink and other small mammals is minimal. To determine if mink reproduction may have been affected by oil in their diet, a laboratory exposure study of ranch-bred mink was conducted. The mink were fed food mixed with small, non-lethal amounts of weathered oil. No changes in reproductive rates or success resulted from this exposure. It was found, however, that oil-contaminated food moved through the intestines of the animals at a more rapid rate than did clean food, possibly providing less nutrition to the animals.

Intensive searches of beaches revealed no Sitka black-tailed deer whose deaths could be attributed to the spill. However, deer taken for purposes of testing for human consumption (not part of the damage assessment) were found to have had slightly elevated concentrations of petroleum hydrocarbons in tissues of some individuals that fed on kelp in intertidal areas. It was determined that the deer were safe to eat.

River Otters

A few river otter carcasses were found by clean-up workers. River otters forage in streams and shallow coastal habitats that were contaminated by the spill. Analysis of river otter bile and blood samples indicated that petroleum hydrocarbons were being accumulated by this species. Moderately elevated concentrations of haptoglobin and activities of amino transferase enzymes in the blood of river otters from oiled areas in 1991 indicate a lingering toxic effect of oil on this species. Studies of radio-tagged animals in Prince William Sound showed that home ranges in oiled areas were twice that of unoiled areas, suggesting that in oiled areas otters must forage over a larger area to obtain sufficient food. In 1991, body lengths, body weights and dietary diversity were lower in oiled areas. River otters often feed on mussels, which continue to be contaminated with oil in many areas of Prince William Sound.

Birds

Introduction

Birds were among the most conspicuous victims of the oil spill. Seabirds are particularly vulnerable to oil, as they spend much of their time on the sea surface while foraging. Oiled plumage insulates poorly and loses its buoyancy, and oiled birds often die from hypothermia or drowning. Birds surviving initial acute exposure to oil may ingest oil by preening. About 36,000 dead birds were recovered after the spill; at least 31,000 of these deaths were attributable to oil. In addition to the large number of murres, sea ducks and bald eagles recovered after the spill, carcasses of loons, cormorants, pigeon guillemots, grebes, murrelets and other species were also recovered. The recovered birds represent only a small proportion of the total number of birds killed by the spill. Many oiled birds undoubtedly floated out to sea and sank. Many oiled birds that were washed onto beaches may have been scavenged, hidden in masses of oil buried under sand and gravel by wave actions, decomposed or simply washed onto a beach that was not searched. In a number of cases carcasses found shortly after the spill were not turned in to receiving stations. The results of analyses using computer models that account for some of these variables suggest that the total number of birds killed by the spill ranged from 300,000 to 645,000, with the best approximation that between 375,000 and 435,000 birds. These estimates reflect only direct mortality occurring in the months immediately following the spill, and do not address chronic effects or loss of reproductive output.

Common and thick-billed Murres

Approximately 1,400,000 murres reside in the Gulf of Alaska region, which stretches from Unimak Pass at the tip of the Alaskan Peninsula to the Canadian border in southeastern Alaska. The total population of murres in Alaska is approximately 12,000,000. The murre colonies on the Chiswell Islands are the colonies most visited by tourists in Alaska. Most of the pre-spill data on murre abundance in the Gulf of Alaska colonies affected by the spill were gathered in the mid-1970s to the early 1980s. In 1989 and 1990 murres were the most heavily affected bird species. As oil moved out of Prince William Sound and along the Kenai Peninsula and the Alaska Peninsula, it encountered major seabird nesting areas, such as the Chiswell and Barren islands, as well as numerous smaller colonies. The oil contaminated these areas in the Gulf of Alaska at the same time that adult murres were congregating on the water near their colonies in anticipation of the nesting season. Approximately 22,000 murre carcasses were recovered following the spill.

At the major colonies in the spill area surveys indicated that an estimated minimum of 120,000 to 140,000 breeding adult murres were killed by the spill. Extrapolating this information to other known murre colonies affected by the spill, but not specifically studied, the mortality of breeding adult murres is estimated to have been 172,000 to 198,000 birds. The spill also affected wintering and non-breeding birds and the total area-wide mortality of murres is estimated to be about 300,000. Numbers of breeding murres declined in 1989 from pre-spill counts or estimates at Alaska Peninsula sites (50-60 percent), the Barren Islands (60-70 percent) and the Triplet Islands (35 percent). These decreases persisted in 1990 and 1991. No significant changes in murre numbers were noted for the Semidi Islands and Middleton Island, colonies which are in the Gulf of Alaska, but outside the spill zone. Murres exhibit strong fidelity to traditional breeding sites and infrequently immigrate to new colonies.

Normally, murres breed on cliff faces in densely packed colonies. Each murre colony initiates egg laying almost simultaneously. Synchronized breeding helps repel predators such as gulls and ravens. In oiled areas, murre colonies have fewer breeding individuals than before the spill, breeding is later than normal and breeding synchrony has been disrupted.

These changes in numbers of birds and their behavior have caused complete reproductive failure in several of the large colonies during 1989, 1990 and 1991,
and thus lost production of at least 300,000 chicks. There are some indications
that normal breeding occurred in isolated areas of the Barren Island colonies in 1991, but it is uncertain when the whole colony will start to produce significant numbers of viable chicks. Murre colonies in unoiled areas displayed none of these injuries and had normal productivity in the years since the spill.

Bald Eagles

Of the estimated Alaskan bald eagle population of 39,000 birds (27,000 adults and 12,000 fledglings), an estimated 4,000 reside in Prince William Sound, and an estimated 8,000 to 10,000 reside along the northern Gulf of Alaska coast. One hundred fifty-one (151) dead bald eagles were found following the spill. Although there is considerable uncertainty regarding the total mortality of bald eagles, several times this number may have been killed initially by the spill. Seventy-four percent of radio-tagged bald eagles that died of natural causes during subsequent studies ended up in the forest or in other places away from the beaches where they would likely not have been found had they not been tagged. If this pattern of carcass deposition is representative of what happened following the oil spill, then as many as 580 bald eagles may have been killed directly by the spill. However, since eagles dying of acute exposure to oil probably behave differently than those dying naturally and the population trend counts did not indicate a significant decline following the spill, the number of eagles killed is certainly less than this number.

To assess injuries to bald eagles, helicopter and fixed-wing surveys were flown to estimate populations and productivity. Radio transmitters were attached to bald eagles to estimate survival, distribution and exposure to oiled areas. Bald eagles in Prince William Sound were most intensively studied. Productivity surveys in 1989 indicate a failure rate of approximately 85 percent for nests adjacent to moderately or heavily oiled beaches compared to 55 percent on unoiled or lightly oiled beaches. This resulted in a lost production of at least 133 chicks in Prince William Sound in 1989. Nest success and productivity on the Alaska Peninsula were also lower in 1989 than in 1990, but differences between these years for eagles residing in other coastal

areas affected by the spill were less apparent. Nest occupancy was lower in oiled areas than in unoiled areas in both 1989 and 1990. Reproduction returned to normal in 1990 and population indices from surveys in 1982, 1989, 1990 and 1991 suggest that the spill has not measurably affected the bald eagle population in Prince William Sound.

Sea Ducks

More than 2,000 sea duck carcasses were recovered after the spill, including more than 200 harlequin ducks. Studies concentrated on harlequins, goldeneyes, and scoters--species that use the intertidal and shallow subtidal habitats most heavily affected by the spill. All of these species feed on invertebrates, such as mussels, which in 1991 continued to show evidence of petroleum hydrocarbon contamination. Harlequin ducks, which feed in the shallowest water of all these species, were most affected. In 1989 and 1990 about 40 percent of the harlequin ducks sampled had tissues contaminated with petroleum hydrocarbons, and about 33 percent of the harlequins collected in the spill area had poor body condition and reduced body fat. The 1991 survey indicates harlequin population declines and a near total reproductive failure in oiled areas of Prince William Sound (Figure 3). Oil-contaminated mussel beds may be the source of this apparent continuing problem.

Other Birds

Changes in populations of waterbirds in the spill area were assessed with boat surveys, the same technique used in surveys carried out in 1972 and 1973, and then, again in 1984. Changes were assessed on the basis of both the earlier and later pre-spill data. Declines occurred in 16 of the 39 species or groups examined for the entire Prince William Sound area between 1972-1973 and post-spill. Declining species or groups of species include: grebes, cormorants, northern pintail, harlequin duck, old squaw, scoters, goldeneyes, bufflehead, black oystercatcher, Bonaparte's gull, black-legged kittiwake, Arctic tern, pigeon guillemot, *Brachyramphus* (marbled and Kittlitz's) murrelets, and northwestern crow. The following species or group of species declined more in oiled areas than in unoiled areas since the early 1970s: harlequin duck, black oystercatcher, pigeon guillemot, northwest crow, and cormorants. Comparisons of post-spill survey data with 1984 pre-spill data indicate that harlequin duck, black oystercatcher, murres, pigeon guillemot, cormorants, Arctic tern, and tufted puffin populations declined more in oiled areas than in unoiled areas.

Marbled and Kittlitz's murrelet populations declined greatly in Prince William Sound since 1972 and 1973. In 1973, the estimated murrelet population in the Sound was 304,000 birds, while murrelet populations were estimated to be 107,000 in 1989, 81,0000 in 1990, and 106,000 in 1991. The length of time between pre-spill and post-spill surveys makes it difficult to determine the relative contribution of the spill to this decline. However, a high proportion of murrelets present in Prince William Sound were killed by the spill. Also, internal contamination of apparently healthy murrelets by petroleum hydrocarbons in the spill area opens the possibility that there were significant effects on murrelets beyond the initial mortality. Disturbance associated with clean-up activities may have influenced the number of murrelets observed in the spill area in 1989.

Nine black oystercatcher carcasses were found after the spill. This species feeds intertidally and breeds on rocky shores throughout the spill zone. In addition to mortality caused directly by the spill, oiling affected their reproductive success. Egg volume and weight gained by chicks raised on oiled sites were substantially lower than chicks raised on unoiled sites. The difference in weight gain by chicks may have resulted from differences in food supply, as the amount of food delivered to chicks raised on oiled sites was significantly less than that delivered to chicks at unoiled sites. Hatching success, fledging success, and productivity of young birds were not significantly different between oiled and unoiled sites. Direct disturbance by clean-up activities significantly reduced oystercatcher productivity on Green Island during 1990.

Pigeon guillemots are nearshore diving seabirds that gather daily on intertidal rocks near their colonies during the breeding season and forage by probing into intertidal and subtidal recesses and kelp. Five hundred sixteen (516) guillemot carcasses were recovered following the spill. Between 1,500 and 3,000 guillemots were estimated to have been killed by the spill, representing as much as 10 percent of the known pigeon guillemot population in the Gulf of Alaska. Boat surveys indicate that in 1973 the Prince William Sound guillemot population was approximately 14,600; while in 1989, 1990 and 1991, the estimated populations were, respectively, 4,000, 3,000 and 6,600. These data indicate that the Prince William Sound guillemot population was declining prior to the spill. The declines were significantly greater, however, in oiled areas. For the four islands of the Naked Island group, post-spill surveys showed a 40 percent decline in guillemots present during peak colony attendance hours compared to pre-spill surveys. Declines corresponded to the degree of shoreline oiling.

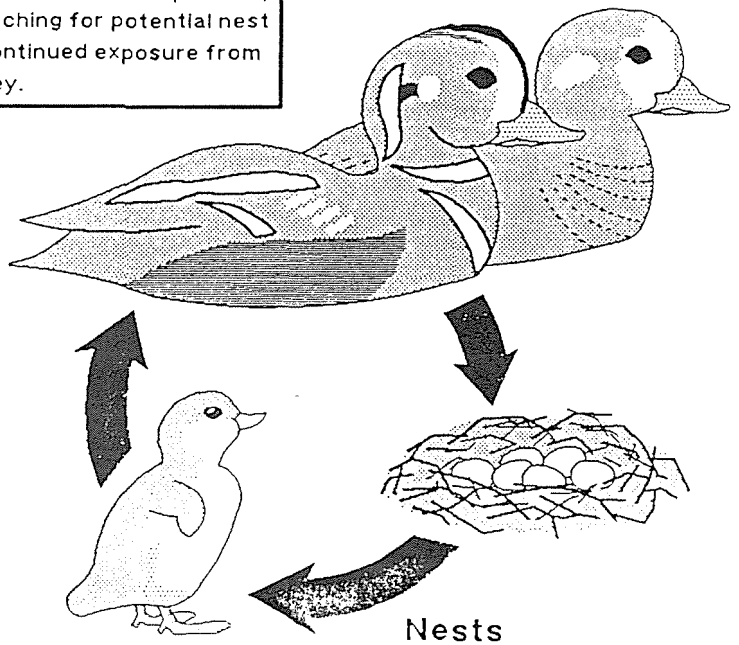
The extent of injury to certain species, including loons, cormorants and gulls, will never be known because pre-spill population estimates for these species in the spill area are not available. Although Peale's peregrine falcons did not appear to be directly affected by the oil spill, disturbance from nearshore activities appears to have affected rates of nest occupancy and reduced clutch and brood sizes in 1989. Studies of song birds did not document an injury from the spill.

Harlequin Ducks

Adults

In early May, paired harlequins congregate at the mouths of anadromous fish streams. The pairs fly upstream to search for suitable nest sites. Wintering harlequins feed on mussels and crustaceans in intertidal waters.

INJURY: Pairs are not congregating at streams in the Exxon Valdez oil spill area, nor are they searching for potential nest sites. Possible continued exposure from contaminated prey.



Broods

Broods hatch in July. They remain on freshwater with the female until August when they return to coastal waters.

INJURY: No broods observed within the Exxon Valdez oil spill area in 1990, and only one brood found in 1991, indicating reproductive failure at nesting and/or poor brood survival.

Nests

Located along shallow and swift rivers and streams. 3 to 7 eggs are laid in May and incubated for 28 - 30 days.

INJURY: No nests discovered in the Exxon Valdez oil spill area.

Figure 3. Summary of the major injuries in relation to the life history of harlequin ducks.

Fish and Shellfish

Introduction

No massive kills of adult open-water fish were observed following the spill. Adult salmon, for example, were able to migrate as expected to spawning areas after the spill. The early life stages of some fish species and adults of others depend on the intertidal and shallow subtidal areas and the upper layers of the sea where the greatest concentrations of oil occurred. In addition the eggs and larvae of fishes are more sensitive to oil contamination than are adults.

It is not surprising, therefore, that the available evidence from this spill indicates that the greatest damage was to the eggs and larvae of some species of fish, especially those that inhabit and spawn in the intertidal zone (salmon) and shallow subtidal zone (herring) or that forage in shallow water (Dolly Varden and cutthroat trout). Many species of fish produce large numbers of eggs and only a relatively small number reach adulthood. Since natural factors affecting such survival change from year to year it is difficult to estimate or measure the effects of oil on adult fish populations whose early stages were injured. Nevertheless, during 1991, data were gathered that would potentially help clarify the effects on adult fish exposed to oil as eggs or larvae. These data are still being analyzed.
The deaths of some rockfish, a deepwater species, also were attributed to oil. Several species of coastal and offshore fish, including pollock, halibut, sablefish, cod, yellowfin and flathead sole and rockfish, showed evidence of continuing
exposure to petroleum hydrocarbons over a large geographic area, but significant injury has not been documented. Because salmon and other fish species can metabolize petroleum hydrocarbons, these contaminants are unlikely to concentrate in fish tissues. Indicators of exposure in fish include increased concentrations of hydrocarbon metabolites in bile and activities of mono-oxygenates in liver tissue.

Pink Salmon

The full extent of short-term injury to pink salmon cannot be assessed until after the 1991 run returns have been analyzed. As predicted before the spill, the catch of pink salmon in Prince William Sound during 1990 was an all-time record high and the 1991 run was also quite high. These catches were primarily due to strong runs of hatchery-produced salmon. Survival to adulthood of salmon fry released from the Armin F. Koerning hatchery, located in the middle of a heavily oiled area of the spill zone, was half that of Esther Hatchery, located outside the spill area. Wild production of pink salmon did not mirror the record production of hatchery fish.

Seventy-five percent of wild pink salmon in Prince William Sound spawn in the intertidal portion of streams. Wild salmon did not shift spawning habitat following the spill and many salmon deposited their eggs in intertidal areas of oiled streams. In the autumn of 1989 egg mortality in oiled streams averaged about 15 percent, compared to about 9 percent in unoiled streams. Subsequently, egg mortality has generally increased. In 1991 there was a 40 to 50 percent egg mortality in oiled streams, and about an 18 percent mortality in unoiled streams. The relative roles of the spill and other factors, including natural variability, in causing the increased 1991 egg mortality are being analyzed. In general the number of spawning fish in streams of Prince

William Sound indicates that the more viable spawn that is produced, the more adults will return to spawn from that year class. If this is true, then it is likely that mortality at the egg stage is additive with other sources of mortality in later stages and that the increased egg mortality observed since the spill is a threat to wild pink salmon in Prince William Sound. Eggs and larvae of wild populations continue to be exposed to oil in intertidal gravel in some areas.

Pink salmon juveniles were exposed to petroleum hydrocarbons from the spill in nearshore marine habitats in oiled portions of Prince William Sound in 1989. The survival of pink salmon to adulthood is directly related to growth rates during the initial marine residency. Growth rates of juvenile pink salmon were lower in oiled locations in 1989, but there was no evidence of continued reduced growth of juvenile salmon in nearshore waters in 1990. Laboratory experiments in 1991 confirmed that ingestion of food contaminated with oil can cause reduced growth and increased mortality of juvenile pink salmon.

Fry growth was decreased in oiled streams as compared to unoiled streams over the winter of 1989-1990 and larvae from some heavily oiled streams showed gross morphological abnormalities, including club fins and curved vertebral columns. The pink salmon that returned to Prince William Sound in the summer of 1990 were hatched prior to the spill and were exposed to oil as larvae. Although there is great uncertainty, some analyses suggest that the 1990 return of both wild and hatchery pink salmon was 20 to 25 percent lower than expected without the spill, resulting in a return of 15 to 25 million fewer fish. Fish that returned in 1991 were the first that were exposed to oil as eggs. The returns of wild salmon to oiled and unoiled streams in 1991 are still being analyzed.

Sockeye Salmon

Commercial harvest of sockeye salmon was curtailed in portions of Cook Inlet, Chignik, and Kodiak in 1989 because of the spill, resulting in an unusually high number of adults returning to spawn in certain lake systems--for example, Kenai and Skilak lakes, Red and Akalura lakes. The number of adults returning to the spawning areas is referred to as the "escapement." Commercial salmon fisheries are actively managed to maintain high production, and large overescapements resulting in low smolt production are a threat to the maintenance of sustained good production. In this case overescapement has resulted in poor survival to the smolt stage in the Kenai and Skilak lakes system. This overescapement is expected to result in a return of adults in 1993 and 1994 that is less than needed for adequate production. Total closure or severe reduction of the commercial and sport sockeye fisheries may be necessary in those years to enable recovery of this species in the Kenai and Red lakes systems. These fisheries account for up to half the commercial sockeye harvest in the Kodiak and Cook Inlet areas.

Dolly Varden and Cutthroat Trout

Prince William Sound is the northern extent of the range of cutthroat trout (Figure 4). Both cutthroat trout and Dolly Varden use nearshore and estuarine habitat for feeding throughout their lives, although they overwinter and spawn in freshwater. The highest concentrations of petroleum hydrocarbon metabolites in bile of all fish sampled in 1989 were found in Dolly Varden. Tagging studies demonstrated that the annual mortality of adult Dolly Varden in oiled areas was 32 percent greater than in unoiled areas. The larger cutthroat trout also showed higher levels of mortality in oiled than in unoiled areas. In 1989-1990, there was 57 percent greater mortality, and in 1990-1991, a 65 percent greater mortality, in oiled streams versus unoiled streams.

Additionally, cutthroat trout growth rates in oiled areas were 68 percent in 1989-1990 and 71 percent in 1990-1991 of those in unoiled areas. Although concentrations of bile hydrocarbons were greatly reduced in 1990 and 1991, indicating less exposure to oil, it is unclear why differences persist in survival rates between oiled and unoiled streams.

Pacific Herring

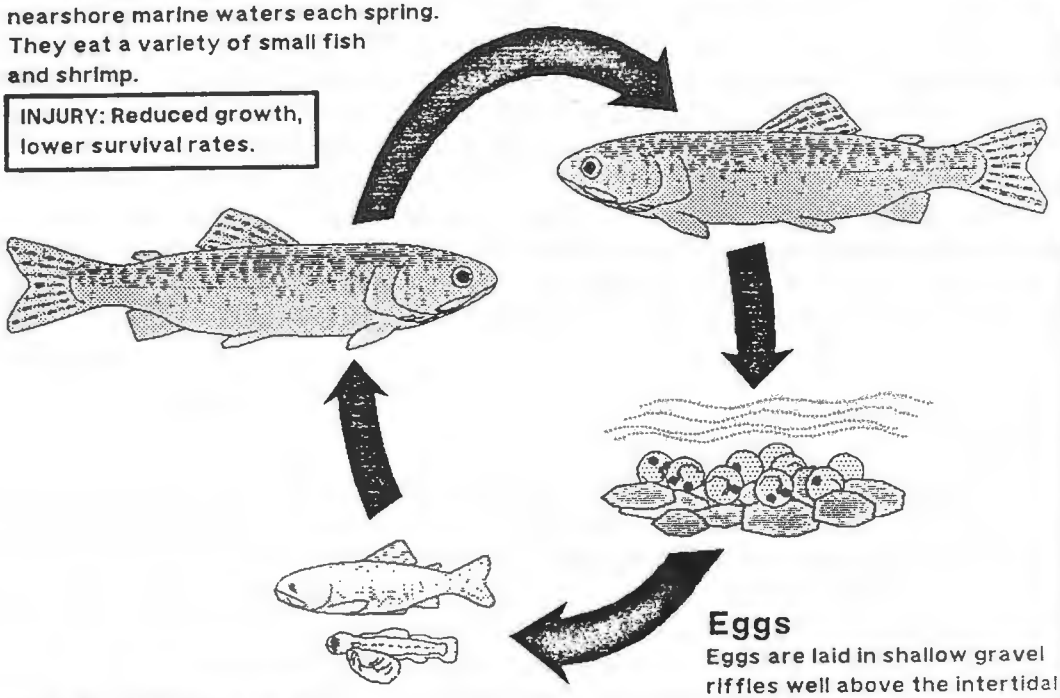
Populations of Pacific herring were spawning in shallow eelgrass and algal beds at the time of the spill. The effects of oil on egg survival, hatching success, larval development and recruitment to the spawning population were studied. A large percentage of abnormal embryos and larvae were found in samples from oiled areas of Prince William Sound collected during the 1989 reproductive season. Larvae in oiled areas also had a greater incidence of eye tumors. Analysis of histopathological abnormalities in tissues of adult herring reveal the occurrence of some lesions whose presence would be consistent with exposure to oil. Whether the adult population has been affected by these larval injuries and lesions will not be determined until the 1989 and 1990 cohorts return to spawn in 1992 and 1993. It will be difficult, however, to measure a change in the adult population, beyond the bounds of the natural variability.

Evidence of oil contamination in adult herring was found in 1989 and 1990. In 1989, hydrocarbon metabolites occurred in the bile of adult fish. There were significant changes in the incidence of histopathological lesions and in the parasite burden of adults found in oiled as compared to unoiled sites. The parasite burden of adult herring returned to pre-spill incidences in 1991.

Rockfish and Other Fish

A small number of dead rockfish were found after the spill; this was the only type of fish observed dying after the spill. Five rockfish were recovered soon enough after death to establish oil exposure as the probable cause of death. Analyses of rockfish bile indicated exposure to oil in a significant portion of the samples collected from oiled areas in 1989, only one individual in 1990 and none in 1991. Histopathological liver lesions were evaluated in 1990 and two types of lesions (liver lipidosis and liver sinusoidal fibrosis) were found to be significantly elevated in oiled areas. Other species that had measurable amounts of petroleum hydrocarbon metabolites in the bile in 1989 included halibut, pollock, rock sole, yellowfin sole, flathead sole and Pacific cod, and in 1990, Dover sole and sablefish.

Cutthroat Trout



Adults in Freshwater

Wild cutthroat mature in 2 - 10 years and may spawn in several consecutive years. Spawning occurs in late fall and winter in small tributaries to coastal streams.

INJURY: None expected.

Adults at Sea

Cutthroat return to estuarine and nearshore marine waters each spring. They eat a variety of small fish and shrimp.

INJURY: Reduced growth, lower survival rates.

Eggs

Eggs are laid in shallow gravel riffles well above the intertidal zone and hatch 28 - 40 days later.

INJURY: None expected.

Fry & Juveniles

Wild cutthroat remain in freshwater until reaching approximately 20 - 25 cm in length. Growth is largely dependent on environmental conditions. Smolt migrate to estuaries between March and July, and return to fresh water in the fall.

INJURY: Unknown or none.

Figure 4. Summary of the major injuries in relation to the life history of cutthroat trout.

Introduction

The coastal tidal zone, commonly known as the "intertidal zone," was the most severely contaminated habitat. Intertidal habitats are highly productive and biologically rich. The intertidal zone is particularly vulnerable to the grounding of oil, its persistence and effects of associated clean-up activities.

Supratidal

The supratidal zone is above the high tide but still within the influence of the ocean from storm surges and wave spray. Results of studies from the Kodiak Island and Alaska Peninsula areas suggest that oil in the supratidal habitat and beach clean-up disturbance decreased the productivity of grasses and other vegetation, including beach rye, a grass that helps stabilize beach berms. In one instance, clean-up activities completely removed the supratidal vegetation. Increased production of supratidal vegetation was found in Prince William Sound in 1989. Increased production as a result of decreased browsing by terrestrial mammals or a fertilizing effect of the oil are possible causes.

Intertidal

Populations of intertidal organisms were significantly reduced along oiled shorelines in Prince William Sound, on Kodiak Island and Cook Inlet, and along the Alaskan Peninsula. Densities of intertidal algae (*Fucus)*, barnacles, limpets, amphipods, isopods, and marine worms were decreased. Although there were increased densities of mussels in oiled areas, they were significantly smaller than mussels in the unoiled areas, and the total biomass of mussels was significantly lower. Sediment traps collected significant concentrations of petroleum hydrocarbons during the winter of 1990-1991, indicating that oil is continuing to be removed from the beaches by cleaning and natural processes and is being transported subtidally. Intertidal organisms continue to be exposed to petroleum hydrocarbons from subsurface oil in beaches.

In 1991 relatively high concentrations of oil were found in mussels and in the dense underlying mat (byssal substrate) of certain oiled mussel beds. These beds were not cleaned or removed after the spill and are potential sources of fresh oil for harlequin ducks, black oystercatchers, river otters and juvenile sea otters--all of which feed on mussels and show signs of continuing biological injury. The extent and magnitude of oiled mussel beds are unknown and continue to be investigated.

Intertidal fishes were less abundant in oiled areas than in unoiled areas in 1990. No such differences were documented in 1991.

Fucus, the dominant intertidal plant, was severely affected by the oil and subsequent clean-up activities. The percentage of intertidal areas covered by *Fucus* was reduced following the spill, but the coverage of opportunistic plant species that characteristically flourish in disturbed areas was increased. The average size of *Fucus* plants was reduced, the number of reproductive-sized plants greatly decreased, and the remaining plants of reproductive size decreased in reproductive potential due to fewer fertile receptacles per plant. Recruitment of *Fucus* at oiled sites was also reduced.

Subtidal Habitat

Between 1989 and 1991, oil concentrations declined in intertidal sediments sampled at most oiled locations, while the concentration in shallow subtidal sediments at depths of 3-20 meters remained about the same or in some cases, rose slightly. Petroleum hydrocarbon accumulation in filter-feeding mussels experimentally placed in the water column in various oiled areas was significant during the summer of 1989, but decreased in 1990. Patterns of sediment toxicity to marine amphipods and larval bivalve molluscs, used as test organisms, reflected similar patterns. In 1990 significant toxicity to these organisms was associated only with intertidal sediment samples from heavily oiled sites, but in 1991 toxicity was associated primarily with sediment samples from the shallow subtidal zone. The current evidence from analyses of petroleum hydrocarbons in the bile of bottom-dwelling fishes suggests that animals living on or near the sea floor continue to be exposed to petroleum hydrocarbons. In this connection the analysis of samples of bottom-dwelling organisms at the 100-m depth is continuing to see if there was a detectable effect of oil deep communities.

Clams exposed to oil actively take up hydrocarbons, but metabolize them very slowly. Hydrocarbons are consequently accumulated in high concentrations in clams. Studies of clam growth rates were initiated after the spill and analyses are still being conducted. Contaminated clams and other invertebrates are a potential continuing source of petroleum hydrocarbons for harlequin ducks, river otters, sea otters and other species that forage in the shallow subtidal zone. Samples from pollock, which feed in the water column, taken 500 miles from the T/V *Exxon Valdez* grounding site on Bligh Reef, showed elevated petroleum hydrocarbon metabolite concentrations in their bile. These data indicate that surface oil affected the water column or food supply at great distances from the spill.

No pre-spill data were available to directly determine if the oil spill had altered shallow subtidal communities, so the effects of hydrocarbons were investigated by comparison of oiled and unoiled areas. Data are available for 1990. The greatest differences between oiled and unoiled areas have been observed in the shallow-water eelgrass beds and their associated habitat. Within the oiled eelgrass beds there were lower densities of eelgrass, fewer *Telmessus* crabs and fewer amphipods, but more small mussels and juvenile cod. Even greater differences were observed, however, in the abundance of fauna at depths from 6-20 meters below the oiled eelgrass beds, where there were far fewer individuals in oiled areas. In the shallow subtidal rocky areas (less than 20m) *Laminaria* communities were studied, both in bays and around points on the open coast. In the *Laminaria* habitat fewer differences were noted between oiled and unoiled areas. The most noticeable difference was the greater abundance of young *Laminaria* plants, but fewer large older plants in oiled areas. In shallow-water sandy areas, eelgrass beds and areas around them were studied.

Post-spill populations of spot shrimp were studied in oiled and unoiled areas of Prince William Sound. Some differences were found between populations in these areas. The results of these studies are still being evaluated.

The spill directly impacted archaeological resources, subsistence, recreation, wilderness qualities and aesthetic and other indirect uses. Clean-up activities and the associated significant increases in human activity throughout the spill zone resulted in additional injuries to these resources and services.

Archaeological Resources

Archaeological resources along the shoreline were injured by the spill. Review of spill response data revealed injuries occurred at a minimum of 35 archaeological sites, including burial and home sites. These injured sites are distributed on both Federal and State lands. While injury to these 35 sites was documented during cleanup, a spill-wide assessment of injuries to archaeological resources has yet to be completed. In addition to oil contamination, increased knowledge of the location of archaeological sites puts them at greater risk from looting. Additional injury due to erosion caused by oil-spill response activities was documented.

A study was conducted to determine impacts caused by oil contamination on radiocarbon dating of archaeological resources and to investigate the potential for cleaning artifacts and materials to allow such dating. Results indicate significant injury to the ability to date artifacts and materials by Carbon ^{14} analysis.

Subsistence

Surveys undertaken by State researchers before the spill and in 1990 indicated that subsistence users in the oil-spill area significantly reduced their use of subsistence resources after the spill, primarily because of concern about contamination of these resources. The oil spill disrupted the subsistence lifestyle of some communities that have historically relied upon these resources for a significant portion of their diet. Some communities virtually or entirely ceased subsistence harvests in 1989 and have only gradually begun to resume harvests, while other communities continued some reduced level of subsistence harvest in 1989 and thereafter. Warnings were issued by the State in 1989 for people to avoid consumption of intertidal invertebrates (such as mussels and clams, which accumulate petroleum hydrocarbons) found along shorelines contaminated by oil. After the spill, an oil-spill health task force was formed, including representatives of the State and Federal governments, subsistence users, and Exxon. This group helped oversee studies conducted by the State and others in conjunction with the Food and Drug Administration and National Oceanic Atmospheric Administration in 1989, 1990 and 1991, on subsistence foods, such as seals, deer, salmon, ducks, clams and bottomfish. Based upon the test results these resources, with the exception of clams and mussels in certain oiled areas, such as Windy Bay, were determined to be safe for human consumption.

Recreation

Following the oil spill, recreational use of public lands and waters declined. Recreationists (e.g., sport fishermen, hunters, campers and sea kayakers) avoided oiled areas and many adjacent areas that were affected by clean-up activity. Many users canceled their plans or pursued their activities in other areas within the state. For example, visitor use in the coastal area of the Kenai Fjords National Park dropped by about 50 percent in 1989, compared to 1988. This disruption

continued in 1990, because oil remained present in many areas and some clean-up activity continued. In 1991 oil remained in many areas used by recreationists.

Wilderness and Intrinsic Values

There are designated "wilderness areas" in Kachemak Bay State Wilderness Park, Katmai National Park, and Becharof National Wildlife Refuge. In addition Federal "wilderness study" areas are located in Kenai Fjords National Park and the Chugach National Forest. Portions of these areas were oiled by the *Exxon Valdez* spill. The Wilderness Act of 1964 requires that Federal wilderness areas be "administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired..." Thus, the presence of oil, which was most recently documented by the 1991 May Shoreline Assessment, may be perceived as an injury to these areas. In addition to the injury from the oil, hundreds of workers, motorized machinery and support equipment were used in the wilderness areas during the cleanup. These clean-up activities disrupted uses of the wilderness, such as camping and fishing. These lands and resources may have intrinsic or nonuse values, as well as uses, which also were affected by the oil spill.

APPENDIX B:
EVALUATION OF THE PROPOSED PROJECTS BY THE CHIEF SCIENTIST

APPLIED
marine
SCIENCES

September 22, 1992

To: Trustee Council for the *Exxon Valdez* Oil Spill

From: Dr. Robert B. Spies, Chief Scientist

Subject: Recommendations on the 1993 Workplan (revision of 9/20/92 memo)

In carrying out the independent review of the 1993 workplan that you requested at the September 14th meeting of the Trustee Council, I have assumed that restoration funds should be used for one of the following purposes:

1. Further define the nature of damage from the oil spill and differentiate it from other sources of variability in populations and communities of organisms in the oil spill area.

2. Document the rate of recovery of populations and communities where measurable damage has been found.

3. Supplement natural recovery processes or prevent further degradation of habitat that could negatively influence recovery of injured resources.

4. Help in the regulation of the harvest of natural resources to contribute to recovery of injured resources.

An ideal restoration program would directly aid the replenishment of populations of seabirds, sea otters, some anadramous fish and intertidal communities injured by the spill. The adaptations for survival in organisms are the ultimate technological fix for replenishment and mother nature is doing most of the restoration for the Trustees (in a very cost effective manner). We can influence resource recovery most directly where an active harvest of resources (mainly fish or trees, in this case) can be regulated, provided we have enough information to implement effective regulations.

The other lines of action are (1) study to clarify injury and document recovery and (2) habitat protection. The Trustees may wish to examine the possibility that establishment of an endowment in the near future would assure continuing study of natural resources beyond the date that funds would be depleted at the present rate of spending. I would endorse, in concept, such a proposal as providing the most efficient and lasting source for funding for study leading to better resource

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management, just as habitat protection and acquisition has been advocated as a lasting solution to resource protection.

The 1993 workplan was developed by obtaining ideas from agencies and the public, and then combining and culling these ideas using various criteria to produce the final package before you. The votes in the package are the recommendations of the Restoration Team. My review and those of the peer reviewers were based on our knowledge of the injuries and the three-page descriptions provided for each project. This provided enough conceptual information to judge the proposals on the basis of the criteria listed above. Some relative differences between the Restoration Team's vote and the scores in this memo may be resolved after the review of the detailed study plans.

The recommendations in this memo represent an assessment of each project without much analysis of the accompanying budgets, as detailed budgets were not available in time for the kind of review carried out for the 1992 workplan. In addition, the overall cost of the projects put out for competitive bid could differ significantly from the estimates currently available from the agencies. I recommend that detailed analysis of each proposed project be carried out later in conjunction with the finance committee.

I have used a simple scoring system for evaluating the 52 projects in the package:

"1" Contributes directly to the restoration of injured species with a high probability of success.

"2" May help in restoration of the injured species through management actions, provides a better understanding of the nature of the injury, is a restoration feasibility study or documents the course of recovery.

"3" Project has a low probability of contributing to recovery.

"4" Project is inappropriate for a restoration program as it will not contribute to recovery of injured resources.

"E" The project may enhance natural resources, but is unrelated to recovery of injured resources.

"S" Special consideration. In several cases, I thought it inappropriate for me to score projects that did not deal with damage to natural resources (e.g., damage to recreation, s of the proposals received a score of "1".

Project Number	Score	Comments
93002	2	This project is an attempt to pin down mechanisms responsible for a continuing problem of poor smolt survival in the Kenai River system.
93003	2	This project investigates the continuing damage to pink salmon eggs, particularly with regard to whether this may be due to oil or other factors.
93004	E	No data exist that demonstrate a measurable effect of the oil spill on adult pink salmon.
93005	S	The peer reviewer for archeology was generally supportive of the educational goals of this project.
93006	2	There was also a favorable review of this project. Some actual restoration of resources and services will occur through this project.
93007	S	This was endorsed by the archaeological reviewer. This has no score as it is an enforcement action.
93008	S	The Trustees may wish to consider whether the additional funds for training and education beyond normal agency activities are justified by the spill injury.
93009	S	The Trustees will have to determine the need for a public information project. I have no opinion to offer on this project.
93010	2	This may help a number of greatly affected murre colonies subject to periodic disturbance from firearm discharge on halibut charter boats. If an educational program does not help this problem some enforcement action may eventually be necessary.

Project Number	Score	Comments
93011	3	Develops data on the levels of harvest of river otters, which may or may not have suffered a population-level effect from the spill and harlequin ducks, which did suffer an apparent reproductive effect from the spill, but for which there is little apparent hunting pressure.
93012	2	Aids in the management of the upper Cook Inlet mixed stock fishery and thereby contributes directly to the management of the Kenai River sockeye fishery. This fishery is likely to sustain a low return in 1994 and beyond due to the overescapement problem in the Kenai River system. The Trustees may wish to consider how much additional management costs were caused by the spill-related problem.
93014	E	This will aid in the general management of pink, chum and sockeye salmon. The pink salmon and chum salmon fisheries did not suffer a demonstrated injury as a result of the spill. However, the sockeye salmon fishery may show an effect on adult stocks in the next several years in some systems.
93015	2	This project will contribute to the management of the mixed stock fishery. I can make no recommendation on the appropriate amount of additional funding necessary to properly supplement the ADF&G budget for the extra management of the Kenai River sockeye salmon fishery necessary since the spill.
93016	S	No opinion on the appropriateness of this project.
93017	S	If past reports on safety of subsistence foods have not been accepted in the native community the Trustees may want to consider the chances for a similar approach to work again.
93018	3	This is a management action for stocks not directly affected by the spill, but for stocks outside the spill area for which it is assumed are being impacted by closure of some streams in the oil impacted zones.

Project Number	Score	Comments
93019	4	Oysters (which are not an indigenous species) in particular, and shellfish in general, have not been shown to be depleted because of the spill.
93020	4	Shellfish have not been shown to be depleted because of the spill. The contamination of the shellfish by petroleum hydrocarbons over much of the spill area is likely to be very low or non-existent by the time a hatchery is built. It is not certain whether hatchery output will significantly enhance natural populations of shellfish. There was a large set of mussels in 1992 in PWS.
93022	2	This feasibility study may indicate if there is anything that can be done to help asynchronously breeding murres recover more quickly.
93024	E	The project supposes an injury to sockeye salmon smolt in the spill area that is not documented.
93025	E	There is not data to support an injury to adult chum salmon in the spill area. Montague Island shoreline was not heavily oiled.
93026	S	This is to compensate for a lost service--an expected shortfall of salmon for fisherman on the Kenai within the next several years. There appears to be insufficient independent review of the risks to natural runs of salmon and other fishes from hatchery rearing of several species with subsequent release in upper Cook Inlet.
93028	E	No strong link to injured resources. May help some migratory birds.
93029	E	No strong link to injured resources. May eventually help some species, but probably long after spill recovery is completed.

Project Number	Score	Comments
93030	2	This is a management action (hatchery incubation of eggs of natural run fish) to compensate for likely injury to adult run from overescapement in 1989. This project will be activated only if escapement falls below 150,000 by August 1, 1993. Natural recovery of this system will take longer than if action were to be taken.
93031	S	This aquaculture project will raise sockeye smolts in net pens to be released into Kitoi Bay. It is not designed to rebuild the natural run at Red Lake, but is compensation for loss of services--commercial fishing around Kodiak Island.
93032	E	No data exist that demonstrate a measurable effect of the oil spill on adult pink salmon.
93033	2	A worthwhile project on an injured species.
93034	3	This project will identify areas that could be protected to prevent further habitat degradation during natural recovery of pigeon guillemots. There were at least 600 and perhaps as many as 3000 pigeon guillemots killed by the spill. Tracking natural recovery of this species is problematical since pre-spill population estimates occurred only in 1973 and 1984/1985 and the boat survey data have low precision. It is uncertain to what extent there are impediments to recovery for this species. Their habitats are not greatly threatened by development and existing laws are probably sufficient to provide such protection.
93035	3	There has been no population-level injury established for oyster catchers, only a continued indication of a slight effect on egg size during development. With the lack of pre-spill data in the study areas the injury is somewhat uncertain.
93036	2	This study will attempt to determine to what extent oil remains in intertidal mussel beds and whether it is a source of continuing contamination of higher trophic level organisms.

Project Number	Score	Comments
93038	2	Needed to monitor natural recovery of oiled intertidal habitat in PWS.
93039	2	This study will document the recovery of intertidal communities affected by the oil spill and cleanup.
93041	2	This will form the basis of formulating a long-term plan of study and monitoring within the spill zone. The effort needs focus.
93042	E	In my opinion killer whales were not affected by the spill, although something abnormal happened around the time of the spill to AB pod.
93043	3	This project will (1) survey otter populations by fixed-winged aircraft, (2) construct a population model to help predict recovery, (3) identify patterns of habitat use, and (4) classify sea otter habitat within PWS. Goals 1 and 2 are worthwhile supplements to the boat surveys (93045) in studying and in prediction of recovery. Some collation of past data is justified under goals 3 and 4, but there is concern about the size of the overall budget and the number of USFWS employees proposed.
93045	2	This is the only continuous set of data on bird and sea otter populations since the spill and should be continued.
93046	3	The surveys of harbor seal haulouts are very valuable in tracking recovery. The habitat use studies will yield valuable information but have little probability of assisting in the recovery of this species. With a reduced scope of work and budget, this would move to a score of 2.
93047	2	This is a worthwhile study of the recovery of the subtidal habitat.

Project Number	Score	Comments
93048	S	The existing communications have been useful for field work in the spill area, but the replacement costs proposed here are very high.
93050	2	This will provide a catalog of existing data on resource inventories, resource damages, management plans, land ownership, etc. that will be very useful in the restoration process.
93051	3	This project has three components: (1) to identify marbled murrelet nesting habitat ($480K), (2) to complete a foot survey of anadramous streams on all private lands in the oil spill area ($335K), and (3) to develop channel typing procedures for evaluation from aerial photography of anadramous stream habitat ($745K). Goal 3 will be useful only if the Trustees feel the need to gather further information on public lands. New rules for the Chugash National Forest have reduced the threat of logging on public lands in the spill area. Adequate information for the purposes of proposed habitat protection on private lands will be provided by component 2. As components 1 and 2 are more germane to achieving restoration through management or acquisition, removal of component 3 would improve the score to a 2. Data is needed on land adjacent to streams to evaluate it suitability for supporting injured species
93052	4	Bald eagles were injured by the spill, but this could not be detected in the population surveys. Since we have no way of measuring recovery of this species restoration action seems inappropriate.
93053	2	This project is technical support for other ongoing studies.
93057	2	This project is technical support for other ongoing studies. Funding for this and other GIS projects (93062) should be contingent on peer review.
93058	2	Habitat protection will prevent degradation that could have a negative effect on natural recovery of injured species.

Project Number	Score	Comments
93059	2	Information needed to develop a restoration option for early habitat protection.
93060	2	Information needed to develop a restoration option for habitat protection.
93061	2	Information needed to develop a restoration option for habitat protection.
93062	2	GIS: restoration. A needed tool for data analysis and mapping.
93063	E	There was not an injury to pink and chum salmon and this project is mainly to benefit these species.
93064	2	Habitat protection will prevent degradation that could have a negative effect on natural recovery of injured species.

CC: Barton
Cole
McVee
Pennoyer
Rozier
Sandor
Restoration Team

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1993 WORK PLAN

SUMMARY RECOMMENDATION MATRIX

INCLUDING TRUSTEE COUNCIL ACTIONS

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93002 - Sockeye Overescapement	Recommended Y-5 N-1	Recommended	Recommended Y-9 N-5	Approved [1]	$ 714,600
93003 - Pink Salmon Egg to Pre-emergent Fry Survival in PWS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 686,000
93004 - Documentation, Enumeration and Preservation of Genetically Discrete Wild Populations of Pink Salmon Impacted by EVOS in PWS	Recommended Y-5 N-1	Enhancement Project	Recommended Y-8 N-3 A-2	Not Approved	------

[1] Approved contingent upon review of potential modifications resulting from sockeye synthesis (peer review) meeting in March and a detailed review of the overall budget by ADF&G and discussion at the next Trustee Council meeting. Only essential commitments should be expended until that time.

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93005 - Cultural Resources, Information, Education and Interpretation	Unanimously Recommended	No Opinion	Recommended with Qualifications	Not Approved	------
93006 - Site-Specific Archeological Restoration	Unanimously Recommended	Recommended	Recommended with Qualifications	Approved	$ 260,100
93007 - Archeological Site Stewardship Program	Unanimously Recommended	No Opinion	Recommended with Qualifications	Not Approved	------
93008 - Archeological Site Patrol and Monitoring	Unanimously Recommended	No Opinion	Recommended with Qualifications	Not Approved	------
93009 - Public Information, Education and Interpretation	Recommended Y-5 N-1	No Opinion	Recommended with Qualifications	Not Approved	------
93010 - Reduce Disturbance Near Murre Colonies Showing Indications of Injury From the EVOS	Not Recommended Tie Vote Y-3 N-3	Recommended	Unanimously Not Recommended	Not Approved	------

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93011 - Develop Harvest Guidelines to Aid Restoration of River Otters and Harlequin Ducks	Recommended Y-5 N-1	Recommended	Recommended Y-9 N-3 A-1	Deferred until 2/16/93 Meeting[1]	To be Determined
93012 - Genetic Stock Identification of Kenai River Sockeye Salmon	Recommended Y-5 N-1	Recommended	Unanimously Recommended Look at reducing budget combine with 93015	Approved[1]	$ 300,600
93014 - Quality Assurance for Coded-Wire Tag Application in Fish Restoration Projects	Not Recommended Tie Vote Y-3 N-3	Enhancement Project	Unanimously Not Recommended	Withdrawn	------
93015 - Kenai River Sockeye Salmon Restoration	Recommended Y-5 N-1	Recommended	Unanimously Recommended Look at reducing budget	Approved[1]	$ 732,600

[1] Approved contingent upon review of potential modifications resulting from sockeye synthesis (peer review) meeting in March and a detailed review of the overall budget by ADF&G and discussion at the next Trustee Council meeting. Only essential commitments should be expended until that time.

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93016 - Chenega Chinook and Coho Salmon Release Program	Recommended Y-5 N-1	No Opinion	Unanimously Recommended Increase budget to $50.9K to cover Hatchery costs	Deferred until NEPA Completed Evaluate at next 2/16/93 meeting	To be Determined
93017 - Subsistence Food Safety Survey and Testing Restoration Project	Unanimously Recommended	No Opinion	Unanimously Recommended More local community involvement	Approved with Modifications Remove $53.5 for Transportation Costs	$ 307,100
93018 - Enhanced Management for Wild Stocks in PWS, Special Emphasis on Cutthroat Trout and Dolly Varden	Recommended Y-5 N-1	Not Recommended	Unanimously Recommended	Not Approved	------
93019 - Chugach Region Village Mariculture Project	Unanimously Not Recommended	Not Recommended	Recommended Y-8 N-4 Contingent upon legal approval	Not Approved	------

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93020 - Bivalve Shellfish Hatchery and Research Center	Not Recommended Tie Vote Y-3 N-3	Recommended Closer Study for Feasibility	Unanimously Recommended Contingent upon legal review	Not Approved	------
93022 - Evaluating the Feasibility of Enhancing Productivity of Murres by Using Decoys, Dummy Eggs and Recordings of Murre Calls to Simulate Normal Densities at Breeding Colonies Affected by EVOS and Monitoring the Recovery of Murres in the Barren Islands	Unanimously Recommended	Recommended	Unanimously Not Recommended	Approved Monitoring Component only	$ 177,200
93024 - Restoration of the Coghill Lake Sockeye Salmon Stock	Recommended Y-5 N-1	Enhancement Project	Unanimously Recommended	Deferred until 2/16/93 meeting	To be Determined
93025 - Montague Island Chum Salmon Restoration	Recommended Y-5 N-1	Enhancement Project	Unanimously Recommended	Not Approved	------
93026 - Fort Richardson Hatchery Water Pipeline	Not Recommended Tie Vote Y-3 N-3	No Opinion	Recommended Y-9 N-4	Not Approved	------

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93028 - Restoration and Mitigation of Wetland Habitats for Injured PWS Fish and Wildlife Species	Recommended Y-5 N-1	Enhancement Project	Not Recommended Y-3 N-8	Not Approved	------
93029 - PWS Second Growth Management	Recommended Y-5 N-1	Enhancement Project	Tie Vote Y-5 N-5 A-1	Withdrawn	------
93030 - Red Lake Restoration	Recommended Y-5 N-1	Recommended	Unanimously Recommended	Deferred until 2/16/93 meeting	To be Determined
93031 - Red Lake Mitigation for Red Salmon Fishery	Recommended Y-5 N-1	No Opinion	Recommended Y-10 N-1 A-2	Not Approved	------
93032 - Pink and Cold Creek Pink Salmon Restoration	Recommended Y-5 N-1	Enhancement Project	Recommended Y-12 N-1 Consult w/ Landowner	Not Approved	------
93033 - Harlequin Duck Restoration Monitoring Study in PWS, Kenai and Afognak Oil Spill Areas	Unanimously Recommended	Recommended	Unanimously Recommended	Approved at Reduced Level	$ 300,000
93034 - Pigeon Guillemot Colony Survey	Recommended Y-5 N-1	Recommended	Unanimously Recommended	Approved	$ 165,800

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93035 - Potential Impacts of Oiled Mussel Beds on Higher Organisms: Contamination of Black Oystercatchers Breeding on Persistently Oiled Sites in PWS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 107,900
93036 - Recovery Monitoring and Restoration of Intertidal Oiled Mussel Beds in PWS and the GOA Impacted by EVOS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 404,800
93038 - Shoreline Assessment	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 524,200
93039 - Herring Bay Experimental and Monitoring Studies	Unanimously Recommended	Recommended	Recommended Y-12 N-0 A-1 Look at reducing budget	Approved	$ 507,500
93041 - Comprehensive Restoration Monitoring Program Phase 2: Monitoring Plan Development	Unanimously Recommended	Recommended	Recommended Y-8 N-4 A-1	Approved	$ 237,900
93042 - Recovery Monitoring of PWS Killer Whales Injured by EVOS Using Photo Identification Techniques	Recommended Y-4 N-2 At the request of the Trustee Council	Enhancement Project	Unanimously Recommended	Approved	$ 127,100

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93043 - Sea Otter Population Demographics and Habitat Use in Areas Affected by EVOS	Recommended Y-5 N-1	Recommended with reduced budget	Recommended Look at contracting Y-8 N-5	Approved	$ 291,900
93045 - Surveys to Monitor Marine Bird and Sea Otter Populations in PWS During Summer and Winter	Unanimously Recommended	Recommended	Previously Approved by Trustee Council	Previously Approved 12/11/92	$ 262,400
93046 - Habitat Use, Behavior and Monitoring of Harbor Seals in PWS, Alaska	Unanimously Recommended	Recommended	Unanimously Recommended Look at more local involvement	Approved	$ 230,500
93047 - Subtidal Monitoring: Recovery of Sediments, Hydrocarbon-degrading Microorganisms, Eelgrass Communities and Fish in the Shallow Subtidal Environment	Unanimously Recommended	Recommended	Recommended Y-12 N-0 A-1 Look at reducing costs	Approved	$ 1,000,800
93050 - Update: Restoration Feasibility Study #5 (Identification and Recordation of Information Sources Relevant to Land and Resources Affected by EVOS)	Not Recommended Tie vote Y-3 N-3	Recommended	Agency will do work with existing in-house funding	Withdrawn	------

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93051 - Habitat Protection Information for Anadromous Streams and Marbled Murrelets	Unanimously Recommended	Recommended with removal of channel typing	Recommended with removal of channel typing portion Y-9 N-4	Approved	$ 1,222,300
93052 - Identification and Protection of Important Bald Eagle Habitats	Unanimously Not Recommended	Not Recommended	Not Recommended Y-3 N-8	Withdrawn	------
93053 - Hydrocarbon Data Analysis, Interpretation and Database Maintenance for Restoration and NRDA Environmental Samples Associated with the EVOS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 105,500
93057 - Damage Assessment GIS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 67,500
93059 - Habitat Identification Workshop	Unanimously Recommended	Recommended	Previously approved by the Trustee Council	Previously Approved 12/11/92	$ 42,300
93060 - Accelerated Data Acquisition	Unanimously Recommended	Recommended	Previously approved by the Trustee Council	Previously Approved 12/11/92	$ 43,900

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93061 - New Data Acquisition	Unanimously Recommended	Recommended	Recommended Y-11 N-2	Rolled into 93064	-----
93062 - Restoration GIS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 123,300
93063 - Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Anadromous Fish	Unanimously Recommended	Enhancement Project	Unanimously Recommended	Approved	$ 59,400
93064 - Habitat Protection Fund	Unanimously Recommended	Recommended	Recommended PAG request review before acquiring parcels Y-10 N-1 A-2	Approved[1,2]	$20,000,000

[1] Now includes 93061.

[2] Funds for Kachemak Purchase included in the Project.

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93 AD - Administrative Director's Office	Unanimously Recommended	------	Increase Public Advisory Group Budget to $225,000	Approved Long-Term contracts and 3 months funding for the rest pending further Trustee Council Review	$ 1,501,000
93 FC - Finance Committee	Unanimously Recommended	------	------		$ 45,000
93 RT - Restoration Team Support	Unanimously Recommended	------	------		$ 1,232,900

1993 Additional Projects
Recommended by the
Public Advisory Group
on 1/7/93

Project	Cost
1[1]. Planning for expansion of the Kodiak Industrial Technology Center Public Idea #310 VOTE: Y-7 N-4 A-1	$ 100,000
2[1]. First phase construction of a Kodiak Archeological Museum Public Idea #298-17 VOTE: Unanimously Recommended	800,000
3[1]. Prince William Sound Herring Damage Assessment Vote: Unanimously Recommended	237,889
4[1]. Prince William Sound Pink Salmon Coded Wire Tag Project Vote: Y-7 N-4	773,600
5[1]. Prince William Sound Chum, Sockeye, Coho and Chinook Salmon Coded Wire Tag Project VOTE: Y-9 N-2	249,590
TOTAL	$ 2,161,079

[1] All of these projects were deferred.

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SUMMARY RECOMMENDATION MATRIX

INCLUDING TRUSTEE COUNCIL ACTIONS

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93002 - Sockeye Overescapement	Recommended Y-5 N-1	Recommended	Recommended Y-9 N-5	Approved [1]	$ 714,600
93003 - Pink Salmon Egg to Pre-emergent Fry Survival in PWS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 686,000
93004 - Documentation, Enumeration and Preservation of Genetically Discrete Wild Populations of Pink Salmon Impacted by EVOS in PWS	Recommended Y-5 N-1	Enhancement Project	Recommended Y-8 N-3 A-2	Not Approved	------

[1] Approved contingent upon review of potential modifications resulting from sockeye synthesis (peer review) meeting in March and a detailed review of the overall budget by ADF&G and discussion at the next Trustee Council meeting. Only essential commitments should be expended until that time.

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93005 - Cultural Resources, Information, Education and Interpretation	Unanimously Recommended	No Opinion	Recommended with Qualifications	Not Approved	------
93006 - Site-Specific Archeological Restoration	Unanimously Recommended	Recommended	Recommended with Qualifications	Approved	$ 260,100
93007 - Archeological Site Stewardship Program	Unanimously Recommended	No Opinion	Recommended with Qualifications	Not Approved	------
93008 - Archeological Site Patrol and Monitoring	Unanimously Recommended	No Opinion	Recommended with Qualifications	Not Approved	------
93009 - Public Information, Education and Interpretation	Recommended Y-5 N-1	No Opinion	Recommended with Qualifications	Not Approved	------
93010 - Reduce Disturbance Near Murre Colonies Showing Indications of Injury From the EVOS	Not Recommended Tie Vote Y-3 N-3	Recommended	Unanimously Not Recommended	Not Approved	------

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93011 - Develop Harvest Guidelines to Aid Restoration of River Otters and Harlequin Ducks	Recommended Y-5 N-1	Recommended	Recommended Y-9 N-3 A-1	Deferred until 2/16/93 Meeting[1]	To be Determined
93012 - Genetic Stock Identification of Kenai River Sockeye Salmon	Recommended Y-5 N-1	Recommended	Unanimously Recommended Look at reducing budget combine with 93015	Approved[1]	$ 300,600
93014 - Quality Assurance for Coded-Wire Tag Application in Fish Restoration Projects	Not Recommended Tie Vote Y-3 N-3	Enhancement Project	Unanimously Not Recommended	Withdrawn	------
93015 - Kenai River Sockeye Salmon Restoration	Recommended Y-5 N-1	Recommended	Unanimously Recommended Look at reducing budget	Approved[1]	$ 732,600

[1] Approved contingent upon review of potential modifications resulting from sockeye synthesis (peer review) meeting in March and a detailed review of the overall budget by ADF&G and discussion at the next Trustee Council meeting. Only essential commitments should be expended until that time.

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93016 - Chenega Chinook and Coho Salmon Release Program	Recommended Y-5 N-1	No Opinion	Unanimously Recommended Increase budget to $50.9K to cover Hatchery costs	Deferred until NEPA Completed Evaluate at next 2/16/93 meeting	To be Determined
93017 - Subsistence Food Safety Survey and Testing Restoration Project	Unanimously Recommended	No Opinion	Unanimously Recommended More local community involvement	Approved with Modifications Remove $53.5 for Transportation Costs	$ 307,100
93018 - Enhanced Management for Wild Stocks in PWS, Special Emphasis on Cutthroat Trout and Dolly Varden	Recommended Y-5 N-1	Not Recommended	Unanimously Recommended	Not Approved	------
93019 - Chugach Region Village Mariculture Project	Unanimously Not Recommended	Not Recommended	Recommended Y-8 N-4 Contingent upon legal approval	Not Approved	------

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93020 - Bivalve Shellfish Hatchery and Research Center	Not Recommended Tie Vote Y-3 N-3	Recommended Closer Study for Feasibility	Unanimously Recommended Contingent upon legal review	Not Approved	------
93022 - Evaluating the Feasibility of Enhancing Productivity of Murres by Using Decoys, Dummy Eggs and Recordings of Murre Calls to Simulate Normal Densities at Breeding Colonies Affected by EVOS and Monitoring the Recovery of Murres in the Barren Islands	Unanimously Recommended	Recommended	Unanimously Not Recommended	Approved Monitoring Component only	$ 177,200
93024 - Restoration of the Coghill Lake Sockeye Salmon Stock	Recommended Y-5 N-1	Enhancement Project	Unanimously Recommended	Deferred until 2/16/93 meeting	To be Determined
93025 - Montague Island Chum Salmon Restoration	Recommended Y-5 N-1	Enhancement Project	Unanimously Recommended	Not Approved	------
93026 - Fort Richardson Hatchery Water Pipeline	Not Recommended Tie Vote Y-3 N-3	No Opinion	Recommended Y-9 N-4	Not Approved	------

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93028 - Restoration and Mitigation of Wetland Habitats for Injured PWS Fish and Wildlife Species	Recommended Y-5 N-1	Enhancement Project	Not Recommended Y-3 N-8	Not Approved	------
93029 - PWS Second Growth Management	Recommended Y-5 N-1	Enhancement Project	Tie Vote Y-5 N-5 A-1	Withdrawn	------
93030 - Red Lake Restoration	Recommended Y-5 N-1	Recommended	Unanimously Recommended	Deferred until 2/16/93 meeting	To be Determined
93031 - Red Lake Mitigation for Red Salmon Fishery	Recommended Y-5 N-1	No Opinion	Recommended Y-10 N-1 A-2	Not Approved	------
93032 - Pink and Cold Creek Pink Salmon Restoration	Recommended Y-5 N-1	Enhancement Project	Recommended Y-12 N-1 Consult w/ Landowner	Not Approved	------
93033 - Harlequin Duck Restoration Monitoring Study in PWS, Kenai and Afognak Oil Spill Areas	Unanimously Recommended	Recommended	Unanimously Recommended	Approved at Reduced Level	$ 300,000
93034 - Pigeon Guillemot Colony Survey	Recommended Y-5 N-1	Recommended	Unanimously Recommended	Approved	$ 165,800

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93035 - Potential Impacts of Oiled Mussel Beds on Higher Organisms: Contamination of Black Oystercatchers Breeding on Persistently Oiled Sites in PWS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 107,900
93036 - Recovery Monitoring and Restoration of Intertidal Oiled Mussel Beds in PWS and the GOA Impacted by EVOS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 404,800
93038 - Shoreline Assessment	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 524,200
93039 - Herring Bay Experimental and Monitoring Studies	Unanimously Recommended	Recommended	Recommended Y-12 N-0 A-1 Look at reducing budget	Approved	$ 507,500
93041 - Comprehensive Restoration Monitoring Program Phase 2: Monitoring Plan Development	Unanimously Recommended	Recommended	Recommended Y-8 N-4 A-1	Approved	$ 237,900
93042 - Recovery Monitoring of PWS Killer Whales Injured by EVOS Using Photo Identification Techniques	Recommended Y-4 N-2 At the request of the Trustee Council	Enhancement Project	Unanimously Recommended	Approved	$ 127,100

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93043 - Sea Otter Population Demographics and Habitat Use in Areas Affected by EVOS	Recommended Y-5 N-1	Recommended with reduced budget	Recommended Look at contracting Y-8 N-5	Approved	$ 291,900
93045 - Surveys to Monitor Marine Bird and Sea Otter Populations in PWS During Summer and Winter	Unanimously Recommended	Recommended	Previously Approved by Trustee Council	Previously Approved 12/11/92	$ 262,400
93046 - Habitat Use, Behavior and Monitoring of Harbor Seals in PWS, Alaska	Unanimously Recommended	Recommended	Unanimously Recommended Look at more local involvement	Approved	$ 230,500
93047 - Subtidal Monitoring: Recovery of Sediments, Hydrocarbon-degrading Microorganisms, Eelgrass Communities and Fish in the Shallow Subtidal Environment	Unanimously Recommended	Recommended	Recommended Y-12 N-0 A-1 Look at reducing costs	Approved	$ 1,000,800
93050 - Update: Restoration Feasibility Study #5 (Identification and Recordation of Information Sources Relevant to Land and Resources Affected by EVOS)	Not Recommended Tie vote Y-3 N-3	Recommended	Agency will do work with existing in-house funding	Withdrawn	------

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93051 - Habitat Protection Information for Anadromous Streams and Marbled Murrelets	Unanimously Recommended	Recommended with removal of channel typing	Recommended with removal of channel typing portion Y-9 N-4	Approved	$ 1,222,300
93052 - Identification and Protection of Important Bald Eagle Habitats	Unanimously Not Recommended	Not Recommended	Not Recommended Y-3 N-8	Withdrawn	------
93053 - Hydrocarbon Data Analysis, Interpretation and Database Maintenance for Restoration and NRDA Environmental Samples Associated with the EVOS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 105,500
93057 - Damage Assessment GIS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 67,500
93059 - Habitat Identification Workshop	Unanimously Recommended	Recommended	Previously approved by the Trustee Council	Previously Approved 12/11/92	$ 42,300
93060 - Accelerated Data Acquisition	Unanimously Recommended	Recommended	Previously approved by the Trustee Council	Previously Approved 12/11/92	$ 43,900

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93061 - New Data Acquisition	Unanimously Recommended	Recommended	Recommended Y-11 N-2	Rolled into 93064	-----
93062 - Restoration GIS	Unanimously Recommended	Recommended	Unanimously Recommended	Approved	$ 123,300
93063 - Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Anadromous Fish	Unanimously Recommended	Enhancement Project	Unanimously Recommended	Approved	$ 59,400
93064 - Habitat Protection Fund	Unanimously Recommended	Recommended	Recommended PAG request review before acquiring parcels Y-10 N-1 A-2	Approved[1,2]	$20,000,000

[1] Now includes 93061.

[2] Funds for Kachemak Purchase included in the Project.

PROJECT Number and Brief Description	RESTORATION TEAM Recommended/ Not Recommended	CHIEF SCIENTIST Recommended/ Not Recommended	PUBLIC ADVISORY GROUP Recommended/ Not Recommended	TRUSTEE COUNCIL ACTION Approved/ Not Approved/ Withdrawn	APPROVED '93 BUDGET INFORMATION
93 AD - Administrative Director's Office	Unanimously Recommended	------	Increase Public Advisory Group Budget to $225,000	Approved Long-Term contracts and 3 months funding for the rest pending further Trustee Council Review	$ 1,501,000
93 FC - Finance Committee	Unanimously Recommended	------	------		$ 45,000
93 RT - Restoration Team Support	Unanimously Recommended	------	------		$ 1,232,900

1993 Additional Projects
Recommended by the
Public Advisory Group
on 1/7/93

Project	Cost
1[1]. Planning for expansion of the Kodiak Industrial Technology Center Public Idea #310 VOTE: Y-7 N-4 A-1	$ 100,000
2[1]. First phase construction of a Kodiak Archeological Museum Public Idea #298-17 VOTE: Unanimously Recommended	800,000
3[1]. Prince William Sound Herring Damage Assessment Vote: Unanimously Recommended	237,889
4[1]. Prince William Sound Pink Salmon Coded Wire Tag Project Vote: Y-7 N-4	773,600
5[1]. Prince William Sound Chum, Sockeye, Coho and Chinook Salmon Coded Wire Tag Project VOTE: Y-9 N-2	249,590
TOTAL	$ 2,161,079

[1] All of these projects were deferred.

Table 1 1993 PUBLIC PROPOSALS FOR HABITAT ACQUISITION 09/08/92

PROJECT	PROPONENT[1]	COST[2] $MILLIONS
Kachemak State Park inholdings	Seldovia Native Association *	22.0
Kachemak State Park inholdings	Kachemak Bay Citizens Coalition	22.0
North Afognak Island	Jerome Selby	84.0
Afognak Island	Afognak Native Corporation *	113.5
Shuyak Island	Jerome Selby	0.2
Kodiak Island Borough/State land exchange, acquistion of recreation sites on Kodiak	Kodiak State Parks Citizens' Advisory Board	0.07
Kodiak Refuge inholdings	World Wildlife Fund	None provided
Kodiak Refuge inholdings	Jerome Selby	45.0
Kodiak Island	Old Harbor Native Corp. *	50.0
Kodiak Refuge inholdings	Koniag, Inc. *	77.4
Kodiak weirs/watersheds	ADF&G, FRED	3.0
Kodiak Refuge stream mouths	Jerome Selby	9.0
Kodiak recreation sites	Jerome Selby	5.0
Afognak I, Cape Suckling, Kachemak Bay, Kenai Fjords, Kodiak Refuge, PWS	Alaska Center for Environment	None provided
Archeological sites	DNR, DPOR	0.235
Recreational lands	DNR, DPOR	2.5
Olsen Bay watershed	Jack Helle	None provided
TOTAL COST, WILLING SELLERS		262.9
TOTAL COST, OTHER PROPONENTS		171.1
TOTAL COST, WILLING SELLERS PLUS OTHER PROPONENTS (Kachemak State Park inholdings ($22.0) count once)		412.0

1. [*] denotes willing seller

2. Proponent estimated cost

Table 2

PRELIMINARY SUMMARY OF RECENT AND PROJECTED TIMBER HARVEST ACTIVITY IN SPILL AREA

09/08/92

AREA	LANDOWNER	ESTIMATED ACREAGE	STATUS
Two Moon Bay/ Irish Cove	Tatitlek	3,900	Harvested[1]
Two Moon Bay South	Tatitlek	1,100	Projected harvest[2]
Fish Bay	Chugach Alaska	2,000	Projected harvest
Orca Bay Narrows	Eyak	1,150	Projected harvest
Eyak River East	Eyak	50	Projected harvest
Eyak Lake	Eyak	50	Harvested
Elsner Lake/ Scott Lake/ Sheridan Glac.	Eyak	3,000	Harvested
Power Creek	Eyak	1,000	Projected harvest
Eyak River West	Eyak	200	Projected harvest[3]
MacLeod Harbor	Chugach Alaska	150	Harvested
Patton Bay	Chugach Alaska	1,000	Projected harvest
Windy Bay	Port Graham	800	Harvested
Rocky Bay	Port Graham	150	Projected harvest
Port Graham	BIA Allotments	300	Projected harvest
Dogfish Bay	English Bay	5,000[3]	Harvested
Sadie Cove	Seldovia	150	Projected harvest
Jakolof Bay	Seldovia	250	Projected harvest
Peterson Bay/ China Poot Bay	Seldovia	4,000	Projected harvest
Afognak Island	Koncor[4], Afognak, Afognak Joint Venture	12,000[5]	Harvested
Afognak Island	Koncor, Afognak, Afognak Joint Venture	2,500	Projected harvest
TOTAL ACRES HARVESTED		24,750	
TOTAL ACRES PROJECTED FOR HARVEST		14,000	

1. Harvested or in the process of being harvested in 1992.

2. Projected to begin harvest in 1993.

3. Selective harvest within this acreage.

4. Koncor represents Natives of Kodiak, Ouzinkie, Akhiok/Kaguyak, Old Harbor and several partners in Afognak Joint Venture.

5. Includes approximately 2,000 acres of previous Chugach National Forest harvest.

Table 3 PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
89	CRD	LAND DISPOSAL	DAN O'BRIEN	LOT 4, SEC 8, T15S, R3W, CRM	DNR:LU	06/15/89	1291
89	CRD	LAND DISPOSAL	ERIC J. & DANNY K. WEATHERS	BLM LOT 4, SEC8, T15S, R3W, CRM	DNR:LU	06/15/89	1292
89	CRD	LAND DISPOSAL	WILLIAM STAFFORD	BLM LOT 4, SEC 8, T15S, R3W, CRM	DNR:LU	06/15/89	1293
89	CRD	LAND DISPOSAL	SAM CRISTENSEN	BLM LOT 4, SEC 17, T15S, R3W, CRM	DNR:LU	06/15/89	1294
89	CRD	LAND DISPOSAL	TIM TIRRELL	BLM LOT 2, SEC 8, T15S, R3W, CRM	DNR:LU	06/15/89	1296
89	CRD	LAND DISPOSAL	WALTER RABER	BLM LOT 5, SEC 17, T15S, R3W, CRM	DNR:LU	06/15/89	1295
89	CRD	TIMBER	DNR	SHERIDAN GLACIER	DNR:TI	07/01/88	1643
89	EKP	CULVERT/BRIDGE	CHUGACH FOREST PRODUCTS INC.	SPRING CREEK	DFG:NP	05/30/89	1270
89	EKP	DOCK/BOAT LAUNCH/RAMP/PILING	CHUGACH ALASKA CORP.	RESURRECTION BAY	OMB:50;DEC:401;FED:COE	07/01/88	1192
89	EKP	LAND USE	CHUGACH ALASKA CORP.	RESURRECTION BAY	DNR:LU	03/15/89	887
89	EKP	WATER USE	AFOGNAK LOGGING	AIALIK BAY	DNR:WU	09/26/88	213
89	PWS	DOCK/BOAT LAUNCH/RAMP/PILING	ROBERT & ROSE ARVIDSON	ORCA INLET	OMB:50;DEC:401;FED:COE	10/13/88	227
89	PWS	DOCK/BOAT LAUNCH/RAMP/PILING	CHUGACH ALASKA CORP.	SEC 29, T3S, R10E, SM	OMB:50	05/26/89	399
89	PWS	LAND DISPOSAL	RALPH PIRTLE	WHITESHED ROAD	DNR:O	07/12/88	1729
89	PWS	LAND USE	JAMES LENTINI	SEC 8, T8S, R6W, CRM	DNR:LU	11/21/88	492
89	PWS	LAND USE	TIMOTHY R. TIRRELL	SEC 8, T15S, R3W, CRM	DNR:LU	05/19/89	1274

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
89	PWS	MATERIAL REMOVAL/DREDGING	DUANE DUNNING	LOWE RIVER	DFG:NP	08/17/88	55
89	PWS	MATERIAL REMOVAL/DREDGING	RICK WADE	LOWE RIVER FLATS	DFG:NP	08/23/88	106
89	PWS	MATERIAL REMOVAL/DREDGING	CLIFFORD COLLINS	EYAK LAKE	DFG:NP	06/21/89	1458
89	PWS	PLACER MINING	JAMES LENTINI	MINERAL CREEK	DFG:PL	09/13/88	191
89	PWS	PLACER MINING	JACK MURPHY	JOHNSON GLACIER RUNOFF	DFG:PL	01/04/89	572
89	PWS	PLACER MINING	JAMES LENTINI & JACKIE R. SEE	MINERAL CREEK	OMB:30;DFG:PL	02/27/89	620
89	PWS	PLACER MINING	ROBERT W. BLONDEAU	MINERAL CREEK	DFG:PL	04/04/89	641
89	PWS	PLACER MINING	ROY DIEHL	LOWE RIVER & TRIB.	OMB:30;DFG:PL	05/10/89	972
89	PWS	TIMBER	ADNR/DOF	TWO MOON BAY	DNR:TI	07/07/88	1661
89	PWS	TIMBER	TATITLEK CORPORATION	PRINCE WILLIAM SOUND	DNR:WU;DEC:SW	12/15/88	565
89	PWS	WATER USE	CHUGACH ALASKA CORP.	SEC 29, T3S, R10E, SM	DNR:WU	06/21/89	1474
89	SKP	MARICULTURE	KATHRYN MCNEVIN	HALIBUT COVE	OMB:50;DFG:SA;DNR:LU; DEC:401;FED:COE	09/15/88	95
89	SKP	MARICULTURE	JIM & NANCY HEMMING	HALIBUT COVE	DFG:SA	02/21/89	862
89	SKP	MARICULTURE	MARK BRADLEY	HALIBUT COVE	DFG:SA	02/21/89	320
89	SKP	MARICULTURE	JOE BANTA	KACHEMAK BAY CHA	DFG:SA	02/21/89	560
89	SKP	MARICULTURE	RICHARD PEREA	JAKOLOF BAY	DFG:SA	02/22/89	675
89	SKP	MARICULTURE	KEVIN SIDELINGER	HALIBUT COVE LAGOON	DFG:SA	02/22/89	708
89	SKP	MARICULTURE	KATHRYN MCNEVIN	KACHEMAK BAY CHA	DFG:SA	02/22/89	666

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
89	SKP	MARICULTURE	J. BRANSON & N. MUNRO (SINGING MUSSELS)	KACHEMAK BAY CHA	DFG:SA	02/22/89	683
89	SKP	MARICULTURE	JAMES JENKIN	HALIBUT COVE	DFG:SA	02/22/89	716
89	SKP	MARICULTURE	R.E. ATKINSON & K. KULETZ	KACHEMAK BAY	DFG:SA	02/22/89	681
89	SKP	MARICULTURE	DIANA TILLION	HALIBUT COVE	DFG:SA	02/22/89	861
89	SKP	MARICULTURE	JON ZUCK	KACHEMAK BAY CHA	DFG:SA	02/22/89	696
89	SKP	MARICULTURE	PETER J. MOORE	HALIBUT COVE LAGOON	DFG:SA	02/22/89	636
89	SKP	MARICULTURE	JOE BANTA	KACHEMAK BAY	DNR:WU	05/12/89	1351
89	SKP	MARICULTURE	BRENDA HAYS	HALIBUT COVE LAGOON	DFG:SA	02/21/89	421
89	SKP	CULVERT/BRIDGE	KLUKWAN FOREST PRODUCTS, INC.	STARISKI CREEK	DFG:NP	10/10/88	293
89	SKP	CULVERT/BRIDGE	KLUKWAN FOREST PRODUCTS	SILVER SALMON CREEK	DFG:NP	03/01/89	853
89	SKP	CULVERT/BRIDGE	KLUKWAN FOREST PRODUCTS	SILVER SALMON CREEK	DFG:NP	03/22/89	912
89	SKP	DAM/IMPOUNDMENT	VILLAGE OF PORT GRAHAM	UNNAMED STREAM, T9S, R15W, SM	DFG:NP	07/13/88	12
89	SKP	DOCK/BOAT LAUNCH/RAMP/PILING	CHUGACH ALASKA CORP	RESURRECTION BAY	DEC:401;FED:COE	12/30/88	582
89	SKP	EASEMENT/EASEMENT VACATION	T. & J. ANDERSON	SECS 4 & 9, T2S, R14W, SM	MUN:KPB	04/03/89	1098
89	SKP	EASEMENT/EASEMENT VACATION	DOI/BLM, PORT GRAHAM CORP,SELDOVIA NATIVE		FED:BLM	04/21/89	996
89	SKP	LAND CONVEYANCE	PAUL OSKOLKOFF AND SOA	NINILCHIK	DNR:O	12/27/88	597
89	SKP	LAND USE	DOLINA VILLAGE	FOX RIVER FLATS CHA	DFG:SA	02/10/89	830
89	SKP	LAND USE	DOLINA VILLAGE	FOX RIVER FLATS CHA	DFG:SA	03/01/89	924

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[4]	DATE	FILE
89	SKP	LAND USE	UNIVERSITY OF ALASKA	ANCHOR RIVER/FRITZ CREEK CHA	DFG:SA	04/03/89	985
89	SKP	MARICULTURE	BRENDA HAYS	HALIBUT COVE LAGOON	OMB:50;DFG:SA;DNR:LU; DEC:401;FED:COE	09/30/88	59
89	SKP	SOLID WASTE	KLUKWAN FOREST	NINILCHIK	DEC:SW	06/30/89	1512
89	SKP	TIMBER	KENAI PACIFIC LUMBER	DEEP CREEK	DNR:TI	08/25/88	64
89	SKP	TIMBER	KLUKWAN FOREST PRODUCTS	SEC 22,23,26-28,33,34, T3S, R14W, SM	DNR:TI	10/06/88	300
89	SKP	TIMBER	KLUKWAN FOREST PRODUCTS	OILWELL ROAD	DNR:TI	12/05/88	505
89	SKP	TIMBER	KLUKWAN FOREST PRODUCTS	KENAI PENINSULA	DNR:TI	02/06/89	731
89	SKP	WETLAND FILL	CLARK GARRISON	NINILCHIK RIVER	OMB:50;DEC:401;FED:COE	08/22/88	52
90	CRD	DOCK/BOAT LAUNCH/RAMP/PILING	EYAK CORP.	ORCA INLET	FED:COE	02/22/90	846
90	CRD	MATERIAL REMOVAL/DREDGING	JAMES R. WEBBER	EYAK LAKE	DFG:NP	06/14/90	1199
90	CRD	TIMBER	WHITESTONE LOGGING	CABIN LAKE	DNR:TI	11/08/89	110
90	EKP	DOCK/BOAT LAUNCH /RAMP/PILING	RAY SIMUTIS	RESURRECTION BAY	OMB:30;FED:COE	04/12/90	1069
90	EKP	HARDROCK MINING	G. G. MINING CO.	PORCUPINE CREEK	FED:USFS	11/03/89	402
90	EKP	MATERIAL REMOVAL/DREDGING	METCO	RESURRECTION RIVER	DFG:NP	12/29/89	608
90	EKP	TIMBER	KENAI PACIFIC LUMBER	NASH ROAD	DNR:TI	02/20/90	700
90	EKP	TIMBER	KENAI PACIFIC LUMBER	NEAR SALMON CREEK	DNR:TI	02/21/90	729
90	EKP	TIMBER	CHUGACH TIMBER CORP.	WINDY BAY	DNR:TI	03/01/90	792

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
90	EKP	TIMBER	CHUGACH TIMBER CORPORATION	WINDY BAY	DNR:TI	03/27/90	910
90	EKP	TIMBER	CHUGACH TIMBER CORPORATION	SEWARD	DNR:TI	05/31/90	1272
90	EKP	TIMBER	KENAI PACIFIC LUMBER	WOODS/KPL	DNR:TI	06/27/90	1548
90	EKP	WATER USE	ALBERT SCHAEFER	SEC 1, T1S, R1W, SM	DNR:WU	08/09/89	68
90	EKP	WATER USE	ALBERT SCHAEFER	SEC 1, T1S, R1W, SM	DNR:WU	08/09/89	67
90	EKP	WATER USE	ALBERT SCHAEFER	SEC 1, T1S, R1W, SM	DNR:WU	08/09/89	69
90	EKP	WETLAND FILL	ALBERT SCHAEFER	RESURRECTION BAY	OMB:30;DEC:401;FED:COE	12/06/89	436
90	PWS	BANK STABILIZATION /RIVER TRAINING	JAMES WEBBER	EYAK LAKE/MURCHESON CREEK	DFG:NP	12/05/89	405
90	PWS	DOCK/BOAT LAUNCH/RAMP/PILING	RICHARD CASCIANO	ODIAK SLOUGH 3	OMB:50;FED:COE	06/08/90	1234
90	PWS	EASEMENT/EASEMENT VACATION	BLM/CHENEGA CORPORATION	PRINCE WILLIAM SOUND	FED:BLM	03/27/90	1010
90	PWS	EASEMENT/EASEMENT VACATION	DOI/BLM/CHENEGA CORPORATION	ESHAMY LAKE	FED:BLM	06/27/90	1439
90	PWS	LAND CONVEYANCE	SAMUEL CHRISTENSEN	HAWKINS ISLAND, SHIPYARD BAY	DNR:O	05/04/90	1162
90	PWS	LAND DISPOSAL	DANIEL C. O'BRIEN	SECTION 8, T. 15 S., R. 3 W., C.R.M.	DNR:O	05/04/90	1160
90	PWS	LAND DISPOSAL	WILLIAM STAFFORD	SECTION 8, T. 15 S., R. 3 W., C.R.M.	DNR:O	05/04/90	1165
90	PWS	LAND DISPOSAL	ERIC AND DENNY WEATHERS	SECTION 8, T. 15 S., R. 3 W., C.R.M.	DNR:O	05/04/90	1161
90	PWS	LAND DISPOSAL	WILLAIM WALTER RABER	SECTION 17, T. 15 S., R. 3 W., C.R.M.	DNR:O	05/04/90	1164

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[4]	DATE	FILE
90	PWS	LAND USE	VRCA	VALDEZ	MUN:VALDEZ	09/27/89	177
90	PWS	LAND USE	SORBY ALASKA	KNIGHT ISLAND	DNR:LU	05/04/90	1251
90	PWS	MATERIAL REMOVAL/DREDGING	WAYNE BLONDEAU	MINERAL CREEK	DFG:NP	09/27/89	623
90	PWS	MATERIAL REMOVAL/DREDGING	DWAIN DUNNING	LOWE RIVER	DFG:NP	09/29/89	106
90	PWS	MATERIAL REMOVAL/DREDGING	HARRIS SAND AND GRAVEL	LOWE RIVER	OMB:50;DFG:NP	11/03/89	30
90	PWS	PLACER MINING	ROBERT BLONDEAU	MINERAL CREEK	DFG:PL	02/22/90	669
90	PWS	PLACER MINING	WILLIAM HARRIS	MINERAL CREEK	DFG:PL	03/27/90	865
90	PWS	PLACER MINING	ROY A. DIEHL	LOWE RIVER	OMB:30;DFG:PL;DNR:LU	05/02/90	1005
90	PWS	PLACER MINING	JACK V. MURPHY	MINERAL CREEK TRIBUTARY	OMB:30;DFG:PL;DNR:RW	06/13/90	1316
90	PWS	TIMBER	TATITLEK NATIVE CORP.	TWO MOON BAY	FED:COE	03/15/90	954
90	PWS	VEHICLE STREAM CROSSING	TIMBER TRADING CO.	MISC. STREAMS /MONTAGUE ISLAND	DFG:NP	07/10/89	17
90	PWS	VEHICLE STREAM CROSSING	TATILLEK CORP	FISH BAY	DNR:WU;DEC:SW; FED:COE	10/11/89	223
90	PWS	WASTEWATER	CHENEGA IRA COUNCIL	CHENEGA BAY	DEC:WW	07/14/89	1502
90	PWS	WASTEWATER	CHUGACH ALASKA CORP	PRINCE WILLIAM SOUND	DEC:WW	09/12/89	124
90	PWS	WATER USE	ROBERT BURDEN	MARSHA BAY	DNR:WU	07/10/89	1437
90	PWS	WATER USE	WILLIAM LORENSON	SURPRISE GLACIER	DNR:WU	01/18/90	468
90	PWS	WATER USE	JERRY THOMPSON	ICY BAY	DNR:WU	01/18/90	467
90	PWS	WATER USE	ALASKA ICE AGE	HARRIS BAY	DNR:WU	01/18/90	465
90	PWS	WATER USE	ALASKA ICE AGE	ICY BAY	DNR:WU	01/18/90	464

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[4]	DATE	FILE
90	PWS	WATER USE	JERRY THOMPSON	COLUMBIA BAY	DNR:WU	01/18/90	466
90	PWS	WATER USE	WILLIAM LORENSON	BARRY GLACIER	DNR:WU	01/18/90	473
90	PWS	WATER USE	WILLIAM LORENSON	COXE GLACIER	DNR:WU	01/18/90	472
90	PWS	WATER USE	WILLIAM LORENSON	HARRIMAN GLACIER	DNR:WU	01/18/90	471
90	PWS	WATER USE	WILLIAM LORENSON	HARVARD GLACIER	DNR:WU	01/18/90	470
90	PWS	WATER USE	WILLIAM LORENSON	CASCADE GLACIER	DNR:WU	01/18/90	469
90	PWS	WATER USE	WILLIAM LORENSON	YALE GLACIER	DNR:WU	01/18/90	475
90	PWS	WATER USE	WILLIAM LORENSON	ROARING GLACIER	DNR:WU	01/18/90	474
90	PWS	WATER USE	WILLIAM LORENSON	COLUMBIA GLACIER	DNR:WU	01/18/90	476
90	SKP	MARICULTURE	JON C. ZUCK	KACHEMAK BAY	DFG:SA	01/04/90	566
90	SKP	MARICULTURE	DIANA TILLION	HALIBUT COVE	DFG:SA	01/04/90	604
90	SKP	MARICULTURE	BRENDA HAYS	KACHEMAK BAY CHA	DFG:SA	01/04/90	625
90	SKP	MARICULTURE	JIM BRANSON & NANCY MUNRO	HALIBUT COVE, KACHEMAK BAY CHA	DFG:SA	02/21/90	774
90	SKP	CULVERT/BRIDGE	KLUKWAN FOREST PRODUCTS	SOUTH FORK NINILCHIK RIVER	DFG:NP	05/01/90	973
90	SKP	CULVERT/BRIDGE	KLUKWAN FOREST	SOUTH FORK NINILCHIK RIVER TRIBUTARY	DFG:NP	05/01/90	1214
90	SKP	CULVERT/BRIDGE	CHUGACH FOREST PRODUCTS	SCURVEY CREEK	DFG:NP	05/10/90	1101
90	SKP	CULVERT/BRIDGE	BERNIE VON KEITZ	STARISKI CREEK TRIBUTARY	DFG:NP	05/15/90	745
90	SKP	CULVERT/BRIDGE	CHUGACH TIMBER ASSOCIATION	WINDY CREEK	DFG:NP	05/17/90	1187
90	SKP	CULVERT/BRIDGE	CHUGACH TIMBER	WINDY CREEK TRIBUTARY	DFG:NP	05/17/90	1299

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[4]	DATE	FILE
91	CRD	EASEMENT/EASEMENT VACATION	DOE/BLM/EYAK CORPORATION	CORDOVA/PRINCE WILLIAM SOUND	FED:BLM	03/07/91	941
91	CRD	EASEMENT/EASEMENT VACATION	DOI/BLM/TATITLEK CORPORATION	PRINCE WILLIAM SOUND	FED:BLM	03/21/91	947
91	CRD	EASEMENT/EASEMENT VACATION	DOI/BLM/EYAK CORPORATION	CORDOVA	FED:BLM	04/25/91	1096
91	CRD	LAND LEASE	ERIC AND DENNY WEATHERS	SECTION 8, T.15S., R.3W., C.R.M.	DNR:LU	07/17/90	1535
91	CRD	LAND USE	ERIC AND DENNY WEATHERS	SECTION 8, T.15S., R.3W., C.R.M.	DNR:LU	07/17/90	1534
91	EKP	MARICULTURE	CHRIS SUNDBY	HUMPY COVE 1	OMB:50,FRD:O,DNR:LU, FED:COE	12/14/90	173
91	EKP	MARICULTURE	JAMES AVELLANEDA	PUGET BAY 1	OMB:50,FRD:O,DNR:LU, FED:COE:USFS	12/31/90	176
91	EKP	MARICULTURE	JIM H. BRANSON	HALIBUT COVE LAGOON	FRD-O	02/13/91	827
91	EKP	MARICULTURE	JAMES HEMMING	JAKALOF BAY	FRD-O	02/14/91	936
91	EKP	MARICULTURE	JAMES E. HEMMING	JAKALOF BAY	FRD-O	02/14/91	937
91	EKP	MARICULTURE	JAMES E. HEMMING	JAKALOF BAY	FRD-O	02/15/91	938
91	EKP	MARICULTURE	JIM H. BRANSON	SOUTHSIDE KACHEMAK BAY	FRD-O	02/15/91	828
91	EKP	CULVERT/BRIDGE	ALBERT SCHAFER	HUMPY CREEK	DFG-NP	04/05/91	1079
91	EKP	LAND USE	JOHN BAIRD	PRINCE WILLIAM SOUND	DNR-LU	05/31/91	1531
91	EKP	TIMBER	KENAI PACIFIC LUMBER COMPANY	SEWARD	DNR-TI	07/24/90	58
91	EKP	TIMBER	KENAI PACIFIC LUMBER	SECTION 26, T. 1 N., R. 1 W., S.M.	DNR-TI	03/15/91	1034

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
91	EKP	VEHICLE STREAM CROSSING	JOHN M. KINNEY	SURPRISE BAY	OMB-30,DFG-NP,DNR-WU	11/21/90	482
91	EKP	WETLAND FILL	MICHAEL MILLER	RESURRECTION BAY 92	OMB-50,DED-401,FED-COE	07/20/90	1487
91	PWS	MARICULTURE	SCZAWINSKI AND BELKNAP	WELLS PASSAGE 3	OMB-50,FRD-O,DNR-LU, FED-COE	12/14/90	188
91	PWS	MARICULTURE	AQUABIONICS INCORPORATED	PERRY PASSAGE 1	OMB-50,FRD-O,DNR-LU, FED-COE	11/21/90	229
91	PWS	MARICULTURE	TATITLEK CORPORATION	BOULDER BAY 2	OMB-50,FRD-O,DNR-LU, FED-COE	11/22/90	226
91	PWS	MARICULTURE	E. AND DK. WEATHERS	ORCA INLET 115	OMB-50,FRD-O,DNR-LU, FED-COE	12/12/90	245
91	PWS	MARICULTURE	EYAK CORPORATION	PRINCE WILLIAM SOUND 77	OMB-50,FRD-O,DNR-LU, FED-COE	12/14/90	251
91	PWS	MARICULTURE	FAIRMOUNT ISLAND SEAFOODS	PRINCE WILLIAM SOUND 73	OMB-50,FRD-O,DNR-LU, FED-COE	12/14/90	274
91	PWS	MARICULTURE	SCZAWINSKI AND BELKNAP	WELLS PASSAGE 2	OMB-50,FRD-O,DNR-LU, FED-COE	12/14/90	180
91	PWS	MARICULTURE	KANE AND BLACKARD	CONSTANTINE HARBOR 3	OMB-50,FRD-O,DNR-LU, FED-COE	12/14/90	248
91	PWS	MARICULTURE	TATITLEK CORPORATION	PRINCE WILLIAM SOUND 79	OMB-50,FRD-O,DNR-LU, FED-COE	12/14/90	257
91	PWS	MARICULTURE	TATITLEK CORPORATION	PRINCE WILLIAM SOUND 78	OMB-50,FRD-O,DNR-LU, FED-COE	12/14/90	242
91	PWS	MARICULTURE	SCZAWINSKI AND BELKNAP	WELLS PASSAGE 1	OMB-50,FRD-O,DNR-LU, FED-COE	12/14/90	184
91	PWS	MARICULTURE	EYAK CORPORATION	SIMPSON BAY 1	OMB-50,FRD-O,DNR-LU, FED-COE	12/17/90	254
91	PWS	MARICULTURE	EYAK CORPORATION	SIMPSON BAY2	OMB-50,FRD-O,DNR-LU, FED-COE	12/17/90	260

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
91	PWS	MARICULTURE	J. BANTA/JEFF HETRICK	PORT ETCHES 1	OMB-50,FRD-O,DNR-LU, FED-COE	12/18/90	239
91	PWS	MARICULTURE	JEFF HETRICK	FAIRMOUNT BAY 1	OMB-30,FRD-O,DNR-LU, FED-COE	12/21/90	723
91	PWS	MARICULTURE	UNDERSEA FARMS	DEEP BAY 1	OMB-50,FRD-O,DNR-LU, FED-COE	12/31/90	233
91	PWS	MARICULTURE	CHENEGA BAY IRA	CRAB BAY 1	OMB-30,FRD-O,DNR-LU, FED-COE	06/04/91	1377
91	PWS	MARICULTURE	CHENEGA BAY IRA	ELRINGTON PASSAGE 1	OMB-30,FRD-O,DNR-LU, FED-COE	06/04/91	1379
91	PWS	CULVERT/BRIDGE	CITIFOR	SECTION 21, T. 13 S., R. 7 W., C.R.M.	DFG-NP	10/04/90	525
91	PWS	CULVERT/BRIDGE	GAY & JUDY DUNHAM	ALPINE WOODS	DFG-NP	05/22/91	1360
91	PWS	DOCK/BOAT LAUNCH/RAMP/PILING	R.C. COLLIN	PASSAGE CANAL 26	OMB-30,DNR-LU,FED-COE	10/16/90	503
91	PWS	DOCK/BOAT LAUNCH/RAMP/PILING	MIKE HEIMBUCH	MAIN BAY 2	OMB-50,DNR-LU,FED-COE	06/19/91	1489
91	PWS	EASEMENT/EASEMENT VACATION	CHENEGA & CHUGACH ALASKA CORPORATIONS	ESHAMY LAKE	FED-BLM	11/01/90	544
91	PWS	FOREST PRACTICE	WHITESTONE LOGGING	CABIN LAKE	DNR-TI	01/22/91	818
91	PWS	LAND LEASE	JOHN BRADLEY/MIDDLE ROCK, INC.	SECTION 36, T. 10 S., R. 9 W., C.R.M.	DNR-LU	10/14/90	519
91	PWS	LAND USE	JOHN BAIRD	DAY HARBOR	DNR-LU	05/31/91	1530
91	PWS	LAND USE	FRANK A. BLOOD	SEC 17, T9S, R6W, S.M.	DNR-LU	06/03/91	1591
91	PWS	MATERIAL REMOVAL	RICK WADE	LOWE RIVER	DFG-NP	06/21/91	1898
91	PWS	MATERIAL REMOVAL/DREDGING	WAYNE BLONDEAU	MINERAL CREEK	DFG-NP	01/02/91	708

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[4]	DATE	FILE
91	SKP	MARICULTURE	ANTHONY AND CHERYL BESS	PORT CHATHAM 4	OMB-50,FRD-O,DNR-LU, FED-COE	12/31/90	207
91	SKP	MARICULTURE	JAMES AND NANCY HEMMING	KACHEMAK BAY CRITICAL HABITAT AREA	DFG-SA	12/31/90	634
91	SKP	MARICULTURE	BRENDA HAYS	KACHEMAK BAY CRITICAL HABITAT AREA	DFG-SA	12/31/90	699
91	SKP	MARICULTURE	JOE BANTA	KACHEMAK BAY CRITICAL HABITAT AREA	DFG-SA	12/31/90	763
91	SKP	MARICULTURE	BANTA/HEMMING	JAKALOF BAY 5	OMB-50,DFG-SA,DNR-LU, FED-COE	03/12/91	199
91	SKP	MARICULTURE	ZARAHEMLA SEA FARMS	JAKALOF BAY 2	OMB-50,DFG-SA,FED-COE	03/12/91	210
91	SKP	MARICULTURE	B. AND L. PAINE	JAKALOF BAY 4	OMB-50,DFG-SA,DNR-LU, FED-COE	03/12/91	203
91	SKP	MARICULTURE	JAMES M. MCCANN	JAKALOF BAY 9	OMB-50,DFG-SA,DNR-LU, FED-COE	03/12/91	218
91	SKP	MARICULTURE	CLAIR MCCANN	JAKALOF BAY 10	OMB-50,DFG-SA,DNR-LU, FED-COE	03/12/91	222
91	SKP	MARICULTURE	ANTHONY AND CHERYL BESS	JAKALOF BAY 12	OMB-50,DFG-SA,DNR-LU, FED-COE	03/12/91	214
91	SKP	MARICULTURE	BLUE SEA FARMS (PEREA)	JAKALOF BAY 8	OMB-50,DFG-SA,DNR-LU, FED-COE	03/14/91	191
91	SKP	MARICULTURE	STANLEY MCGRORTY	KACHEMAK BAY	OMB-50,DFG-SA,DNR-LU, FED-COE	03/21/91	471
91	SKP	MARICULTURE	MARK R. BRADLEY	HALIBUT COVE LAGOON	DFG-SA	03/29/91	1044
91	SKP	MARICULTURE	DONNA MCCUBBINS	JAKALOF BAY 3	OMB-50,DFG-SA,DNR-LU, FED-COE	04/10/91	195
91	SKP	MARICULTURE	JON C. ZUCK	HALIBUT COVE LAGOON	DFG-SA	05/31/91	1409
91	SKP	MARICULTURE	KEVIN SIDELINGER	HALIBUT COVE	DFG-SA	05/31/91	1285

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
91	SKP	MARICULTURE	JOSEPH BANTA	HALIBUT COVE LAGOON 1	OMB-50,FRD-O,DNR-LU	06/19/91	1451
91	SKP	MARICULTURE	DIANA TILLION	HALIBUT COVE LAGOON 3	OMB-50,FRD-O,DNR-LU	06/19/91	1332
91	SKP	MARICULTURE	KEVIN SIDELINGER	HALIBUT COVE 5	OMB-50,DNR-LU	06/19/91	1453
91	SKP	MARICULTURE	KATHRYN MCNEVIN	HALIBUT COVE 10	OMB-30,FRD-O	06/21/91	1366
91	SKP	MARICULTURE	JAMES HAMING	KACHEMAK BAY 102	OMB-30,FRD-O	06/21/91	1452
91	SKP	MARICULTURE	JIM BRANSON/NANCY MUNROE	KACHEMAK BAY 134	OMB-30,FRD-O	06/21/91	1367
91	SKP	CULVERT/BRIDGE	KLUKWAN FOREST PRODUCTS, INC.	SOUTH FORK NINILCHIK RIVER	DFG-NP	08/13/90	50
91	SKP	CULVERT/BRIDGE	CHUGACH TIMBER CORPORATION	SOUTH FORK WINDY CREEK	DFG-NP	08/22/90	78
91	SKP	CULVERT/BRIDGE	CHUGACH TIMBER CORPORATION	NORTH FORK WINDY CREEK	DFG-NP	08/30/90	375
91	SKP	CULVERT/BRIDGE	CHUGACH TIMBER CORPORATION	STARISKI CREEK TRIBUTARY	DFG-NP	12/06/90	660
91	SKP	CULVERT/BRIDGE	CHUGACH TIMBER CORPORATION	STARISKI CREEK	DFG-NP	12/06/90	659
91	SKP	CULVERT/BRIDGE	CHUGACH TIMBER CORPORATION	DOG CREEK	DFG-NP	03/29/91	1047
91	SKP	CULVERT/BRIDGE	CHUGACH TIMBER	SECTION 14, T11S, R14W, S.M.	DFG-NP	04/09/91	1046
91	SKP	CULVERT/BRIDGE	CHUGACH FOREST PRODUCTS	STARISKI CREEK	DFG-NP	04/12/91	1133
91	SKP	CULVERT/BRIDGE	CHUGACH TIMBER CORPORATION	DEEP CREEK TRIBUTARY	DFG-NP	04/12/91	1119
91	SKP	CULVERT/BRIDGE	KOLON CALIFORNIA CORPORATION	ENGLISH BAY RIVER TRIBUTARY	DFG-NP	04/17/91	1147

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[4]	DATE	FILE
91	SKP	DOCK/BOAT LAUNCH/RAMP/PILINGS	ERNEST AND JANICE SOUJA	TUTKA BAY 3	OMB-50,DFG-SA,DNR-LU, DEC-401,FED-COE	03/26/91	1131
91	SKP	DOCK/BOAT LAUNCH/RAMP/PILINGS	JOHN AND DONNA VAUGHAN	TUTKA BAY 2	OMB-50,DFG-SA,DNR-LU, DEC-401,FED-COE	03/26/91	1117
91	SKP	DOCK/BOAT LAUNCH/RAMP/PILINGS	R. KRANICH AND E. WYTHE	TUTKA BAY 1	OMB-50,DFG-SA,DNR-LU, DEC-401,FED-COE	03/26/91	678
91	SKP	DOCK/BOAT LAUNCH/RAMP/PILINGS	CARITA BACKMAN	SELDOVIA SLOUGH 2	OMB-30,DFG-SA,FED-COE	04/03/91	799
91	SKP	DOCK/BOAT LAUNCH/RAMP/PILINGS	KENNETH A. ROWELL	KACHEMAK BAY	DFG-SA	04/11/91	1186
91	SKP	EASEMENT/EASEMENT VACATION	DOI/BLM/ENGLISH BAY CORPORATION	ENGLISH BAY	FED-BLM	04/16/91	1028
91	SKP	LAND DISPOSAL	BUREAU OF LAND MANAGEMENT	SECTION 5., T. 6 S., R. 12 W., S.M.	DNR-O	07/10/90	1544
91	SKP	LAND DISPOSAL	BUREAU OF LAND MANAGEMENT	SECTION 22, T. 2 S., R. 13 W., S.M.	DNR-O	07/10/90	1629
91	SKP	LAND DISPOSAL	BUREAU OF LAND MANAGEMENT	KACHEMAK BAY AND FRITZ CREEK	DNR-O	09/18/90	347
91	SKP	LAND USE	VILLAGE OF DOLINA	FOX RIVER FLATS CRITICAL HABITAT AREA	DFG-SA	07/11/90	1543
91	SKP	LAND USE	LEE M. RICKETTS	KACHEMAK BAY	DFG-SA,DNR-WU-RW	02/20/91	687
91	SKP	LAND USE	DAVID P. PETERSON	SECTION 27 & 34, T5S, R13W, S.M.	DNR-LU	03/26/91	1011
91	SKP	TIMBER	CHUGACH TIMBER	WINDY BAY	DNR-TI	07/03/90	1563
91	SKP	TIMBER	CHUGACH TIMBER CORPORATION	WINDY BAY	DNR-TI	07/03/90	1621
91	SKP	TIMBER	BIA/FORESTRY	PORT GRAHAM	DNR-TI	07/03/90	1473

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
91	SKP	TIMBER	CHUGACH TIMBER COMPANY	WINDY BAY	DNR-TI	07/24/90	59
91	SKP	TIMBER	CHUGACH TIMBER ASSOCIATION	HAPPY VALLEY AREA	DNR-TI	09/25/90	431
91	SKP	TIMBER	CHUGACH TIMBER CORPORATION	NINILCHIK	DNR-TI	10/19/90	494
91	SKP	TIMBER	CHUGACH TIMBER CORPORATION	STARISKI CREEK AREA	DNR-TI	11/16/90	590
91	SKP	TIMBER	CHUGACH TIMBER CORPORATION	WINDY BAY	DNR-TI	11/16/90	617
91	SKP	TIMBER	COOK INLET REGION INC.	CLAM GULCH/DEEP CREEK	DNR-TI	01/04/91	764
91	SKP	TIMBER	KLUKWAN FOREST	NINILCHIK	DNR-TI	02/07/91	873
91	SKP	TIMBER	CHUGACH TIMBER	STARISKI AREA	DNR-TI	02/08/91	874
91	SKP	TIMBER	CHUGACH TIMBER CORPORATION	WINDY BAY	DNR-TI	03/29/91	1055
91	SKP	TIMBER	CHUGACH TIMBER CORPORATION	HAPPY VALLEY AREA	DNR-TI	04/12/91	1266
91	SKP	TIMBER	KOLON CALIFORNIA CORPORATION	ENGLISH BAY RIVER DRAINAGE	DNR-TI	04/18/91	1221
91	SKP	TIMBER	KOLON CALIFORNIA CORP.	ENGLISH BAY VICINITY	DNR-TI	05/21/91	1346
91	SKP	WATER USE	RICHARD E. TISCH	AIALIK BAY AND HOLOGATE ARM	DNR-WU	08/08/90	87
91	SKP	WATER USE	DAVE'S SUNDOG SERVICES, INC.	AIALIK BAY AND HOLOGATE ARM	DNR-WU	08/08/90	86
91	SKP	WETLAND FILL	KIM TURLEY	ENGLISH BAY 3	OMB-50	07/13/90	1477
91	SKP	WETLAND FILL	KENNETH A. ROWELL	KACHEMAK BAY 147	OMB-50,FED-COE	06/04/91	1251
92	CRD	CULVERT/BRIDGE	SHERSTONE INC.	SEC. 20,T15,R1W,CRM	DFG-NP	12/10/91	390

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
92	CRD	CULVERT/BRIDGE	SHERSTONE INC.	SEC. 20, T15, R1W, CRM	DFG-NP	12/19/91	391
92	CRD	CULVERT/BRIDGE	SHERSTONE INC.	SEC. 20, T15, R1-10, CRM	DFG-NP	12/19/91	392
92	CRD	CULVERT/BRIDGE	SHERSTONE, INC.	SEC. 20, T15, R1-10, CRM	DFG-NP	12/23/91	393
92	CRD	EASEMENT/EASEMENT VACATION	TATITLEK CORPORATION	TATITLEK	FED-BLM	02/12/92	672
92	CRD	TIMBER	WHITESTONE LOGGING	ELSNER NORTH	DNR-TI	11/26/91	386
92	CRD	TIMBER	WHITESTONE LOGGING	SIAMESE LAKE	DNR-TI	11/26/91	385
92	CRD	TIMBER	WHITESTONE LOGGING	CORDOVA AREA	DNR-TI	02/05/92	594
92	CRD	TIMBER	WHITESTONE LOGGING	EYAK LAKE	DNR-TI	02/20/92	652
92	CRD	TIMBER	SHERSTONE, INC.	SCOTT LAKE #1	DNR-TI	06/03/92	1262
92	CRD	TIMBER	SHERSTONE, INC.	SCOTT LAKE #2	DNR-TI	06/03/92	1268
92	CRD	TIMBER	SHERSTONE, INC.	POWER CREEK 1	DNR-TI	06/05/92	1266
92	CRD	TIMBER	SHERSTONE, INC.	POWER CREEK	DNR-TI	06/05/92	1263
92	CRD	TIMBER	SHERSTONE, INC.	POWER CREEK #3	DNR-TI	06/05/92	1264
92	CRD	TIMBER	SHERSTONE, INC.	POWER CREEK #4	DNR-TI	06/05/92	1267
92	EKP	MARICULTURE	GILBERT, ORV AND BOBBY	THUMB COVE 1	OMB-50,FRD-O,DNR-LU, FED-COE	10/30/91	436
92	EKP	MARICULTURE	MOUNT MARATHON NATIVE ASSOCIATION	SEWARD	FRD-O	04/06/92	788
92	EKP	BANK STABILIZATION /RIVER TRAINING	MCDONALD, WILLIAM S.	UNNAMED CRK MILE 2 /NASH ROAD	DFG-NP	12/27/91	350
92	EKP	EASEMENT/EASEMENT VACATION	DOI/BLM/ENGLISH BAY CORP	ENGLISH BAY	FED-BLM	08/07/91	17
92	EKP	TIMBER	KENAI PACIFIC LUMBER CO.	SEWARD	DNR-TI	07/08/91	1938

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
92	EKP	TIMBER	KENAI PACIFIC LUMBER CO	SEWARD	DNR-TI	07/30/91	81
92	EKP	TIMBER	NIMAX CORPORATION	SEWARD	DNR-TI	08/02/91	82
92	PWS	MARICULTURE	TATITLEK CORP	BOULDER BAY 2	OMB-30,FRD-O,DNR-LU	07/23/91	55
92	PWS	MARICULTURE	TATITLEK CORP	PRINCE WILLIAM SOUND 78	OMB-30,FRD-O,DNR-LU	07/23/91	57
92	PWS	MARICULTURE	TATITLEK CORP	PRINCE WILLIAM SOUND 79	OMB-30,FRD-O,DNR-LU	07/23/91	56
92	PWS	MARICULTURE	CHENEGA BAY CORP.	ELRINGTON PASSAGE 2	OMB-50,FRD-O,DNR-LU, DEC-O,FED-COE	09/04/91	1905
92	PWS	MARICULTURE	CHENEGA BAY CORP.	ELRINGTON PASSAGE 3	OMB-50,DFG-O,DNR-LU, DEC-O,FED-COE	09/04/91	1917
92	PWS	MARICULTURE	BRIDGEMAN, JOSEPH & RACHEL	WEST BAY 1	OMB-50,FDR-O,DNR-LU, DEC-O,FED-COE	09/04/91	1908
92	PWS	MARICULTURE	CHENEGA BAY CORP.	CRAB BAY 2	OMB-50,FRD-O,DNR-LU, DEC-O,FED-COE	09/04/91	1920
92	PWS	MARICULTURE	BANTA/MCCRACKEN/SIEMON	ORCA INLET 128	OMB-50,FRD-O,DNR-LU, DEC-O,FED-COE	09/05/91	1914
92	PWS	MARICULTURE	BANTA/MCCRACKEN/SIEMON	WINDY BAY 2	OMB-50,FRD-O,DNR-LU, DEC-O,FED-COE	09/05/91	1911
92	PWS	MARICULTURE	BRIDGEMAN, JOSEPH AND RACHEL	WEST BAY 1	OMB-30,FRD-O,DNR-LU, DEC-O,FED-COE	12/12/91	501
92	PWS	CULVERT/BRIDGE	BROWNING TIMBER	SEC 18, T13S, R7W, CRM	DFG-NP	07/12/91	61
92	PWS	CULVERT/BRIDGE	BROWNING TIMBER	SEC 22, T13S, R7W, CRM	DFG-NP	07/17/91	62
92	PWS	CULVERT/BRIDGE	JOHNSON EXCAVATION	MINERAL CREEK	DFG-NP	09/23/91	358
92	PWS	CULVERT/BRIDGE	CITIFOR, INC.	SEC. 14, T13S, R7W, CRM	DFG-NP	10/31/91	439
92	PWS	CULVERT/BRIDGE	CITIFOR, INC.	SEC. 14, T13S, 7W, CRM	DFG-NP	10/31/91	441

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
92	PWS	CULVERT/BRIDGE	CITIFOR, INC.	SEC. 14, T13S, R7W, CRM	DFG-NP	10/31/91	440
92	PWS	CULVERT/BRIDGE	CITIFOR INC.	SEC. 14,T13S,R7W,CRM	DFG-NP	12/02/91	364
92	PWS	CULVERT/BRIDGE	BROWNING TIMBER	UNNAMED STREAM/SEC. 32,T13S,R7W,CRM	DFG-NP	02/05/92	667
92	PWS	CULVERT/BRIDGE	CITIFOR, INC.	SEC. 11, T13S, R7W, CRM	DFG-NP	03/09/92	728
92	PWS	CULVERT/BRIDGE	CITIFOR, INC.	SEC. 11, T13S, R7W, CRM	DFG-NP	03/09/92	725
92	PWS	CULVERT/BRIDGE	CITIFOR INC.	SEC. 11, T13S, R7W, CRM	DFG-NP	03/09/92	724
92	PWS	CULVERT/BRIDGE	TIMBER TRADING CO.	MACLEOD HARBOR #4	DFG-NP	06/08/92	996
92	PWS	CULVERT/BRIDGE	TIMBER TRADING COMPANY	MACLEOD HARBOR/#9	DFG-NP	06/08/92	1002
92	PWS	CULVERT/BRIDGE	TIMBER TRADING CO.	CHARLIE CREEK/#2	DFG-NP	06/12/92	993
92	PWS	CULVERT/BRIDGE	TIMBER TRADING CO.	MACLEOD HARBOR/#1	DFG-NP	06/12/92	994
92	PWS	CULVERT/BRIDGE	TIMBER TRADING CO.	MACLEOD HARBOR/#3	DFG-NP	06/18/92	995
92	PWS	CULVERT/BRIDGE	TIMBER TRADING CO.	MACLEOD HARBOR/#4A	DFG-NP	06/18/92	998
92	PWS	DOCK/BOAT LAUNCH/RAMP/PILING	JENSEN, CARL A.	CANOE PASSAGE 1	FED-COE, 0MB-30, DNR-LU	06/12/92	850
92	PWS	DOCK/BOAT LAUNCH/RAMP/PILINGS	TATITLEK CORPORATION	PRINCE WILLIAM SOUND 74	OMB-15, FED-COE, DEC-401, FED-EPA	05/04/92	537
92	PWS	EASEMENT/EASEMENT VACATION	TATITLEK CORPORATION	TATITLEK	FED-BLM	03/03/92	653
92	PWS	FOREST PRACTICE NOTIFICATION	BROWNING TIMBER	TWO MOON BAY	DNR-TI	10/02/91	352
92	PWS	HARDROCK MINING	ALASKA UNITED MINING	CULROSS ISLAND	OMB-30, DFG-PL, FED-USFS	03/13/92	592
92	PWS	MATERIAL REMOVAL	BLONDEAU, WAYNE	MINERAL CREEK	DFG-NP	02/20/92	636

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[4]	DATE	FILE
92	SKP	AIR QUALITY	CROCKETT, RON P.	WINDY BAY	DEC-O	03/06/92	751
92	SKP	MARICULTURE	BRADLEY, MARK	HALIBUT COVE 3	OMB-30, FRD-O	07/03/91	1364
92	SKP	MARICULTURE	HAYS, BRENDA	HALIBUT COVE 11	OMB-30, FRD-0	07/03/91	1328, 1329
92	SKP	MARICULTURE	EASON, ROBERT G.	PETERSON BAY 2	OMB-50,FRD-O,DNR-LU, FED-COE	12/05/91	529
92	SKP	MARICULTURE	MILLER, BRYAN	HALIBUT COVE 16	OMB-50,DFG-SA,FRD-O, DNR-LU,DEC-401	12/06/91	889
92	SKP	MARICULTURE	BELLAMY, MARVIN & ANNETTE	HALIBUT COVE 19	OMB-50,DFG-SA,FRD-O, DNR-LU,DEC-401	12/06/91	891
92	SKP	MARICULTURE	BECWAR-LEWIS, VICTORIA	HALIBUT COVE 17	OMB-50,DFG-SA,FRD-O, DEC-401,DNR-LU	12/06/91	890
92	SKP	MARICULTURE	CLAPP, RAY	PETERSON BAY 3	OMB-50,FRD-O,DNR-LU, DEC-401,FED-C0E	12/06/91	885
92	SKP	MARICULTURE	GODFREY/OSGOOD	TUTKA BAY 4	OMB-50,DFG-SA,FRD-O, DNR-LU,DEC-401	12/06/91	886
92	SKP	MARICULTURE	CLAPP, RAY	KASITSNA BAY 3	OMB-50,KNR-LU,DEC-401, FRD-O,FED-COE	12/06/91	887
92	SKP	MARICULTURE	LEWIS, JOSHUA	HALIBUT COVE 18	OMB-50,DFG-SA,FRD-0, DNR-LU,DEC-401	12/06/91	892
92	SKP	MARICULTURE	FRITZ, GRANT & SHIRLEY	HALIBUT COVE 15	OMB-50,DFG-SA,FRD-0, DNR-LU,DEC-401	12/06/91	888
92	SKP	MARICULTURE	WHITNEY, CLARK & CHERYL	BEAR COVE 2	OMB-50,DFG-SA,FRD-O, DNR-LU,DEC-401	12/06/91	893
92	SKP	MARICULTURE	BRANSON, JIM/MUNRO, NANCY	HALIBUT COVE	DFG-SA	01/10/92	581
92	SKP	MARICULTURE	BANTA, JOE	HALIBUT COVE LAGOON 2	DFG-SA	01/10/92	583
92	SKP	MARICULTURE	HAYS, BRENDA	HALIBUT COVE 11	DFG-SA	01/10/92	584

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
92	SKP	MARICULTURE	BRADLEY, MARK	HALIBUT COVE 3	DFG-SA	01/10/92	582
92	SKP	MARICULTURE	HARTLEY, ROBERT & DIANE	PETERSON BAY 4	OMB-50,DFG-SA,FRD-O, DNR-LU,DEC-401	03/02/92	412
92	SKP	MARICULTURE	BADER, RONALD	PETERSON BAY 5	OMB-50,DFG-SA,DNR-LU, FRD-O,FED-COE	03/03/92	526
92	SKP	MARICULTURE	SEIMS, GARY	PETERSON BAY 1	OMB-50,DFG-SA,DNR-LU, FED-COE,FRD-O	03/03/92	528
92	SKP	MARICULTURE	SIDELINDER, KEVIN	HALIBUT COVE 14	OMB-50,DFG-SA,FRD-O, DNR-LU,FED-COE	03/04/92	1060
92	SKP	MARICULTURE	BRADLEY, MARK	HALIBUT COVE 13	OMB-50,DFG-SA,FRD-O, DEC-401,FED-COE	03/04/92	1059
92	SKP	MARICULTURE	EASON, ROBERT G.	KASITSNA BAY 2	OMB-50,FED-COE,DNR-LU DFG-SA,FRD-O	03/05/92	527
92	SKP	MARICULTURE	HAYS, BRENDA	KACHEMAK BAY	FRD-O	04/06/92	779
92	SKP	MARICULTURE	PAINE, BRENT & LUTHER	JAKALOF BAY 4	OMB-15,FRD-O,DFG-SA, DNR-LU,DEC-401	04/17/92	1025
92	SKP	MARICULTURE	FELL, DONALD & MARY	LITTLE JAKALOF BAY 13	OMB-50,FED-COE,DNR-LU FRD-O,DFG-SA	03/18/92	413
92	SKP	CULVERT/BRIDGE	PACIFIC/GRADNEY	ENGLISH BAY RIVER	DFG-NP	03/04/92	806
92	SKP	CULVERT/BRIDGE	I.T.T. RAYNIER	ROCKY RIVER TRIBUTARY	DFG-NP	04/17/92	905
92	SKP	CULVERT/BRIDGE	ITT RAYONIER	ROCKY RIVER	DFG-NP	05/07/92	1199
92	SKP	DOCK/BOAT LAUNCH/RAMP/PILING	BUREAU OF INDIAN AFFAIRS	PORT GRAHAM 2	OMB-15,FED-COE,DNR-LU	06/05/92	1404
92	SKP	HALIBUT COVE 10	MCNEVIN, KATHRYN	HALIBUT COVE 10	DFG-SA	01/10/92	578
92	SKP	TIMBER	CHUGACH FOREST PRODUCTS	WINDY BAY	DNR-TI	07/03/91	1822

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[4]	DATE	FILE
92	SKP	TIMBER	CHUGACH FOREST PRODUCTS	UNIT 13	DNR-TI	08/09/91	107
92	SKP	TIMBER	CHUGACH FOREST PRODUCTS	WINDY BAY	DNR-TI	08/22/91	231
92	SKP	TIMBER	UNIVERSITY OF ALASKA	FALLS CREEK	DNR-TI	08/23/91	175
92	SKP	TIMBER	KOLON CORPORATION	KOYUKTOLIK BAY 1	OMB-30	11/25/91	380
92	SKP	TIMBER	KOLON CALIFORNIA CORP.	ENGLISH BAY RIVER AREA	DNR-TI	01/07/92	513
92	SKP	TIMBER	ITT RAYONIER	WINDY BAY	DNR-TI	02/18/92	702
92	SKP	TIMBER	KOLON CALIFORNIA CORP.	KOYUKTOLIK BAY 1	OMB-30,DNR-LU	03/03/92	781
92	SKP	TIMBER	ITT RAYONIER	WINDY BAY	DNR-TI	04/08/92	960
92	SKP	TIMBER	ITT RAYONIER	WINDY BAY/UNITS 29,40,101,102,107-109	DNR-TI	04/15/92	1072
92	SKP	TIMBER	KOLON CORPORATION	ENGLISH BAY/PORT CHATAM	DNR-TI	04/16/92	959
92	SKP	TIMBER	ITT RAYONIER	WINDY BAY	DNR-TI	04/28/92	1175
92	SKP	WETLAND FILL	BUREAU OF INDIAN AFFAIRS	KACHEMAK BAY 149	OMB-50,FED-COE,DEC-401	01/03/92	397
92	SWK	MARICULTURE	BARNHART, JEFFREY	COOK BAY 1	OMB-50,FRD-0,DNR-LU, DEC-WW,FED-COE	10/30/91	482
92	SWK	MARICULTURE	PORT LIONS SHELLFISH	PORT LIONS	OMB-50,FRD-0,DNR-LU, FED-COE	12/04/91	557
92	SWK	MARICULTURE	TILL, PAT	MIDDLE BAY 1	OMB-30,FRD-O,DNR-LU, FED-COE	12/04/91	559
92	SWK	MARICULTURE	KODIAK NATIVE ASSOCIATION	MIDDLE BAY 2	OMB-50,FRD-0,DNR-LU, FED-COE	12/04/91	558
92	SWK	MARICULTURE	OSWALT, REED	MARMOT STRAIGHT	OMB-50,FRD-O,DNR-LU, DEC-WW,FED-COE	12/20/91	689

PRIVATE OWNER PERMIT AUTHORIZATIONS IN SPILL AREA 1989-92

FY	AREA[1]	ACTIVITY	APPLICANT	LOCATION	PERMIT[2]	DATE	FILE
92	SWK	MARICULTURE	WELCH, JEFF	HIDDEN BASIN	OMB-50,FRD-O,DNR-LU, DEC-WW,FED-COE	12/20/91	690
92	SWK	MARICULTURE	OSBORNE	LARSEN BAY 5	FRD-O,OMB-30,DNR-LU, FED-COE	06/23/92	1457
92	SWK	MARICULTURE	KODIAK ARE NATIVE ASSOCIATION	KEMPFF BAY 1	OMB-30,FRD-O,DNR-LU	07/22/91	54
92	SWK	CULVERT/BRIDGE	KONCOR FOREST PRODUCTS	SEC. 32, T23S, R19W, S.W.	DFG-NP	07/09/91	1668
92	SWK	CULVERT/BRIDGE	KONCOR FOREST PRODUCTS	AFOGNAK LAKE	DFG-NP	07/12/91	1669
92	SWK	CULVERT/BRIDGE	KONCOR FOREST PRODUCTS	SEC. 33, T23S, R19W, S.M.	DFG-NP	08/20/91	165
92	SWK	CULVERT/BRIDGE	KONCOR FOREST PRODUCTS	SEC. 3, T24S, R19W, S.M.	DFG-NP	10/09/91	337
92	SWK	CULVERT/BRIDGE	KONCOR FOREST PRODUCTS	SEC. 2, T24S, R19W, S.M.	DFG-NP	10/31/91	430
92	SWK	CULVERT/BRIDGE	KONCOR	BIG KITOI LAKE	DFG-NP	03/25/92	911
92	SWK	CULVERT/BRIDGE	KONCOR	LAURA-GRETCHEN CRK /630 ROAD	DFG-NP	04/02/92	817
92	SWK	CULVERT/BRIDGE	KONCOR	LAURA-GRETCHEN CRK /600 ROAD	DFG-NP	04/02/92	816
92	SWK	CULVERT/BRIDGE	AFOGNAK NATIVE CORPORATION	ELK LAKE	DFG-NP	04/10/92	962
92	SWK	EASEMENT/EASEMENT VACATION	KODIAK, NATIVES OF	KODIAK ISLAND	FED-BLM	05/22/92	1034
92	SWK	FOREST PRACTICES NOTIFICATION	AFOGNAK NATIVE CORPORATION	AFOGNAK ISLAND	DNR-TI	08/30/91	315
92	SWK	KILIUDA BAY	LAND DISPOSAL	BUREAU OF INDIAN AFFAIRS	DNR-O	05/29/92	1250
92	SWK	LAND DISPOSAL	CHOKWAK, PHILIP	KODIAK	DNR-O	07/25/91	72
92	SWK	LAND DISPOSAL	SHUGAK, MIKE/WILLIE	KODIAK ISLAND	DNR-O	04/22/92	1035

Table 4 PRELIMINARY SUMMARY OF HABITAT CHARACTERISTICS OF INJURED SPECIES 09/09/92

SPECIES	RECOVERY		LIMITING FACTORS	KEY HABITAT CHARACTERISTICS	DATA LAYERS NEEDED	COMMENTS
	DEGREE	RATE				
Marbled murrelet	Inadequate, population well below pre-spill estimates	Static	Forage fish, nesting habitat, gillnet mortality, predation	Use areas: inland areas at heads of bays; slopes facing NW, W, SW; **Flight corridors:** open bog meadows, especially at bay heads; Nesting areas: old growth spruce/hemlock forest (volume class 4, stand class 4), <0.25 mi. from salt water, 65% slope, 75 - 115 m elevation, NW-W aspect, 70 - 85% canopy closure, contiguous stand area >18 hectares, nest tree 30 - 80 cm dbh, nest tree height 20 - 30 m.	Shoreline Vegetation Aspect Slope Elevation Ownership	The confidence in the degree and rate of recovery is rated moderate. More years of post-spill population data are needed. The confidence that nesting habitat is limiting is rated low and is based primarily on circumstantial evidence from Pacific NW. The confidence in key habitat characteristics is rated high for Naked Island but extrapolation to other spill-affected areas is uncertain.
Sea otter	Unknown	Unknown	Bivalve prey abundance and contamination	Shallow, nearshore subtidal with abundant prey. Haul-out sites in the intertidal zone with low relief and algal-covered rocks.	Shoreline Slope Bathymetry Ownership	Recovery is either not occurring or is slow. Possible continuing contamination of bivalve prey. Females with pups may require protected nearshore areas.
Pigeon guillemot	Inadequate	Low	Prey abundance Predation Nest site availability (?)	Nest cavities. In PWS: 1) Talus slopes, 2) Cliff crevices, 3) Cliff-edge burrows. Also use edificarian nesting habitat Characteristics of intertidal zone important part of breeding habitat.. Nearshore feeding habitat.	Shoreline Slope Bathymetry Ownership Landforms	Population decline documented for both pre- and post-spill; continuing decline in PWS (high level of confidence). Reasons for continuing decline are unknown. Naked Is. population does not appear to be limited by nest site availability.
Black oystercatcher	Beginning to recover	Moderate	Predation	Intertidal zone with a gradual slope and gravel substrate. Intertidal nesters. Nest substrate type may be an important factor in nesting success.	Shoreline Slope Ownership	Mussels and limpets are significant prey items.
Common murre	Beginning to recover	Slow	Reduced colony size Abnormal age class distribution Human disturbance	Nesting ledges . Juxtaposition of nesting habitat to marine feeding habitat.	Seabird atlas Ownership	Confidence in recovery projection is high to moderate. Confidence in factors limiting recovery is low. Nesting habitat is well known. Information on feeding habitat is limited.

Table 4 PRELIMINARY SUMMARY OF HABITAT CHARACTERISTICS OF INJURED SPECIES 09/09/92

SPECIES	RECOVERY		LIMITING FACTORS	KEY HABITAT CHARACTERISTICS	DATA LAYERS NEEDED	COMMENTS
	DEGREE	RATE				
Harlequin duck	Declining	Moderate	Uncontaminated food, primarily mussels, *Mytilus edulis*	**Nesting areas:** Small openings on steep, v-shaped, old-growth spruce/hemlock slopes adjacent to tributaries to anadromous streams (FPA Class C); elevation 100-250 m; south aspect; nests on mossy ledges concealed by shrubs and ferns 2-5 m above stream; streams relatively swift and shallow with gravel/cobble and cobble/boulder substrate, pool/riffle ratio low, gradient 5-8%. **Brood rearing areas:** Lower reaches and estuaries of relatively large anadromous fish streams (flows 1.5-7.0 cu.m/sec), salmon spawning from late June-September.	Anad Streams Streams Watersheds Shoreline Vegetation Aspect Slope Elevation Ownership	Data limited to PWS. Confidence in recovery rated moderate. Confidence is high that food (uncontaminated mussels) is a limiting factor, moderate that nesting habitat is limiting. Confidence in key habitat characteristics is moderate; information limited by small sample size.
Bald eagle	Not available	Not available	Not available	Not available	Ownership Eagle Nests Vegetation Shoreline	Not available
Harbor seal	Inadequate, population well below pre-spill estimates	Static or slowly declining	Unknown, possibly human-caused mortality, inadequate food, disease	**Haulout areas:** Sand, gravel, & rocky beaches, offshore rocks, glacial ice. Pups and adults regularly use specific areas. **Feeding areas:** Bays and mouths of rivers. Major PWS prey include: walleye pollock, herring, salmon, squid, and octopus.	Shoreline Ownership	The degree of movement of individual seals and their fidelity to specific haulout areas is unknown. Physical characteristics of haulout areas does not appear to be unique. Factors including traditional use, low disturbance, and proximity to food may be important. Commercial fishing of major prey species may affect nutrition.
River otter	Not available	Not available	Not available	Not available	Ownership Anad Streams Watersheds Vegetation	Not available

Table 4 PRELIMINARY SUMMARY OF HABITAT CHARACTERISTICS OF INJURED SPECIES 09/09/92

SPECIES	RECOVERY		LIMITING FACTORS	KEY HABITAT CHARACTERISTICS	DATA LAYERS NEEDED	COMMENTS
	DEGREE	RATE				
Pink salmon	Declining	Moderate	Uncontaminated intertidal spawning habitat, pelagic zooplankton	**Spawning areas:** well sorted gravel (1.3-10 cm, fines <5% of volume), stable stream flows (<2.1 m/sec), excellent water quality. **Rearing areas:** shallow bays (initial outmigration), steep rocky shorelines exposed to currents (later development).	Anad Streams Watersheds Shoreline Vegetation Ownership	Confidence in recovery is rated moderate. Confidence in limiting factors is moderate; genetic damage to eggs/fry caused by residual oil contamination not completely known. Confidence in habitat characteristics for pink salmon in PWS is high.
Sockeye salmon	Declining	Rapid	Rearing habitat (freshwater lakes), especially zooplankton availability and fry density	**Rearing areas:** nutrient rich lakes w/zooplankton **Spawning areas:** well sorted gravel (50% 2.5-7.5 cm, 40% <2.5 cm), stable stream flows (0.21-1.01 m/sec), excellent water quality **Non-specific:** water quality, natural vegetation along banks, water temperature, wetlands, emergence timing	Anad Streams Watersheds Lakes Shoreline Vegetation Ownership	Confidence in recovery is rated moderated to high. Confidence in limiting factors moderate to low. Confidence in habitat characteristics low to high. Need a full technical review of overescapement studies.
Cutthroat trout	Unknown	Unknown	Unknown	**Spawning areas:** small streams, 5-10 cfs, pea-gravel, <1 ft. depth **Rearing areas:** freshwater streams, high pool/riffle ratio, abundant woody debris and overhanging vegetation **Adult foraging areas:** coastal beaches and estuaries near overwintering stream/lake systems **Overwintering areas:** freshwater lakes	Anad Streams Watersheds Shoreline Vegetation Ownership	Growth and survival in oiled areas significantly lower than in unoiled areas. Confidence in key habitat characteristics is rated moderate. Additional identification of critical spawning and overwintering areas is needed.
Dolly Varden	Unknown	Unknown	Fishing mortality	**Spawning areas:** freshwater streams **Rearing areas:** freshwater streams **Adult foraging areas:** estuaries and streams, often associated with salmon spawning **Overwintering areas:** freshwater lakes	Anad Streams Watersheds Shoreline Vegetation Ownership	Survival in oiled areas significantly lower than unoiled areas. Confidence in recovery and key habitat characteristics is rated low. Additional identification of critical spawning and rearing areas is needed.

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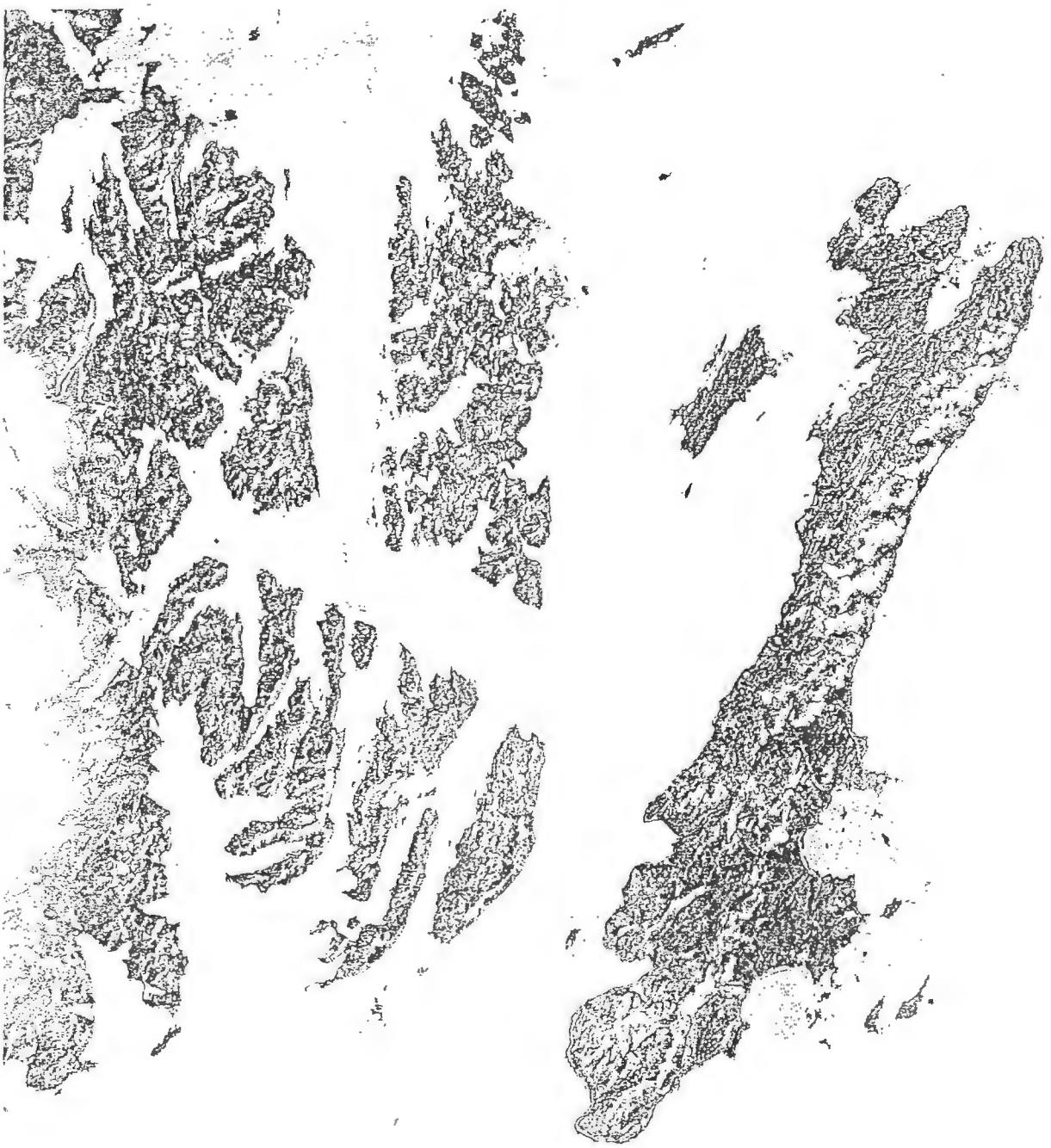

Opportunities for Habitat Protection/Acquisition

Prepared by:
Exxon Valdez Oil Spill Restoration Team
Habitat Protection Work Group
February 16, 1993

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Opportunities for Habitat Protection / Acquisition

February 16, 1993

SUMMARY OF PUBLIC COMMENTS ON RESTORATION FRAMEWORK SUPPLEMENT: HABITAT PROTECTION AND ACQUISITION PROCESS

COMMENTER	PREFERRED HABITAT PROTECTION STRATEGY		PREFERRED THRESHOLD CRITERIA			OTHER COMMENTS
	CONCUR.	HIER.	A	B	C	
The Wilderness Society	X		X			Support imminent threat protection process. Habitat acquisition is the most meaningful form of restoration. "Adequate" rate and degree of recovery and "no further action" decisions on flow charts should incorporate provision for change if monitoring detects latent injury. Set C, criteria #4 (inadequate protection afforded by existing laws and regulations) is unrealistic and is a political rather than biological determination. Contingent Valuation studies should be made available and considered in Sets A and B. Add additional criteria: The degree to which the proposed action minimizes further impact on an injured resource and service.
National Parks (on behalf of National Parks and Conservation Association)	X		X			Scientific information inadequate to draw precise conclusions about effectiveness of management strategies; habitat protection is best means of protecting natural and cultural resources. Process described in Supplement document is confusing. Cost effectiveness is an inappropriate criteria for assessing habitat and ecosystem values; cost benefit analysis may be better. Document should be rewritten for clarity; all studies should be released to public; same stringent process and standards for habitat acquisition should be applied to other restoration options.
Knik Canoers and Kayakers	No comment	No comment		X		Set A is too broad, allowing for indirect linkage and no physical limits on spill affected area. Set C are too narrow, not enough room for Trustee Council to judge selections, too time consuming. Set B limits number of actions but allows for flexibility and timely decisions.
Homer Society of Natural History	No comment	No comment	No comment	No comment	No comment	Supports state purchase of Seldovia Native Association lands, timber, and mineral rights in Kachemak Bay State Park.
Wayne Ash	No comment	No comment			X	Federal Exchange Process on page 41 should include a step for preparing an Environmental Assessment; opposes Set A.
Alaska Survival	No comment	No comment	No comment	No comment	No comment	Supplement document is too complex for general public to understand. Acquisition process taking too much time; no more talk - start using funds to buy land. Settlement monies are being wasted on bureaucrats, consultants, and scientists.

See figures 1, 2, 6 & 7 in Restoration Framework Supplement

SUMMARY OF PUBLIC COMMENTS ON RESTORATION FRAMEWORK SUPPLEMENT: HABITAT PROTECTION AND ACQUISITION PROCESS

COMMENTER		PREFERRED HABITAT PROTECTION STRATEGY		PREFERRED THRESHOLD CRITERIA			OTHER COMMENTS
		CONCUR.	HIER.	A	B	C	
John Grimes		No comment	No comment	No comment	No comment	No comment	Should include an alternative for public taking; imminent domain for unwilling sellers. An advantage of this method is that land owner doesn't have to pay taxes on imminent domain sales. Recommends that Kachemak Bay State Park inholdings be acquired by this method.
Kodiak Island Borough		X		X			The proposed process is complex and bureaucratic with a clear bias against land acquisition; substitute a simpler process. Process favors staff input over public input; example, public nominations (step #10) does not occur until well into the process.
Kodiak Environmental Network		X		X			
Kodiak Audubon		X		X			
Eric Meyers		No comment	No comment	X			Opposes Set C; too burdensome, would frustrate restoration goals.
Kristin Stall-Johnson		X		No comment	No comment	No comment	Supports use of Figure #7.
TOTALS	16	9	0	9	1	1	

See figures 1, 2, 6 & 7 in Restoration Framework Supplement

SECTION 1

SUMMARY OF PUBLIC COMMENTS ON RESTORATION FRAMEWORK SUPPLEMENT: HABITAT PROTECTION AND ACQUISITION PROCESS

COMMENTER	PREFERRED HABITAT PROTECTION STRATEGY		PREFERRED THRESHOLD CRITERIA			OTHER COMMENTS
	CONCUR.	HIER.	A	B	C	
Natural Resources Defense Council	X		X			Evaluation process too long and cumbersome. Step #2, natural recovery could be used as an excuse to avoid protecting habitat. Step #5 puts Trustees in awkward position of ruling that regulations are inadequate. Step #14 needs to list other criteria that will be used. Step #20, non-acquisition tools seem ineffective. Broaden imminent threat process to include opportunities to purchase habitat in addition to imminently threatened lands. Drop recreation from step # 7, threat analysis.
Nancy Hillstrand	No comment	No comment	No comment	No comment	No comment	Acquisition should be priority, particularly Afognak Island. Revitalize Forest Practices Regulations to minimize ecosystem injury and fragmentation. Resource agency mismanagement can be more destructive than oil spill. Renovate resource agency mandates. Monitoring should encompass widespread health of ecosystem.
Sierra Club / Alaska Center for the Environment	X		X			Hierarchical approach is completely unacceptable and unjustifiable. Proposed process is too complex and cumbersome. Step #2 should be deleted. Step #5 puts an unnecessary hurdle in path of restoration. Step #6 should provide for permanent protection, not just until resource recovers. Step #9 delete, "that are not adequately recovering". Asking price should be considered at time of applying threshold criteria; ranking acquisitions during step #s 14 & 15 will drive up asking price. Support imminent threat process but delete step #2.
The Nature Conservancy of Alaska	X		X			"Best professional judgement" must be a key component of the decision making process. Land owner should not have to create "imminent threat" in order to have their property seriously considered; strategically important, but unthreatened parcels should be given full consideration.

See figures 1, 2, 6 & 7 in Restoration Framework Supplement

Interim Threshold Criteria *

1. There is a willing seller of the parcel or property right.

2. The parcel contains key habitats that are linked to, replace, provide the equivalent of, or substitute for injured resources or services based on scientific data or other relevant information.

3. The seller acknowledges that the government cannot purchase the parcel or property rights in excess of fair market value.

4. Recovery of the injured resource or service would benefit from protection in addition to that provided by the owner and applicable laws and regulations.

5. The acquired property rights can reasonably be incorporated into public land management systems.

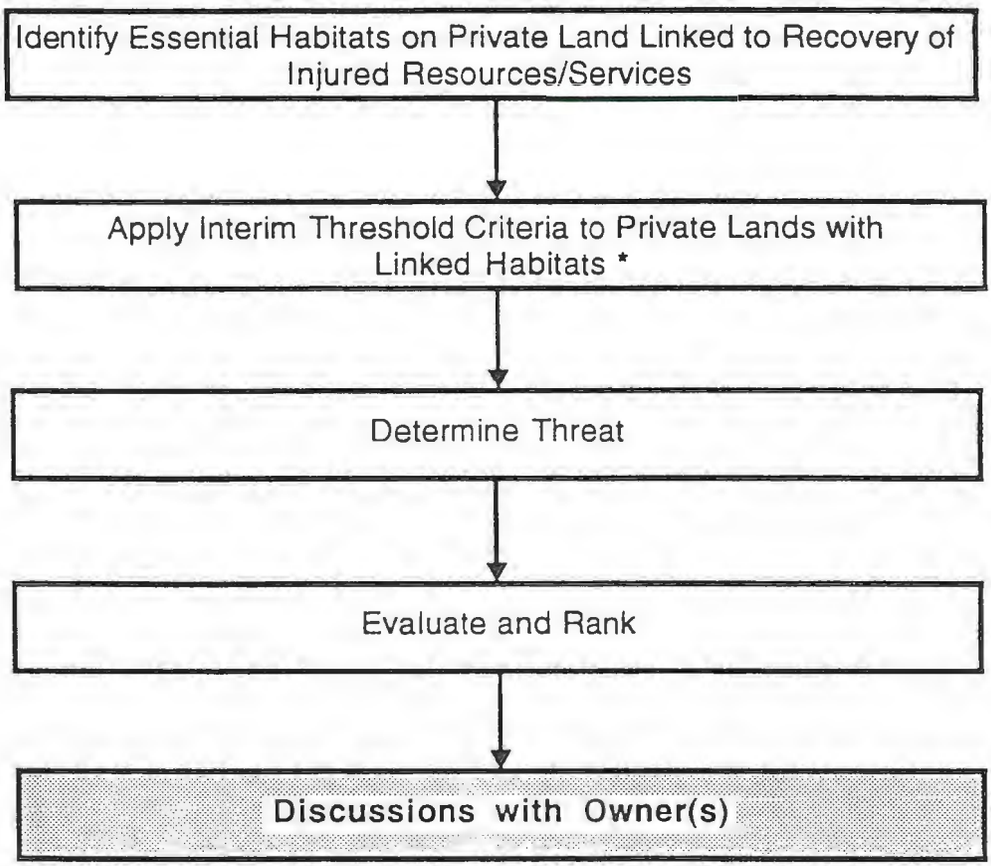
*Approved by the Trustee Council at their January 19, 1993 meeting.

	Alternative 1 Natural Recovery	Alternative 2 Protection	Alternative 3 Limited Restoration	Alternative 4 Moderate Restoration	Alternative 5 Comprehensive Restoration
THEME	No action other than monitoring and normal agency management.	Protect injured resources and services from further degradation or disturbance.	Take the most effective actions to protect and restore injured services and resources whose population has declined. Maintain the existing character of the affected area.	Take the most effective actions to protect and restore all injured resources and services. Increase, to a limited extent, opportunities for human use in the affected area.	Take all reasonable actions to protect, restore, and enhance all injured resources and services. Increase opportunities for human use in the affected area.
VARIABLES					
Injury	N/A	All injured resources.	Injured resources whose populations declined.	All injured resources.	All injured resources.
Status of Recovery	N/A	All stages of recovery.	Resources not yet recovered.	Resources not yet recovered.	All stages of recovery.
Effectiveness of Restoration Actions	N/A	All beneficial actions.	Most effective actions.	Most effective actions.	All beneficial actions.
Opportunities for Human Use	N/A	N/A	Protect existing uses.	Protect or increase existing uses.	Protect or increase existing uses; or encourage appropriate new uses.

Monitoring and information programs are included in all alternatives.
Restoration actions may be undertaken for injured resources, services, or their equivalents.

Table 2. Summary of Draft Restoration Plan Alternatives

SUMMARY OF INTERIM PROTECTION PROCESS



Abstracted from Figures 1 & 2 of the Framework Supplement.

* Criteria #1 and #3 cannot be applied until approval is received from the Trustee Council to obtain this information from landowners.

SECTION 2

Interim Evaluation/Ranking Criteria *

1. The parcel contains essential habitat(s)/sites for injured species or services. Essential habitats include feeding, reproductive, molting, roosting, and migration concentrations; essential sites include known or presumed high public use areas. Key factors for determining essential habitat/sites are:

   a. population or number of animals or number of public users.
   b. number of essential habitats/sites on parcel, and
   c. quality of essential habitats/sites.

2. The parcel can function as an intact ecological unit or essential habitats on the parcel are linked to other elements/habitats in the greater ecosystem.

3. Adjacent land uses will not significantly degrade the ecological function of the essential habitat(s) intended for protection.

4. Protection of the habitats on parcel would benefit more than one injured species/service (unless protection of a single species/service would provide a high recovery benefit).

5. The parcel contains critical habitat for a depleted, rare, threatened, or endangered species.

6. Essential habitat/sites on parcel are vulnerable or potentially threatened by human activity.

7. Management of adjacent lands is, or could easily be made compatible with protection of essential habitats on parcel.

8. The parcel is located within the oil spill affected area.

*Approved by the Trustee Council at their January 19, 1993 meeting.

CRITERIA FOR RATING BENEFIT OF PARCEL TO INJURED RESOURCES / SERVICES

INJURED RESOURCE / SERVICE	HIGH	MODERATE	LOW
Anadromous Fish	High density of anadromous streams per parcel; multiple injured species; and/or system known to have exceptional productivity.	Average density of anadromous streams for area; two or more injured species present.	Few or no streams on parcel; one or less injured species.
Bald Eagle	High density of nests on parcel; and/or known critical feeding area.	Average density of nests on or immediately adjacent to parcel (at least one); important feeding area.	Few or no nests on parcel; may be used for perching and/or feeding.
Black Oystercatcher	Area known to support nesting or concentration area for feeding.	Possible nesting; known feeding area.	Probable feeding.
Common Murre	Known nesting on or immediately adjacent to parcel.	Nesting in vicinity of parcel; known feeding concentration adjacent to parcel.	Possible feeding in area adjacent to parcel.
Harbor Seal	Known haul out on or immediately adjacent to parcel.	Probable haul outs in vicinity of parcel; probable feeding in nearshore waters adjacent to parcel.	Probable feeding in nearshore waters.
Harlequin Duck	Known nesting or molting on parcel; feeding concentration area.	Probable nesting on or adjacent to parcel; probable feeding in stream, estuary, or intertidal adjacent to parcel.	Probable feeding and loafing in area adjacent to parcel.

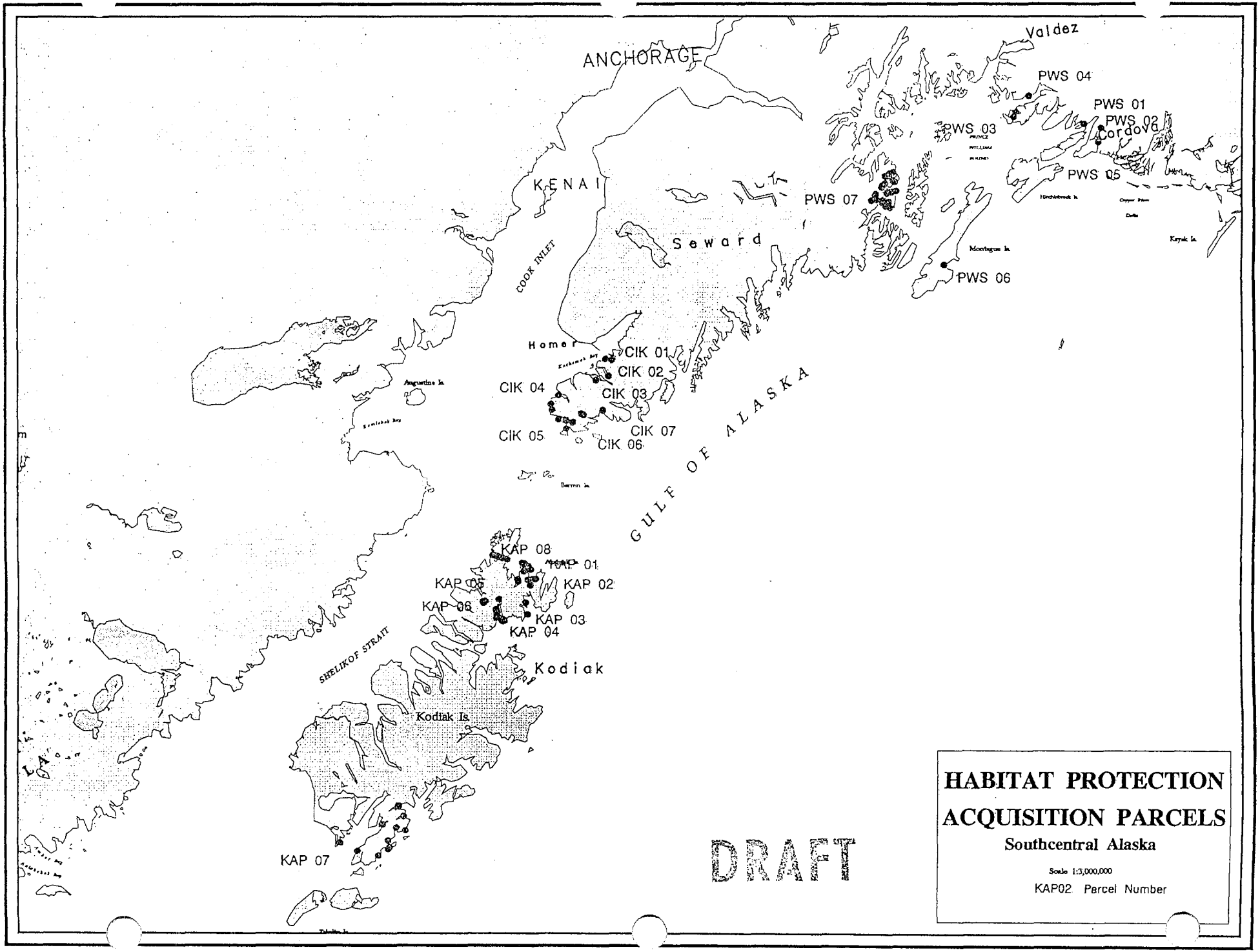
CRITERIA FOR RATING BENEFIT OF PARCEL TO INJURED RESOURCES / SERVICES

INJURED RESOURCE / SERVICE	HIGH	MODERATE	LOW
Intertidal/subtidal Biota	Known high productivity/species richness. Oiled or adjacent to oiled area where recruitment may be important.	High productivity/species richness; not oiled or near oiled area.	Average productivity/species richness; no documented shoreline oiling.
Marbled Murrelet	Known nesting or high confidence that nesting occurs; concentrated feeding in nearshore waters.	Good nesting habitat characteristics; known feeding in nearshore waters adjacent to parcel.	Low likelihood of nesting; possible feeding in nearshore waters.
Pigeon Guillemot	Known nesting on or immediately adjacent to parcel; feeding concentrations in nearshore waters.	Good nesting habitat characteristic; known feeding in nearshore waters adjacent to parcel.	Low likelihood of nesting; possible feeding in nearshore waters.
River Otter	Known high use of parcel for denning/latrine sites.	Known or probable latrine and/or denning sites; known feeding in adjacent intertidal/streams/nearshore area.	Probable feeding in adjacent intertidal/streams.
Sea Otter	Known haulout or pupping concentrations.	Concentration area for feeding and/or shelter; potential pupping.	Feeding in adjacent waters.

CRITERIA FOR RATING BENEFIT OF PARCEL TO INJURED RESOURCES / SERVICES

INJURED RESOURCE / SERVICE	HIGH	MODERATE	LOW
Recreation/Tourism	Receives high public use; highly visible to a large number of recreationists/tourists; area nominated for special recreational designation.	Accessible by road, boat, or plane; adjacent area used for recreational boating; adjacent area receives high public use.	Occasional recreational use; access may be difficult.
Wilderness	Area remote; little or no evidence of human development.	Area remote; evidence of human development.	Area accessible; high/moderate evidence of human development (roads, clearcuts, cabins).
Cultural Resources	Documented concentration or significant cultural resources/sites on parcel.	Evidence of cultural resources/sites on or adjacent to parcel.	Possible cultural resources/sites on parcel.
Subsistence	Known resource harvest area; multiple resource use.	Known harvest area for at least one resource.	Possible harvest area.

SECTION 3


ANCHORAGE
Valdez
PWS 04
PWS 01
PWS 02
Cordova
PWS 03
PWS 05
KENAI
PWS 07
Seward
COOK INLET
PWS 06
Homer
CIK 01
CIK 02
CIK 04
CIK 03
CIK 05
CIK 07
CIK 06
GULF OF ALASKA
KAP 08
KAP 01
KAP 05
KAP 02
KAP 06
KAP 03
KAP 04
SHELIKOF STRAIT
Kodiak
Kodiak Is.
KAP 07
DRAFT
HABITAT PROTECTION
ACQUISITION PARCELS
Southcentral Alaska
Scale 1:3,000,000
KAP02 Parcel Number

PARCEL RANKING ANALYSIS

PARCEL		[1]RANKING CRITERIA								
#	NAME	1	2	3	4	5	6	7	8	SCORE[2]
PWS 01	Orca Narrows	0-H, 6-M	Y	N	Y	N	Y	N	Y	12
PWS 02	Power Creek	4-H, 0-M	Y	Y	Y	N	Y	Y	Y	24
PWS 03	Two Moon Bay	1-H, 5-M	Y	N	Y	N	Y	N	Y	14
PWS 04	Fish Bay	1-H, 7-M	Y	Y	Y	N	Y	Y	Y	27
PWS 05	Eyak River	1-H, 3-M	N	N	N	N	Y	N	Y	5
PWS 06	Patton Bay	1-H, 4-M	Y	Y	Y	N	Y	Y	Y	18
PWS 07*	Chenega	6-H, 8-M	Y	Y	Y	N	Y	Y	Y	60
CIK 01	China Poot	4-H, 7-M	Y	Y	Y	N	Y	Y	Y	45
CIK 02	Sadie Cove	0-H, 3-M	Y	N	Y	N	Y	Y	Y	7.5
CIK 03	Jakalof Bay	0-H, 3-M	Y	N	Y	N	Y	N	Y	6
CIK 04	Port Graham	1-H, 2-M	Y	N	Y	N	Y	N	Y	8
CIK 05	Lower Kenai Peninsula	0-H, 9-M	Y	Y	Y	N	Y	N	Y	22.5
CIK 06	Windy Bay	0-H, 0-M	N	N	N	N	Y	N	Y	0
CIK 07	Rocky Bay	0-H, 2-M	N	N	Y	N	Y	N	Y	3
KAP 01	Seal Bay	2-H, 11-M	Y	N	Y	N	Y	N	Y	30
KAP 02	Pauls Lake	0-H, 4-M	N	N	Y	N	Y	N	Y	6

PARCEL RANKING ANALYSIS

PARCEL		[1]RANKING CRITERIA								
#	NAME	1	2	3	4	5	6	7	8	SCORE[2]
KAP 03	Izhut Bay	1-H, 3-M	Y	N	Y	N	Y	N	Y	10
KAP 04	Kazakof Bay	0-H, 5-M	Y	N	Y	N	Y	N	Y	10
KAP 05	Danger Creek	0-H, 1-M	N	N	N	N	Y	N	Y	1
KAP 06	Paramanof Creek	0-H, 1-M	N	N	N	N	Y	N	Y	1
KAP 07*	Alitak Bay	3-H, 4-M	Y	Y	Y	N	Y	Y	Y	30
KAP 08*	Shuyak Strait	3-H, 10-M	Y	Y	Y	N	Y	Y	Y	48

* = Opportunity Parcel

1. Refer to Interim Evaluation and Ranking Criteria.

Criteria 2 - 8

N = No (does not meet criteria)
Y = Yes (does meet criteria)

Criteria 1 from table: "Criteria for Rating Benefit of Parcel to Injured Resources/Services"

H = High Benefit
M = Moderate Benefit
L = Low Benefit (not included in this analysis)

2. Scoring Formula: Parcel Score = (Sum of H + (0.5 x Sum of M)) x Sum of Y
Example: KAP 08 Score = (3 + (0.5 x 10)) x 6 = (3 + 5) x 6 = 48
Note: Formula emphasizes degree of linkage to injured resource/service.

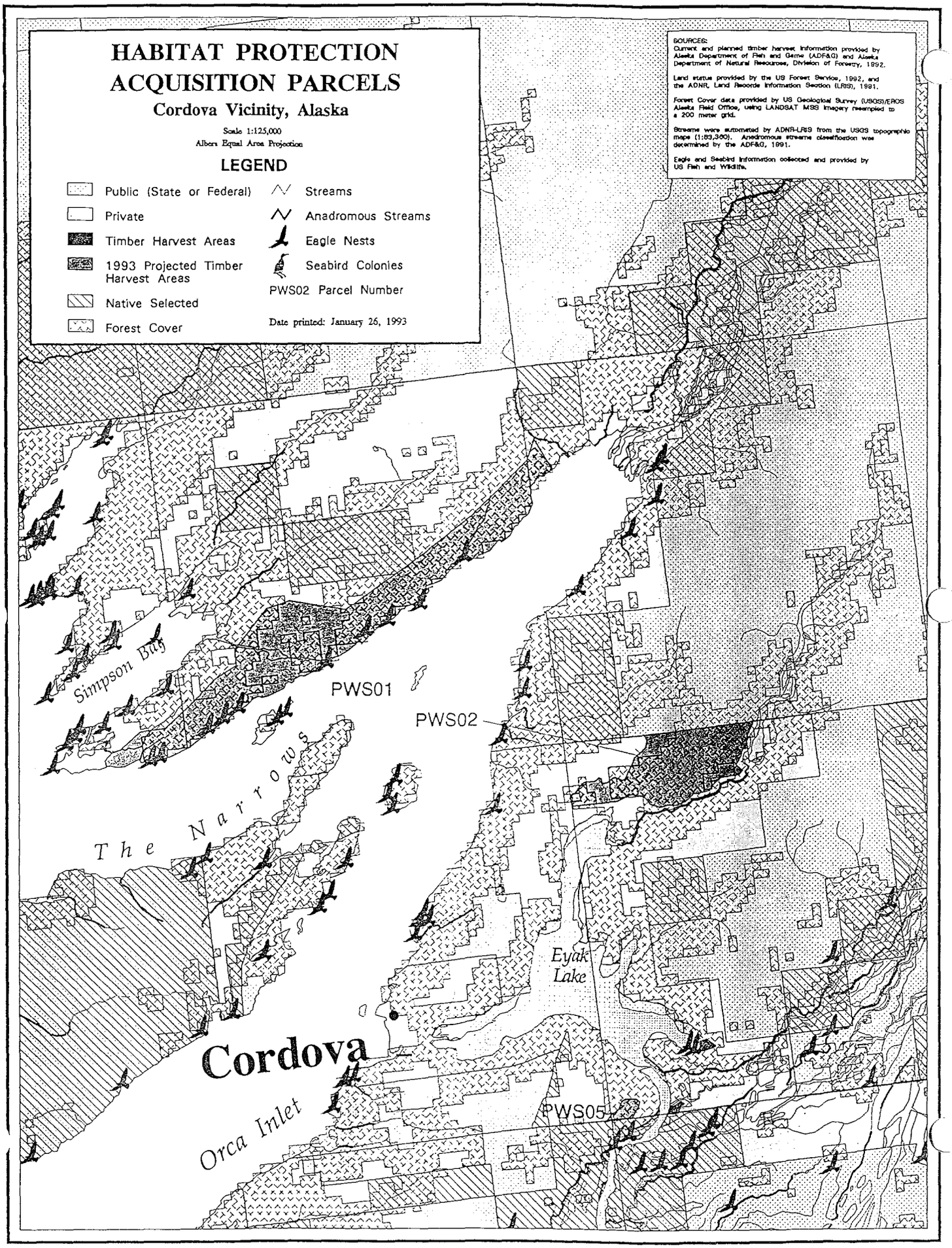
PARCEL RANKING AND ACREAGE SUMMARY

RANK	PARCEL #	NAME	ACREAGE	SCORE
Imminent Threat Parcels				
1	CIK 01	China Poot, Kachemak Bay	7,500	45
2	KAP 01	Seal Bay, Afognak I.	15,000	30
3	PWS 04	Fish Bay, Port Fidalgo	1,700	27
4	PWS 02	Power Creek, Cordova	1,300	24
5	CIK 05	Lower Kenai Peninsula	3,000	22.5
6	PWS 06	Patton Bay, Montague I.	3,300	18
7	PWS 03	Two Moon Bay, Port Fidalgo	2,100	14
8	PWS 01	Orca Narrows / Nelson Bay	3,500	12
9	KAP 03	Izhut Bay, Afognak I.	1,000	10
9	KAP 04	Kazakof Bay, Afognak I.	1,500	10
10	CIK 04	Port Graham Allotments	200	8
11	CIK 02	Sadie Cove, Kachemak Bay	400	7.5
12	CIK 03	Jakalof Bay, Kachemak Bay	600	6
12	KAP 02	Pauls Lake, Afognak I.	500	6
13	PWS 05	Eyak River, Cordova	100	5
14	CIK 07	Rocky Bay	100	3
15	KAP 05	Danger Creek, Afognak I.	120	1
15	KAP 06	Paramanof Cr., Afognak I.	500	1
16	CIK 06	Windy Bay	400	0
TOTAL IMMINENT THREAT ACRES			42,320	
Opportunity Parcels				
1	PWS 07	Chenega I./Eshamy/Jackpot	57,000	60
2	KAP 08	Shuyak Strait, Afognak I.	51,000	48
3	KAP 07	Alitak Bay, Kodiak I.	230,000	30
TOTAL OPPORTUNITY ACRES			338,000	
TOTAL ACRES ANALYZED			380,320	

Habitat Protection Working Group 02/16/93

Prince William Sound (PWS)

PWS 01, 02, 05


HABITAT PROTECTION ACQUISITION PARCELS
Cordova Vicinity, Alaska
Scale 1:125,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Timber Harvest Areas
1993 Projected Timber Harvest Areas
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
PWS02 Parcel Number
Date printed: January 26, 1993
SOURCES:
Current and planned timber harvest information provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources, Division of Forestry, 1992.
Land status provided by the US Forest Service, 1992, and the ADNR, Land Records Information Section (LRIS), 1991.
Forest Cover data provided by US Geological Survey (USGS)/EROS Alaska Field Office, using LANDSAT MSS imagery resampled to a 200 meter grid.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1991.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Simpson Bay
PWS01
PWS02
The Narrows
Eyak Lake
Cordova
Orca Inlet
PWS05

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 01	PARCEL NAME: Orca Narrows / Nelson Bay		
[1]LANDOWNER: Eyak Corporation	[2]PARCEL ACREAGE: 3,500	[3]TOTAL ACREAGE: 66,000	[4]AFFECTED ACREAGE: 3,500

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	Two documented anadromous streams; pink, coho, cutthroat.
Bald Eagle	Moderate	Ten documented nest sites.
Black Oystercatcher	Low	Probable feeding in intertidal.
Common Murre	None	
Harbor Seal	Low	Probable feeding in nearshore waters.
Harlequin Duck	Unknown	Possible nesting on anadromous streams, feeding and loafing in intertidal area.
Intertidal/subtidal biota	Low	Shoreline not oiled; potential for impact from log transfer, storage and sedimentation.
Marbled Murrelet	Moderate	Habitat characteristics appear favorable for nesting. Feeding in adjacent marine waters.
Pigeon Guillemot	Low	Possible nesting along shoreline. Feeding in adjacent marine waters.
River Otter	Moderate	Probable feeding and latrine sites along shoreline; possible denning.
Sea Otter	Low	Feeding along shoreline.
Recreation/Tourism	Moderate	Milton Lake corridor and Hole-in-Wall nominated public recreation sites. Most recreation use out of Cordova. Highly visible along main ferry and boat route to Cordova.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 01	PARCEL NAME: Orca Narrows / Nelson Bay	
Wilderness	Moderate	Little visible evidence of human use.
Cultural Resources	Low	One archeological site documented on parcel.
Subsistence	Low	Use appears low.
ECOLOGICAL SIGNIFICANCE: The Milton Lake corridor and the Hole-in-the-Wall area have been nominated for acquisition as public recreation sites. This parcel is highly visible along the main ferry and boat route.		
ADJACENT LAND MANAGEMENT: Eyak Corporation.		
IMMINENT THREAT/OPPORTUNITY: Forest practices notifications to initiate timber harvest on 700 acres have been filed by Sherstone. Additional timber harvest is proposed on Eyak lands adjacent to this area in subsequent years.		
PROTECTION OBJECTIVE: 1) Maintain water quality and riparian habitats for anadromous fish; 2) maintain nesting habitat for marbled murrelet; 3) maintain nesting and perching opportunities for bald eagle; 4) minimize visual impacts of timber harvest to marine corridor; 5) enhance recreational opportunities for the Milton Lake corridor.		
USEFUL PROTECTION TOOL(S): Timber acquisition; conservation easement; cooperative management agreement.		
RECOMMENDED ACTION: Request Eyak Corporation to provide interim protection; discuss options for long term protection.		

1. Parties other than landowner may own partial rights (e.g., timber, minerals)

2. Area evaluated.

3. Estimated acreage held by the owner in the spill area.

4. Estimated area to be affected by imminent development activity.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 02	PARCEL NAME: Power Creek		
[1]LANDOWNER: Eyak Corporation	[2]PARCEL ACREAGE: 1,300	[3]TOTAL ACREAGE: 66,400	[4]AFFECTED ACREAGE: 1,300

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	High	Power Creek is designated anadromous stream; coho, sockeye, pink, cutthroat, Dolly Varden; supports significant recreational and commercial fishery.
Bald Eagle	High	No documented nest sites. Highly important fall feeding for eagles along Power Creek and Eyak Lake shore (estimated up to one-third of PWS eagle population).
Black Oystercatcher	None	
Common Murre	None	
Harbor Seal	None	
Harlequin Duck	Unknown	Potential nesting in upper Power Creek riparian zone.
Intertidal/subtidal biota	None	
Marbled Murrelet	High	Habitat characteristics appear favorable; high confidence that nesting occurs on parcel.
Pigeon Guillemot	None	
River Otter	Unknown	Probable feeding, possible denning in upper Power Creek.
Sea Otter	None	

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 02	PARCEL NAME: Power Creek	
Recreation/Tourism	High	Receives high recreational use (hiking, fishing, berry picking); established trail easement through parcel; road accessible.
Wilderness	Low	High evidence of human use (road, houses) in lower area.
Cultural Resources	Low	One archeological site documented on parcel.
Subsistence	Unknown	Probable hunting, fishing, plant gathering, berry picking.
ECOLOGICAL SIGNIFICANCE: Power Creek supports a large, late run of sockeye and coho salmon and is a fall and winter feeding area for bald eagles. Eyak Lake is the northernmost winter concentration area for trumpeter swan. Area receives high recreational and visitor use.		
ADJACENT LAND MANAGEMENT: Eyak Corporation; U.S. Forest Service.		
IMMINENT THREAT/OPPORTUNITY: Forest Practices Notifications have been filed for timber harvest on this parcel.		
PROTECTION OBJECTIVE: 1) Maintain water quality and riparian habitat for anadromous fish; minimize disturbance to bald eagles; and 3) maintain and enhance recreational opportunities.		
USEFUL PROTECTION TOOL(S): Timber acquisition; fee title; conservation easement; cooperative management agreement.		
RECOMMENDED ACTION: Request Eyak Corporation to provide interim protection; discuss options for long term protection.		

1. Parties other than landowner may own partial rights (e.g., timber, minerals).

2. Area evaluated.

3. Estimated acreage held by the owner in the spill area.

4. Estimated area to be affected by imminent development activity.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 05	PARCEL NAME: Eyak River		
[1]LANDOWNER: Eyak Corporation	[2]PARCEL ACREAGE: 100	[3]TOTAL ACREAGE: 66,400	[4]AFFECTED ACREAGE: 100

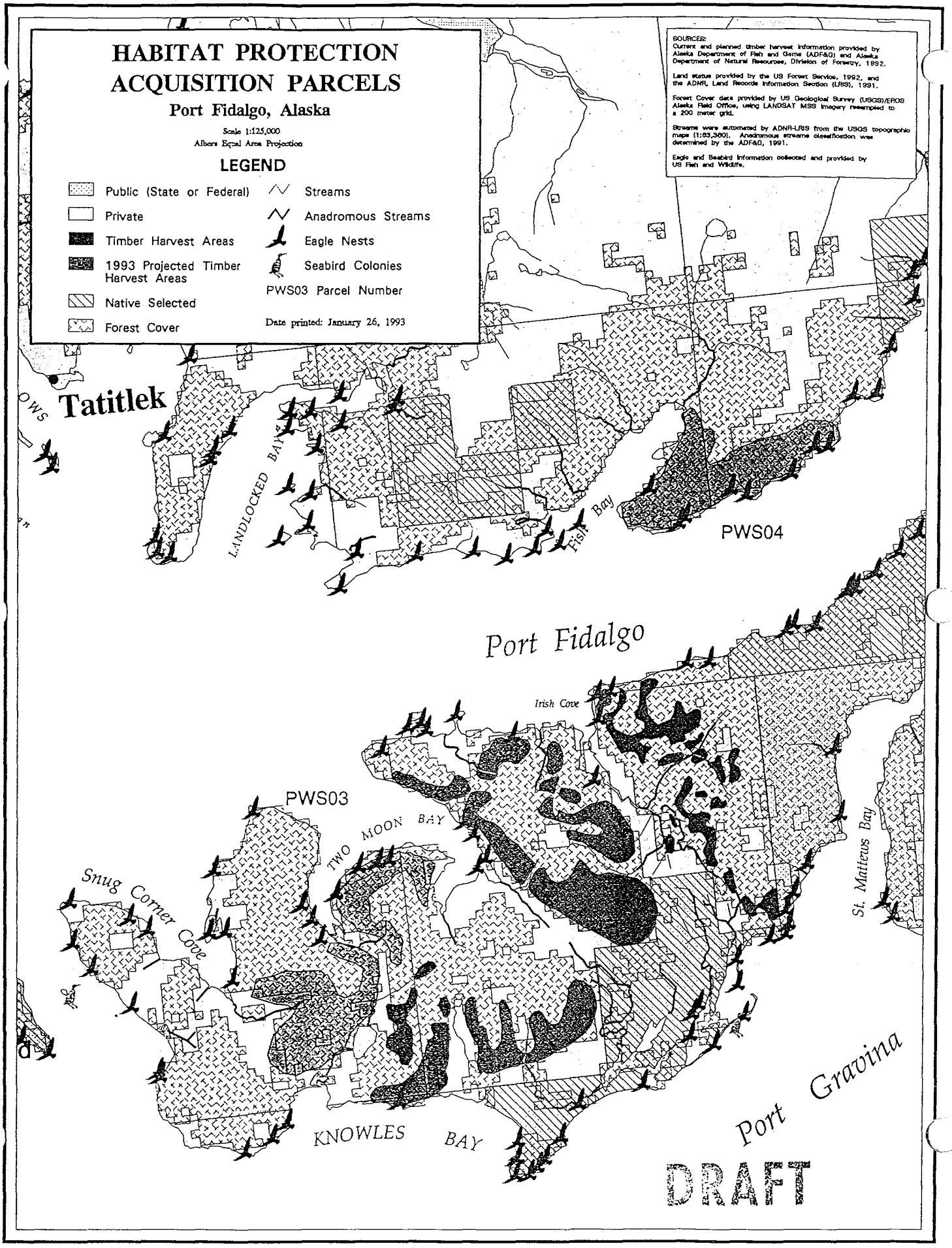
INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	Adjacent to Eyak River which is a highly productive anadromous stream; coho, sockeye, pinks, cutthroat, Dolly Varden.
Bald Eagle	Moderate	No documented nesting sites on parcel. Eight nest sites adjacent. High use area for eagles; feeding and roosting.
Black Oystercatcher	None	
Common Murre	None	
Harbor Seal	Low	Harbor seals may use Eyak River for feeding.
Harlequin Duck	None	
Intertidal/subtidal biota	None	
Marbled Murrelet	Moderate	High confidence that nesting occurs on parcel; good nesting habitat characteristics.
Pigeon Guillemot	None	
River Otter	Low	Probable feeding, possible den sites.
Sea Otter	None	
Recreation/Tourism	High	Eyak River trail receives high recreational use. Site highly visible from Copper River Highway.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 05	PARCEL NAME: Eyak River	
Wilderness	None	High evidence of human use in area; road, houses.
Cultural Resources	Low	No evidence of archeological sites on parcel; two sites adjacent.
Subsistence	Low	Salmon, bears, plants, berry picking.
ECOLOGICAL SIGNIFICANCE: The Eyak River is a highly productive anadromous fish stream; area receives intensive use by bald eagles for feeding and perching; Eyak River trail receives high recreational use; site is visible from the Copper River Highway.		
ADJACENT LAND MANAGEMENT: Eyak Corporation; Chugach National Forest;		
IMMINENT THREAT/OPPORTUNITY: Forest Practices Notification filed for timber harvest in 1993.		
PROTECTION OBJECTIVE: 1) Minimize visual impacts to high use recreation/tourist areas; 2) maintain nesting opportunities for marbled murrelets; 3) maintain water quality and riparian habitat in Eyak River.		
USEFUL PROTECTION TOOL(S): Timber acquisition; conservation easement; cooperative management agreement.		
RECOMMENDED ACTION: Request Eyak Corporation to provide interim protection; discuss options for long term protection.		

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

PWS 03, 04


HABITAT PROTECTION ACQUISITION PARCELS
Port Fidalgo, Alaska
Scale 1:125,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Timber Harvest Areas
1993 Projected Timber Harvest Areas
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
PWS03 Parcel Number
Date printed: January 26, 1993
SOURCES:
Current and planned timber harvest information provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources, Division of Forestry, 1992.
Land status provided by the US Forest Service, 1992, and the ADNR, Land Records Information Section (LRIS), 1991.
Forest Cover data provided by US Geological Survey (USGS)/EROS Alaska Field Office, using LANDSAT MSS imagery resampled to a 200 meter grid.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1991.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Tatitlek
LANDLOCKED BAY
Fish Bay
PWS04
Port Fidalgo
Irish Cove
PWS03
TWO MOON BAY
Snug Corner Cove
St. Matthews Bay
KNOWLES BAY
Port Gravina
DRAFT

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 03	PARCEL NAME: Two Moon Bay		
[1]LANDOWNER: Tatitlek Corporation	[2]PARCEL ACREAGE: 2,100	[3]TOTAL ACREAGE: 72,800	[4]AFFECTED ACREAGE: 2,100

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	Eight documented anadromous streams; pink, coho, cutthroat, Dolly Varden.
Bald Eagle	Moderate	Five documented nest sites on parcel and two nest sites immediately adjacent. Area important for feeding.
Black Oystercatcher	Unknown	Probable feeding in intertidal.
Common Murre	None	
Harbor Seal	Low	Feeding in nearshore waters, probable hauling out on nearshore rocks.
Harlequin Duck	Unknown	Possible nesting in upper riparian zones on anadromous streams; feeding and loafing in intertidal.
Intertidal/subtidal biota	Moderate	Herring spawning on algae, productive intertidal zone, shoreline not oiled.
Marbled Murrelet	High	High confidence that nesting occurs on parcel; good nesting habitat characteristics; high use of adjacent marine waters for feeding.
Pigeon Guillemot	Low	Possible nesting along shoreline, feeding in nearshore marine waters.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 03	PARCEL NAME: Two Moon Bay	
River Otter	Moderate	River otter latrine and denning sites documented. Feeding along shoreline.
Sea Otter	Low	Sea otter concentrations in area.
Recreation/Tourism	Moderate	Snug Corner Cove and Two Moon Bay are important recreational boating anchorages; Hell's Hole is important recreational fishing site; visible from tour boat and ferry routes.
Wilderness	None	Extensive recent clearcuts in area; roads and logging camp in Two Moon Bay.
Cultural Resources	Low	One archeological site documented on parcel; one site adjacent.
Subsistence	Low	Herring, waterfowl, marine mammals, black bears.
ECOLOGICAL SIGNIFICANCE: Snug Corner Cove has been nominated as a state recreation area; the surrounding waters provide important feeding habitat for marbled murrelet, high probability of marbled murrelet nesting on the parcel; sea otters concentrate in the surrounding waters; herring spawn in Two Moon Bay; important coho salmon sport fishery in adjacent Hell's Hole; river otter latrine and denning sites documented on parcel; high density of black bears.		
ADJACENT LAND MANAGEMENT: Tatitlek Corporation, Chugach National Forest		
IMMINENT THREAT/OPPORTUNITY: Forest Practices Notifications have been filed for timber harvest on the is parcel; extension of ongoing timber harvest operations in this area.		
PROTECTION OBJECTIVE: 1) Maintain marbled murrelet nesting habitat; 2) maintain water quality and riparian habitat for anadromous fish; 3) minimize disturbance to bald eagles nesting and feeding; 4) maintain recreational values; 5) minimize disturbance to river otters; 6) minimize visual impacts to ferry route and other high use recreational/tourist areas.		

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 03	PARCEL NAME: Two Moon Bay
USEFUL PROTECTION TOOL(S): Timber acquisition; conservation easement; cooperative management agreement.	
RECOMMENDED ACTION: Request Tatitlek Corporation to provide interim protection; discuss options for long term protection.	

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 04	PARCEL NAME: Fish Bay		
[1]LANDOWNER: Chugach Alaska Corporation	[2]PARCEL ACREAGE: 1,700	[3]TOTAL ACREAGE: 51,200	[4]AFFECTED ACREAGE: 1,700

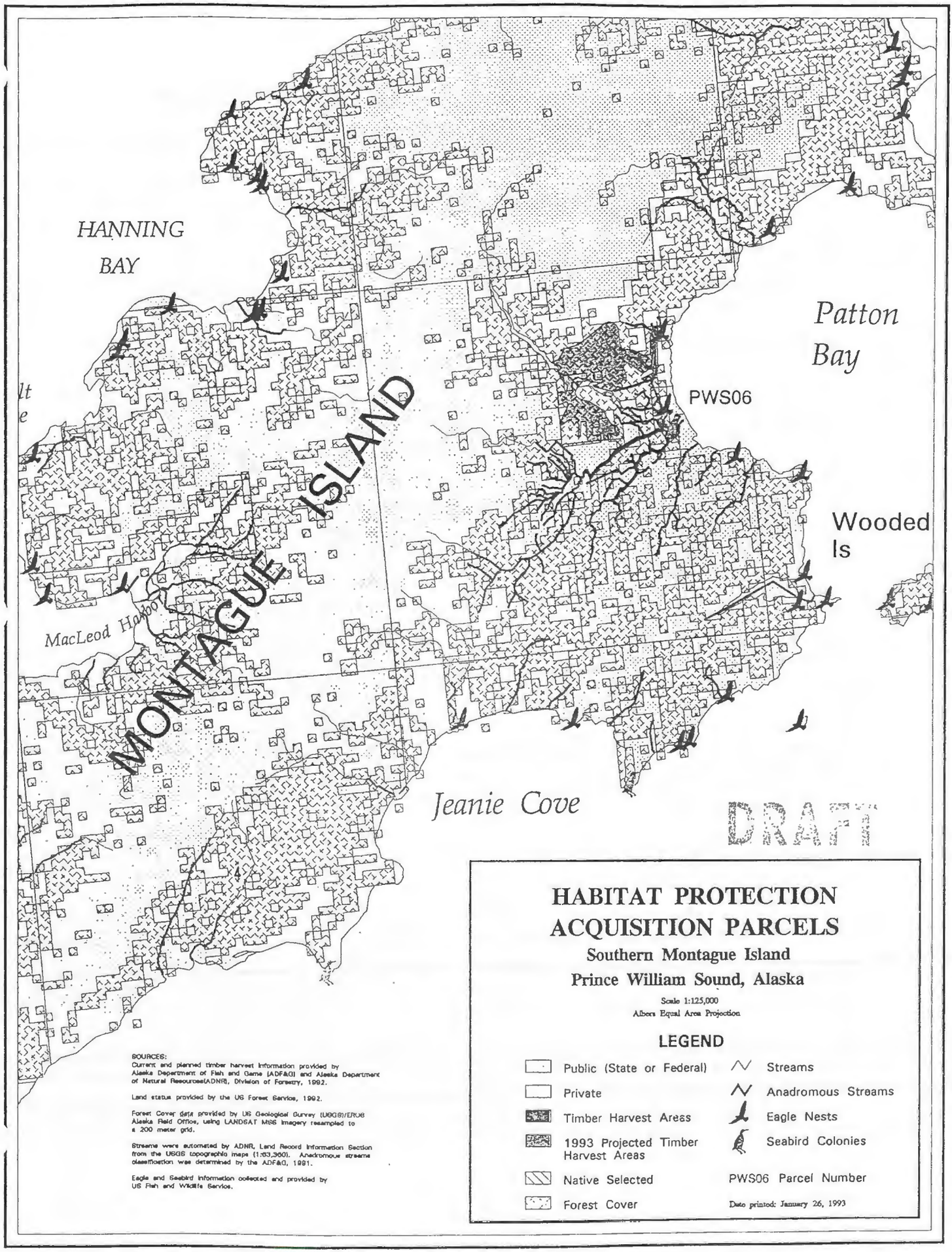
INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Low	No documented anadromous on parcel, adjacent to important anadromous stream at head of Fish Bay.
Bald Eagle	Moderate	Eight documented nest sites.
Black Oystercatcher	Low	Probable feeding along intertidal.
Common Murre	None	
Harbor Seal	Moderate	Historic harbor seal haul out concentration area.
Harlequin Duck	Moderate	Probable feeding, loafing, and molting in intertidal.
Intertidal/subtidal biota	Moderate	Highly productive rocky intertidal. Herring spawning on algae.
Marbled Murrelet	High	High confidence that nesting occurs on parcel; good nesting habitat characteristics; high use of adjacent marine waters for feeding.
Pigeon Guillemot	Low	Possible nesting along shoreline; probable feeding in nearshore marine waters.
River Otter	Low	Probable feeding and latrine sites along shoreline.
Sea Otter	Low	Feeding along shoreline.
Recreation/Tourism	Low	Occasional recreational boating, hunting for bear and goats, visible from Port Fidalgo.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 04	PARCEL NAME: Fish Bay	
Wilderness	Moderate	Remote, minimal evidence of human use.
Cultural Resources	Moderate	Two archeological sites documented on parcel.
Subsistence	Moderate	Herring, marine mammals, salmon, bears, goats, invertebrates.
ECOLOGICAL SIGNIFICANCE: The parcel is a relatively steep, south facing timbered slope on Port Fidalgo; high potential use for marbled murrelet nesting; timber stands support overwintering mountain goats; highly visible to adjacent marine waters.		
ADJACENT LAND MANAGEMENT: Tatitlek Corporation; Chugach Alaska Corporation; Chugach National Forest		
IMMINENT THREAT/OPPORTUNITY: Forest Practices Notifications have been filed for timber harvest; timber volume pledged to operate Seward lumber mill.		
PROTECTION OBJECTIVE: 1) Minimize visual impacts to high use recreation/tourist areas; 2) maintain nesting opportunities for marbled murrelets; 3) maintain water quality and riparian habitat for anadromous fish; and 4) minimize disturbance to nesting bald eagles.		
USEFUL PROTECTION TOOL(S): Timber acquisition; conservation easement; cooperative management agreement.		
RECOMMENDED ACTION: Request Chugach Alaska Corporation to provide interim protection; discuss options for long term protection.		

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

PWS 06



HABITAT PROTECTION ACQUISITION PARCELS

Southern Montague Island

Prince William Sound, Alaska

Scale 1:125,000

Albers Equal Area Projection

LEGEND

- Public (State or Federal)
- Private
- Timber Harvest Areas
- 1993 Projected Timber Harvest Areas
- Native Selected
- Forest Cover
- Streams
- Anadromous Streams
- Eagle Nests
- Seabird Colonies
- PWS06 Parcel Number

Date printed: January 26, 1993

SOURCES:
Current and planned timber harvest information provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources(ADNR), Division of Forestry, 1992.

Land status provided by the US Forest Service, 1992.

Forest Cover data provided by US Geological Survey (USGS)/EROS Alaska Field Office, using LANDSAT MSS imagery resampled to a 200 meter grid.

Streams were automated by ADNR, Land Record Information Section from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1991.

Eagle and Seabird information collected and provided by US Fish and Wildlife Service.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 06	PARCEL NAME: Patton Bay		
[1]LANDOWNER: Chugach Alaska Corporation	[2]PARCEL ACREAGE: 3,300	[3]TOTAL ACREAGE: 51,200	[4]AFFECTED ACREAGE: 3,300

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	High	Approximately 45 documented anadromous streams; pink, coho, Dolly Varden
Bald Eagle	Moderate	Two documented nest sites. High use for feeding on salmon and scavenging along beaches.
Black Oystercatcher	Low	Feeding in intertidal.
Common Murre	None	
Harbor Seal	Low	Feeding in Patton Bay and mouth of Nellie Martin River.
Harlequin Duck	Unknown	Possible nesting in upper riparian zone on anadromous streams. Feeding and loafing in intertidal and along beaches.
Intertidal/subtidal biota	Low	Sand beach, no documented oiling.
Marbled Murrelet	Unknown	High energy coast probably limits feeding; characteristics appear suitable for nesting.
Pigeon Guillemot	Low	High energy coast probably limits feeding; shoreline area adjacent to parcel does not appear to be suitable for nesting.
River Otter	Moderate	Feeding and latrine sites throughout area: possible denning.
Sea Otter	Low	Low use area.

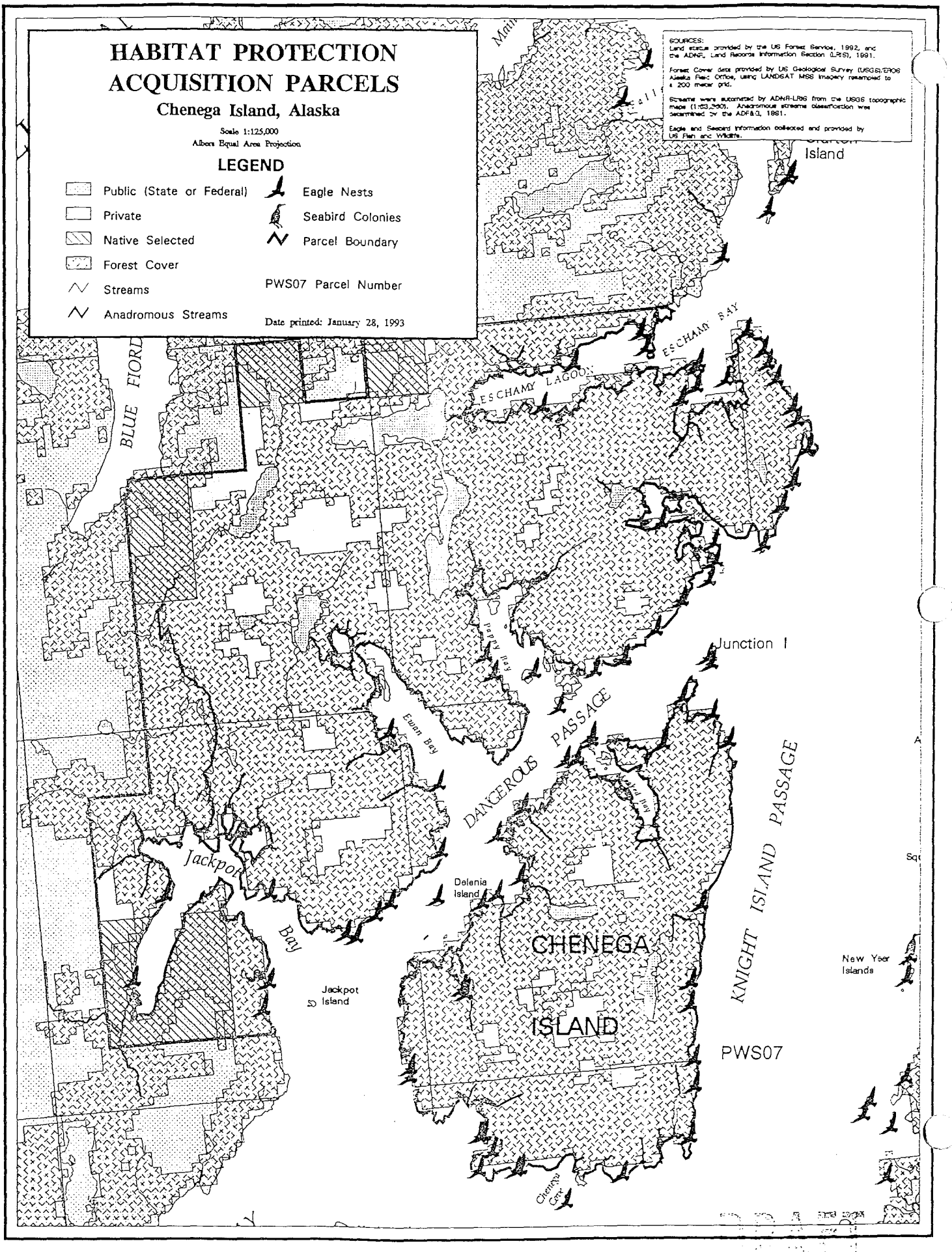
HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 06	PARCEL NAME: Patton Bay	
Recreation/Tourism	Moderate	Popular recreational public use cabin on Nellie Martin River. Recreational hunting (deer, bear) and fishing (coho, Dolly Varden). One of the few remote recreational areas in PWS accessible to wheel planes.
Wilderness	Moderate	Three public use cabins; evidence of previous timber harvest; road access from MacLeod Harbor imminent.
Cultural Resources	Low	One archeological site documented on parcel.
Subsistence	Low	Access difficult.
ECOLOGICAL SIGNIFICANCE: This parcel contains some of the most productive timber stands in Prince William Sound. Anadromous fish values are high, however remoteness of area limits recreational and commercial uses. Arctic tern colony (approx 200 birds) in Patton Bay adjacent to parcel.		
ADJACENT LAND MANAGEMENT: Chugach Alaska Corporation; Chugach National Forest; timber owned and managed by Koncor Forest Products.		
IMMINENT THREAT/OPPORTUNITY: Forest Practices Notifications have been filed for timber harvest on this parcel; Koncor plans to harvest all merchantable timber in this area over the next decade; timber haul road currently under construction from MacLeod Harbor to Patton Bay.		
PROTECTION OBJECTIVE: Maintain anadromous fish habitat including water quality and riparian values; maintain bald eagle nesting and perching habitat adjacent to streams and shore; maintain opportunities for marbled murrelet and harlequin duck nesting if found to be important; enhance recreational opportunities.		
USEFUL PROTECTION TOOL(S): Timber acquisition; conservation easement; cooperative management agreement.		
RECOMMENDED ACTION: Request Chugach Alaska Corporation and Koncor to provide interim protection; evaluate parcel for marbled murrelet and harlequin duck habitat; discuss options for long term protection.		

HABITAT PROTECTION PARCEL ANALYSIS

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

PWS 07


HABITAT PROTECTION
ACQUISITION PARCELS
Chenega Island, Alaska
Scale 1:125,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
Parcel Boundary
PWS07 Parcel Number
Date printed: January 28, 1993
SOURCES:
Land status provided by the US Forest Service, 1992, and the ADNR, Land Records Information Section (LRIS), 1991.
Forest Cover data provided by US Geological Survey (USGS)/EROS Alaska Field Office, using LANDSAT MSS imagery resampled to a 200 meter grid.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1991.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Main
Island
BLUE FIORD
ESCHAMY LAGOON
ESCHAMY BAY
Junction I
Eagle Bay
Evans Bay
DANGEROUS PASSAGE
Jackpot
Bay
Jackpot
Island
Delania
Island
CHENEGA
ISLAND
KNIGHT ISLAND PASSAGE
New Year
Islands
PWS07
Chenega
City

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 07	PARCEL NAME: Chenega I./Eshamy/Jackpot		
[1]LANDOWNER: Chenega Corporation	[2]PARCEL ACREAGE: 57,000	[3]TOTAL ACREAGE: 77,800	[4]AFFECTED ACREAGE: Unknown

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	High	Fifty eight documented anadromous streams; sockeye, pink, chum, coho, Dolly Varden, cutthroat. Eshamy and Jackpot lake systems have historically supported important commercial and recreational fisheries.
Bald Eagle	High	Seventy three documented nest sites. Feeding concentrations in Ewan and Paddy bays.
Black Oystercatcher	Moderate	Probable nesting and feeding concentrations along shoreline and nearshore rocks in Dangerous Passage.
Common Murre	None	
Harbor Seal	Moderate	Probable feeding in nearshore waters, probable haul outs on rocks in Dangerous Passage.
Harlequin Duck	Moderate	Probable nesting in upper riparian zone on anadromous streams; feeding, molting, and loafing in intertidal.
Intertidal/subtidal biota	Moderate	Productive sheltered rocky intertidal, particularly on Chenega Island and along Dangerous Passage; portions of Eshamy and Chenega Island were oiled.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 07	PARCEL NAME: Chenega I./Eshamy/Jackpot	
Marbled Murrelet	Moderate	Feeding concentrations in adjacent marine waters, habitat characteristics appear favorable for nesting.
Pigeon Guillemot	Moderate	Feeding in adjacent marine waters; habitat characteristics appear favorable for nesting.
River Otter	High	Feeding along intertidal and adjacent nearshore waters; probable latrine and denning sites.
Sea Otter	Moderate	Concentration areas in Dangerous Passage, Granite, Ewan, and Paddy bays for feeding and shelter; probable pupping.
Recreation/Tourism	High	High value wilderness-based recreation area for sailing, kayaking, boating, fly-in fishing, hunting; Dangerous Passage and Knight Island Passage along ferry route; visible from tour boat routes along Knight Island passage.
Wilderness	High	Area mostly remote with minimal evidence of human disturbance.
Cultural Resources	Moderate	Twenty sites documented on parcel.
Subsistence	High	Known resource harvest area; salmon, black bear, harbor seals, waterfowl, other marine mammals, deer, marine invertebrates, plants.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: PWS 07	PARCEL NAME: Chenega I./Eshamy/Jackpot
ECOLOGICAL SIGNIFICANCE: This parcel encompasses a relatively sheltered rocky shore containing numerous bays, coves, islets, and estuaries. Numerous anadromous streams occur throughout the area: high use by sea otters and bald eagles; Eshamy and Jackpot lakes systems are the focus of recreational fishing; Eshamy, Jackpot, Ewan, Paddy bays have been nominated as potential state recreation areas.	
ADJACENT LAND MANAGEMENT: Chugach National Forest, several private recreational cabin sites in Eshamy Bay	
IMMINENT THREAT/OPPORTUNITY: No known imminent threats; Chenega Corporation has expressed interest in habitat protection/acquisition.	
PROTECTION OBJECTIVE: Maintain anadromous fish habitat including water quality and riparian values; maintain bald eagle nesting and perching habitat; maintain opportunities for marbled murrelet and harlequin duck nesting; maintain or enhance wilderness-based recreational opportunities.	
USEFUL PROTECTION TOOL(S): Timber acquisition; fee title acquisition; cooperative management agreement; conservation easement.	
RECOMMENDED ACTION: Request Chenega Corporation to provide interim protection; discuss options for long term protection.	

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

summaries. Technical paper no. 150. 690 p. Alaska Department of Fish and Game, Division of Subsistence, Juneau, Alaska.

Sowls, A.L.; Hatch, S.A.; Lensing, C.J. 1978. Catalog of Alaskan seabird colonies. FWS/OBS-78/78. U.S. Fish and Wildlife Service, Office of Biological Services, Coastal Ecosystems Project, Anchorage, Alaska.

Stanek, Ronald T. 1982. Natural resource harvests at Port Graham and English Bay, 1982: an interim report. Technical paper no. 32. 35 p. Alaska Department of Fish and Game, Division of Subsistence, Anchorage, Alaska.

Stanek, Ronald T. 1985. Patterns of wild resource use in English Bay and Port Graham, Alaska. Technical paper no. 104. 226 p. Alaska Department of Fish and Game, Division of Subsistence, Anchorage, Alaska.

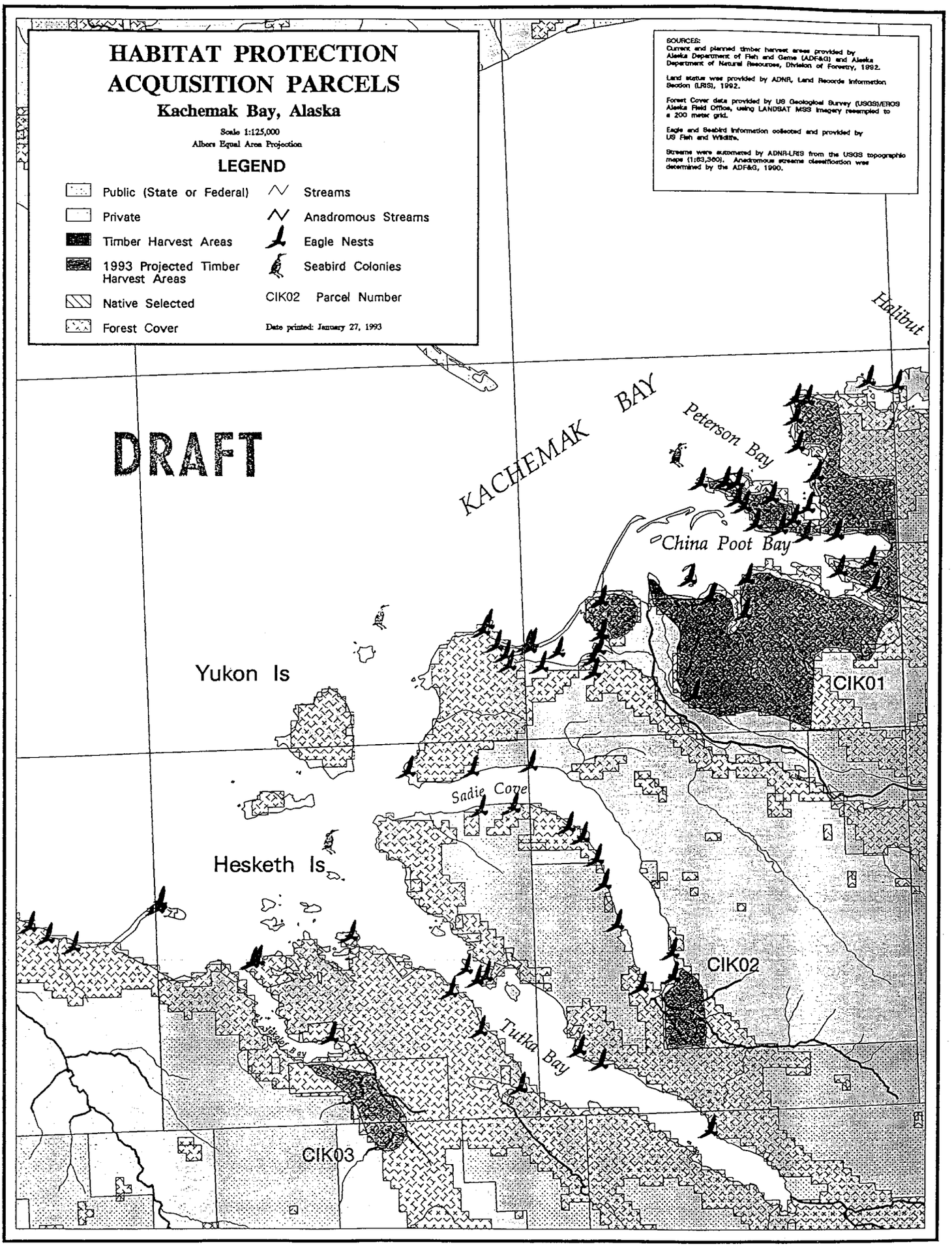
Stratton, Lee. 1990. Resource harvest and use in Tatitlek, Alaska. Technical paper no. 181. 163 p. Alaska Department of Fish and Game, Division of Subsistence, Anchorage, Alaska.

Stratton, Lee; Chisum, Evelyn B. 1986. Resource use patterns in Chenega, western Prince William Sound : Chenega in the 1960's and Chenega Bay 1984-1986. Technical paper no. 139. 161 p. Alaska Department of Fish and Game, Division of Subsistence, Juneau, Alaska.

U.S. Fish & Wildlife Service, Region 7. 1989-1992. Bald eagle surveys. Unpublished ARC/INFO data files. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Cook Inlet, Kenai (CIK)

CIK 01, 02, 03


HABITAT PROTECTION ACQUISITION PARCELS
Kachemak Bay, Alaska
Scale 1:125,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Timber Harvest Areas
1993 Projected Timber Harvest Areas
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
CIK02 Parcel Number
Date printed: January 27, 1993
SOURCES:
Current and planned timber harvest areas provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources, Division of Forestry, 1992.
Land status was provided by ADNR, Land Records Information Section (LRIS), 1992.
Forest Cover data provided by US Geological Survey (USGS)/EROS Alaska Field Office, using LANDSAT MSS imagery resampled to a 200 meter grid.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1990.
DRAFT
KACHEMAK BAY
Peterson Bay
China Poot Bay
Halibut
Yukon Is
Hesketh Is
Sadie Cove
Tutka Bay
CIK01
CIK02
CIK03

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 01	PARCEL NAME: China Poot, Kachemak Bay		
[1]LANDOWNER: Seldovia Native Association	[2]PARCEL ACREAGE: 7,500	[3]TOTAL ACREAGE: 106.000	[4]AFFECTED ACREAGE: 5,300

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	Five cataloged anadromous streams on parcel. Coho, chum, sockeye, and pink salmon and Dolly Varden spawning and rearing habitat; enhanced sockeye salmon runs in Leisure Lake and Hazel Lake.
Bald Eagle	High	Intertidal foraging and feeding on anadromous fish. Thirty seven documented nest sites on parcel.
Black Oystercatcher	Low	Likely that oystercatchers use gravel spits and intertidal for feeding and nesting.
Common Murre	Moderate	Murre colony (est. 5,075 birds) on Gull Rock may benefit from adjacent habitat protection.
Harbor Seal	Moderate	Harbor seals feed in area and frequently haul-out on nearshore rocks and bars.
Harlequin Duck	Moderate	Probable nesting in upper riparian areas; probable feeding in streams and estuaries.
Intertidal/subtidal biota	High	China Poot Bay is documented as one of the most productive shallow benthic habitats in Kachemak Bay.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 01	PARCEL NAME: China Poot, Kachemak Bay	
Marbled Murrelet	High	High confidence that nesting occurs on parcel. Large numbers of murrelets forage on Kachemak Bay.
Pigeon Guillemot	Low	Foraging occurs in adjacent marine waters.
River Otter	Moderate	High use area for feeding and latrine sites; possible denning inland.
Sea Otter	Low	Established population in area; feeding and possible pupping in adjacent marine waters.
Recreation/Tourism	High	Neptune, Peterson, and China Poot bays and Gull Rock receive high use. Highly visible from Homer and Kachemak Bay. Adjacent to Kachemak Bay State Park.
Wilderness	Low	Area is moderately developed, primarily recreational homesites. High human use area.
Cultural Resources	Moderate	Twenty eight documented archeological sites on parcel.
Subsistence	Moderate	Within resource use area of Port Graham and English Bay.
ECOLOGICAL SIGNIFICANCE: China Poot, Neptune, and Peterson bays are highly productive estuaries that provide habitat for birds, anadromous fish, mammals, and intertidal marine life. This area receives very high recreational use, has significant archeological sites, and is highly visible from Homer and adjacent marine waters. The timbered lands are probably important to marbled murrelets. This area also provides access to a recreational dip-net fishery at the outlet of Leisure Lake.		

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 01	PARCEL NAME: China Poot, Kachemak Bay
ADJACENT LAND MANAGEMENT: This parcel is adjacent to Kachemak Bay State Park; the park receives a significant amount of recreational use by residents of Anchorage and the Kenai Peninsula and is also an important tourist attraction. The parcel is also adjacent to other Seldovia Native Association lands.	
IMMINENT THREAT/OPPORTUNITY: This parcel is proposed for logging in 1993. Permit approvals are pending additional information, Corps of Engineers Public Notice, and ACMP review.	
PROTECTION OBJECTIVE: 1) Maintain water quality of the estuary and associated riparian habitats for anadromous fish; 2) maintain bald eagle, marbled murrelet, and harlequin nesting habitat; 3) maintain and enhance recreational opportunities and scenic values; and 4) maintain public access to Leisure Lake stream.	
USEFUL PROTECTION TOOL(S): Timber acquisition; fee simple purchase; conservation easement; cooperative management; public access acquisition.	
RECOMMENDED ACTION: The Trustee Council has approved a resolution to acquire fee title for Kachemak Park inholdings. Habitat and service values are among the highest for imminent threat lands evaluated. Request SNA to provide interim protection; begin negotiations to acquire long term protection; December 31, 1993 deadline.	

1. Parties other than landowner may own partial rights (eg. timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 02	PARCEL NAME: Sadie Cove		
[1]LANDOWNER: Seldovia Native Association	[2]PARCEL ACREAGE: 400	[3]TOTAL ACREAGE: 106,000	[4]AFFECTED ACREAGE: 400

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	Two cataloged anadromous streams. Pink and chum spawning.
Bald Eagle	Moderate	Three documented nest sites on parcel.
Black Oystercatcher	None	
Common Murre	None	
Harbor Seal	Low	Foraging in Sadie Cove estuary.
Harlequin Duck	Low	Possible nesting in upper reaches of riparian habitat (adjacent to parcel). Potential feeding in lower stream and estuary.
Intertidal/subtidal biota	Low	Species diversity and richness relatively low at head of Sadie Cove.
Marbled Murrelet	Low	No evidence of use of this parcel.
Pigeon Guillemot	None	
River Otter	Low	Probable feeding in adjacent marine habitat and stream.
Sea Otter	Low	Occasional use of Sadie Cove for feeding and shelter.
Recreation/Tourism	Moderate	Recreational cabins and boating. High scenic values.
Wilderness	Low	Area is moderately developed, primarily recreational homesites. Moderate evidence of human use.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 02	PARCEL NAME: Sadie Cove	
Cultural Resources	None	No evidence that archeological sites exist on parcel.
Subsistence	Low	Waterfowl, marine mammals
ECOLOGICAL SIGNIFICANCE: Sadie Cove is a deep fjord estuary that provides habitat for anadromous fish and overwintering waterfowl. It is a moderately used recreational area accessible by boat from Homer.		
ADJACENT LAND MANAGEMENT: Kachemak Bay State Park; Seldovia Native Association.		
IMMINENT THREAT/OPPORTUNITY: This parcel is proposed for logging in 1993.		
PROTECTION OBJECTIVE: 1) Maintain water quality of the estuary and associated riparian anadromous fish habitat; 2) protect bald eagle nesting and roosting habitat.		
USEFUL PROTECTION TOOL(S): Timber acquisition; fee simple purchase; conservation easement; cooperative management.		
RECOMMENDED ACTION: Request interim protection from SNA. partial interests (timber rights, easement) and/or cooperative management may provide adequate long-term protection.		

1. Rights other than title may be held by other parties.
2. Area evaluated.
3. Total acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 03	PARCEL NAME: Jakolof Bay		
[1]LANDOWNER: Seldovia Native Association	[2]PARCEL ACREAGE: 600	[3]TOTAL ACREAGE: 106,000	[4]AFFECTED ACREAGE: 500

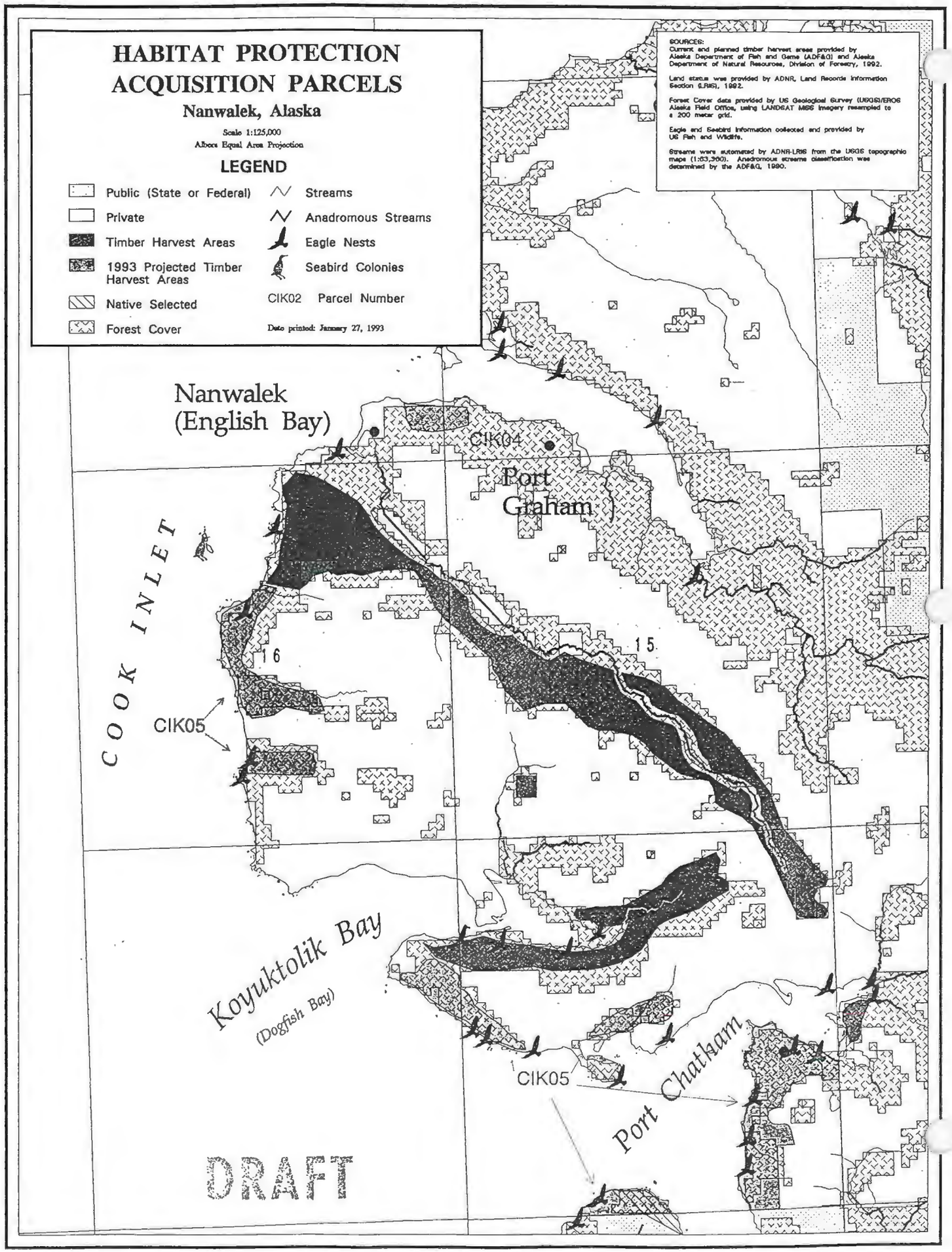
INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	One mainstem and four tributaries cataloged as anadromous. Pink, chum, sockeye. and coho salmon spawning and rearing, Dolly Varden.
Bald Eagle	Low	One nest site adjacent to parcel. Probable feeding in stream and estuary.
Black Oystercatcher	None	
Common Murre	None	
Harbor Seal	Low	Feeding in Jakolof Bay and estuary.
Harlequin Duck	Low	Possible nesting in upper reaches of riparian habitat. Potential feeding in lower stream and estuary.
Intertidal/subtidal biota	Moderate	Jakalof Bay known to be highly productive for shellfish and other marine invertebrates
Marbled Murrelet	Low	Possible feeding in Jakolof Bay.
Pigeon Guillemot	None	
River Otter	Low	Probable feeding in adjacent marine habitat and stream.
Sea Otter	Low	Use Jakalof Bay for feeding and shelter.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 03	PARCEL NAME: Jakolof Bay	
Recreation/Tourism	Moderate	Road accessible from Seldovia. Recreational use of Rocky Bay road. Public boat harbor in Jakolof Bay. Recreational boating and fishing.
Wilderness	None	High evidence of human use (road, sawmill, boat harbor, mariculture)
Cultural Resources	Low	One archeological site documented adjacent to parcel.
Subsistence	Low	Shellfish, waterfowl
ECOLOGICAL SIGNIFICANCE: Jakolof Bay is a productive shallow estuary providing habitat for anadromous fish, shellfish, waterfowl, and mammals. It is a moderately used recreational area easily accessible by road from Seldovia.		
ADJACENT LAND MANAGEMENT: Kachemak Bay State Park; Seldovia Native Association.		
IMMINENT THREAT/OPPORTUNITY: This area is proposed for logging in 1993. It has an existing road access, and an abandoned sawmill and log transfer facility.		
PROTECTION OBJECTIVE: 1) Maintain water quality of the estuary and associated riparian habitats for anadromous fish; 2) maintain recreational values and recreational access.		
USEFUL PROTECTION TOOL(S): Timber acquisition; fee simple purchase; conservation easement; cooperative management.		
RECOMMENDED ACTION: Request SNA to provide interim protection; long-term protection may be acheived through acquisition of partial interests (timber, easements) and cooperative management agreement.		

1. Rights other than title may be held by other parties.
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

CIK 04, 05


HABITAT PROTECTION ACQUISITION PARCELS
Nanwalek, Alaska
Scale 1:125,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Timber Harvest Areas
1993 Projected Timber Harvest Areas
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
CIK02 Parcel Number
Date printed: January 27, 1993
SOURCES:
Current and planned timber harvest areas provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources, Division of Forestry, 1992.
Land status was provided by ADNR, Land Records Information Section (LRIS), 1992.
Forest Cover data provided by US Geological Survey (USGS/EROS Alaska Field Office, using LANDSAT MSS imagery resampled to a 200 meter grid.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1990.
Nanwalek
(English Bay)
CIK04
Port
Graham
COOK INLET
16
15
CIK05
Koyuktolik Bay
(Dogfish Bay)
CIK05
Port Chatham
DRAFT

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 04	PARCEL NAME: Port Graham BIA Parcels		
[1]LANDOWNER: Various Native Allotees	[2]PARCEL ACREAGE: 200	[3]TOTAL ACREAGE: 200	[4]AFFECTED ACREAGE: 200

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	None	No documented anadromous streams.
Bald Eagle	Low	One documented nest site: probable feeding and roosting.
Black Oystercatcher	Low	Feeding along intertidal zone.
Common Murre	None	
Harbor Seal	Low	Feeding in adjacent marine waters.
Harlequin Duck	Low	Probable feeding and loafing in nearshore zone.
Intertidal/subtidal biota	Moderate	Rocky intertidal zone.
Marbled Murrelet	Unknown	No available information.
Pigeon Guillemot	Unknown	No available information.
River Otter	Unknown	No available information.
Sea Otter	Low	Feeding in adjacent marine waters.
Recreation/Tourism	Moderate	Marine waters used for recreational halibut fishing. Visible from ferry route, recreational boaters and tour boats.
Wilderness	Low	High evidence of human use. Adjacent to Port Graham and English Bay.
Cultural Resources	Low	One archeological site documented adjacent to parcel.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 04	PARCEL NAME: Port Graham BIA Parcels	
Subsistence	High	Extensive subsistence use of adjacent marine and intertidal areas; salmon, marine mammals, invertebrates, plants, berries.
ECOLOGICAL SIGNIFICANCE: This is a relatively steep, north-facing timbered slope adjacent to Port Graham. Habitat and service value characteristics on parcel appear to be relatively low; however, detailed habitat information for some species is lacking.		
ADJACENT LAND MANAGEMENT: Port Graham; Nanwalek village corporations.		
IMMINENT THREAT/OPPORTUNITY: Logging (under BIA management) is planned for 1993.		
PROTECTION OBJECTIVE: Maintain water quality in Port Graham.		
USEFUL PROTECTION TOOL(S): Cooperative management agreement.		
RECOMMENDED ACTION: Request interim protection from BIA and landowners; obtain additional information on habitat and service values.		

1. Parties other than landowner may own partial rights (e.g., timber, minerals), BIA serves as trust manager.

2. Area evaluated.

3. Estimated acreage held by the owner(s) in the spill area.

4. Estimated area to be affected by imminent development activity.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 05	PARCEL NAME: Lower Kenai Peninsula		
[1]LANDOWNER: Nanwalek Corporation	[2]PARCEL ACREAGE: 3,000	[3]TOTAL ACREAGE: 46,000	[4]AFFECTED ACREAGE: 1,800

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Low	Two cataloged anadromous streams; pink salmon spawning.
Bald Eagle	Moderate	Ten documented nest sites.
Black Oystercatcher	Moderate	Feeding along shoreline. Potential nesting habitat in Port Chatham.
Common Murre	Low	Potential feeding in adjacent marine waters.
Harbor Seal	Low	Hauling out on nearshore rocks; feeding in adjacent marine waters.
Harlequin Duck	Low	Feeding and loafing along shoreline.
Intertidal/subtidal biota	Moderate	Highly productive rocky intertidal and shallow subtidal habitat in Port Chatham area. Abundant Fucus and other seaweeds.
Marbled Murrelet	Moderate	Habitat characteristics appear favorable for nesting; feeding in adjacent marine waters.
Pigeon Guillemot	Low	Probable nesting; feeding nearshore.
River Otter	Moderate	Probable feeding along shoreline, possible latrine and denning sites.
Sea Otter	Moderate	Concentration area for feeding, shelter, potential pupping in Port Chatham.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 05	PARCEL NAME: Lower Kenai Peninsula	
Recreation/Tourism	Moderate	Marine waters used for recreational halibut fishing. Visible from ferry route, recreational boaters and tour boats.
Wilderness	Low	Abandoned sawmill and cannery; adjacent timber harvest and log transfer facility; frequent boat activity.
Cultural Resources	Moderate	Two archeological sites documented on parcel; three adjacent.
Subsistence	Moderate	Waterfowl, marine mammals
ECOLOGICAL SIGNIFICANCE: These parcels are adjacent to productive rocky intertidal and subtidal areas. The offshore waters are highly productive marine bird and marine mammal feeding areas. Forest habitats near this area have recently been disturbed by logging activities.		
ADJACENT LAND MANAGEMENT: Nanwalek; Port Graham village corporations.		
IMMINENT THREAT/OPPORTUNITY: Forest Practices Notices have been filed to harvest timber in 1993.		
PROTECTION OBJECTIVE: 1) Maintain water quality in the nearshore are; 2) maintain bald eagle and marbled murrelet nesting habitat; and 3) minimize visual impacts to recreational users in adjacent marine waters.		
USEFUL PROTECTION TOOL(S): Timber acquisition; cooperative management; conservation easement.		
RECOMMENDED ACTION: Request Nanwalek Corporation to provide interim protection; discuss options with land owner to provide long-term protection.		

1. Parties other than landowner may own partial rights (e.g. timber, minerals).

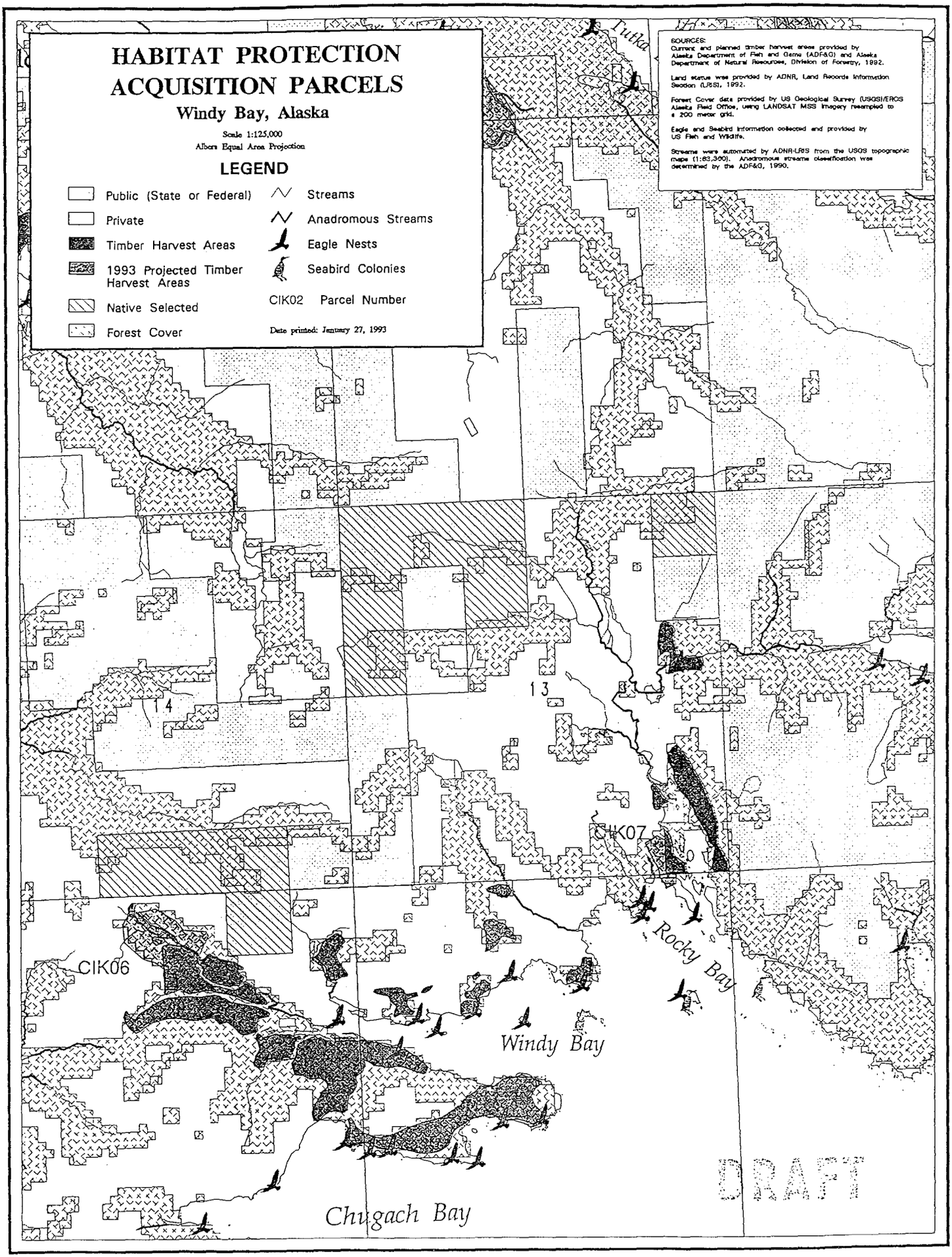
2. Area evaluated.

3. Estimated acreage held by the owner in the spill area.

HABITAT PROTECTION PARCEL ANALYSIS

4. Estimated area to be affected by imminent development activity.

CIK 06, 07


HABITAT PROTECTION ACQUISITION PARCELS
Windy Bay, Alaska
Scale 1:125,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Timber Harvest Areas
1993 Projected Timber Harvest Areas
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
CIK02 Parcel Number
Date printed: January 27, 1993
SOURCES:
Current and planned timber harvest areas provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources, Division of Forestry, 1992.
Land status was provided by ADNR, Land Records Information Section (LRIS), 1992.
Forest Cover data provided by US Geological Survey (USGS)/EROS Alaska Field Office, using LANDSAT MSS imagery resampled to a 200 meter grid.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1990.
Tutka
14
13
CIK07
CIK06
Rocky Bay
Windy Bay
Chugach Bay
DRAFT

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 06	PARCEL NAME: Windy Bay		
[1]LANDOWNER: Port Graham	[2]PARCEL ACREAGE: 400	[3]TOTAL ACREAGE: 63,500	[4]AFFECTED ACREAGE: 400

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Low	One documented anadromous stream; pink, chum, coho.
Bald Eagle	Low	No documented nesting; possible feeding and perching.
Black Oystercatcher	None	
Common Murre	None	
Harbor Seal	None	
Harlequin Duck	Low	Possible nesting.
Intertidal/subtidal biota	None	
Marbled Murrelet	Unknown	Habitat characteristics appear favorable for nesting.
Pigeon Guillemot	None	
River Otter	Low	Possible denning.
Sea Otter	None	
Recreation/Tourism	Low	Limited access, low use for bear and goat hunting.
Wilderness	Low	Extensive recent clear cuts in area.
Cultural Resources	None	No evidence of archeological sites on parcel.
Subsistence	Low	Most use confined to marine area.

ECOLOGICAL SIGNIFICANCE: The associated streams within this parcel support anadromous fish spawning and rearing habitat. This is one of the few remaining unharvested forest stands within the Windy Bay watershed.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 06	PARCEL NAME: Windy Bay
ADJACENT LAND MANAGEMENT: Nanwalek Corporation; Kachemak Bay State Wilderness Park.	
IMMINENT THREAT/OPPORTUNITY: Forest Practices Notice has been filed for clear-cutting this parcel in 1993.	
PROTECTION OBJECTIVE: 1) Maintain water quality and riparian habitat for anadromous fish; 2) maintain nesting opportunities for marbled murrelets and bald eagles.	
USEFUL PROTECTION TOOL(S): Cooperative management agreement.	
RECOMMENDED ACTION: Habitats on this parcel have relatively low value for recovery of injured species/services; request Nanwalek Corporation to provide interim protection; discuss options for long term protection.	

1. Parties other than landowner may own partial rights (e.g. timber, minerals).
2. Area evaluated.
3. Estimate acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 07	PARCEL NAME: Rocky Bay		
[1]LANDOWNER: Port Graham Corporation	[2]PARCEL ACREAGE: 100	[3]TOTAL ACREAGE: 63,500	[4]AFFECTED ACREAGE: 100

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Low	One documented anadromous stream; pink.
Bald Eagle	Low	No documented nest sites on parcel, three sites in Rocky Bay.
Black Oystercatcher	Low	Probable feeding in intertidal.
Common Murre	None	
Harbor Seal	Low	Probable feeding, hauling out in adjacent marine area; documented harbor seal haul out concentration area approx. one mile to the south.
Harlequin Duck	Low	Probable feeding and loafing in intertidal.
Intertidal/subtidal biota	Low	Shore was very lightly oiled.
Marbled Murrelet	Low	Habitat characteristics appear favorable for nesting, probable feeding in nearshore waters.
Pigeon Guillemot	Low	Possible nesting, probable feeding in nearshore waters.
River Otter	Low	Possible feeding and latrine sites.
Sea Otter	Moderate	Documented sea otter concentration area.
Recreation/Tourism	Moderate	Road accessible from Seldovia, occasional boat use, recreational fishing for cohos.
Wilderness	Low	Extensive recent clearcuts in area.

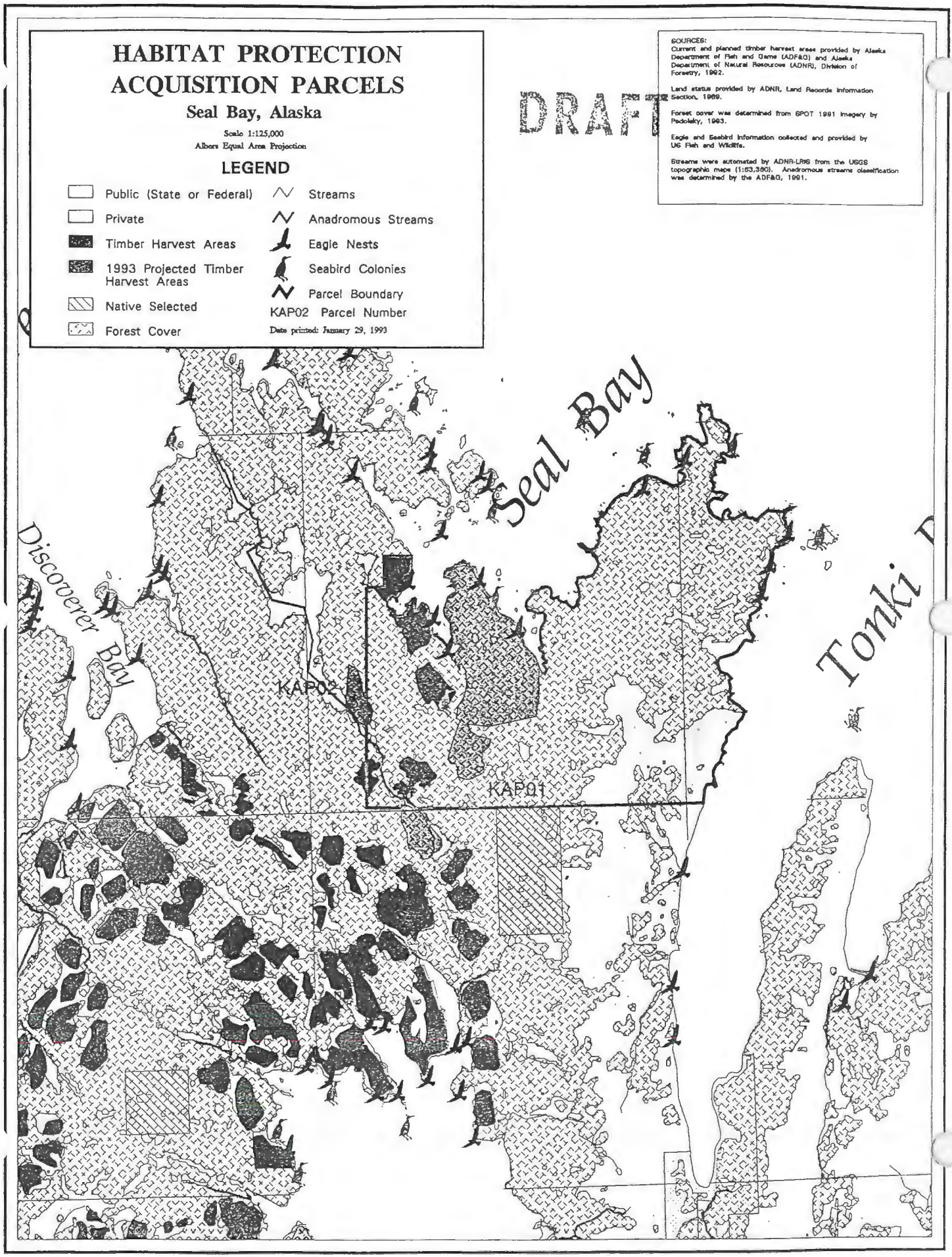
HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: CIK 07	PARCEL NAME: Rocky Bay	
Cultural Resources	None	No evidence of archeological sites on parcel.
Subsistence	Low	Waterfowl, marine mammals.
ECOLOGICAL SIGNIFICANCE: Coho and pink salmon support recreational and commercial fisheries; accessible via old logging road (trail) from Seldovia; area has been extensively harvested for timber during the past twenty years.		
ADJACENT LAND MANAGEMENT: Port Graham Corporation; near Kachemak Bay State Wilderness Park.		
IMMINENT THREAT/OPPORTUNITY: This parcel is proposed for timber harvest in 1993.		
PROTECTION OBJECTIVE: 1) Maintain water quality and riparian habitats for anadromous fish; maintain recreational fishing opportunities; 3) maintain recreational access.		
USEFUL PROTECTION TOOL(S): Cooperative management agreement; acquire and enhance recreational access.		
RECOMMENDED ACTION: Request Port Graham Corporation to provide interim protection; discuss options for cooperative management and recreational access improvements.		

1. Parties other than landowner may own partial rights (e.g. timber minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

Kodiak, AK Peninsula (KAP)

KAP 01


HABITAT PROTECTION ACQUISITION PARCELS
Seal Bay, Alaska
Scale 1:125,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Timber Harvest Areas
1993 Projected Timber Harvest Areas
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
Parcel Boundary
KAP02 Parcel Number
Date printed: January 29, 1993
SOURCES:
Current and planned timber harvest areas provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources (ADNR), Division of Forestry, 1992.
Land status provided by ADNR, Land Records Information Section, 1989.
Forest cover was determined from SPOT 1991 imagery by Pedolsky, 1993.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1991.
DRAFT
Seal Bay
Discoverer Bay
Tonki
KAP02
KAP01

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 01	PARCEL NAME: Seal Bay		
[1]LANDOWNER: Akhiok Kaguyak/ Old Harbor	[2]PARCEL ACREAGE: 15,000	[3]TOTAL ACREAGE: 253,000	[4]AFFECTED ACREAGE: 1,600

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	Six documented anadromous streams; pink, sockeye, coho, Dolly Varden, steelhead.
Bald Eagle	High	Fourty two documented nest sites; feeding and roosting along shoreline.
Black Oystercatcher	Moderate	Feeding in intertidal; probable nesting along shoreline and nearshore islets.
Common Murre	None	
Harbor Seal	Moderate	Area historically supported large numbers of seals. Feeding in nearshore waters and haul-outs on nearshore rocks.
Harlequin Duck	Moderate	Up to 64 birds observed in Seal Bay. Nearshore habitat appears good for feeding and molting. Potential for nesting appears low.
Intertidal/subtidal biota	Moderate	Productive sheltered rocky intertidal and shallow subtidal habitat. Steep slopes adjacent to intertidal may become source of erosion sedimentation. No documented oiling of shoreline.
Marbled Murrelet	High	High confidence that nesting occurs on parcel; good nesting habitat characteristics; high use of adjacent marine waters for feeding.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 01	PARCEL NAME: Seal Bay	
Pigeon Guillemot	Moderate	Documented nesting of up to 36 birds on or immediately adjacent to parcel; feeding in nearshore waters.
River Otter	Moderate	Probable feeding and latrine sites along shoreline. Possible denning. Habitat characteristics appear very favorable for river otters.
Sea Otter	Moderate	Known concentration area off Tolstoi Point. Feeding in nearshore waters.
Recreation/Tourism	Moderate	Area has historically supported high value wilderness-based recreation for boats and lodge. Access was previously difficult but is now road accessible.
Wilderness	Moderate	Wilderness characteristics are declining. Recent clearcuts and road are visible.
Cultural Resources	Moderate	Six archeological sites documented on parcel.
Subsistence	Low	Marine invertebrates, deer, elk, possibly marine mammals.
ECOLOGICAL SIGNIFICANCE: This parcel contains old growth forest habitat adjacent to highly productive marine waters. Streams within the parcel support a diversity of anadromous fish. Forests on this parcel are suspected of providing high value marbled murrelet nesting habitat. Wilderness recreation values, particularly for fishing and hunting are high. Parcel supports non-injured species including deer, elk, and brown bear.		
ADJACENT LAND MANAGEMENT: Afognak Joint Venture; primarily for timber harvest and tree farming.		

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 01	PARCEL NAME: Seal Bay
IMMINENT THREAT/OPPORTUNITY: A portion of this parcel is proposed for logging in 1993 as an extension of an ongoing timber management operation by Koncor Forest Products. Akhiok-Kaguyak has expressed an interest in discussing habitat protection for remainder of parcel.	
PROTECTION OBJECTIVE: 1) Maintain water quality and riparian habitat for anadromous fish; 2) maintain marbled murrelet and bald eagle nesting habitat; 3) maintain and enhance wilderness-based recreational opportunities.	
USEFUL PROTECTION TOOL(S): Timber acquisition; fee title acquisition; cooperative management agreement; conservation easement.	
RECOMMENDED ACTION: This is one of highest priority imminent threat parcels; request Akhiok/Kaguyak/Old Harbor joint venture to provide interim protection; discuss options for long-term protection.	

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

KAP 02

HABITAT PROTECTION ACQUISITION PARCELS

Seal Bay, Alaska

Scale 1:125,000
Albers Equal Area Projection

DRAFT

LEGEND

- Public (State or Federal)
- Private
- Timber Harvest Areas
- 1993 Projected Timber Harvest Areas
- Native Selected
- Forest Cover
- Streams
- Anadromous Streams
- Eagle Nests
- Seabird Colonies
- KAP02 Parcel Number

Date printed: January 29, 1993

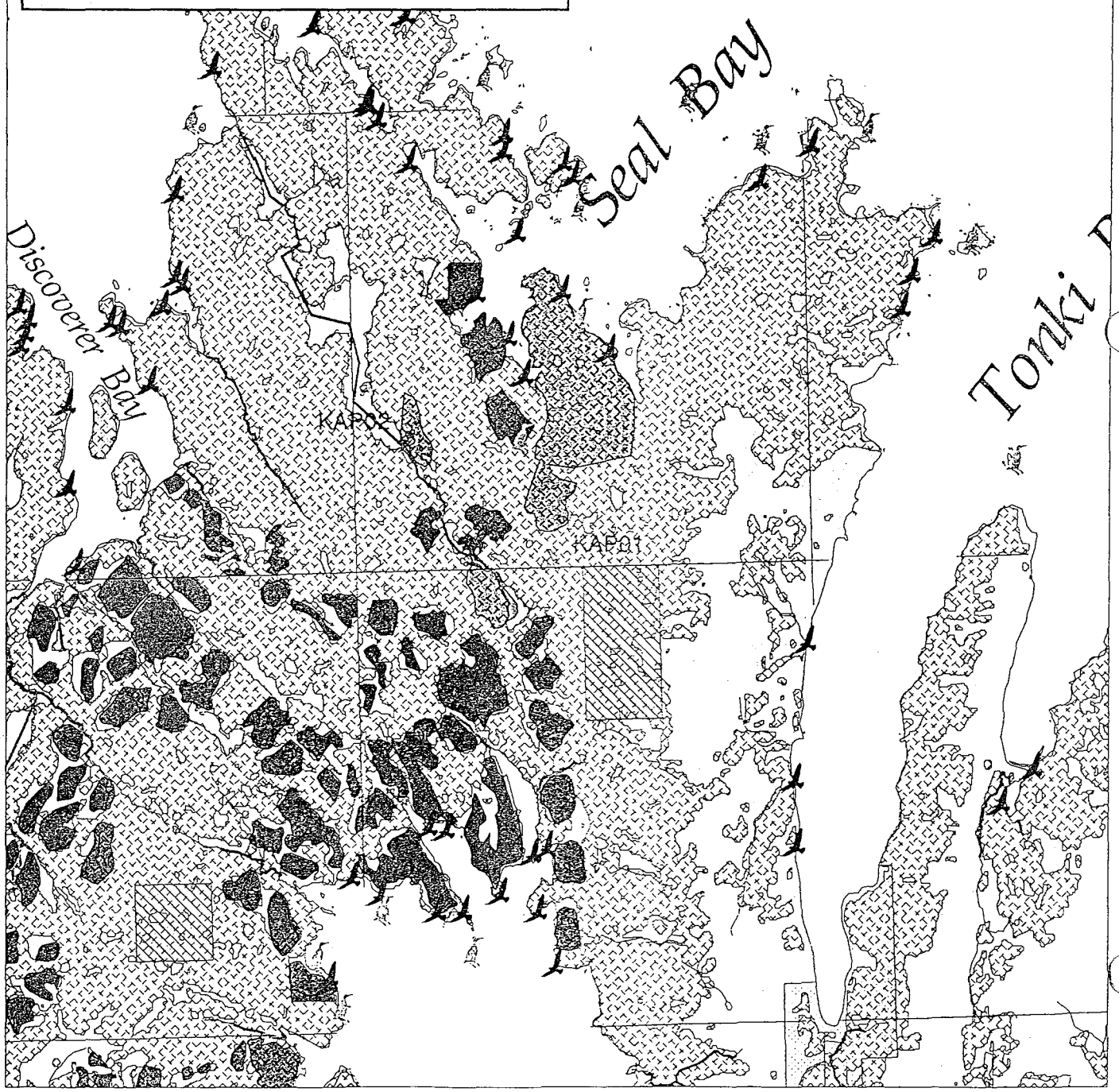
SOURCES:
Current and planned timber harvest areas provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources (ADNR), Division of Forestry, 1992.

Land status provided by ADNR, Land Records Information Section, 1988.

Forest cover was determined from SPOT 1991 imagery by Podolsky, 1993.

Eagle and Seabird information collected and provided by US Fish and Wildlife.

Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1991.



HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 02	PARCEL NAME: Pauls / Laura / Gretchen lakes		
[1]LANDOWNER: Afognak Joint Venture	[2]PARCEL ACREAGE: 500	[3]TOTAL ACREAGE: 150,000	[4]AFFECTED ACREAGE: 370

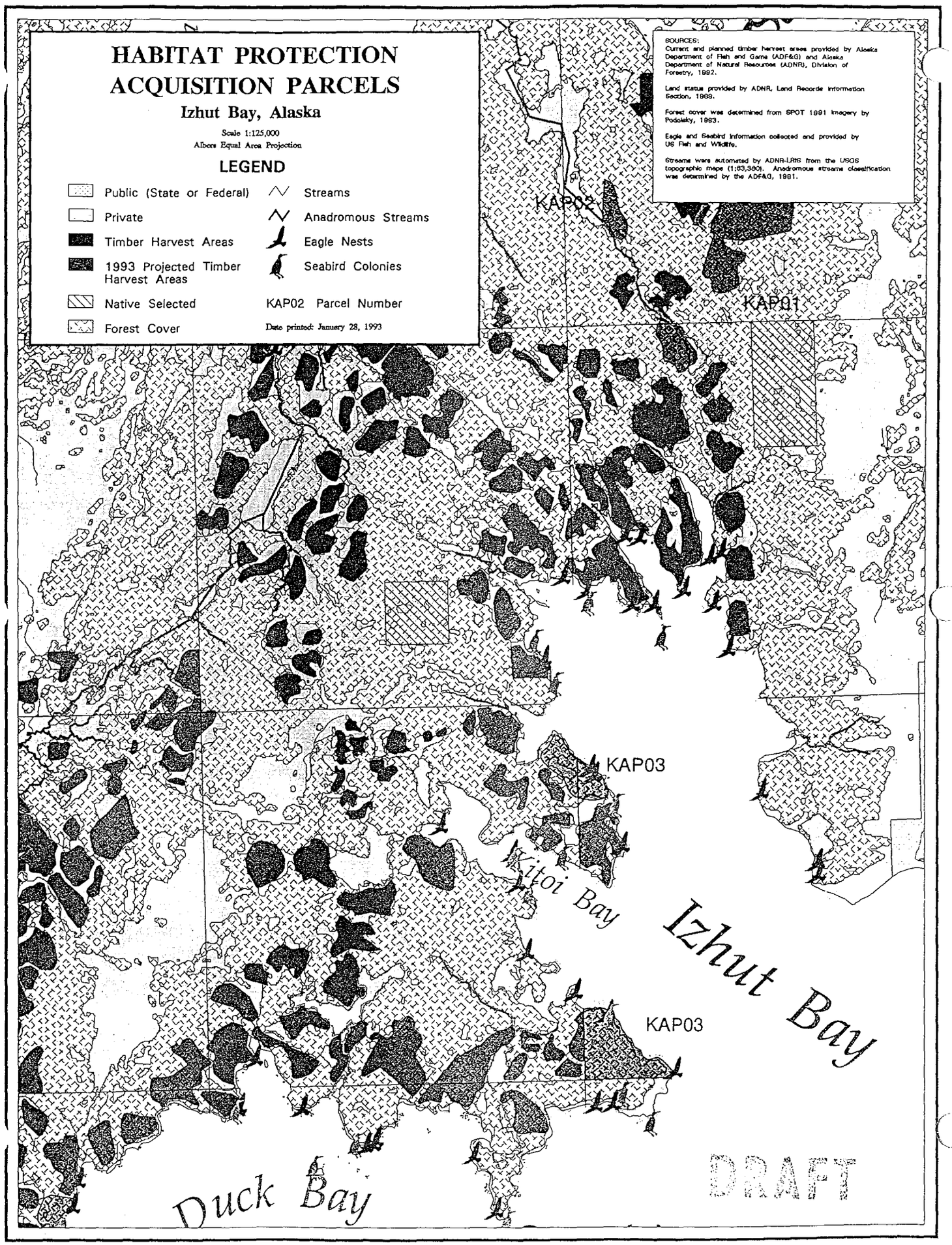
INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	One documented anadromous stream/lake system; coho, sockeye, steelhead, Dolly Varden.
Bald Eagle	Low	No documented nest sites. Probable feeding on anadromous stream/lakes.
Black Oystercatcher	None	
Common Murre	None	
Harbor Seal	None	
Harlequin Duck	Unknown	Possible nesting in riparian zone.
Intertidal/subtidal biota	None	
Marbled Murrelet	Moderate	High confidence that nesting occurs on parcel; good nesting habitat characteristics
Pigeon Guillemot	None	
River Otter	Moderate	Probable feeding, latrine sites; possible denning.
Sea Otter	None	
Recreation/Tourism	Moderate	Pauls Lake used for recreational fishing; recently made road accessible.
Wilderness	Low	Recent clearcuts and roads in area.
Cultural Resources	None	No evidence of archeological sites on parcel.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 02	PARCEL NAME: Pauls / Laura / Gretchen lakes	
Subsistence	Unknown	
ECOLOGICAL SIGNIFICANCE: The stream and lake system on this parcel supports highly productive anadromous fish habitat including sockeye and coho salmon, Dolly Varden, and steelhead; supports recreational and commercial fishing.		
ADJACENT LAND MANAGEMENT: Timber harvest is actively occuring on this and adjacent lands. Surrounding lands are owned by Afognak Joint Venture and managed by Koncor Forest Products for timber production.		
IMMINENT THREAT/OPPORTUNITY: This parcel is proposed for logging in 1993; it is an extension of an ongoing timber harvest.		
PROTECTION OBJECTIVE: 1) Maintain water quality and riparian habitats for anadromous fish; 2) maintain nesting opportunities for marbled murrelets.		
USEFUL PROTECTION TOOL(S): Timber acquisition; cooperative management agreement; conservation easement.		
RECOMMENDED ACTION: Request Afognak Joint Venture to provide interim protection; discuss options for long term protection.		

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

KAP 03


HABITAT PROTECTION
ACQUISITION PARCELS
Izhut Bay, Alaska
Scale 1:125,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Timber Harvest Areas
1993 Projected Timber Harvest Areas
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
KAP02 Parcel Number
Date printed: January 28, 1993
SOURCES:
Current and planned timber harvest areas provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources (ADNR), Division of Forestry, 1992.
Land status provided by ADNR, Land Records Information Section, 1989.
Forest cover was determined from SPOT 1991 imagery by Podolsky, 1993.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous stream classification was determined by the ADF&G, 1991.
KAP02
KAP01
KAP03
KAP03
Kitoi Bay
Izhut Bay
Duck Bay
DRAFT

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 03	PARCEL NAME: Izhut Bay		
[1]LANDOWNER: Afognak Joint Venture	[2]PARCEL ACREAGE: 1,000	[3]TOTAL ACREAGE: 150,000	[4]AFFECTED ACREAGE: 960

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	None	No documented anadromous fish streams. Terrain appears to have low potential for supporting anadromous streams.
Bald Eagle	Moderate	Four documented nest sites.
Black Oystercatcher	Low	Fourteen birds documented in area. Probable feeding, possible nesting in intertidal adjacent to parcel.
Common Murre	None	
Harbor Seal	Moderate	Known haul-out concentration area; probable feeding in nearshore waters.
Harlequin Duck	Low	Possible feeding and loafing on intertidal adjacent to parcel.
Intertidal/subtidal biota	Low	Steep rocky shoreline; lightly oiled in places.
Marbled Murrelet	High	Documented nesting in vicinity of parcel; good nesting habitat characteristics; high use of adjacent marine waters for feeding.
Pigeon Guillemot	Moderate	Twenty six birds documented in area; probable nesting and feeding along shoreline.
River Otter	Low	Steep shoreline probably indicates low use by river otter.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 03	PARCEL NAME: Izhut Bay	
Sea Otter	Low	Feeding in nearshore waters. Habitat appears to have low capacity to support sea otters.
Recreation/Tourism	Low	Recreational fishing and hunting in area.
Wilderness	Low	Fish hatchery in vicinity, recent clearcuts and roads.
Cultural Resources	Low	One archeological site documented on parcel; four adjacent.
Subsistence	Low	Use of parcel appears low; uses adjacent to parcel include: crabs, marine fish, invertebrates, marine mammals, salmon, elk.
ECOLOGICAL SIGNIFICANCE: This parcel contains relatively steeply sloping timbered lands bordering a protected rocky shore and productive marine area in Izhut Bay. The Izhut Bay area has been extensively modified by timber harvest during the past several years. A marbled murrelet nest was found in a felled tree in the vicinity of this parcel in 1992.		
ADJACENT LAND MANAGEMENT: Afognak Joint Venture; timber harvest and forest management are under direction of Koncor Forest Products.		
IMMINENT THREAT/OPPORTUNITY: Timber harvest is currently occurring on and adjacent to this parcel; timber harvest likely to be completed on this parcel in 1993.		
PROTECTION OBJECTIVE: 1) Maintain marbled murrelet nesting opportunities; 2) maintain forested shoreline fringe for bald eagles and protection of nearshore habitat.		
USEFUL PROTECTION TOOL(S): Timber acquisition; conservation easement; cooperative management agreement.		
RECOMMENDED ACTION: Request AJV to provide interim protection; develop options for long term protection.		

1. Parties other than landowner may own partial rights (e.g, timber, minerals).

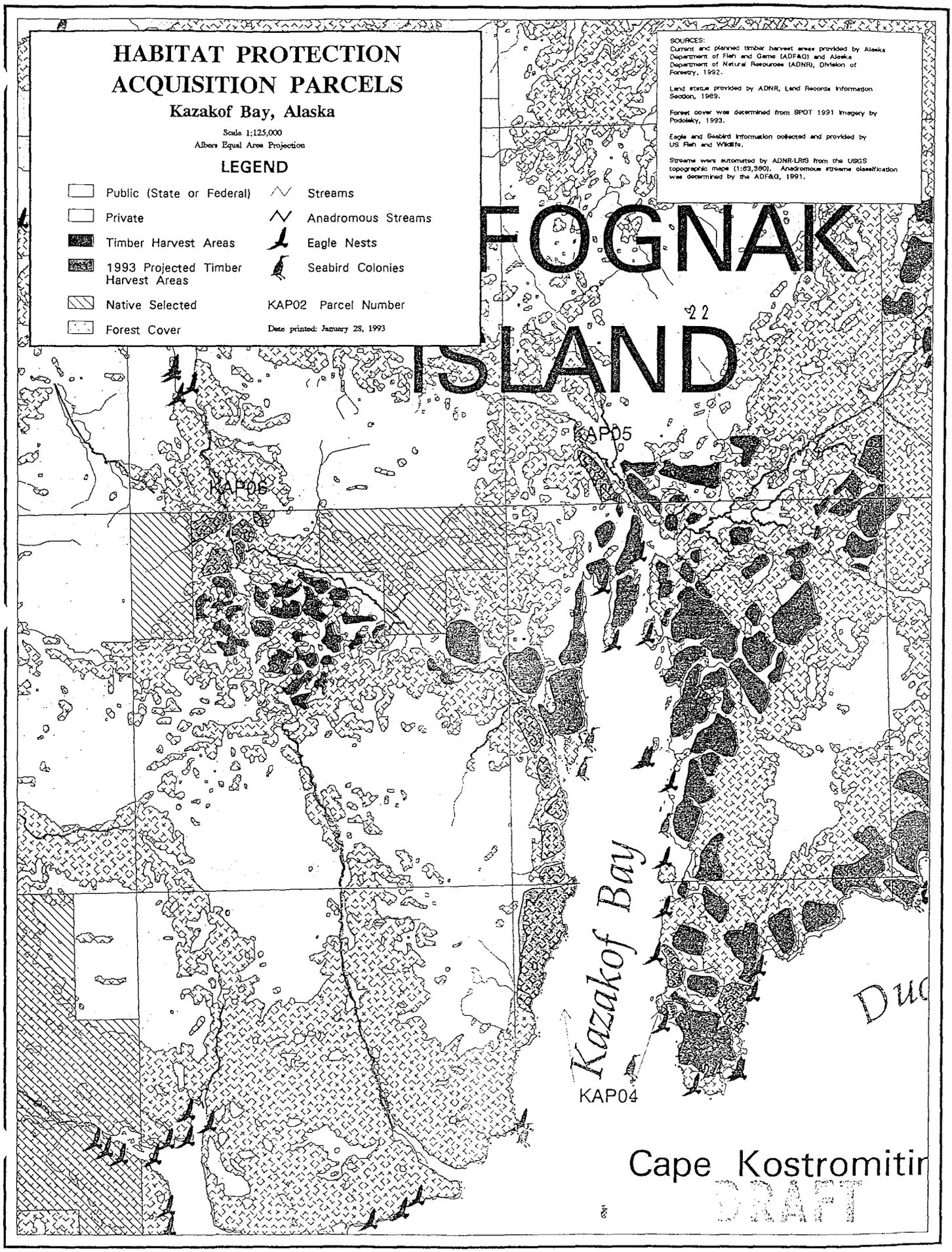
HABITAT PROTECTION PARCEL ANALYSIS

2. Area evaluated.

3. Estimated acreage held by the owner in the spill area.

4. Estimated area to be affected by imminent development activity.

KAP 04, 05, 06


HABITAT PROTECTION
ACQUISITION PARCELS
Kazakof Bay, Alaska
Scale 1:125,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Timber Harvest Areas
1993 Projected Timber Harvest Areas
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
KAP02 Parcel Number
Date printed: January 28, 1993
SOURCES:
Current and planned timber harvest areas provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources (ADNR), Division of Forestry, 1992.
Land status provided by ADNR, Land Records Information Section, 1989.
Forest cover was determined from SPOT 1991 imagery by Podolsky, 1993.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1991.
FOGNAK
ISLAND
KAP05
KAP06
Kazakof Bay
KAP04
Cape Kostromitin
DRAFT

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 04	PARCEL NAME: Kazakof Bay		
[1]LANDOWNER: Afognak Joint Venture; Afognak Native Corporation	[2]PARCEL ACREAGE: 1,500	[3]TOTAL ACREAGE: 150,000	[4]AFFECTED ACREAGE: 1,400

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Low	No documented anadromous streams on parcels; potential for additional streams being found.
Bald Eagle	Low	One documented nest site. Feeding and perching along shoreline.
Black Oystercatcher	Low	Possible feeding in intertidal.
Common Murre	None	
Harbor Seal	Moderate	Known haul-out concentration near parcel. Feeding in nearshore waters.
Harlequin Duck	Low	Thirteen birds documented in eastern Kazakof Bay. Potential for nesting on parcels appears low; probable feeding and loafing in intertidal.
Intertidal/subtidal biota	Moderate	Sheltered rocky intertidal areas, productive shallows, kelp beds.
Marbled Murrelet	Unknown	Habitat characteristics appear suitable for nesting; feeding in adjacent marine waters.
Pigeon Guillemot	Low	Thirty four birds documented on nearby Parrot Island. Possible nesting on or near parcels, probable feeding in nearshore area.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 04	PARCEL NAME: Kazakof Bay	
River Otter	Low	Possible feeding and latrine sites on or near parcels.
Sea Otter	Low	Established sea otter population in area; probable feeding in nearshore waters.
Recreation/Tourism	Moderate	Area receives local recreational use from logging camps, Afognak I. lodges/residences, Port Lions and Ouzinkie. Hunting and fishing from Kodiak-based guide operations.
Wilderness	Low	Established logging camps, transfer and storage facilities, roads, recent clearcuts.
Cultural Resources	Moderate	Two archeological sites documented on parcel.
Subsistence	Moderate	Uses include: crabs, marine fish, invertebrates, marine mammals, salmon, elk, trapping, deer.
ECOLOGICAL SIGNIFICANCE: These parcels contain relatively steeply sloping timbered lands bordering a protected rocky shore and productive marine area in Kazakof Bay. The Kazakof Bay area has been extensively disturbed by timber harvest during the past decade.		
ADJACENT LAND MANAGEMENT: Afognak Native Corporation; Afognak Joint Venture; managed primarily for timber harvest and production.		
IMMINENT THREAT/OPPORTUNITY: This parcel is proposed for timber harvest in 1993 as an extension of ongoing timber harvest operations in area.		
PROTECTION OBJECTIVE: 1) Maintain marbled murrelet nesting opportunities; 2) maintain forested shoreline fringe for bald eagles and protection of nearshore habitat.		
USEFUL PROTECTION TOOL(S): Timber acquisition; conservation easement; cooperative management agreement.		

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 04	PARCEL NAME: Kazakof Bay
RECOMMENDED ACTION: Request ANC and AJV to provide interim protection; develop options for long term protection.	

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 05	PARCEL NAME: Big Danger Creek		
[1]LANDOWNER: Afognak Native Corporation	[2]PARCEL ACREAGE: 120	[3]TOTAL ACREAGE: 112,000	[4]AFFECTED ACREAGE: 120

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Low	One documented pink salmon stream.
Bald Eagle	Low	No documented nest sites; probable feeding and perching.
Black Oystercatcher	None	
Common Murre	None	
Harbor Seal	None	
Harlequin Duck	Low	Habitat characteristics appear to have low suitability.
Intertidal/subtidal biota	None	
Marbled Murrelet	Moderate	Habitat characteristics appear suitable for nesting; feeding in Kazakof Bay.
Pigeon Guillemot	None	
River Otter	Unknown	Possible feeding and latrine sites.
Sea Otter	None	
Recreation/Tourism	Low	Known elk winter concentration area.
Wilderness	Low	Roads, recent clearcuts.
Cultural Resources	Low	No evidence of archeological sites on parcel.
Subsistence	Low	Deer, elk, trapping.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 05	PARCEL NAME: Big Danger Creek
ECOLOGICAL SIGNIFICANCE: This parcel contains a remanent forest surrounded by an extensively harvested areas. It is a known elk winter concentration area.	
ADJACENT LAND MANAGEMENT: Afognak Native Corporation; Afognak Joint Venture; area primarily managed for timber harvest and production.	
IMMINENT THREAT/OPPORTUNITY: This area may be harvested in 1993; a Forest Practices Notification has been filed.	
PROTECTION OBJECTIVE: Maintain riparian area and opportunities for marbled murrelet nesting.	
USEFUL PROTECTION TOOL(S): Timber acquisition; conservation easement; cooperative management agreement.	
RECOMMENDED ACTION: Discuss interim protection with ANC; discuss long term protection options; this parcel appears to have a low potential to benefit restoration.	

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 06	PARCEL NAME: Paramanof Creek		
[1]LANDOWNER: Afognak Joint Venture	[2]PARCEL ACREAGE: 500	[3]TOTAL ACREAGE: 150,000	[4]AFFECTED ACREAGE: 330

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	Two documented anadromous streams; coho, sockeye, pink, Dolly Varden, steelhead.
Bald Eagle	Low	No documented nest sites; possible nesting, probable feeding and perching.
Black Oystercatcher	None	
Common Murre	None	
Harbor Seal	None	
Harlequin Duck	Unknown	Possible nesting in riparian zone.
Intertidal/subtidal biota	None	
Marbled Murrelet	Unknown	Habitat characteristics appear suitable for nesting; feeding in nearby marine waters.
Pigeon Guillemot	None	
River Otter	Low	Probable feeding and latrine sites; possible denning.
Sea Otter	None	
Recreation/Tourism	Low	Recreational hunting and fishing; recent road access in vicinity of parcel.
Wilderness	Low	Roads and recent clearcuts in vicinity.
Cultural Resources	Low	No evidence of archeological sites on parcel; two sites adjacent.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 06	**PARCEL NAME:** Paramanof Creek	
Subsistence	Low	Recent road access may increase use.
ECOLOGICAL SIGNIFICANCE: Parcel supports important anadromous fish stream.		
ADJACENT LAND MANAGEMENT: Afognak Native Corporation; extensive recent timber harvest on adjacent lands.		
IMMINENT THREAT/OPPORTUNITY: Parcel is proposed for timber harvest in 1993; extension of current timber harvest opperations.		
PROTECTION OBJECTIVE: Maintain anadromous fish habitat and water quality.		
USEFUL PROTECTION TOOL(S): Conservation easement; timber acquisition; cooperative management agreement.		
RECOMMENDED ACTION: Discuss interim protection with ANC; develop long term protection options; parcel appears to have a low potential to benefit restoration.		

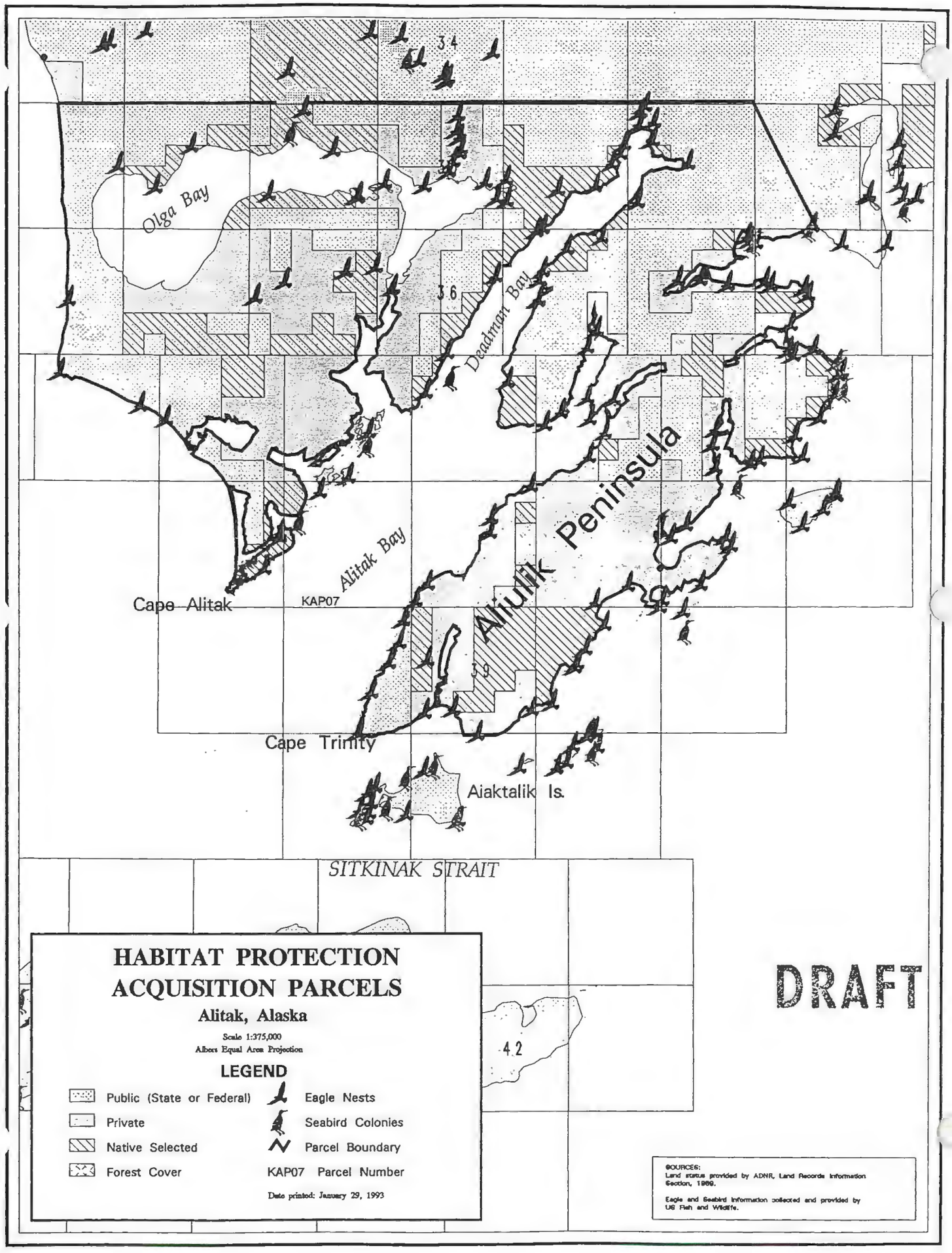
1. Parties other than landowner may own partial rights (e.g., timber, minerals).

2. Area evaluated.

3. Estimated acreage held by the owner in the spill area.

4. Estimated area to be affected by imminent development activity.

KAP 07


Olga Bay
Deadman Bay
Alitak Bay
Alitak Peninsula
Cape Alitak
KAP07
Cape Trinity
Aiaktalik Is.
SITKINAK STRAIT
3.4
3.6
3.9
4.2
HABITAT PROTECTION ACQUISITION PARCELS
Alitak, Alaska
Scale 1:375,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Native Selected
Forest Cover
Eagle Nests
Seabird Colonies
Parcel Boundary
KAP07 Parcel Number
Date printed: January 29, 1993
DRAFT
SOURCES:
Land status provided by ADNR, Land Records Information Section, 1989.
Eagle and Seabird information collected and provided by US Fish and Wildlife.

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 07	PARCEL NAME: Alitak Bay		
[1]LANDOWNER: Akhiok-Kaguyak, Inc.	[2]PARCEL ACREAGE: 230,000	[3]TOTAL ACREAGE: 139,000	[4]AFFECTED ACREAGE: Unknown

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	High	In excess of 100 documented anadromous streams; sockeye, coho, pink, chum, king, Dolly Varden. Olga Lakes ranked among top four sockeye salmon systems in Kodiak Archipelago.
Bald Eagle	High	Ninety two documented nest sites; concentrated feeding in Upper Station Lakes area.
Black Oystercatcher	Low	Probable feeding, possible nesting along shoreline; most nearshore rocks and islets in Refuge.
Common Murre	Low	Probable feeding in adjacent marine waters.
Harbor Seal	Moderate	Known haul-out concentration area that historically supported large numbers of seals. Feeding in nearshore waters and haul-outs on nearshore rocks.
Harlequin Duck	Unknown	Probable feeding and loafing along shoreline.
Intertidal/subtidal biota	Low	Rich intertidal and subtidal biota; recruitment value appears to be low because of distance to oiled shorelines.
Marbled Murrelet	Low	Possible feeding.

HABITAT PROTECTION PARCEL ANALYSIS

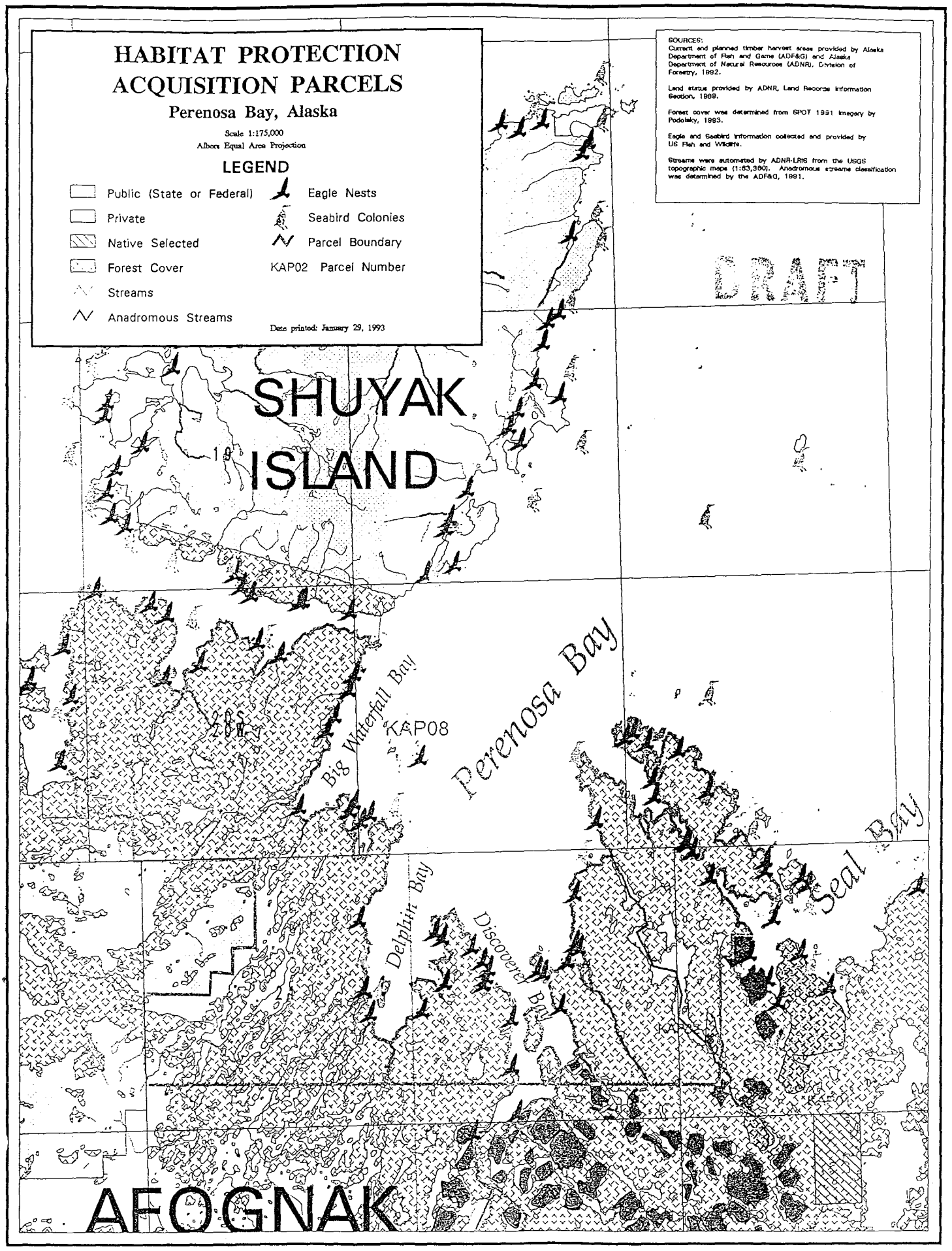
PARCEL #: KAP 07	PARCEL NAME: Alitak Bay	
Pigeon Guillemot	Moderate	One-hundred four birds documented in area; nesting and feeding along shoreline.
River Otter	Unknown	Probable feeding, possible latrine sites and denning.
Sea Otter	Low	Probable feeding.
Recreation/Tourism	Moderate	Recreational fishing and hunting; moderately difficult access.
Wilderness	Low	Moderate evidence of human development; village, shore fishery cabins, lodges, recreational cabins.
Cultural Resources	Moderate	Seventeen archeological sites documented in the Alitak Bay area.
Subsistence	High	Resource harvest area; crab, marine fish, marine invertebrates, plants, marine mammals, salmon, waterfowl.
ECOLOGICAL SIGNIFICANCE: This parcel contains high value anadromous fish, bald eagle and brown bear habitat adjacent to a highly productive estuary and marine ecosystem; very high brown bear densities around Olga Bay; shoreline was not significantly oiled.		
ADJACENT LAND MANAGEMENT: Kodiak National Wildlife Refuge		
IMMINENT THREAT/OPPORTUNITY: Recreational development (lodges, cabins), fisheries development (year-round residences); Akhiok-Kaguyak has expressed interest in participating in habitat protection/acquisition.		
PROTECTION OBJECTIVE: Maintain anadromous fish habitat, bald eagle nesting opportunities, subsistence resources.		
USEFUL PROTECTION TOOL(S): Fee title acquisition; conservation easement; cooperative management agreement.		

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 07	PARCEL NAME: Alitak Bay
RECOMMENDED ACTION: Request Akhiok Kaguyak to provide interim protection; discuss long term protection options; appears to have relatively low potential to directly benefit restoration; higher potential for equivalent protection.	

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated (contains Akhiok-Kaguyak overselections).
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

KAP 08


HABITAT PROTECTION ACQUISITION PARCELS
Perenosa Bay, Alaska
Scale 1:175,000
Albers Equal Area Projection
LEGEND
Public (State or Federal)
Private
Native Selected
Forest Cover
Streams
Anadromous Streams
Eagle Nests
Seabird Colonies
Parcel Boundary
KAP02 Parcel Number
Date printed: January 29, 1993
SOURCES:
Current and planned timber harvest areas provided by Alaska Department of Fish and Game (ADF&G) and Alaska Department of Natural Resources (ADNR), Division of Forestry, 1992.
Land status provided by ADNR, Land Records Information Section, 1992.
Forest cover was determined from SPOT 1991 imagery by Podolsky, 1993.
Eagle and Seabird information collected and provided by US Fish and Wildlife.
Streams were automated by ADNR-LRIS from the USGS topographic maps (1:63,360). Anadromous streams classification was determined by the ADF&G, 1991.
DRAFT
SHUYAK ISLAND
KAP08
Big Waterfall Bay
Perenosa Bay
Delphin Bay
Discovery Bay
Seal Bay
AFOGNAK

HABITAT PROTECTION PARCEL ANALYSIS

PARCEL #: KAP 08	PARCEL NAME: Shuyak Strait / Perenosa Bay		
[1]LANDOWNER: Afognak Joint Venture	[2]PARCEL ACREAGE: 51,000	[3]TOTAL ACREAGE: 150,000	[4]AFFECTED ACREAGE: Unknown

INJURED RESOURCE / SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	Moderate	Twenty three documented anadromous streams; pink, coho, Dolly Varden, steelhead, sockeye.
Bald Eagle	High	Fifty eight documented nest sites; feeding and roosting along shoreline.
Black Oystercatcher	Moderate	Feeding in intertidal; probable nesting along shoreline and nearshore islets.
Common Murre	None	
Harbor Seal	Moderate	Historic seal concentration area; feeding in nearshore waters; hauling out on nearshore rocks.
Harlequin Duck	Moderate	Nearshore rocks and shoreline used for feeding, loafing, and molting; 143 birds documented in area; potential nesting in riparian habitat along anadromous streams.
Intertidal/subtidal biota	Moderate	Productive rocky intertidal and shallow subtidal habitat; important herring spawning area; some beaches were lightly oiled.
Marbled Murrelet	High	High confidence that nesting occurs on parcel; good nesting habitat characteristics; high use of adjacent marine waters for feeding.

HABITAT PROTECTION PARCEL ANALYSIS

Pigeon Guillemot	Moderate	Documented nesting of 214 birds on or immediately adjacent to parcel; feeding in nearshore waters.
River Otter	Moderate	Probable feeding and latrine sites along shoreline; possible denning; habitat characteristics appear highly favorable for river otter.
Sea Otter	Moderate	Documented concentration area; feeding along shoreline.
Recreation/Tourism	Moderate	Area supports high value wilderness-based recreation for boats and lodge; current use relatively low because of difficult access.
Wilderness	High	High wilderness characteristics for most of parcel; log transfer facility in southern Discoverer Bay near parcel; little other evidence of human use or disturbance.
Cultural Resources	Moderate	Twenty six documented sites.
Subsistence	Low	Salmon, deer, elk, marine invertebrates, trapping; difficult access.
ECOLOGICAL SIGNIFICANCE: The parcel is primarily forested with sitka spruce with scattered small ponds, grass meadows, shrub thickets, and muskegs. Adjacent marine waters are highly productive. Shoreline is convoluted and semi-protected with numerous islets, rocks, reefs and kelp beds. In addition to injured species, elk, deer, and brown bear utilize area.		
ADJACENT LAND MANAGEMENT: Kodiak National Wildlife Refuge; Akhiok/Kaguyak/Old Harbor Joint Venture.		
IMMINENT THREAT/OPPORTUNITY: Afognak Native Corporation, a partner in Afognak Joint Venture has expressed interest in participating in habitat protection/acquisition; these lands were selected, in part, for their merchantable timber resources		

HABITAT PROTECTION PARCEL ANALYSIS

PROTECTION OBJECTIVE: 1) Maintain water quality and riparian habitat for anadromous fish; 2) maintain marbled murrelet and bald eagle nesting habitat; 3) maintain and enhance wilderness-based recreational opportunities.
USEFUL PROTECTION TOOL(S): Timber acquisition; fee title acquisition; cooperative management agreement; conservation easement.
RECOMMENDED ACTION: Request AJV to provide interim protection; discuss options for long term protection.

1. Parties other than landowner may own partial rights (e.g., timber, minerals).
2. Area evaluated.
3. Estimated acreage held by the owner in the spill area.
4. Estimated area to be affected by imminent development activity.

SECTION 4

Table 3-1
Summary of Strengths, Limitations, and Requirements of Protection Tools

PROTECTION TOOL	STRENGTHS	LIMITATIONS	REQUIREMENTS
Landowner Contact and Education	• Low cost • Covers large area quickly • Prevents destruction through inadvertence • Builds relationship to negotiate stronger levels of protection in the future • Opportunity to gain information about site and owner • Encourages informed management	• Very low level of protection, if any • Interim protection only, if any.	• Identification of strategic sites • Trained fieldworkers with expertise in habitat and recreation and excellent people skills • Stylish brochures, attractive information package • Newsletters • File or database system for reporting information from contacts
Voluntary Agreements: Registration and Cooperative Management Agreements	• All advantages of landowner contact and education, above • Flexible • Higher level of protection than landowner contact alone • Can function as holding action while funds for stronger protection level obtained	• Low level of protection, depends entirely on voluntary commitment • Interim protection only • Ill suited for core areas	• Same as above, plus: • Plaque, certificate, or other memorial • Well-drafted sets of voluntary landowner agreement forms • Word processing equipment • Trained negotiators with skills needed to customize forms and create specialized agreements
Rights of First Refusal	• Protects against changes in use if current owner decides to sell • Can buy time	• Little warning or time to arrange financing for purchase price • Contingent entirely on owner deciding to sell and terms of actual offer	• Same as fee acquisitions, below
Leases, Licenses, and Management Agreements	• Flexible • Allows for active management or restoration short of paying full purchase price • Does not require acquisition • Works well in buffer areas	• Interim protection only • May be ill-suited for core areas	• Experienced negotiators with knowledge and skills in finance, land use, real estate, and law • Experienced land managers with expertise in habitat and recreation • Detailed management plan developed by experts • Experienced attorneys with expertise in real estate law, tax law, estate and family planning law, and environmental/natural resources law • Well-drafted sets of form legal documents • Word processing equipment and other administrative capabilities (telecopying, photocopying, etc.) • Skilled administrative staff • Reliable information about market rents and fees • May need hazardous materials evaluation • Clear policies and procedures for decision making and management

Table 3-1 (Cont'd)
Summary of Strengths, Limitations, and Requirements of Protection Tools

PROTECTION TOOL	STRENGTHS	LIMITATIONS	REQUIREMENTS
Conservation Easements	• Flexible • Usually restricts land use permanently • Keeps property in private hands and on the tax rolls • Can be low cost because of tax incentives to donate • Works well in buffer areas, especially if historic uses are compatible	• May be ill suited for active management or restoration of core areas, unless restrictions on landowner's use are very tight, and rights granted very broad • Possible management difficulties when there is a change in ownership • Requires high level of monitoring	• Experienced negotiators with knowledge and skills in finance, land use, real estate and law • Experienced land stewards with expertise in habitat and recreation • Experienced attorneys with expertise in real estate law, tax law, estate and family planning law, and environmental and natural resources law • Well-drafted sets of form legal agreements • Word processing equipment and other administrative capabilities (telecopying, photocopying, etc.) • Skilled administrative staff • Appraisal • Title report and underlying documents • Survey, where needed • Thorough hazardous materials evaluation • Easement documentation report prepared by experts • Clear policies and procedures for decision making and management
Deed Restrictions and Reverters	• Permanent restrictions • Keeps property in private hands and on the tax rolls • May be able to recover costs on re-sale	• May be difficult to resell to a buyer willing to take subject to the restrictions • May be difficult to enforce	• Same as above
Acquisition of Undivided Interests	• Buys "seat at the table" in management decisions • Potential step to full fee ownership • Way to divide ownership among conservation partners making contributions of different value toward purchase	• Can present serious management problems, especially in the absence of a well drafted co-tenancy agreement • Undesirable legal remedies in the event of deadlock	• Same as fee acquisitions, below
Acquisition of Remainder Interests Subject to Restricted Life Estates	• Low cost way to gain possession and control in the future	• Uncertain date of transfer of possession (depends on death of last tenant) • Management problems during occupancy of life tenant	• Same as fee acquisitions, below

Table 3-1 (Cont'd)
Summary of Strengths, Limitations, and Requirements of Protection Tools

PROTECTION TOOL	STRENGTHS	LIMITATIONS	REQUIREMENTS
Acquisitions of Partial Interests: Water, Timber, Mineral, Grazing Rights and Access Rights	• Lower cost way to control resource than full fee acquisition • Keeps title to land in private hands and on the tax rolls	• May not be permanent (e.g.,other owners may be able to reapply for rights or rights acquired may be term rights only) • May not completely control use of the resource • Difficult to establish good title in seller	• Same as fee acquisitions, below, plus: • Technical experts, (such as hydrologists and water rights attorneys in the case of water rights acquisitions)
Fee Acquisitions	• High level of protection, gives full ownership and control	• Can be expensive if property is not donated • If government owned, public may perceive that property is withdrawn from the private domain and may reduce local tax revenues	• Experienced negotiators with knowledge and skills in finance, land use, real estate and law • Experienced land stewards with expertise in habitat and recreation • Experienced attorneys with expertise in real estate law, tax law, estate and family planning law, and environmental and natural resources law • Well-drafted sets of form legal agreements • Word processing equipment and other administrative capabilities (telecopying, photocopying, etc.) • Skilled administrative staff • Professional specialists (land surveyors, geologists, water quality engineers, appraisers, hazardous waste inspectors, structural engineers, etc.) • Appraisal • Title report and underlying documents • Survey, where needed • Thorough hazardous materials evaluation • Clear policies and procedures for decision making and management
Dedications	• High level of protection, privately owned land, especially if title will be retained by a private conservation organization (protects against condemnation or conversion) • Can be flexible by allowing only specific interests to be dedicated	• Uncertain incentives for private owners	Same as fee acquisitions, above

The Nature Conservancy of Alaska. 1991. Options for identifying and protecting strategic fish and wildlife habitats and recreation sites. p. 3-10 - 3-12.

SAMPLE

AGREEMENT
STATE OF ALASKA

THIS AGREEMENT OF RIGHT OF FIRST REFUSAL, is made this _____ day of _____, 1993, by and between _____, Grantor, and the United States of America (or State of Alaska), Grantee. In consideration of the sum of Ten Dollars ($10.00) cash in hand paid, the mutual covenants and assents of the parties hereto, and other good valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the following agreements are made:

1. GRANT OF RIGHT OF FIRST REFUSAL. The Grantor hereby grants to the Grantee the privilege or Right of First Refusal to purchase the Property (as described in Exhibit A hereto), or any portion thereof, or interests therein, according to the following conditions. If and when the Grantor shall receive an offer of purchase for said property, or any portion thereof, or interests therein, from a third party, which said offer the Grantor wishes to accept, Grantor shall notify the Grantee in writing of the terms of said offer. If the Grantee notifies the Grantor, in writing, within ninety (90) days of the receipt of said offer, that the Grantee agrees to purchase said Property upon the same terms and conditions as contained in said offer, the Grantee shall have the right to purchase said property for such terms and conditions. If the Grantor receives no reply to the notice given to the Grantee within ninety (90) days of the receipt thereof by the Grantee, the Grantor shall be free to sell said Property to the original offeror. If the Grantee elects to exercise such right of first refusal, the Grantor and the Grantee shall execute a sales contract within thirty (30) days for said property on the terms and conditions set forth in said written offer, or as otherwise mutually agreed.

2. STUDIES. The Grantee shall have the right to access and conduct non-destructive research on said property during the term of this grant of right of first refusal, in order to better determine the desireability of exercising this right of first refusal. The Grantee will notify the Grantor in writing at least thirty (30) days before conducting any such research on said property. The Grantee will provide Grantor with at least one copy of any final research report that results from such research.

3. RUNNING OF BENEFITS OF THIS AGREEMENT. The Benefits of this grant of right of first refusal are limited to the Grantee, and are not assignable or transferable.

4. CONSTRUCTION. The rule of strict construction does not apply to this grant. The interpretation of this grant shall be

given a reasonable construction so that the intention of parties hereto to grant and receive a privilege or right of first refusal is carried out.

5. TERMINATION OF RIGHT. The right of first refusal made by this Agreement shall automatically terminate in two (2) years from the date of this Agreement, unless otherwise extended by mutual agreement of the parties hereto.

6. NOTICES. All notices, requests, consents and other communications required or permitted by this Agreement shall be in writing, sent by registered or certified mail, and be addressed as follows:

To Grantor: ABLE Native Corporation
P.O. Box
, Alaska

To Grantee: Fish, Forest and Park Service
P.O. Box
, Alaska

Any changes of address of either Grantor or Grantee must be promptly submitted in writing to the other party.

7. BENEFIT. This right of first refusal is being acquired for the _____(agency)_____.

WITNESS the following signatures and seals:

_____	_____
President ABLE Native Corporation	Functionary United States of America (or State of Alaska)

EXHIBIT A--LEGAL DESCRIPTION
ACKNOWLEDGEMENT & NOTARY
RECORDING

SECTION 5

Challenge Cost-Share Agreement
between
The Nature Conservancy
and
USDA, Forest Service, Alaska Region
September 25, 1992

Task II Report
December 8, 1992

Cost-Share Agreement

A cost-share agreement provides an effective framework for cooperative efforts between organizations which have certain goals and objectives in common. The Nature Conservancy and the U.S. Forest Service (USFS) have a long history of working cooperatively on projects throughout the United States.

The purpose of the September 25, 1992 agreement was for the Conservancy to provide specific short-term information gathering assistance to the State/Federal Exxon Valdez Habitat Work Group, on which the USFS is represented. It was intended that information gathered about privately owned lands would be used to initiate interim protection discussions with willing land owners.

Task II Objectives

The purpose of Task II was to develop and conduct a workshop "designed to assess the rate of recovery of injured resources and services; identify specific tracts of privately-owned upland habitats that should be subjected to threshold criteria and threat/opportunity assessments; describe habitat characteristics associated with injured resources and services; and identify information needs that should be addressed" by Task 1(b) of the agreement.

The workshop was to be completed and information transferred to the Habitat Work Group by November 16, 1992, about eight weeks from the effective date of agreement. Due to the limited time available, it was necessary for the Conservancy to limit the scope of Task II information gathering activities.

Project Summary

A. Questionnaires

The Conservancy and Habitat Work Group developed a questionnaire designed to gather information necessary to accomplish Task II objectives. The questionnaire was sent to individuals identified as having significant knowledge about the injured resources and services. The Habitat Work Group identified most of the respondents. Of the 45 questionnaires sent out, 27 responses were received.

B. Interviews

Individuals identified as having significant site-specific knowledge about injured resources and services were invited to Anchorage to be interviewed. Twenty three interviews were conducted. Fourteen of the interview participants had also responded to the questionnaire.

Three teams interviewed the individuals. Each team was led by a senior Conservancy employee and supported by two technical assistants. A modified questionnaire was developed for the interviews. Interview information was recorded in the following manner:

1. A team transcriber took rough notes during the interview.

2. Each interview was taped.

3. All sites discussed during the interviews were mapped on mylar overlays using USGS base maps at a scale of 1:250,000.

4. Significant site information was entered into a Conservancy data base.

C. Site Identification

The interviews took three days to complete. Based upon an accelerated analysis of the interview information (two days), eleven areas were identified as areas meriting special attention during the interim protection phase of the restoration process. The analysis took numerous factors into consideration, such as the existence of multiple benefits to injured resources and services, existing threats, and confidence levels of the respondents.

The project succeeded in using existing information and expertise to identify areas meriting special attention. The process used to delineate the sites should be considered a "course filter" approach since it is primarily based upon the best professional judgement of project participants. In many cases more "fine filter" work is necessary to determine the site's specific relationship to injured services and resources.

Additionally, the eleven identified areas should not be

considered an exclusive list of important areas. The acquisition of additional information will undoubtedly result in the delineation of additional areas meriting special attention. Given information acquired as a result of Task II activities, additional efforts should be focused on the Kodiak, Montegue and Shuyak Island areas.

D. Cordova Workshop

In addition to information obtained from questionnaire responses and interviews, the project benefitted from information-sharing activities associated with workshops conducted by The Prince William Sound Science Center and the Copper River Delta Institute in Cordova during the week of November 1, 1992. Cordova workshop discussions included a specific focus on critical habitat areas within the Prince William Sound area. The Conservancy sent representatives to the workshop and contracted with Ecotrust, an Oregon based non-profit conservation organization and workshop participant, to assist in efforts to transfer Cordova mapped information to Task II maps.

More information can be obtained about the Cordova workshop by contacting the Science Center or Institute directly.

E. Considerations

When reviewing and using the report the following should be considered:

1. The information contained in this report represents a reporting of information obtained from the questionnaires and interviews, and should not be considered as an expression of the Conservancy's knowledge of or opinion about a particular site and activities associated with it.

2. Project participation was limited because of severe time constraints. Project participants and others identified additional sources of information that should be reviewed or contacted. Some of the additional sources are identified in this report.

3. Text contained in this report has not been reviewed by questionnaire respondents or interview participants.

4. Some project participants were concerned about inappropriate use of information. If there is

doubt about whether or not a specific use is appropriate, the information source should be contacted.

5. Many project participants were concerned about inappropriate use of the mylar overlays. A specific concern was that the mapped information should not be made to look more precise than originally intended.

6. Questionnaire and interview participants were not asked to limit their information to private lands. Accordingly, the results provide an indication of the relative importance of both private and public lands to injured resources and services.

Report Summary

A. Volume 1

1. *Summary Map.* The map provides the identification and approximate location of the eleven sites referenced above.

2. *Data Base Information.* Information is provided in the form of "Site Basic Records" and "Summary Element Occurrence Records." An "element occurrence" (as that term is used in this report) is an area that appears to benefit an injured resource or service. A "site" encompasses several element occurrences.

   (a) Site Basic Records. All eleven sites have several associated element occurrences. The site basic records summarize the element occurrence information associated with the site, as well as other information from interview notes and questionnaire responses.

   (b) Summary Element Occurrence Records. After an element occurrence was mapped, the respondent was asked specific questions about the mapped area. Some of the information was recorded in the element occurrence record. For reporting purposes, a summary of the element occurrence record was developed. One hundred thirty nine summary records are provided in this report for those occurrences that are associated with the eleven sites.

   Ninety two element occurrences are not encompassed

within the eleven sites. A minimal amount of information was recorded in the element occurrence record for those areas. Summary tables about these element occurrences are found behind the "Additional EOR" tabs at the end of Volume 1. The term "survey site" on those tables refers to the geographic area where the element occurrence is located.

(c) Maps. This report contains minimal map information. The original mylar overlays upon which this report is based have been delivered to the Habitat Work Group. The Work Group should be contacted with specific requests for map information.

(d) Computer Disks. The WordPerfect tables are contained on a computer disk in the pocket of Volume 1 of the Task II report. The transfer of electronic data base information to the Habitat Working Group will occur once agreement is reached on appropriate software.

(E) Information Gaps. The level of detail associated with the summary element occurrence records and site basic records varies. Accordingly, the records can be effectively used to identify data gaps associated with the element occurrences and larger sites.

3. *Recovery/Habitat Characteristics*. This section contains a summary of responses to questions regarding rate of recovery and habitat characteristics associated with injured species.

B. Volume 2

1. *Respondent Matrix*. Identifies questionnaire and interview participants as well as their species, service and geographic expertise.

2. *Additional Contacts Table*. Identifies other individuals who questionnaire and interview participants recommended contacting.

4. *Literature Sources Table*. Identifies reports recommended by questionnaire and interview participants for review.

5. *Original Questionnaire, A-K.*

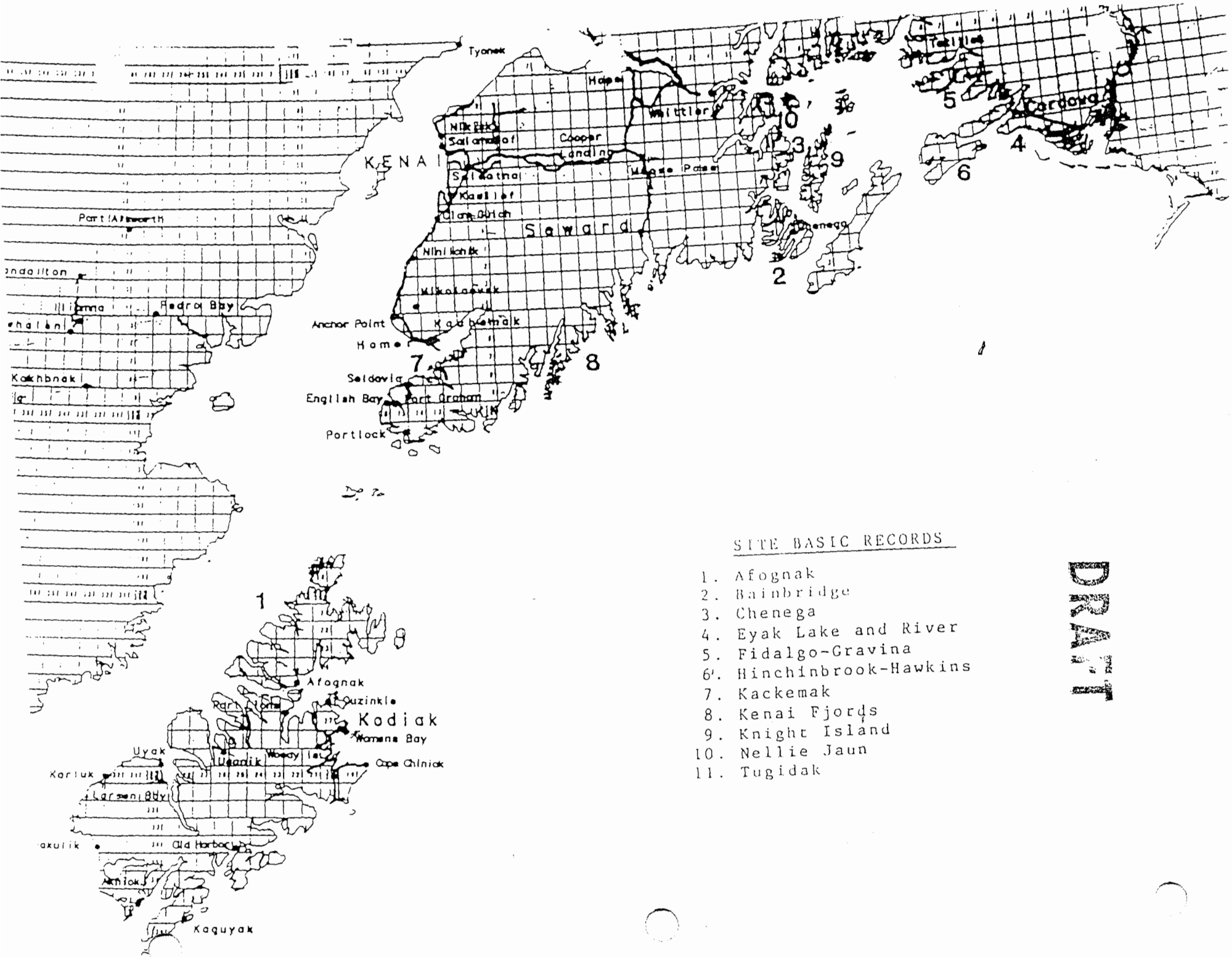
6. *Interview Questionnaire, A-K.*

7. *Cost-Share Agreement/Project 93059 Summary.*

8. *Questionnaire Responses/Interview Notes.*

C. Volume 3

Questionnaire Responses/Interview Notes, continued - L-Z.



SITE BASIC RECORDS

1. Afognak
2. Bainbridge
3. Chenega
4. Eyak Lake and River
5. Fidalgo-Gravina
6. Hinchinbrook-Hawkins
7. Kackemak
8. Kenai Fjords
9. Knight Island
10. Nellie Jaun
11. Tugidak

APPLICABLE QUESTIONNAIRE/INTERVIEW RESPONSES

RESPONDENT NAME	SPECIES/ SERVICE	Q or I	EXPERTISE TYPE		
			General	EVOS Area	Site Specific
Albert, Steve ADF&G, Anchorage	Species - General	I	xx		Eyak Fidalgo/Gravina Afognak
Andres, Brad USFWS, Anchorage	Black Oystercatcher	Q and I			Montegue Island
Ballachey, Brenda USFWS, Anchorage	Sea otter	Q and I			Prince William Sound
Burger, Alan British Colombian Biologist	Marbled murrelet	Q	xx		
Bowman, Tim USFWS, Juneau	Bald eagle	I			Prince William Sound
Braund, Steve Anchorage Consultant	Subsistence	Q	xx		
Cody, Mary USFWS	Marbled murrelet	Q			Afognak
Dorhoff, Angie USFWS	Sea otter	I		xx	
Erikson, David Consultant, Homer	Common murre Harlequin duck	Q			Kachemak Bay
Faro, Jim ADF&G, Soldotna	River otter	Q and I			
Don Ford/Paul/Twardock National Outdoor Leadership School	Wilderness/Recreation	Q and I			Prince William Sound
Frost, Kathy ADF&G, Fairbanks	Pacific harbor seal	Q and I		xx	

RESPONDENT NAME	SPECIES/ SERVICE	Q or I	EXPERTISE TYPE		
			General	EVOS Area	Site Specific
Fry, Mike University of California, Davis	Marbled murrelet Harlequin duck Pigeon guillemot Bald eagle Common murre Black oystercatcher	Q and I			Kachemak Bay Kenai Fjords
Hamer, Thomas Consultant, Washington State	Marbled murrelet	Q	xx		
Hennig, Steve USFS, Anchorage	Wilderness/Recreation	Q and I			Prince William Sound
Hensel, Dick Consultant, Anchorage		I	xx		Afognak/Kodiak
Holbrook, Ken USFS, Anchorage	Black oystercatcher Cutthroat trout Marbled murrelet Sea otter	Q			Prince William Sound
Johannsen, Neil Division of Parks	Wilderness/Recreation	I		xx	
Juday, Glenn WOFA Fairbanks	Old growth	I			Prince William Sound
Knecht, Rick Kodiak Native Association	Subsistence	I			Afognak/Kodiak
Lemon, Moira British Colombian Biologist	Pigeon guillemot	Q	xx		
Lensik, Cal Consultant	Seabirds - general	I		xx	
Lethcoe, Nancy AWR & TA	Wilderness/Recreation	Q and I			Prince William Sound

RESPONDENT NAME	SPECIES/ SERVICE	Q or I	EXPERTISE TYPE		
			General	EVOS Area	Site Specific
McAllister, Mike Naturalist	Marbled murrelet	Q and I		xx	
McBride, Mike Naturalist		Q and I			Kachemak Bay
McCarron, Susan ADF&G, Anchorage	Cutthroat trout	Q			Prince William Sound
Meiners, Al Division of Parks	Wilderness/Recreation	I		xx	
Million, Marsha Naturalist, Homer	Sea otter	Q			Kachemak Bay
Miraglia, Rita ABF&G, Anchorage	Subsistence	Q and I		xx	
Muehlenhardt, Gary USFWS	U.S.F.W.S. Acquisition Priorities	I	xx		Kodiak
Oakley, Karen USFWS, Anchorage	Pigeon guillemot	Q			Naked Island
Olesiuk, Peter Department of Ocean Fisheries, British Columbia	Pacific harbor seals	Q			N/A
Podolsky, Richard Island Institute, New York	Harlequin duck Marbled murrelet	Q		xx	
Rice, Bud NPS, Anchorage	Wilderness/Recreation	Q and I			Kenai Fjords
Sharr, Sam ADF&G, Cordova	Pink salmon	Q and I			Prince William Sound
Sundberg, Kim ADF&G	Marbled murrelet	I			Prince William Sound

RESPONDENT NAME	SPECIES/ SERVICE	Q or I	EXPERTISE TYPE		
			General	EVOS Area	Site Specific
Weiland, Ann Naturalist	Pigeon guillemot Cutthroat trout Harlequin duck Marbled murrelet Sea otter River otter Pacific harbor seal	Q and I			Kachemak Bay
West, George Ornithologist	Bald eagles Birds - general	Q	xx		Kachemak Bay

ADDITION RESOURCES

TITLE/DATE	AUTHOR	AREA/SITE
Recreation, Scenic and Heritage Areas of Particular Concern: Kodiak Archipelago/August 1980	Division of Parks, AKDNR Contact: Kathryn A. Troll	Afognak
Recreation, Scenic, and Heritage Areas of Particular Concerns: Cape Pugent to Cape Suckling, Alaska/August 1977	Division of Parks, AKDNR Contact: Al Meiners	Bainbridge Chenega Eyak Lake and River Fidalgo/Gravina Hinchinbrook/Hawkins Island Knight Island Nellie Juan
Prince William Sound Diary	Kelley Weaverling	
Sea Otters of Prince William Sound, Alaska	Ancel M. Johnson	
Prince William Sound Sea Otter Distribution/April 1988	USF&WS	
Subsistence Harvests and Uses in Seven Gulf of Alaska Communities in the Second Year Following the Exxon Valdez Oil Spill/March 1992	James A. Fall	
Resource Use Pattern in Chenega, Western Prince William Sound: Chenega in the 1960's and Chenega Bay 1984-86/December 1986	Lee Stratton and Evelyn B. Chisom	
Cordova: A 1988 Update on Resource Harvests and Uses/June 1992	Lee Stratton	Eyak Lake and River Fidalgo/Gravina Hinchinbrook/Hawkins Island
Resource Use in Cordova, A Coastal Community of Southcentral Alaska/December 1989	Lee Stratton	
Resource Harvest and Use in Tatitlek, Alaska/1990	Lee Stratton	Fidalgo/Gravina, Hinchinbrook/Hawkins Island and Knight Island
Recreation, Scenic and Wilderness Areas of Particular Concern, Cook Inlet, Alaska/July 1978	Division of Parks, AKDNR Contact: Al Meiners	Kachemak Bay
The Role of Wild Resource Use in Communities of the Central Kenai Peninsula and Kachemak Bay/October 1985	Division of Subsistence, ADF&G Contact: Al Meiners	
Patterns of Wild Resource Use in English Bay and Port Graham, AK/1985	Ronald T. Stanek	
Breeding Seabirds at Gull Island and Sixty Foot Rock During 1990	USF&WS, unpublished administrative report, Homer, AK	

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