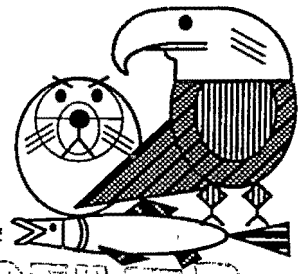
18.1.4E

Exxon V..dez Oil Spill Trustee Council
Restoration Office
645 G Street, Suite 402, Anchorage, Alaska 99501
Phone: (907) 278-8012 Fax: (907) 276-7178



Date: April 11, 1994
Subject: Trustee Council Meeting Actions on 4/11/94
Contact: L.J. Evans or Molly McCammon at 278-8012

Interdisciplinary Ecosystem Research and Restoration Effort Moves Forward

Anchorage – The Trustee Council today gave their final go ahead on one element of an ambitious approach to implementing ecosystem-based restoration in the oil spill-affected region.

With their approval of the Project 94320: Prince William Sound System Investigation, which consists of 16 integrated and interrelated sub-projects, the Trustees will address a number of important research questions. The findings will be used to:

- Guide further restoration activities
- Improve management of common property fishery resources as a means of effecting restoration
- Identify important marine resources and processes for long-term recovery monitoring.

"Taking an ecosystem approach means that we examine several key indicator species and use that information to tell us more about the whole ecosystem which was injured by the spill," said Jim Ayers, Executive Director for the Trustee Council. "In this case, we're looking at a number of species, with the focus particularly tuned in to try to understand what has caused the serious problems with pink salmon populations in Prince William Sound."

The Trustee Council decided last year upon an ecosystem approach to restoration of resources injured by the 1989 *Exxon Valdez* oil spill after extensive scientific review and public comment. The Prince William Sound System

More...

process to identify subsistence restoration project proposals and to ensure the participation of subsistence users in planning efforts.

- Approved funding of $20.4 thousand for Project 94427/Harlequin Duck Boat Surveys & Methodology Testing to devise and test field methodologies for determining impacts of the oil spill on harlequin ducks.

The next meeting of the Trustee Council is expected to take place in June . The *Exxon Valdez* Oil Spill Trustee Council consists of six representatives, three from the State of Alaska and three from the U.S. Government. The Trustees manage funds obtained in the 1991 civil settlement with Exxon Corporation.

For more information, contact the Oil Spill Public Information Center at 645 G St., Suite 100, Anchorage, Alaska 99501, or call 278-8008, toll-free within Alaska at 1-800-478-7745.

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18.1.4D

Replacement for Attachment A

Draft - 4/07/94

Organization Structure
Monitoring/Research Science Planning and Management
DRAFT DRAFT DRAFT

The Trustee Council has identified the need for an explicit organizational structure for science planning and management. Science needs to address a series of questions for the restoration process: Are the injured resources recovering? (Monitoring). If not, why? (research on toxicological linkages, ecosystem processes, other anthropogenic impacts). How can recovery be achieved or accelerated? (general restoration). This organizational structure must address the public and scientists' concerns that the Council is directing its efforts at the priority restoration issues; that the work is technically appropriate and feasible; and that programs are efficient and effective, with appropriate coordination and integration. The Council has also recognized the need for an adaptive management approach to the process, with on-going review and revision utilizing the results of monitoring and research efforts to guide restoration activities.

The attached draft organization diagram (Figure 1) was developed at the Implementation Management Structure work sessions held by the Executive Director on January 13 & 14 and March 21 & 23 to address these needs and concerns. This management structure works from the base of injured resources to develop an integrated, ecosystem approach to accomplishing the goals of healthy ecosystem components, and thus the Mission "to restore the environment injured by the *Exxon Valdez* oil spill to a healthy, productive, world-renowned ecosystem..." The court settlement requires that restoration funds must be used "... for the purpose of restoring, replacing, enhancing, 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..." Thus, general restoration and monitoring/research activities must be linked to the injured resources. However, we have recognized that a single-species approach to restoration is not adequate. The first policy stated in the Draft Restoration Plan is that the restoration program will take an **ecosystem approach**. Restoration of the injured resources will require attention to ecosystem processes that may be limiting recovery, as well as monitoring/ research and active restoration that addresses the specific needs of particular injured resources.

The structure proposed to address these concerns and provide a process to pose and answer the appropriate questions includes Interdisciplinary Work Groups, a Coordinating Committee for the Work Groups, and a Science Review Board (SRB). The responsibilities and composition of the Interdisciplinary Work Groups Coordinating Committee are outlined below. An Annual Workshop and an annual cycle of review and revision provide the feedback loop for adaptive management. The Annual Workshop provides the opportunity for informing the scientific community, the public, and the Trustee Council about the results from restoration activities. This information can then be used to refine on-going projects and revise strategies and research approaches for future work. A schematic of the annual cycle is attached (Figure 2).

Draft - 4/07/94

I. Interdisciplinary Work Groups: Structured around groups of injured resources, including fish, birds, mammals, nearshore organisms and sediments, and archeology. This is not a restatement of the single-species paradigm, but a basis to build an ecosystem approach from the need to restore injured resources.

1.) Responsibilities

A. Identify strategies, research approaches, and testable hypotheses for monitoring, research, and general restoration.

a. Emphasis on integrated, interdisciplinary approaches. SEA plan as an example.

b. Needed for guidance of FY-95 proposals and beyond.

B. Annual review of resource status and strategies for achieving restoration objectives.

C. Recommend priorities for research and restoration activities needed to achieve restoration objectives.

D. Ensure communication, cooperation, and integration

a. Within Work Group.

b. Determine representative for Coordinating Committee for communication with other Work Groups.

2.) Composition

A. Scientists from resource disciplines, including PI's with projects for monitoring and restoration of the injured resources.

B. Scientists from other disciplines (e.g., oceanography, toxicology, ecosystem modeling).

C. Public participation. Meetings are open to the public and interested public are a part of the planning and review process. Administrative funds will be available to ensure appropriate representation.

II. Coordinating Committee

1.) Responsibilities

A. Communication, coordination, and cooperation among Work Groups to ensure an integrated effort directed at restoration of injured resources and services and a healthy ecosystem.

B. Coordination of information from Work Groups on strategies, testable hypothesis, priorities, and progress towards restoration for review by the SRB and the Executive Director.

C. Coordination of activities with Restoration Work Force to facilitate agency administration and cooperation.

D. Organizes the agenda for the Annual Workshop, in conjunction with the SRB.

2.) Composition

A. Representatives from Work Groups.
   a. One representative from each Work Group.
   b. Executive Director must confirm selection.

B. Three at-large members
   a. Two selected by the Executive Director from nominees chosen by Work Group representatives.
   b. One public member selected by the Executive Director from nominees chosen by the Public Advisory Group.

C. Trustee Council Chief Scientist.

D. All meetings are open to the public.

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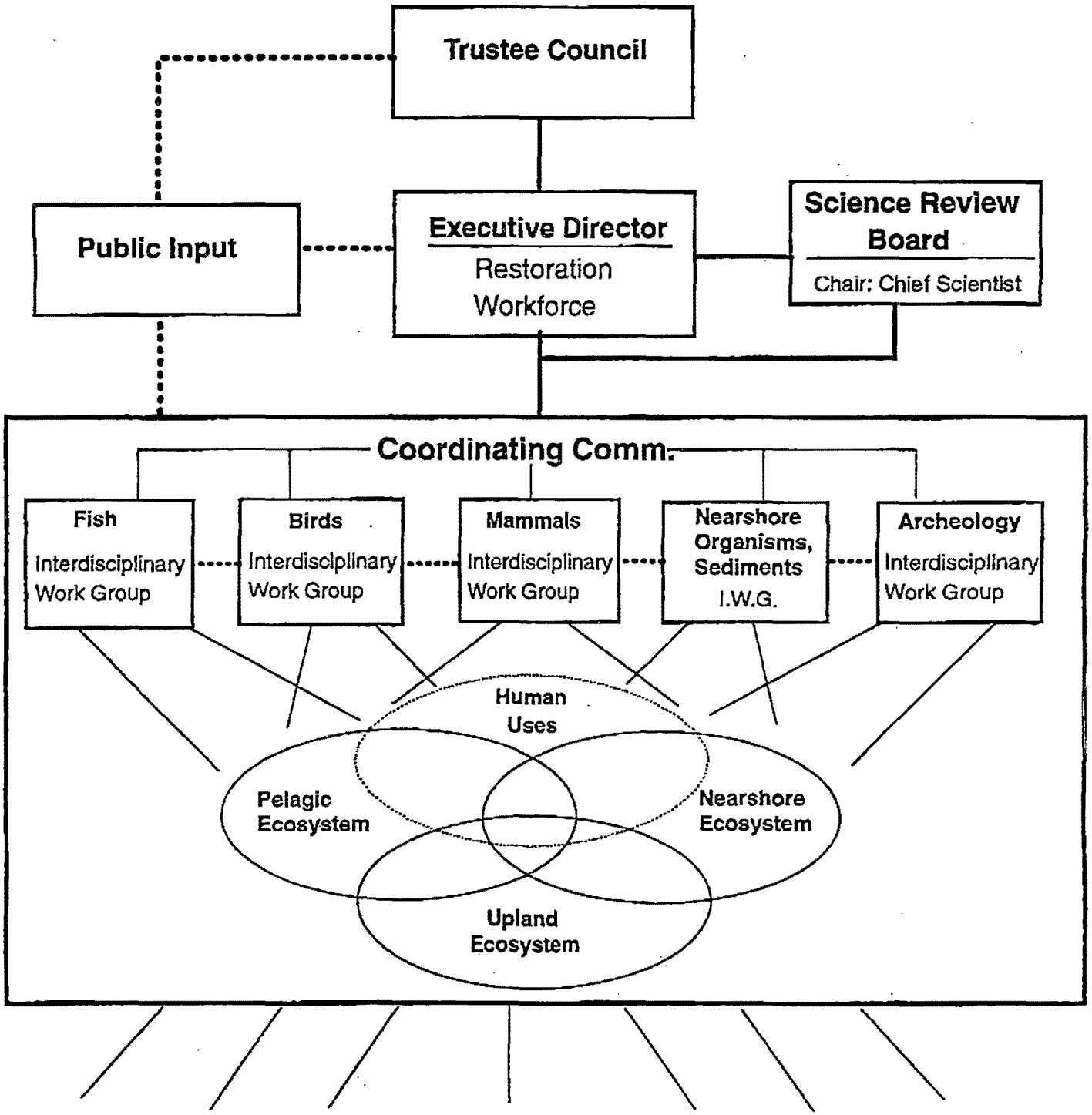
Figure 1A
Organizational Diagram Science Planning and Management

(DRAFT 4/07/94)

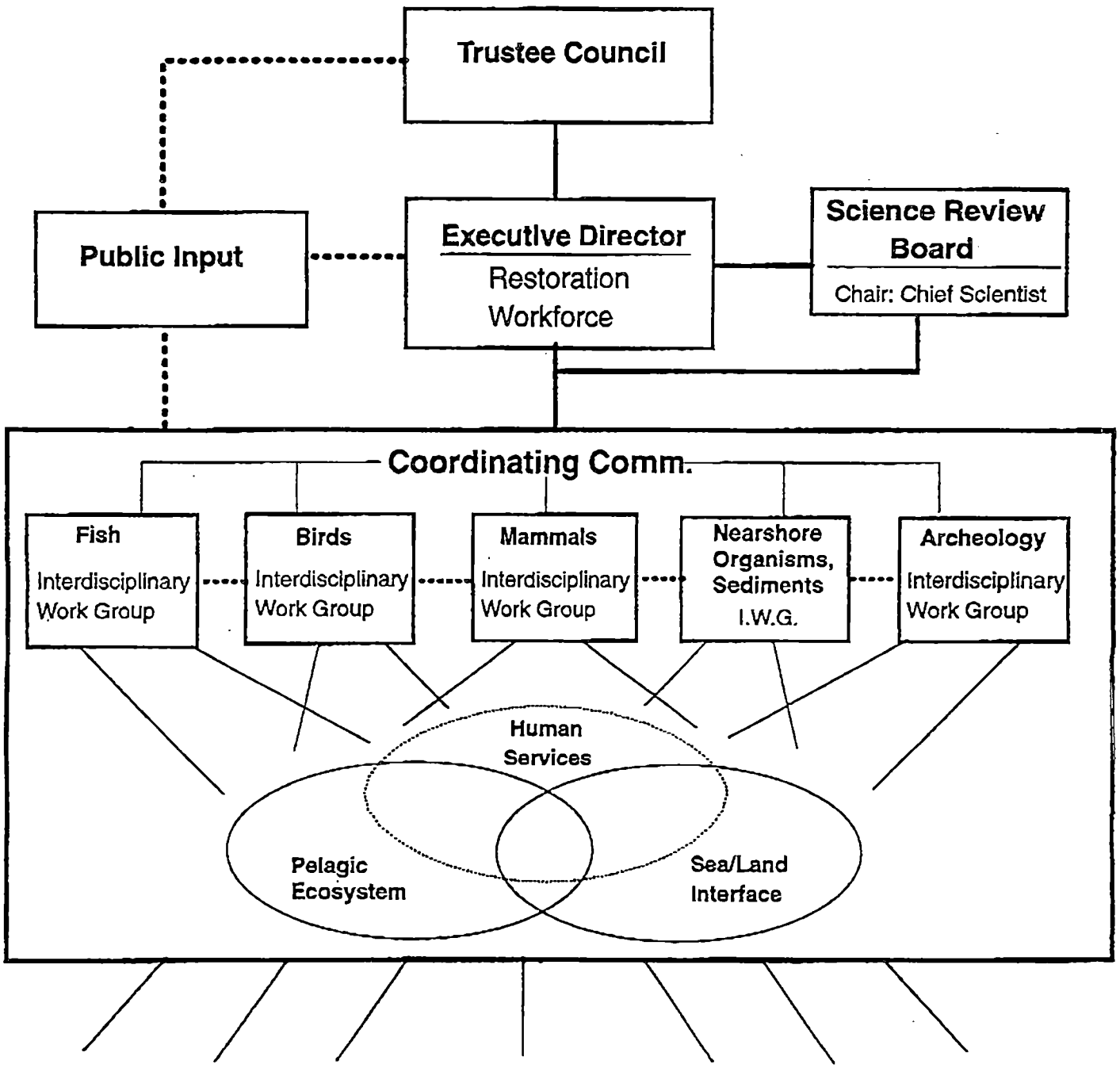


Monitoring; Ecosystem Research; General Restoration; Habitat Protection

Figure 1B

Organizational Diagram Science Planning and Management

(DRAFT 4/07/94)



Monitoring; Ecosystem Research; General Restoration; Habitat Protection

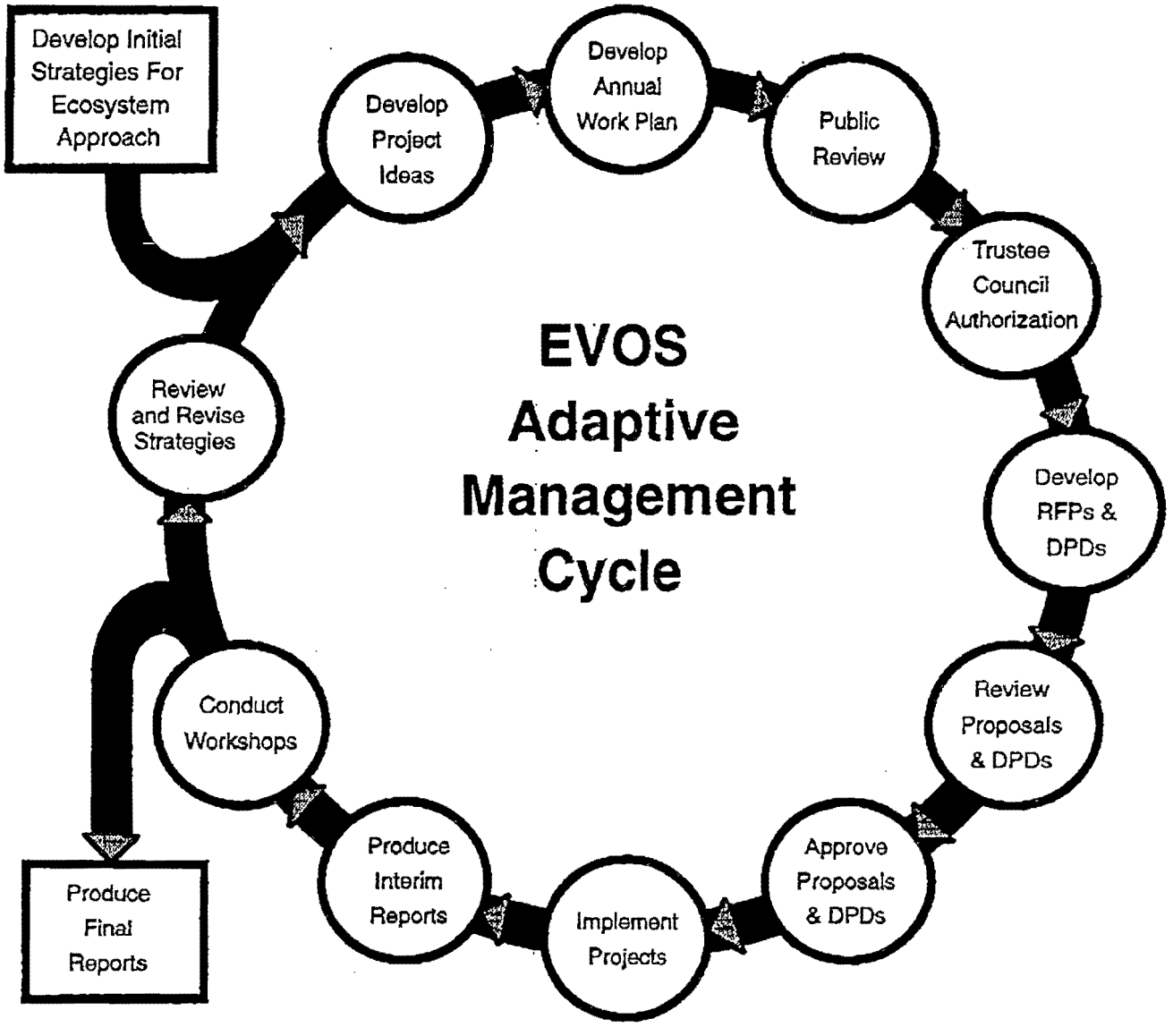


Figure 2. An annual workshop and an annual cycle of review and revision provide the feedback loop for adaptive management. The Annual Workshop provides the opportunity for informing the scientific community, the public, and the Trustee Council about the results from restoration activities. This information can then be used to refine on-going projects and revise strategies and research approaches for future work. Public input is an integral part in the development, review, and revision of the ecosystem approach. The Science Review Board (see Figure 1) provides objective, credible scientific review and guidance.

18.1.4 C

Research Priorities For Restoration
April 13-15, 1994
Anchorage, Alaska

Location: First United Methodist Church, 725 West 9th Avenue (April 13-14)
Oil Spill Restoration Office, 645 "G" Street (April 15)

April 13 Part 1. Guidance for the 1995 Work Plan and Beyond

0900 Science Planning and Management for the Restoration Process
Jim Ayers, Executive Director for the Trustee Council

0920 Ecosystem Approach to Restoration
Dr. Bob Spies, Chief Scientist for the Trustee Council

0940 Game Plan for the Work Shop: Part 1
Molly McCammon, Operations Director for the Trustee Council

1000 Break

1020 Directing the Research: Examples of Hypotheses
Presentations by members of the Interdisciplinary Work Groups

1200 Lunch

1300 Interdisciplinary Work Groups Meet
- Selection of Coordinating Committee Representative
- Development of hypotheses list

1500 Coffee Break
- Perspective on the process
- Reconfiguration of work group sessions

1700 Dinner Break

1900 Continued development of hypotheses list

April 14

0830 Meeting of the Whole
- ·Coordinating Committee Representatives present hypotheses from Work Groups
- · Discussion of classification of hypotheses by ecosystem component (nearshore, pelagic) and/or type of hypotheses (e.g. ecosystem processes, ecotoxicology)

1000 Break

1020 Interdisciplinary Work Groups Meet
- ·Classify, prioritize hypotheses

1200 Working Lunch

1400 Break

1430 Meeting of the Whole
- ·Coordinators present draft final lists for review by participants
- ·Revised lists are compiled as draft for mail-out review

1630 How We Get There From Here
Jim Ayers, Executive Director

April 15 Part 2. Revision of Draft Restoration Plan

0830 Management By Objective: Strategies for Restoration
Molly McCammon, Operations Director

0850 Game Plan for the Work Shop: Part 2

0900 Monitoring Strategies for the Restoration Plan
Byron Morris, NOAA

0930 Research/Restoration Strategies for the Restoration Plan
Veronica Gilbert, Alaska Department of Natural Resources

1000 Break

1020 Interdisciplinary Work Group Meetings
·Review Monitoring, Research, and Restoration Strategies
·Provide comments and revisions for inclusion in DEIS review document

1200 Working Lunch

1430 Revising the Injured Resource Listing
Bob Spies, Chief Scientist for the Trustee Council

1700 Closing Comments
Molly McCammon, Operations Director

18.1.4B

Restoration Goals, Objectives & Strategies

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DRAFT

Restoration Goals

A goal is a mental concept of what one wishes to achieve. The restoration program has two goals: an overall goal of recovery and ecosystem goals.

Overall Goal: The overall goal of restoration is recovery of all injured resources and services.

Ecosystem Goals: For each of the three ecosystems in the spill area -- pelagic, nearshore, and upland -- an additional goal is a healthy, productive, ecosystem that supports resources and services injured by the oil spill, and that maintains naturally occurring biodiversity.

The three ecosystem types described below are intended to describe areas that generally contain similar biological and physical features that influence the relationships of the resources that exist in the spill area and the services they support.

Pelagic Ecosystem. The deeper, open water region offshroe that is not directly affected by wave action, terrestrial runoff, or other nearshore processes. Examples are the center of Prince William Sound and a few hundred yards beyond the steep cliffs and fiord mouths of the outer Kenai coast.

Nearshore Ecosystem. Terrrestrial and aquatic areas dominated by nearshore processes such as tidal movement, salt spray, intertidal and shoreline vegetation, wave action, and terrestrial runoff. nearshore areas include the intertidal zone, salt marshes, and beach areas where salt and shoreline processes dominate, as well as shallower offshore waters that are greatly influenced by nearshore processes. It also includes narrow fjords and channels that occur in the spill area.

Upland Ecosystem. The area of land and water uphill of the nearshore ecosystem.

Restoration Objectives and Strategies

An objective is a statement that pertains to a measurable, specific object. Restoration objectives are defined as measures of recovery to meet the overall restoration goal and ecosystem goals. This section also presents strategies for achieving objectives. For some resources, little is known about their injury and recovery, so it is difficult to define recovery or develop restoration strategies.

In general, resources and services will have recovered when they return to conditions that would have existed had the spill not occurred. Because it is difficult to predict conditions that would have existed in the absence of the spill, recovery is often defined as a return to prespill conditions. For resources that were in decline before the spill, like marbled murrelets, recovery may consist of stabilizing the population at a lower level than before the spill.

Where little prespill data exist, injury is inferred from comparison of oiled and unoiled areas, and recovery is usually defined as a return to conditions comparable to those of unoiled areas. Because the differences between oiled and unoiled areas may have existed before the spill, statements of injury and objectives for recovery based on these differences are often less certain than in those cases where prespill data exist. However, there can also be some uncertainty associated with interpreting the significance of prespill population data since populations undergo natural fluctuations. Indicators of recovery can include increased numbers of individuals, reproductive success, improved growth and survival rates, and normal age and sex composition of the injured population.

Archaeological Resources

Ecosystems. Nearshore and Upland.

Recovery Status. Injury to archaeological resources stems from increased looting and vandalism of sites and artifacts, and erosion within and around the sites resulting from cleanup activities. In addition, archaeological artifacts may have been oiled. Injuries attributed to looting and vandalism still occur. These injuries diminish the availability or quality of scientific data and opportunities to learn about the cultural heritage of people in the spill area.

Restoration Objective. Archaeological resources will be considered recovered when spill-related injury ends, and looting and vandalism are at or below prespill levels. Restoration cannot regenerate what has been destroyed, but it can prevent further degradation of both sites and the scientific information that would otherwise be lost.

Restoration Strategy. The restoration strategy for archaeological resources has three parts:

Repair spill-related injury to archaeological sites and artifacts. Injuries may be repaired to some extent through stabilizing eroding sites, or removing and restoring artifacts.

Protect sites and artifacts from further injury and store them in appropriate facilities. Archaeological sites and artifacts could be protected from further injury through the reduction of looting and vandalism, or the removal of artifacts from sites and storage in an appropriate facility. Opportunity for people to view or learn about the cultural heritage of people in the spill area would also provide protection by increasing awareness and appreciation of cultural heritage and would replace services lost as a result of irretrievable damage to some artifacts.

Monitor recovery. Monitoring of archaeological resources may detect increases or decreases in rates of looting, vandalism, and erosion of archaeological sites.

Implementation By Restoration Category

General Restoration. Archaeological resources could be restored through stabilizing eroding sites, removing and restoring artifacts, the reduction of looting and vandalism, the removal of artifacts from sites and storage in an appropriate facility, or affording the opportunity to view or learn about the cultural heritage of people in the spill area.

More specific strategies, if any, would go here.

Habitat Protection and Acquisition. Archaeological resources are one of 19 injured resources and services for which habitat is being evaluated. With regard to archaeological resources, habitat protection and acquisition seeks to maintain or reduce disturbance to cultural resource sites.

Recovery Monitoring. The monitoring program for archaeological resources will detect changes in rates of looting, vandalism, and erosion of archaeological sites.

More specific strategies, if any, would go here.

Research. No research strategies have been identified.

Bald Eagles

Ecosystems. Bald eagles belong to the nearshore and upland ecosystems.

Recovery Status. Two hundred to 300 bald eagles may have been killed in the spill. However, population estimates made in 1989, 1990, and 1991 indicate that there may have been an increase in the bald eagle population since the previous survey conducted in 1984. Productivity also decreased in 1989, but appeared to have recovered by 1990.

Restoration Objective. Because population and productivity appear to have returned to prespill levels, bald eagles may have already recovered from the effects of the spill.

Restoration Strategy. The restoration strategy for bald eagles has three parts:

Rely on natural recovery. Natural processes aided by protective measures will be the main agents of restoration.

Monitor recovery. Because bald eagles are believed to be recovering and may have recovered, the monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that a bald eagles may not recover as expected, alternative means of restoration will be considered.

Protect injured resources and their habitats. Recovering resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. If results of the monitoring program suggest that bald eagles may not recover as expected, alternative means of restoration will be considered. Meanwhile, protective management practices and the reduction of marine pollution may protect bald eagles from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. The bald eagle is one of 19 injured resources and services for which habitat is being evaluated. With regard to bald eagles, habitat protection and acquisition seeks to maintain adequate nesting habitat and reduce disturbance in feeding and roosting areas.

Recovery Monitoring. The monitoring program for bald eagles will track the progress of recovery and detect major reversals.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Because bald eagles are recovering and may have recovered from the effects of the spill, no specific research strategies are identified.

Black Oystercatchers

Ecosystems. Black oystercatchers belong to the nearshore and upland ecosystems.

Recovery Status. Black oystercatchers are recovering, although they may still be exposed to hydrocarbons when feeding in intertidal areas.

Restoration Objective. Black oystercatchers will have recovered when populations attain prespill levels and when reproduction and growth in oiled areas are comparable to those in unoiled areas.

Restoration Strategy. The restoration strategy for black oystercatchers has three parts:

Rely on natural recovery. Natural processes aided by protective measures will be the main agents of restoration.

Monitor recovery. The monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that black oystercatchers may not recover as expected, alternative means of restoration will be considered.

Protect injured resources and their habitats. Recovering resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. If results of the monitoring program suggest that black oystercatchers may not recover as expected, alternative means of restoration will be considered. Meanwhile, protective management practices and the reduction of marine pollution may protect black oystercatchers from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Black oystercatchers are one of 19 injured resources and services for which habitat is being evaluated. With regard to black oystercatchers, habitat protection and acquisition seeks to protect nesting or feeding habitat.

Recovery Monitoring. The monitoring program for black oystercatchers will track the progress of recovery and detect major reversals.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Because black oystercatchers are recovering, no specific research strategies are identified.

Clams

Ecosystem. Clams belong to the nearshore ecosystem.

Recovery Status. Littleneck clams and butter clams on sheltered beaches were killed by oiling and clean-up activities. In addition, growth appeared to be reduced by oil, but determination of sublethal or chronic effects is awaiting final analyses. Insufficient data are available to determine whether they are recovering.

Restoration Objective. Clams will have recovered when populations and productivity are at prespill levels.

Restoration Strategy. Because clams are important for subsistence, and because subsistence communities may be harmed by waiting for natural recovery, activities that initiate or accelerate recovery of clams, or increase their reliability for subsistence are important. The restoration strategy for clams has four parts:

Promote recovery of subsistence as soon as possible. Many subsistence communities will be significantly harmed while waiting for subsistence resources, such as clams, to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of subsistence resources and services. This may be accomplished through increasing availability, reliability, or quality of subsistence resources like clams or increasing the confidence of subsistence users.

Rely on natural recovery. Outside of subsistence use areas, natural processes aided by protective measures will be the main agents of recovery.

Monitor recovery. The monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that a resource is not recovering, alternative means of restoration will be considered.

Protect injured resources and their habitats. All injured resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. General restoration may be used to increase the availability, reliability, or quality of clams for subsistence users. Furthermore, if results of the monitoring program suggest that clams are not recovering, alternative means of restoration will be considered. Meanwhile, protective management practices and the reduction of marine pollution may protect clams from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Clams are part of the intertidal biota; they are also a subsistence food source. These are two of the 19 injured resources and services for which habitat is being evaluated. With regard to intertidal biota, habitat protection and acquisition seeks to maintain water quality along shorelines and reduce disturbance in nearshore areas. With regard to subsistence food sources, habitat protection and acquisition seeks to ensure subsistence opportunities in known harvest areas.

Recovery Monitoring. The monitoring program will track the progress of recovery and detect major reversals.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Until monitoring determines that clams are not recovering, no research is expected.

Commercial Fishing

Recovery Status. Commercial fishing was injured through injury to commercial fish species and also through fishing closures. Continuing injuries to commercial fishing may cause hardships for fishermen and related businesses. Each year that commercial fishing remains below prespill levels compounds the injury to the fishermen and, in many instances, the communities in which they live or work.

The Trustee Council recognizes the impact to communities and people of the Prince William Sound region resulting from the sharp drop in pink salmon and herring fisheries in past years. In the 1994 work program, the Trustee Council has committed to the expenditure of five million dollars to help address these issues through the development of an ecosystem study for Prince William Sound. Some of the pink salmon and herring problems may be unrelated to the oil spill. However, the Council will continue to address these important problems as they relate to the oil spill.

Restoration Objective. Commercial fishing will have recovered when the population levels and distribution of injured or replacement fish used by the commercial fish industry match conditions that would have existed had the spill not occurred. Because of the difficulty of separating spill-related effects from other changes in fish runs, the Trustee Council may use prespill conditions as a substitute measure for conditions that would have existed had the spill not occurred.

Restoration Strategy. Restoration of fish and wildlife resources are covered elsewhere in this chapter. The restoration strategy for commercial fishing has three parts:

Promote recovery of commercial fishing as soon as possible. Many communities that rely on commercial fishing will be significantly harmed while waiting for commercial fish resources to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of commercial fishing. This objective may be accomplished through increasing availability, reliability, or quality of commercial fishing resources, depending on the nature of the injury. For resources that have sharply declined since the spill, like pink salmon and Pacific herring in Prince William Sound, this objective may take the form of increasing availability in the long run through improved fisheries management. Another example is providing replacement fish for harvest.

Protect commercial fish resources from further degradation. Further stress on commercial fish resources could impede recovery. Appropriate protection can take the form of habitat protection and acquisition if a resource faces loss of habitat. Protective action could also include protective management practices if a resource or service faces further injury from human use and activities.

Monitor recovery. Monitoring the recovery of commercial fishing will track the progress of recovery, detect major reversals, and identify problems with the resources and resource management that may affect the rate or degree of recovery. Inadequate information may require managers to unduly restrict use of the injured resources, compounding the injury to commercial fishing.

Implementation By Restoration Category

General Restoration. General restoration projects may increase the availability, reliability, or quality of commercial fishing resources. General restoration actions could also include protective management practices

More specific strategies, if any, would go here.

Habitat Protection and Acquisition. Commercial fishing will benefit from habitat protection through the benefit it affords to commercial fish species, such as Pacific herring, pink salmon, and sockeye salmon.

Recovery Monitoring. The monitoring program for commercial fishing will track the progress of recovery, detect major reversals, and identify problems with the resources and resource management that may affect the rate or degree of recovery.

More specific strategies, if any, would go here.

Research. No research strategies have been identified.

Common Murres

Ecosystems. Common Murres belong to the pelagic (offshore) and nearshore ecosystems.

Recovery Status. Common murres show signs of recovery in some colonies. However, breeding is still inhibited in some colonies, although differences in breeding patterns may be attributable to conditions that existed before the spill.

Restoration Objective. Common murres will have recovered when populations return to prespill levels at all the injured colonies.

Restoration Strategy. Except for certain protective measures, attempts to restore common murres without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for common murres emphasizes determining why they are not recovering and eliminating threats to the remaining populations. The restoration strategy for common murres has four parts:

Conduct research to find out why common murres are not recovering. Effective restoration of common murres requires an understanding of why breeding is still inhibited in some colonies.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once common murres are recovering in all colonies, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of common murres. Their condition may change due to natural causes or restoration actions.

Protect common murres and their habitat. While protective measures alone may not ensure the recovery of common murres, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why breeding is inhibited in some colonies, general restoration actions may be used to accelerate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect common murres from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. The common murres is one of 19 injured resources and services for which habitat is being evaluated. With regard to common murres, habitat protection and acquisition seeks to reduce disturbance in nearshore feeding areas and near nesting colonies.

Recovery Monitoring. The monitoring program will track changes in the condition of common murres at the injured colonies. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why common murres are not recovering at some colonies. For the Barren Island common murre colonies the reason is unknown (?).

More specific Research strategies, if any, would go here.

Cutthroat Trout and Dolly Varden Trout

Ecosystems. Cutthroat trout and Dolly Varden trout belong to the pelagic (offshore), nearshore, and upland ecosystems.

Recovery Status. Cutthroat trout and Dolly Varden trout have grown more slowly in oiled areas than in unoiled areas. Insufficient data are available to determine whether they are recovering.

Restoration Objective. Cutthroat trout and Dolly Varden trout will have recovered when growth rates within oiled areas are comparable to those for unoiled areas.

Restoration Strategy. Until more is known about whether cutthroat trout and Dolly Varden trout are recovering, restoration will rely primarily on natural recovery, aided by monitoring and protective measures. The restoration strategy for cutthroat trout and Dolly Varden trout has three parts:

Rely on natural recovery. Natural processes aided by protective measures will be the main agents of restoration.

Monitor recovery. The monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that cutthroat trout or Dolly Varden trout are not recovering, alternative means of restoration will be considered.

Protect injured resources and their habitats. All injured resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Implementation by Restoration Category

General Restoration. Protective management practices and the reduction of marine pollution may protect cutthroat trout and Dolly Varden trout from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Cutthroat trout and Dolly Varden trout are two of the 19 resources and services for which habitat is being evaluated. With regard to these two species, habitat protection and acquisition seeks to ensure maintenance of adequate water quality, riparian habitat and intertidal habitat for spawning and rearing.

Recovery Monitoring. The monitoring program will track the progress of recovery of cutthroat trout and Dolly Varden trout and detect major reversals.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Until more is known about the nature and extent of injury to cutthroat trout and Dolly Varden trout, and about the extent of their recovery, no research is expected.

Designated Wilderness Areas

Recovery Status. The oil spill delivered oil in varying quantities to the waters adjoining the seven areas designated as wilderness within the spill area. Oil was also deposited above the mean high tide line in these areas. During the intense clean-up seasons of 1989 to 1990, hundreds of workers and thousands of pieces of equipment were at work in

the spill area. This activity was an unprecedented imposition of people, noise, and activity on the area's undeveloped and normally sparsely occupied landscape.

Restoration Objective. areas will have recovered when oil is no longer encountered in these areas and the public perceives them to be recovered from the spill.

Restoration Strategy. Any restoration objective which aids recovery of injured resources, or prevents further injuries, will assist recovery of designated wilderness areas. No objectives have been identified which benefit only designated wilderness areas without also addressing injured resources.

Implementation by Restoration Category. No implementation measures have been identified.

Harbor Seals

Ecosystems. Harbor seals belong to the nearshore and upland ecosystems.

Recovery Status. Harbor seals were in decline before the spill. Census counts from 1990 to 1992 at haulouts in Prince William Sound may indicate that the population has stabilized in the Sound. If the population has stabilized, normal growth may replace the animals lost. However, if the long-term decline continues, the affected population may not recover.

Harbor seals are an important subsistence food source and restoration of harbor seals is important for restoring subsistence.

Restoration Objective. Recovery will have occurred when harbor seals within the oiled area are at a population level comparable to that which would likely have occurred in the absence of the spill.

Restoration Strategy. Except for certain protective measures, attempts to restore harbor seals without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for harbor seals emphasizes determining why they are not recovering and eliminating threats to the remaining populations. In addition, because harbor seals are important for subsistence, and because subsistence communities will be harmed by waiting for natural recovery, activities that initiate or accelerate recovery of harbor seals or increase their reliability for subsistence are important. The restoration strategy for harbor seals has four parts:

Conduct research to find out why harbor seals are not recovering. Effective

restoration of harbor seals requires an understanding of why they are not recovering.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once harbor seals are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of harbor seals. Their condition may change due to natural causes or restoration actions.

Protect harbor seals and their habitat. While protective measures alone may not ensure the recovery of harbor seals, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why harbor seals are not recovering, general restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect harbor seals from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. The harbor seal is one of 19 injured resources and services for which habitat is being evaluated. With regard to harbor seals, habitat protection and acquisition seeks to reduce disturbance at heal-out sites, pupping sites, and in nearshore feeding areas.

Recovery Monitoring. The monitoring program will track changes in the condition of harbor seals. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why harbor seals are not recovering. One commonly suspected cause is a decline in forage fish.

More specific Research strategies, if any, would go here.

Harlequin Ducks

Ecosystems. Harlequin ducks belong to the nearshore and upland ecosystems.

Recovery Status. There are indications of population decline and possibly reproductive failure.

Restoration Objective. Harlequin ducks will have recovered when populations have returned to prespill levels, or when differences between oiled and unoiled areas are eliminated.

Restoration Strategy. Except for certain protective measures, attempts to restore harlequin ducks without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for harlequin ducks emphasizes determining why they are not recovering and eliminating threats to the remaining populations. The restoration strategy for harlequin ducks has four parts:

Conduct research to find out why harlequin ducks are not recovering. Effective restoration of harlequin ducks requires an understanding of why they are not recovering.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once harlequin ducks are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of harlequin ducks. Their condition may change due to natural causes or restoration actions.

Protect harlequin ducks and their habitat. While protective measures alone may not ensure the recovery of harlequin ducks, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why harlequin ducks are not recovering, general restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect harlequin ducks from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. The harlequin duck is one of 19 injured resources and services for which habitat is being evaluated. With regard to harlequin ducks, habitat protection and acquisition seeks to maintain adequate riparian habitat for nesting and brood rearing, and reduce disturbance to nearshore feeding, molting, and brood-rearing habitats.

Recovery Monitoring. The monitoring program will track changes in the condition of harlequin ducks. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why harlequin ducks are not recovering. One commonly suspected cause is contamination of food supplies, primarily mussels.

More specific Research strategies, if any, would go here.

Intertidal Organisms

Ecosystem. Intertidal organisms belong to the nearshore ecosystem.

Recovery Status. The lower intertidal zone and, to some extent, the middle intertidal zone are recovering. However, injuries persist in the upper intertidal zone, especially on rocky sheltered shores. Recovery of this zone appears to depend, in part, on the return of adult *Fucus* in large numbers.

Restoration Objective. Intertidal communities in the upper intertidal zone will have recovered when community composition, population abundance of component species, and ecosystem functions and services in each injured intertidal habitat have returned to levels that would have prevailed in the absence of the oil spill.

Restoration Strategy. Except for certain protective measures, attempts to restore intertidal organisms without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for intertidal organisms emphasizes determining why they are not recovering and eliminating threats to the remaining populations. The restoration strategy for intertidal organisms has four parts:

Conduct research to find out why intertidal organisms are not recovering. Effective restoration of intertidal organisms requires an understanding of why they are not recovering.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once intertidal organisms are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of intertidal organisms. Their condition may change due to natural causes or restoration actions.

Protect intertidal organisms and their habitat. While protective measures alone may not ensure the recovery of intertidal organisms, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why intertidal organisms are not recovering, general restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect intertidal organisms from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Intertidal/subtidal biota one of 19 injured resources and services for which habitat is being evaluated. With regard to intertidal/subtidal biota, habitat protection and acquisition seeks to maintain water quality along shorelines and reduce disturbance in nearshore areas.

Recovery Monitoring. The monitoring program will track changes in the condition of intertidal organisms. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why intertidal organisms are not recovering.

More specific Research strategies, if any, would go here.

Killer Whales

Ecosystem. Killer whales belong to the pelagic (offshore) ecosystem.

Recovery Status. Thirteen whales disappeared from one pod in Prince William Sound between 1988 and 1990. The injured pod is growing again.

Restoration Objective. Killer whales will have recovered when the injured pod grows to at least 36 individuals (1988 level).

Restoration Strategy. The restoration strategy for killer whales has three parts:

Rely on natural recovery. Natural processes aided by protective measures will be the main agents of restoration.

Monitor recovery. The monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that killer whales may not recover as expected, alternative means of restoration will be considered.

Protect injured resources and their habitats. Recovering resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. If results of the monitoring program suggest that killer whales may not recover as expected, alternative means of restoration will be considered. Meanwhile, protective management practices and the reduction of marine pollution may protect killer whales from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Killer whales are not likely to benefit from the protection and acquisition of upland parcels. Consequently, they are not being considered in the Comprehensive Habitat Protection Process.

Recovery Monitoring. The monitoring program for killer whales will track the progress of recovery and detect major reversals.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Because killer whales are recovering, no specific research strategies are identified.

Marbled Murrelets

Ecosystems. Marbled murrelets belong to the pelagic (offshore), nearshore, and upland ecosystems.

Recovery Status. Marbled murrelets were in decline before the spill and may not attain prespill population levels. The causes of the prespill decline are unknown, but the decline is expected to continue.

Restoration Objective. Marbled murrelets will have recovered when population trends are stable or increasing.

Restoration Strategy. Except for certain protective measures, attempts to restore marbled murrelets without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for marbled murrelets emphasizes determining why they are not recovering and eliminating threats to the remaining populations. The restoration strategy for harbor seals has four parts:

Conduct research to find out why harbor seals are not recovering. Effective restoration of marbled murrelets requires an understanding of why they are not recovering.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once marbled murrelets are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of marbled murrelets. Their condition may change due to natural causes or restoration actions.

Protect marbled murrelets and their habitat. While protective measures alone may not ensure the recovery of marbled murrelets, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why marbled murrelets are not recovering, general restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect marbled murrelets from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. The marbled murrelet is one of 19 injured resources and services for which habitat is being evaluated. With regard to marbled murrelets, habitat protection and acquisition seeks to maintain adequate nesting habitat and reduce disturbance to nearshore feeding and broodrearing habitats.

Recovery Monitoring. The monitoring program will track changes in the condition of marbled murrelets. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why marbled murrelets are not recovering. One commonly suspected cause is a decline in forage fish.

More specific Research strategies, if any, would go here.

Mussels

Ecosystem. Mussels belong to the nearshore ecosystem.

Recovery Status. 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 (unweathered) oil for harlequin duck, black oystercatchers, river otters, and juvenile sea otters, all of which feed on mussels and show signs of continuing injury. The extent and magnitude of oiled mussel beds are unknown.

Restoration Objective. Mussels will have recovered when their populations and productivity are at prespill levels, and do not contain oil that contaminates higher trophic levels.

Restoration Strategy. ?

Implementation by Restoration Category. ?

Pacific Herring

Ecosystems. Pacific herring belong to the pelagic (offshore) and nearshore ecosystems.

Recovery Status. Pacific herring studies have demonstrated egg mortality and larval deformities. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, the stocks in Prince William Sound do not appear to be healthy.

Restoration Objective. They will have recovered when populations are healthy and productive and exist at prespill abundances. One indication of recovery is when the age-class structure and the relative strength of the spawning run in Prince William Sound are comparable to those in Sitka Sound. Historically, the size and age structure of herring populations in Prince William Sound and Sitka Sound have been closely correlated.

Restoration Strategy. Except for certain protective measures, attempts to restore Pacific herring without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for Pacific herring emphasizes determining why they are not recovering and eliminating threats to the remaining populations. The restoration strategy for Pacific herring has four parts:

Conduct research to find out why Pacific herring are not recovering. Effective

restoration of Pacific herring requires an understanding of why they are not recovering.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once Pacific herring are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of Pacific herring. Their condition may change due to natural causes or restoration actions.

Protect Pacific herring and their habitat. While protective measures alone may not ensure the recovery of Pacific herring, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why Pacific herring are not recovering, general restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect Pacific herring from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. The Pacific herring is one of 19 injured resources and services for which habitat is being evaluated. With regard to Pacific herring, habitat protection and acquisition seeks to maintain adequate water quality, riparian habitat and intertidal habitat for spawning and rearing.

Recovery Monitoring. The monitoring program will track changes in the condition of Pacific herring. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why Pacific herring are not recovering.

More specific Research strategies, if any, would go here.

Passive Uses

Recovery Status. Passive use of resources includes the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other nonuse values. Injuries to passive uses are tied to public perceptions of injured resources.

Restoration Objective. Passive uses will have recovered when people perceive that aesthetic and intrinsic values associated with the spill area are no longer diminished by the oil spill.

Restoration Strategy. Any restoration objective which aids recovery of injured resources, or prevents further injuries, will assist recovery of passive-use values. No objectives have been identified which benefit only passive uses, without also addressing injured resources. Since recovery of passive uses requires that people know when recovery has occurred, the availability to the public of the latest scientific information will continue to play an important role in the restoration of passive uses.

Implementation by Restoration Category. No implementation measures have been identified.

Pigeon Guillemots

Ecosystems. Pigeon guillemots belong to the pelagic (offshore) and nearshore ecosystems.

Recovery Status. Pigeon guillemots were in decline before the spill and may not attain prespill population levels. The causes of the prespill decline are unknown, but the decline is expected to continue.

Restoration Objective. Pigeon guillemots will have recovered when population trends are stable or increasing.

Restoration Strategy. Except for certain protective measures, attempts to restore pigeon guillemots without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for pigeon guillemots emphasizes determining why they are not recovering and eliminating threats to the remaining populations. The restoration strategy for pigeon guillemots has four parts:

Conduct research to find out why pigeon guillemots are not recovering. Effective restoration of pigeon guillemots requires an understanding of why they are not recovering.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once pigeon guillemots are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of pigeon guillemots. Their condition may change due to natural causes or restoration actions.

Protect pigeon guillemots and their habitat. While protective measures alone may not ensure the recovery of pigeon guillemots, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why pigeon guillemots are not recovering, general restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect pigeon guillemots from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Pigeon guillemots are not likely to benefit from the protection and acquisition of upland parcels. Consequently, they are not being considered in the Comprehensive Habitat Protection Process.

Recovery Monitoring. The monitoring program will track changes in the condition of pigeon guillemots. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why pigeon guillemots are not recovering.

More specific Research strategies, if any, would go here.

Pink Salmon

Ecosystems. Pink salmon belong to the pelagic (offshore), nearshore, and upland ecosystems.

Recovery Status. Pink salmon studies have demonstrated egg mortality, fry deformities, and reduced growth in juveniles. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, the stocks in Prince William Sound do not appear to be healthy.

Restoration Objective. Pink salmon will have recovered when populations are healthy and productive and exist at prespill abundances. An indication of recovery is when egg mortalities in oiled areas match prespill levels or levels in unoiled areas.

Restoration Strategy. Except for certain protective measures, attempts to restore pink salmon without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for pink salmon emphasizes determining why they are not recovering and eliminating threats to the remaining populations. The restoration strategy for pink salmon has four parts:

Conduct research to find out why pink salmon are not recovering. Effective restoration of pink salmon requires an understanding of why they are not recovering.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once pink salmon are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of pink salmon. Their condition may change due to natural causes or restoration actions.

Protect pink salmon and their habitat. While protective measures alone may not ensure the recovery of pink salmon, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why pink salmon are not recovering, general restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect pink salmon from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. The pink salmon is one of 19 injured resources and services for which habitat is being evaluated. With regard to pink salmon, habitat protection and acquisition seeks to maintain adequate water quality, riparian habitat and intertidal habitat for spawning and rearing.

Recovery Monitoring. The monitoring program will track changes in the condition of pink salmon. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why pink salmon are not recovering.

More specific Research strategies, if any, would go here.

Recreation and Tourism

Recovery Status. The spill disrupted use of the spill area for recreation and tourism. Resources important for wildlife viewing include killer whale, sea otter, harbor seal, bald eagle, and various seabirds. Residual oil exists on some beaches with high value for recreation. It may decrease the quality of recreational experience and discourage recreational use of these beaches.

Closures on sport hunting and fishing also affected use of the spill area for recreation and tourism. Sport fishing resources include salmon, Rockfish, Dolly Varden, and cutthroat trout. Harlequin duck are hunted in the spill area.

Recreation was also affected by changes in human use in response to the spill. For example, displacement of use from oiled areas to unoiled areas increased management problems and facility use in unoiled areas. Some facilities like the Green Island cabin and the Flemming Spit camp area were injured by clean-up workers.

Restoration Objective. Recreation and tourism will have recovered, in large part, when the fish and wildlife resources on which they depend have recovered, recreation use of oiled beaches is no longer impaired, and facilities and management capabilities can accommodate changes in human use.

Restoration Strategy. Restoration of fish and wildlife resources are covered elsewhere in this chapter. The following strategy applies specifically to recreation and tourism services.

Preserve or improve the recreational and tourism values of the spill area. Habitat protection and acquisition are important means of preserving and enhancing the opportunities offered by the spill area. Facilities damaged during cleanup may be repaired if they are still needed. New facilities may restore or enhance opportunities for recreational use of natural resources. Improved or intensified public recreation management may be warranted in some circumstances. Projects that restore or enhance recreation and tourism would be considered only if they are consistent with the character and public uses of the area.

Remove or reduce residual oil if it is cost effective and less harmful than leaving it in place. Removal of residual oil on beaches with high value for recreation and tourism may restore these services for some users. However, this benefit would have to be balanced against cost and the potential for disrupting the recovering intertidal ecosystem.

Monitor recovery. Monitoring the recovery of recreation and tourism services will track the progress of recovery, detect major reversals, and identify problems with the resources and resource management that may affect the rate or degree of recovery.

Implementation By Restoration Category

General Restoration. Facilities damaged during cleanup may be repaired if they are still needed. New facilities may restore or enhance opportunities for recreational use of natural resources. Improved or intensified public recreation management may be warranted in some circumstances. Projects that restore or enhance recreation and tourism would be considered only if they are consistent with the character and public uses of the area. Removal of residual oil on beaches with high value for recreation and tourism may restore these services for some users. However, this benefit would have to be balanced against cost and the potential for disrupting the recovering intertidal ecosystem.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Recreation is one of 19 injured resources and services for which habitat is being evaluated. With regard to recreation, habitat protection and acquisition seeks to maintain or enhance public access for recreational opportunities, and reduce disturbances that would create visual impacts.

Recovery Monitoring. The monitoring program will track the progress of recovery, detect major reversals, and identify problems with the resources and resource management that may affect the rate or degree of recovery.

More specific Recovery Monitoring strategies, if any, would go here.

Research. No research strategies have been identified.

River Otters

Ecosystems. River otters belong to the nearshore and upland ecosystems.

Recovery Status. River otters may have suffered sublethal effects from the spill and continuing exposure to hydrocarbons.

Restoration Objective. Indications of recovery are when habitat use and physiological indices have returned to prespill conditions.

Restoration Strategy. Until more is known about whether river otter are recovering, restoration will rely primarily on natural recovery, aided by monitoring and protective measures. The restoration strategy for river otter has three parts:

Rely on natural recovery. Natural processes aided by protective measures will be the main agents of restoration.

Monitor recovery. The monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that river otter are not recovering, alternative means of restoration will be considered.

Protect injured resources and their habitats. All injured resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Implementation by Restoration Category

General Restoration. Protective management practices and the reduction of marine pollution may protect river otter from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. River otter is one of the 19 resources and services for which habitat is being evaluated. With regard to river otter, habitat protection and acquisition seeks to maintain adequate riparian and shoreline habitats for feeding and denning.

Recovery Monitoring. The monitoring program will track the progress of recovery of river otter and detect major reversals.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Until more is known about the nature and extent of injury to river otter and about the extent of their recovery, no research is expected.

Rockfish

Ecosystem. Rockfish belong to the pelagic (offshore) ecosystem.

Recovery Status. Rockfish were exposed to hydrocarbons and showed sublethal effects. Furthermore, closures to salmon fisheries increased fishing pressures on rockfish which may be affecting their population. However, the extent and mechanism of injury to this species are unknown.

Restoration Objective. Without further study, recovery cannot be defined.

Restoration Strategy. Until more is known about whether rockfish are recovering, restoration will rely primarily on natural recovery, aided by monitoring and protective measures. The restoration strategy for rockfish has three parts:

Rely on natural recovery. Natural processes aided by protective measures will be the main agents of restoration.

Monitor recovery. The monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that rockfish are not recovering, alternative means of restoration will be considered.

Protect injured resources and their habitats. All injured resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Implementation by Restoration Category

General Restoration. Protective management practices and the reduction of marine pollution may protect rockfish from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Rockfish are not likely to benefit from the protection and acquisition of upland parcels. Consequently, they are not being considered in the Comprehensive Habitat Protection Process.

Recovery Monitoring. The monitoring program will track the progress of recovery of rockfish and detect major reversals.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Until more is known about the nature and extent of injury to rockfish and about the extent of their recovery, no research is expected.

Sea Otters

Ecosystems. Sea otters belong to the nearshore and upland ecosystems.

Recovery Status. Sea otters do not appear to be recovering, but are expected to eventually recover to their prespill population. Exactly what population increases would constitute recovery is very uncertain, as there is no population data from 1986 to 1989, and the population may have been increasing in Eastern Prince William Sound during that time. In addition, only large changes in the population can be reliably detected with current measuring techniques. However, there are recent indications that the patterns of juvenile and mid-aged mortalities are returning to prespill conditions.

Restoration Objective. Sea otters will be considered recovered when population abundance and distribution are comparable to prespill abundance and distribution, and when all ages appear healthy.

Restoration Strategy. Except for certain protective measures, attempts to restore sea otters without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for sea otters emphasizes

determining why they are not recovering and eliminating threats to the remaining populations. The restoration strategy for sea otters has four parts:

Conduct research to find out why harlequin ducks are not recovering. Effective restoration of sea otters requires an understanding of why they are not recovering.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once sea otters are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of sea otters. Their condition may change due to natural causes or restoration actions.

Protect sea otters and their habitat. While protective measures alone may not ensure the recovery of sea otters, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why sea otters are not recovering, general restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect sea otters from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. The sea otter is one of 19 injured resources and services for which habitat is being evaluated. With regard to sea otters, habitat protection and acquisition seeks to reduce disturbance at heal-out sites, pupping sites, and in nearshore feeding areas.

Recovery Monitoring. The monitoring program will track changes in the condition of sea otters. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why sea otters are not recovering.

More specific Research strategies, if any, would go here.

Sediments

Ecosystems. Sediments belong to the pelagic (offshore) and nearshore ecosystems.

Recovery Status. With tidal action, oil penetrated deeply into cobble and boulder beaches that are relatively common on the rocky islands of the spill area. Cleaning removed much of the oil from the intertidal zone, but subsurface oil persisted in many heavily oiled beaches, and in mussel beds, which were avoided during the cleanup. Chemical analyses show that *Exxon Valdez* oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen

somewhat deeper in some cases.

Restoration Objective. Sediment will have recovered when contamination, if any, causes no negative effects to the spill-affected ecosystem.

Restoration Strategy. ?

Implementation by Restoration Category. ?

Sockeye Salmon (Kenai River)

Ecosystems. Sockeye Salmon (Kenai River) belong to the pelagic (offshore), nearshore, and upland ecosystems.

Recovery Status. Because of fisheries closures in 1989, a third year of high escapements of adult salmon exceeded the fry-rearing capacity of the lakes in the Kenai River system. Smolt production declined from 30 million in 1989 to six million in 1990 and continued to decline to less than one million in 1992 and 1993.

Restoration Objective. Sockeye salmon will have recovered when populations are healthy and productive and exist at prespill levels. One indication of recovery is when Kenai and Skilak Lakes support sockeye smolt outmigrations comparable to prespill levels.

Restoration Strategy. Sockeye salmon in Kenai Lake are not recovering because of overescapement. Therefore, the restoration strategy for sockeye salmon (Kenai Lake) has three parts:

> Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once sockeye salmon (Kenai Lake) are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.
>
> Monitor recovery. The monitoring program will track changes in the condition of sockeye salmon (Kenai Lake). Their condition may change due to natural causes or restoration actions.

Protect sockeye salmon and their habitat. While protective measures alone may not ensure the recovery of sockeye salmon, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. General restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect sockeye salmon (Kenai Lake) from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Sockeye salmon is one of 19 injured resources and services for which habitat is being evaluated. With regard to sockeye salmon, habitat protection and acquisition seeks to maintain adequate water supply, riparian habitat, and intertidal habitat for spawning and rearing.

Recovery Monitoring. The monitoring program will track changes in the condition of sockeye salmon in Kenai Lake. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. We know that sockeye salmon in Kenai Lake are not recovering because of overescapement. However, research may be needed to understand the dynamics of the Kenai Lake that is inhibiting recovery. (?)

More specific Research strategies, if any, would go here.

Sockeye Salmon (Red Lake)

Ecosystems. Sockeye salmon (Red Lake) belong to the pelagic (offshore), nearshore, and upland ecosystems.

Recovery Status. Sockeye salmon (Red Lake) declined in population because of adult overescapement in 1989. The Red Lake system may be recovering because the plankton has recovered, and fry survival improved in 1993.

Restoration Objective. Sockeye salmon in Red Lake will have recovered when populations are healthy and productive and exist at prespill abundances. One indication

of recovery is when fry production in Red Lake is at prespill levels.

Restoration Strategy. The restoration strategy for sockeye salmon (Red Lake) has three parts:

Rely on natural recovery. Natural processes aided by protective measures will be the main agents of restoration.

Monitor recovery. The monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that the sockeye salmon in Red Lake may not recover as expected, alternative means of restoration will be considered.

Protect injured resources and their habitats. Recovering resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. If results of the monitoring program suggest that the sockeye salmon in Red Lake may not recover as expected, alternative means of restoration will be considered. Meanwhile, protective management practices and the reduction of marine pollution may protect them from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Sockeye salmon is one of 19 injured resources and services for which habitat is being evaluated. With regard to sockeye salmon, habitat protection and acquisition seeks to maintain adequate water supply, riparian habitat, and intertidal habitat for spawning and rearing.

Recovery Monitoring. The monitoring program for sockeye salmon in Red Lake will track the progress of recovery and detect major reversals.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Because sockeye salmon in Red Lake are recovering, no specific research strategies are identified.

Subsistence

Recovery Status. Subsistence users say that maintaining their subsistence culture

depends upon uninterrupted use of subsistence resources. The more time users spend away from subsistence activities, the less likely they will return to it. Continuing injury to natural resources used for subsistence may affect the way of life of entire communities.

Residual oil exists on some beaches with high value for subsistence. Continued presence of hydrocarbons may contaminate subsistence food resources or, at a minimum, create uncertainty about the safety of subsistence food resources that reduces their use and value for subsistence.

Restoration Objective. Subsistence will have recovered when injured subsistence resources are healthy and productive and exist at prespill levels and people are confident that the resources are safe to eat. One indication that recovery has occurred is when the cultural values provided by gathering, preparing, and sharing food are reintegrated into community life.

Restoration Strategy. Restoration of fish and wildlife resources are covered elsewhere in this chapter. The restoration strategy for subsistence services has four parts:

Promote recovery of subsistence as soon as possible. Many subsistence communities will be significantly harmed while waiting for subsistence resources to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of subsistence resources and services. This objective may be accomplished through increasing availability, reliability, or quality of subsistence resources, or increasing the confidence of subsistence users. Specifically, if subsistence harvest has not returned to prespill levels because users doubt the safety of particular subsistence resources, this objective may take the form of increasing the reliability of the resource through food safety testing. Other examples are the acquisition of alternative subsistence food sources and improved use of existing resources.

Remove or reduce residual oil if it is cost effective and less harmful than leaving it in place. Removing residual oil on beaches with high value for subsistence may improve the safety of foods found on these beaches. This benefit would have to be balanced against cost and the potential for disrupting recovering intertidal communities.

Protect subsistence resources from further degradation. Further stress on subsistence resources could impede recovery. Appropriate protection can take the form of habitat protection and acquisition if important subsistence areas are threatened. Protective action could also include protective management practices if a resource or service faces further injury from human use or marine pollution.

Monitor recovery. Monitoring the recovery of subsistence will track the progress of

recovery, detect major reversals, and identify problems with the resources and resource management that may affect the rate or degree of recovery. Inadequate information may require managers to unduly restrict use of injured resources, compounding the injury to subsistence.

Implementation By Restoration Category

General Restoration. General restoration projects may be used to increase the availability, reliability, or quality of subsistence resources, or to increase the confidence of subsistence users. Removal of residual oil on beaches with high value for subsistence may improve the safety of foods found on these beaches. This benefit would have to be balanced against cost and the potential for disrupting recovering intertidal communities. General restoration actions could also include protective management practices.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Subsistence is one of 19 injured resources and services for which habitat is being evaluated. With regard to subsistence, habitat protection and acquisition seeks to ensure subsistence opportunities in known harvest areas.

Recovery Monitoring. The monitoring program for subsistence will track the progress of recovery, detect major reversals, and identify problems with the resources and resource management that may affect the rate or degree of recovery.

More specific Recovery Monitoring strategies, if any, would go here.

Research. No specific research strategies have been identified.

Subtidal Organisms

Ecosystems. Subtidal organisms belong to the pelagic (offshore) and nearshore ecosystems.

Recovery Status. Certain subtidal organisms, like eelgrass and some species of algae, appear to be recovering. Other subtidal organisms, like leather stars and helmet crabs, showed little sign of recovery through 1991.

Restoration Objectives. Subtidal organisms will have recovered when community

composition, population abundance of component species, and ecosystem functions and services in each injured subtidal habitat have returned to levels that would have prevailed in the absence of the oil spill.

Restoration Strategy. Except for certain protective measures, attempts to restore subtidal organisms without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for subtidal organisms emphasizes determining why they are not recovering and eliminating threats to the remaining populations. The restoration strategy for subtidal organisms has four parts:

Conduct research to find out why subtidal organisms are not recovering. Effective restoration of subtidal organisms requires an understanding of why they are not recovering.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once subtidal organisms are recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities.

Monitor recovery. The monitoring program will track changes in the condition of subtidal organisms. Their condition may change due to natural causes or restoration actions.

Protect subtidal organisms and their habitat. While protective measures alone may not ensure the recovery of subtidal organisms, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Implementation By Restoration Category

General Restoration. Once we have a better understanding of why subtidal organisms are not recovering, general restoration actions may be used to initiate recovery. Meanwhile, protective management practices and the reduction of marine pollution may protect intertidal organisms from other sources of potential injury.

More specific General Restoration strategies, if any, would go here.

Habitat Protection and Acquisition. Intertidal/subtidal biota are one of 19 injured resources and services for which habitat is being evaluated. With regard to intertidal/subtidal biota, habitat protection and acquisition seeks to maintain water quality along shorelines and reduce disturbance in nearshore areas.

Recovery Monitoring. The monitoring program will track changes in the condition of subtidal organisms. Their condition may change due to natural causes or restoration actions.

More specific Recovery Monitoring strategies, if any, would go here.

Research. Effective restoration requires an understanding of why subtidal organisms are not recovering.

More specific Research strategies, if any, would go here.

18.1.4A

Exxon Valdez Oil Spill Trustee Council

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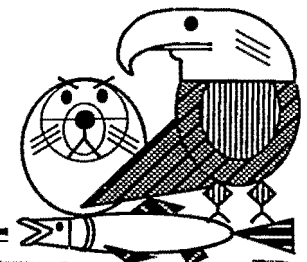

Date: April 11, 1994
Contact: L.J. Evans or Molly McCammon at 278-8012

Project 94320: Prince William Sound System Investigation
FACT SHEET

Background

The Trustee Council sponsored a workshop in Cordova in December 1993 to begin developing an ecosystem approach to restoration. The major objectives of the workshop were to consult national experts and experienced local scientists in designing a multi-disciplinary study of the Prince William Sound marine ecosystem, and to review and critique an ecological study plan – the SEA Plan – already prepared by the Prince William Sound Fisheries Ecosystem Planning Research Group.

The outcome of that workshop was recommendations from the scientists endorsing the SEA plan as a good starting point. Specifically the workshop Steering Committee said that (1) the SEA plan contained an innovative, reasonable, and scientifically-testable hypothesis to explain how certain ecological processes may control fluctuations of key fisheries resources in Prince William Sound, and (2) the ecological approach described in the SEA plan could form the basis of a program that would make an important scientific contribution to the Trustee's mission of restoring a healthy, productive, and biologically diverse ecosystem within the spill area.

The relevance of the SEA Plan to the Trustee's restoration mission led to the development of specific project proposals as the Prince William Sound System Investigation (Project 94320) for the 1994 Work Plan. At their January 31, 1994 meeting, the Trustees approved interim funding for several time-sensitive aspects of the proposal, such as vessel charters which needed to be negotiated in order to conduct field work this spring. After extensive review by the Executive Director, the Chief Scientist, and peer reviewers, the detailed project descriptions and budgets were modified as needed and incorporated in the project for review and today's decision by the Trustee Council.

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Specific Analyses of Each Component of Project 94320
From the Chief Scientist's Recommendations

94320-A: Salmon Growth & Mortality

The purpose of this project is to: (1) estimate the growth of juvenile pink salmon in 1994 and compare the rates to past years, (2) describe their migration through PWS, (3) estimate their diet and compare it to past years, (4) determine the role of food abundance in limiting growth, (5) evaluate past relationships between juvenile growth rates and fry-to-adult survival, and (6) develop techniques to estimate mortality of juveniles in PWS and the Gulf of Alaska. There may be a predictable relationship between food availability to juveniles, juvenile growth rates and survival from juvenile to adult. This project will continue to explore these relationships and in the context of the other studies, particularly those on salmon predation and zooplankton abundance, help improve our understanding of the main factors that determine adult returns.

94320-B: Coded Wire Tag Recoveries from Pink Salmon in Prince William Sound

The purpose of this study is to recover coded wire tags from pink salmon caught by commercial fishermen, researchers, and others. The recovery of the tags and subsequent analyses will provide, among other objectives, data regarding (1) the contribution of tagged hatchery stocks to the commercial harvest, and (2) the growth and marine survival rates of tagged hatchery stocks. These data are quite valuable to fisheries managers, and used for both planning and in-season regulation. The data on salmon growth and survival will also be used in conjunction with data from salmon predation, oceanographic, and zooplankton studies to test the basic hypothesis regarding factors controlling pink salmon production in Prince William Sound.

94320-C: Otolith Marking: In–Season Stock Separation

This study uses oxytetracyline for marking the otoliths (ear bones) of juvenile pink salmon as a technique to help to determine the degree of staying of wild and hatchery fish.

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94320-D: Genetic Structure of Pink Salmon Stock

The objective of this project is to define the genetic structure of pink salmon stocks in PWS. Potential sources of variation include stream-to-stream differences, even and odd-year stocks, upstream and intertidal spawners, and early and late-season spawners. The program proposes to evaluate a series of analyses of allozyme frequencies in fish from a wide geographic range and from two hatcheries and apply a series of statistical measures to determine if different allele frequencies exist, the extent of the difference, and, if there are systematic differences, to construct measures of genetic distances between substocks. In addition a pilot study using DNA techniques will be carried out using mitochondrial DNA.

94320-E: Salmon Predation

The purpose of this project is to: (1) determine the role that variable predation plays in overall survival of pink salmon, and (2) identify and describe the predators and mechanisms of predation under various conditions. This is an ambitious program that will track cohorts of juvenile pink salmon after they are released into PWS, attempt to identify their predators, and examine the mode of interaction of predators with the juvenile fish. This involves a highly coordinated group of vessels using state-of-the-art hydroacoustic equipment to track the juvenile fish and their predators as the fish progress from the Esther Island hatchery towards the southeast passages from PWS to the Gulf of Alaska. At the same time there will be real-time sampling of oceanographic conditions, plankton abundance, predators and the juveniles themselves.

94320-F: Trophic Interactions of Harbor Seals

This project is a small but potentially important part of the overall investigation. The objective of this portion of the project is to determine if links between various food sources and the harbor seal population in PWS can be established either by use of lipid-specific analysis or analysis of stable isotope ratios. The technique being proposed is a relatively new application using lipid markers to indicate food sources in marine food webs.

94320-G: Plankton Dynamics: Phytoplankton and Nutrients

The objective of this part of the program will be to: (1) describe the spatial and temporal extent of the spring-summer phytoplankton bloom in PWS, (2)

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measure phytoplankton primary productivity, (3) identify the major species comprising the bloom, and (4) describe the distribution and abundance of the dissolved inorganic nutrients important to phytoplankton growth. Besides the obvious importance of this program for describing the primary production that eventually supports larval fish growth and production, this program will be making a major contribution in itself to basic understanding of the PWS system. There has simply been very little work done in this area and this study will be a pioneering one in phytoplankton dynamics of PWS.

94320-H: The Role of Zooplankton in the Prince William Sound Ecosystem

The purpose of this project is to: (1) determine the timing, duration and magnitude of the bloom of mixed layer zooplankton stocks in western and northern PWS in the spring and summer, (2) determine how changes in vertical distribution of zooplankton affect their predators, (3) provide estimates of zooplankton abundance to calibrate the acoustic instrumentation used to locate and track swarms and patches of zooplankton in PWS, (4) determine the coupling of the phytoplankton and zooplankton blooms, and (5) provide taxonomic assistance with identification of zooplankton. The main goal of the project is to test the "River-lake" hypothesis which postulates that in years when PWS is swept continuously by buoyancy-driven coastal currents during the spring plankton bloom, food for juvenile fish is poor, and in years when PWS is not so swept — a "lake" year — there are better feeding conditions for juvenile pink salmon. A second and related hypothesis, "prey switching," is that certain fish that feed on zooplankton in "lake" years, when they are abundant, become predators of juvenile pink salmon instead in "river" years when zooplankton are less abundant.

94320-I: Confirming Food Web Dependencies in the Prince William Sound Ecosystem using Stable Isotope Tracers

The objective of this project is to use the predictable shifts in stable isotope ratios of carbon and nitrogen that occur with increasing trophic level to determine if the river-lake and prey switching hypotheses described above can be confirmed. As both of these elements are cycled further up the food chain the heavier natural isotopes (^{13}C and ^{15}N) become relatively less abundant. Such shifts are easily measured and shifts of these isotopes in predatory fish during various types of years — "river' or "lake" — provide a

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novel way to test these hypotheses. This represents a new application of stable isotope ratios.

94320-J: Information Systems and Model Development

This study component is the data and information management element for all the major portions of 94320. The major objectives of this component are (1) to process the data developed by all parts of the project (including available satellite imagery), (2) integrate these data using geographic coordinates and date of collection, (3) adapt an existing computer interface for use by principal investigators for data analysis and interpretation, and (4) plan for the development of a numerical model of the Prince William Sound ecosystem in future years. This program component also includes purchase and modification of the aquashuttle sampling device for biological oceanography, and establishment of a high-speed Internet connection to Cordova for data transmission and analysis.

94320-K: Experimental Fry Release
94320-L: Experimental Manipulation

Standard approaches to aquaculture used previously will again be employed to raise pink salmon fry from eggs. The juveniles will be released from the hatchery after attaining specified sizes, at certain times in relation to plankton abundance and at certain places. By releasing tagged lots and having a juvenile sampling and tag recovery component in other parts of this program it will be possible to do "natural experiments" whose outcome will point to conditions that are optimal for survival of juveniles.

94320-M: Observational Physical Oceanography in PWS & the Gulf of Alaska

The purpose of this project is to: (1) determine the structure and variability of the climatic patterns and oceanographic features in PWS and the Gulf of Alaska, (2) determine the relationship between the atmospheric forcing and the wind and buoyancy-driven ocean currents, (3) determine how currents act to disperse or retain food resources, (4) and determine the relationship between climatic and oceanographic cycles, physical features and changes in abundance of important species. The basic oceanographic processes that influence the abundance of fish food resources will be studied through charting currents and physical structure of the water in relation to biological

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phenomenon. This provides the physical evidence for testing the "River-Lake" hypothesis. The basic measurements will be conducted with conductivity/temperature/depth measurements, acoustic doppler current profilers and chemical analyses of water samples. In addition, towed vehicles with attached instruments will provide the "sections" needed to further characterize water structure. In the future the use of permanent buoys will be considered to supplement these other data gathering modes. The investigator has requested and received assurances that continuing advice from other oceanographers regarding fruitful approaches to measuring physical processes on a scale appropriate to biological resources will be made available.

94320-N: An Ecosystem Research plan for PWS Nearshore Fish

The purpose of this project is to: (1) evaluate the distribution of macrozooplankton in PWS in real time in order to describe the prey field for juvenile pink salmon, and (2) describe the distribution of predators of juvenile fish in real time. This will be an integral part of the complex field studies centered around fry releases in northwestern PWS and provides an important part of the biological picture for the purposes of coordinating net sampling of predators and zooplankton. The investigator faces the challenge of ground truthing the measurements of zooplankton by hydroacoustical methods against the more conventional methods. There is considerable controversy on the ability of single-frequency hydroacoustic equipment to quantitatively measure zooplankton and this is, therefore, a challenging area on the cutting edge of biological oceanography for the investigators. To be convincing, data interpretation will need to rely whenever possible on simultaneous net and hydroacoustic data for zooplankton abundance.

94320-P: Program Management

This program element provides funding for program management in order to ensure that appropriate planning and communication, among and between agencies and researchers, as well as community involvement takes place.

94320-Q: Avian Predation on Herring Spawn

The purpose of this study is to assess the impact of avian predation on herring spawn, with the goal of integrating this information into a model to

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predicts herring embryo survival. Better information regarding factors influencing the mortality of herring eggs should improve our ability to predict the spawning biomass of herring in Prince William Sound. The investigators will use avian census techniques to compare bird densities at sites of low and high density of egg deposition in different habitat types. Predator exclusion techniques will attempt to quantify predation from different sources. In this first year, the project will be limited to herring spawning sites along the northeastern shore of Montague Island.

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