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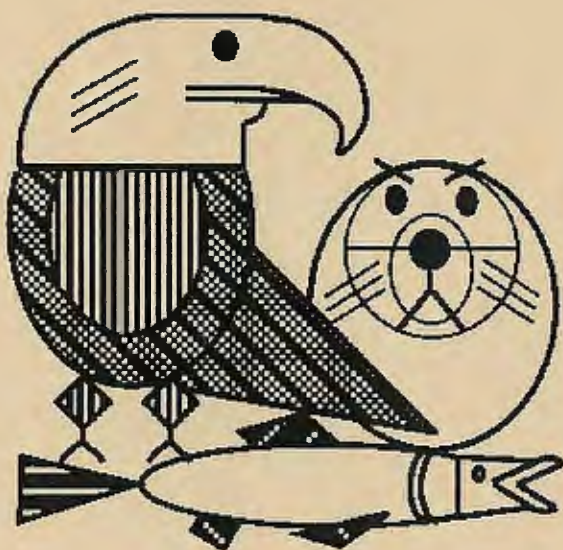
# **Draft Environmental Impact Statement**

for the

## ***Exxon Valdez* Oil Spill Restoration Plan**

Prepared by  
Exxon Valdez Oil Spill Trustee Council  
645 G Street, Suite 401  
Anchorage, Alaska 99501  
(907) 278-8012

**June  
1994**

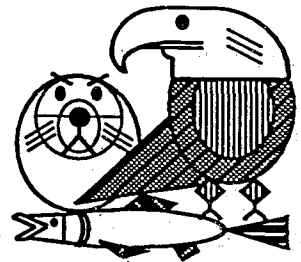


# Exxon Valdez Oil Spill Trustee Council

## Restoration Office

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April 30, 1994

### Memorandum

To: Trustee Council

From: Rod Kuhn  
EIS Project Manager *Rod Kuhn*

Subject: Interagency Review of  
Preliminary DEIS

### REPLY DUE MAY 13, 1994

We have arrived at a critical juncture in the development of the draft environmental impact statement (DEIS). It is time to begin the review process. On the work plan I submitted to the Trustee Council for the January 31 meeting, I said that the interagency review period for the preliminary DEIS would be April 25 through May 6. Due to a change in the printing schedule, this has been changed to May 2 through 13. The extra week was used by the Forest Service regional office staff to do a quick review to eliminate some potential problems that could arise. The Department of the Interior and the Forest Service will have done a preliminary review to assure NEPA compliance. I hope this will allow the interagency review to go smoothly. The DEIS must be in the printers hands no later than May 30.

The DEIS is in the format required for printing of Forest Service EIS documents. Formatting styles such as margins, headers, footers, and font size are dictated by that format.

It is important to recognize that this is still a preliminary draft of what would be sent out for public review and comment. While some chapters have been through various levels of editorial review, others have not. Chapter 4 has been partially edited at this time and will continue to be edited during the next month. In your review you will notice that some citations and appendices are missing from this draft. The EIS team will be working on these during the interagency review period.

Should any reviewer have questions or wish clarification of any part of the document, I will be available to assist you by calling the EVOS restoration office in Anchorage.

It is requested that substitute language be submitted to correct concerns rather than just identifying them. In this way, we can be sure that the desired modifications are made. There will be only two weeks to respond to your comment and produce the camera ready copy of the DEIS for the printer.

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### Trustee Agencies

State of Alaska: Departments of Fish & Game, Law, and Environmental Conservation  
United States: National Oceanic and Atmospheric Administration, Departments of Agriculture, and Interior

# **Chapter 1**

## **Purpose and Need**

|   |    |
|---|----|
| The Proposed Action . . . . .   | 1  |
| Purpose of and Need for the Proposed Action . . . . .                               | 1  |
| Purpose of the Proposed Action . . . . .  | 1  |
| Need for the Proposed Action . . . . .  | 2  |
| Litigation and Settlement . . . . .   | 2  |
| Decision to be Made . . . . .   | 3  |
| Background of the Proposed Action . . . . .   | 4  |
| The <i>Exxon Valdez</i> Oil Spill . . . . .   | 4  |
| Description of the Process . . . . .  | 6  |
| Notice of Intent . . . . .  | 7  |
| Scoping . . . . .   | 7  |
| Preparation of the Draft Environmental Impact Statement (DEIS) . . . . .            | 7  |
| Public Comment Period . . . . .   | 7  |
| Preparation of the Final EIS (FEIS) . . . . .                                       | 7  |
| Record of Decision (ROD) . . . . .  | 8  |
| Implementation . . . . .  | 8  |
| Scoping Process . . . . .   | 8  |
| Public Involvement . . . . .  | 8  |
| Roles of the Agencies . . . . .   | 8  |
| Role of the Public . . . . .  | 8  |
| Issues . . . . .  | 10 |
| Issues Addressed in the EIS . . . . .   | 10 |
| Issues Not Addressed in this EIS . . . . .  | 12 |
| Impact Topics Studied by the EIS . . . . .  | 12 |
| Impact Topics . . . . .   | 14 |
| Fish . . . . .  | 14 |
| Intertidal Resources . . . . .  | 14 |
| Marine Mammals . . . . .  | 14 |
| Birds . . . . .   | 14 |
| Services . . . . .  | 14 |
| Possible Conflicts Between the Proposed Action and Other Plans . . . . .            | 14 |
| Findings . . . . .  | 15 |
| Impacts and Alternatives Considered But Not Analyzed in Detail in the EIS . . . . . | 18 |
| Impact Topics Not Analyzed . . . . .  | 19 |
| Alternative Elements Not Considered in Detail . . . . .                             | 19 |
| Agency Management Actions . . . . .   | 19 |
| Monitoring and Research . . . . .   | 19 |



**Table 1-1**  
**Resources Identified in Scoping<sup>1</sup>**

| Mammals       | Fish and Shellfish     | Birds                  | Intertidal Organisms |
|---------------|------------------------|------------------------|----------------------|
| Harbor Seal   | Cutthroat Trout        | Bald Eagle             | Seaweed              |
| Sea Otter     | Dolly Varden           | Black Oystercatcher    | Snail                |
| Killer Whale  | Pacific Herring        | Common Murre           | Barnacle             |
| River Otter   | Pink Salmon            | Harlequin Duck         | Sea Urchin           |
| Black Bear    | Sockeye Salmon         | Marbled Murrelet       |                      |
| Mountain Goat | Rockfish               | Pigeon Guillemot       |                      |
| Deer          | Tongue Cod             | Eider Duck             |                      |
| Mink          | Silver Salmon          | Other Ducks            |                      |
| Dall Porpoise | Northern Smooth Tongue | Swan                   |                      |
| Sea Lion      | Chum Salmon            | Brant                  |                      |
|               | King Salmon            | Canada Geese           |                      |
|               | Bottomfish             | Loon                   |                      |
|               | Candle Fish            | Cormorant              |                      |
|               | King Crab              | Grebe                  |                      |
|               | Tanner Crab            | Bonaparte's Gull       |                      |
|               | Dungeness Crab         | Arctic Tern            |                      |
|               | Shrimp                 | Black-Legged Kittiwake |                      |
|               |                        | Tufted Puffin          |                      |

<sup>1</sup>Note: Common names of species used in public comments.

Source: Summary of Public Comment on Alternatives, EVOS Trustee Council, September 1993.

**Table 1-2**  
**Services Identified in Scoping**

| Services  | Other Resources             |
|---|-----------------------------|
| Commercial Fishing  | Air, Water, and Sediments   |
| Commercial Tourism  | Archaeological Resources    |
| Passive Use   | Designated Wilderness Areas |
| Recreation Including Sport Fishing, Sport Hunting, And Other Recreation Use |                             |
| Subsistence   |                             |

Source: Summary of Public Comment on Alternatives, EVOS Trustee Council, September 1993.

# 1 Purpose and Need

## Impact Topics

The IDT considered the various proposed alternatives and the issues raised in public comment and selected the following impact topics to cover these issues analytically. This information along with the public comment, the population injury level, and the recovery status of the resources and services is the basis for the decision to analyze the impacts to the following resources and services:

### Fish

Pink Salmon

Sockeye Salmon

Pacific Herring

### Intertidal Resources (Such as Clams, Fucus, Mussels, Limpets, etc.)

### Marine Mammals

Harbor Seals

Sea Otters

### Birds

Common Murres

Harlequin Duck

Marbled Murrelet

Pigeon Guillemot

### Services

Commercial Fishing

Sport Fishing

Recreation

Tourism

Subsistence

Archaeology

Designated Wilderness

The NEPA requires an analysis of impacts on the human environment. Some topics required to be studied by NEPA are not affected by the proposed action. These include land use plans and coastal zone management plans and are discussed below.

### Possible Conflicts Between the Proposed Action and Other Plans

A review of the Coastal Management Programs and other land management plans to identify any conflicts between them and the Draft Restoration Plan (the proposed action in the DEIS) was made in accordance with 40 CFR 1502.16(c).

The programs and plans that were reviewed include:

- The 1964 Chugach National Forest Land and Resource Management Plan, as amended.
- The 1986 Kenai River Comprehensive Management Plan.
- The 1988 Prince William Sound Area Plan for State Lands.
- The 1989 Alaska Coastal Management Program (ACMP) Statutes and Regulations.
- The 1989 City of Whittier Coastal Management Program.
- The Valdez Coastal Management Program, reprinted July 1992.
- The 1986 Cordova Coastal Management Program.
- The 1990 Kenai Peninsula Borough Coastal Management Program.
- The 1992 Port Graham/Nanwalek Area Which Merits Special Attention.
- The 1983 Kodiak Island Borough Coastal Management Program.

# Chapter 1

## Purpose and Need

### The Proposed Action

The Trustee Council has the joint responsibility under a Memorandum of Agreement for the restoration of natural resources and services injured by the *Exxon Valdez* oil spill (EVOS) of 1989. The proposed action is to restore the injured natural resources and services through implementation of a Restoration Plan. The Draft Restoration Plan that is Alternative 5 in this draft environmental impact statement (DEIS) is the proposed action. It was issued in November 1993, and is also being made available concurrently with this DEIS.

### Purpose of and Need for the Proposed Action

#### Purpose of the Proposed Action

The Draft Restoration Plan issued by the EVOS Trustee Council in November 1993 is one of five general approaches to restoration analyzed in this DEIS. The final restoration approach--which will be published in the final Restoration Plan--will be decided by the Trustee Council. The impact analysis in this draft environmental impact statement (DEIS) will be considered in their decision. The final Restoration Plan will provide broad, long-term guidance for implementation of restoration activities to restore resources and the services they provide that were injured during the EVOS in the area shown in the *Exxon Valdez* Oil Spill Area map preceding the first page of the Summary of this document. (The EVOS area includes the area enclosed by the maximum extent of oiled shorelines, severely affected communities and their immediate human-use areas, and uplands adjacent to the watershed divide.)

THIS DOCUMENT IS TO

The purpose of the proposed action analyzed in this DEIS is to analyze the effects of proposed uses of the remaining funds (approximately \$620 million after final reimbursements) should be spent to accomplish the mission of the Trustee Council. The Trustee Council previously completed project-specific National Environmental Policy Act

# 1 Purpose and Need

(NEPA) documentation on the time critical restoration projects undertaken in the 1992 through 1994 Annual Work Plans. This DEIS will analyze the 1995 through 2002 program under which the Annual Work Plans will be developed. (See the following section on "Litigation and Settlement" for a more complete discussion of the terms of this settlement.)

## Need for the Proposed Action

The Federal and State governments, acting as Trustees for natural resources are responsible for taking actions necessary to restore resources and the services they provide that were injured by the EVOS. The Federal Water Pollution Control Act (Clean Water Act) (33 U.S.C. § 1321[f]) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 U.S.C. § 9607[f]) provide the legal basis for these responsibilities.

The EVOS contaminated approximately 1,500 miles of Alaska's coastline. In 1991, Exxon agreed to pay the United States and the State of Alaska \$900 million in civil settlement funds to restore the resources injured by the spill and the reduced or lost services (human uses) they provide. Of that amount, approximately \$620 million remains available to fund restoration activities.

The *Exxon Valdez* Restoration Plan will provide long-term guidance to the Trustee Council for using these funds in restoring the resources and services injured by the oil spill.

### Litigation and Settlement

After the spill, President George Bush and Alaska Governor Steve Cowper both declared their intent to restore the affected ecosystem as well as the local economy. Both the United States and the State of Alaska filed civil complaints against the Exxon Corporation and other parties; separate criminal complaints also were filed.

A settlement between the Exxon companies and the United States and the State of Alaska were approved by the Federal District Court in civil actions A91-082 (*United States v. Exxon Corp.*) and A91-083 (*State of Alaska v. Exxon Corp.*) on October 9, 1991. As part of this settlement, the Exxon companies agreed to pay the United States and the State of Alaska \$900 million over a period of 10 years. These payments are deposited in the registry of the Federal District Court in Alaska and invested in the Federal Court Registry Investment System. As funding needs for restoration projects are identified, the Trustee Council applies for disbursement of funds from the court registry.

Civil action A91-081 (*United States v. State of Alaska*) resolved the claims the United States and the State of Alaska had against each other as a result of the spill. Under the Memorandum of Agreement and Consent Decree, the United States and the State act as co-trustees in the collection and joint use of the restoration funds. Under the Memorandum of Agreement (MOA), the governments may use these funds for the purposes of "... restoring, replacing, enhancing, rehabilitating, or acquiring the equivalent of natural resources injured as a result of the *Exxon Valdez* oil spill and the reduced or lost services provided by such resources."

The MOA also provides for the reimbursement of certain spill-related expenses such as litigation costs, cleanup, and damage assessment.



The MOA provides that the Trustee Council is responsible for making all decisions regarding funding, injury assessment, and restoration. Six individuals have been designated to serve as Trustees; three represent the State of Alaska and three represent the Federal Government. The individuals serving in this capacity are the Commissioner of the Alaska Department of Environmental Conservation (ADEC), the Commissioner of the Alaska Department of Fish and Game (ADF&G), the State Attorney General, the Secretary of the U.S. Department of the Interior (USDO), the Secretary of the U.S. Department of Agriculture (USDA), and the Administrator of the National Oceanic and Atmospheric Administration (NOAA). Each of the Federal Trustees appointed a representative to the Alaska-based Trustee Council, which oversees restoration planning and implementation activities. The Regional Forester of the Forest Service represents USDA, the Assistant Secretary for Fish, Wildlife, and Parks represents USDO, and the Regional Director of the National Marine Fisheries Service (NMFS) represents NOAA. The planning, evaluation, and implementation of restoration activities require the unanimous agreement of the Trustee Council.

In addition to the civil claims described above, the United States and the State of Alaska also filed criminal claims against the Exxon Corporation and Exxon Shipping Company. These claims were settled on October 8, 1991, along with the civil claims. Exxon Corporation and Exxon Shipping entered guilty pleas, admitting that they had violated several environmental laws. A fine of \$150 million dollars was imposed, of which \$125 million was remitted because the Exxon companies had cooperated with the Government during the cleanup, already had paid many private claims, and had tightened their environmental controls after the spill. Of the remaining \$25 million, \$12 million was deposited into the North American Wetlands Conservation Fund, and \$13 million was deposited into the Victims of Crime Account. These funds are not controlled by the Trustee Council and the expenditure of these sums therefore are not considered in the Restoration Plan.

Under the criminal settlement, the companies also agreed to pay \$100 million as restitution. Half of this money was paid to the United States and half was paid to the State of Alaska. By agreement of the governments, these funds are managed separately by the United States and by the State of Alaska. Although these funds are to be used exclusively for restoration projects within the State of Alaska relating to the *Exxon Valdez* oil spill, they are outside the scope of the Restoration Plan and this DEIS because they are managed by each government.

## Decision to be Made

Following public review and comment on the Draft Restoration Plan and the DEIS, the Trustees will decide which of the five alternatives will be adopted as the Final Restoration Plan. During implementation, the Restoration Plan may be amended as needed to respond to new information about injuries and recovery, to make use of new technology, or to respond to other changing conditions. Full public participation would be sought before any changes would be made to the Restoration Plan.

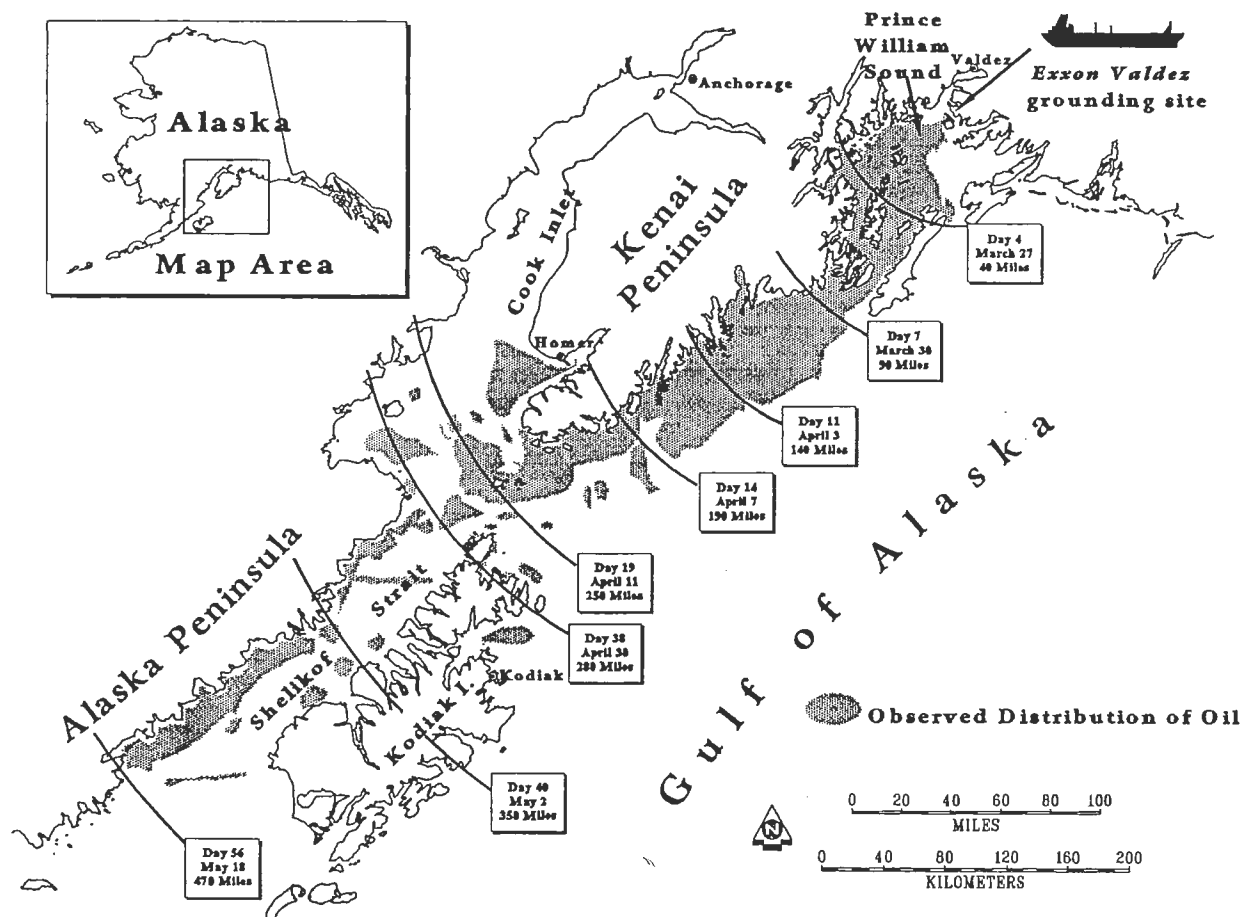
# 1 Purpose and Need

## Background of the Proposed Action

### The *Exxon Valdez* Oil Spill

On March 24, 1989, the tanker *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska, causing the largest tanker oil spill in U.S. history. Approximately 11 million gallons of North Slope crude oil subsequently moved through southwestern Prince William Sound and along the western coast of the Gulf of Alaska, causing injury to both natural resources and services (human uses) in the area. Figure 1-1 shows the extent of surface oiling as recorded by satellite observation at the time of the spill.

Figure 1-1



Because the weather for the first 3 days following the spill was calm, the oil did not move from the immediate area, although the slick expanded during that time. On the fourth day, however, a major storm moved oil through Prince William Sound to the southwest, where it

reached beaches on Little Smith, Naked, and Knight Islands. Within 6 days of the spill, oil had reached the Gulf of Alaska. The leading edge of the oil slick reached the Chiswell Islands and the Kenai Peninsula by April 2 and the Barren Islands by April 11. By the middle of May 1989, some 470 miles of shoreline had been oiled, including parts of Prince William Sound, the Kenai Peninsula, the Kodiak Archipelago, and the Alaska Peninsula. During the summer of 1989, oil from the spill was found as far as 600 miles from Bligh Reef, the site of the grounding.

Immediately following the spill, efforts to clean the oiled beaches and to assess the extent of the damage began. Federal agencies, the State of Alaska, private citizens, and the Exxon Corporation and its contractors mobilized treatment efforts on the oiled shorelines. In the water, containment booms were used to corral the oil. On the beaches, high-pressure hot-water washing, manual rock washing, and bioremediation techniques were among the methods used to remove oil from the shoreline.

Scientists initiated studies during the summer of 1989 to determine the nature and extent of injury to area plants and animals. Although studies began as soon as possible following the spill, some opportunities to gather data were lost, the shortage of resources and the difficulty of the work made immediate response impossible. In 1989, 72 studies have been carried out in 10 categories of natural resources and related services. The number of studies in progress has decreased steadily since 1989, but research is continuing on the effects of residual oil in the ecosystem and on the natural recovery process.

The Trustee Council began developing a restoration plan in 1990. Most of the effort at that time was focused on identifying and developing possible restoration techniques. Following the settlement between the Exxon companies and the United States and the State of Alaska on October 9, 1991, the Trustee Council decided to continue development of a restoration plan and to allow for meaningful public participation. Following public review and comment on the brochure in April 1993, the Trustee Council developed the Draft Restoration Plan in November 1993 as the proposed action for this DEIS. The final Restoration Plan will assist the decisionmaking process by establishing management direction for identifying and selecting activities to restore injured resources and services. Program-level guidelines will assist in evaluating and implementing future proposed restoration activities. These activities will be developed as part of the Trustee Council's Annual Work Program and will be evaluated by the policies set forth in the Restoration Plan. Each Annual Work Program will contain descriptions of the restoration activities to be funded that year, based on the policies and spending guidelines of the Restoration Plan, public comments, and changing restoration needs.

Alternatives for the Draft Restoration Plan were prepared for public review and comment in the publication, Draft Exxon Valdez Restoration Plan Summary of Alternatives for Public Comment, EVOS Trustee Council, April 1993. The brochure described five alternative courses of action, including the no action alternative; explained the evaluation criteria used; and outlined the differences among each of the alternatives. It also discussed an approach to implementing the alternatives; and it covered administration, funding allocation guidelines and mechanisms, monitoring, and public participation.

Based on public comment on the alternatives presented in the brochure, the Trustee Council has modified and designated Alternative 5 as the proposed action for this DEIS and have



# 1 Purpose and Need

published this modified alternative as the Draft Restoration Plan. This DEIS is intended to assist decisionmakers and the public in assessing the merits of the various alternatives and determining which of the possible alternatives should be selected as the final Restoration Plan.

As stated above, each restoration alternative is made up of four types of activities, and each alternative places different emphasis on each category. These activities are as follows:

- Habitat protection and acquisition.

This activity is designed to limit further injury to species and services within the spill area by protecting habitats. Habitat protection options include acquiring privately held land, obtaining less than fee simple acquisition of rights to privately held land, or changing the management of publicly held land.

- General restoration.

General restoration includes actions that manipulate resources directly, such as building new fish passes. It also includes actions that manage human use of affected areas, such as a plan to reduce human disturbance near seabird nesting areas.

- Monitoring and research.

This activity is designed to determine whether the environment is recovering and what can be done to accelerate the recovery process. Monitoring falls into three subcategories: recovery monitoring, restoration monitoring, and ecosystem monitoring. Restoration research could clarify the causes of poor or slowed recovery and then assist in the design, develop, and implement new technologies and approaches to help restore resources and services that are not recovering or those that are recovering at lower than expected rates.

- Administration and public information.

Funding levels for administration and public information activities depend on the number and scope of the other activities. As more projects and programs are implemented, the percentage of funds allocated to management and administration increases. These activities also include providing information to the public about restoration activities and the progress of recovery.

## Description of the Process

This DEIS was written to inform public officials and citizens of potential environmental effects that could result from implementation of the Restoration Plan. This will allow decisions about the Restoration Plan to be based on an understanding of the environmental consequences. This document also is subject to evaluation of subsistence under the Alaska National Interest Land Conservation Act (ANILCA) Section 810, because decisions made in this process may authorize the use, occupancy, or disposition of public lands.



# 1 Purpose and Need

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- Monitoring and research.

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- Administration and public information.

Funding levels for administration and public information activities depend on the number and scope of the other activities. As more projects and programs are implemented, the percentage of funds allocated to management and administration increases. These activities also include providing information to the public about restoration activities and the progress of recovery.

## Description of the Process

This EIS was written to inform public officials and citizens of potential environmental impacts that could result from this planning action. This will allow decisions about the Restoration Plan to be based on an understanding of the environmental consequences. This document also is subject to evaluation of subsistence under the Alaska National Interest Lands Conservation Act (ANILCA) Section 810, because decisions made in this process may authorize the use of Federal lands.

The EIS is a requirement under Federal law (NEPA, 1969) for the Federal actions that will take place under the Restoration Plan. The State of Alaska is cooperating in this EIS because the Trustees will implement actions that are jointly funded.

As a programmatic EIS, this document does not address site-specific situations, proposals, or regulations. Site-specific actions by Federal agencies are subject to review under ANILCA Section 810 and may be subject to additional NEPA action.

A brief discussion of the EIS process follows.

## Notice of Intent

On April 10, 1992, a Notice of Intent to prepare an EIS for the development of a restoration plan following the March 24, 1989, *Exxon Valdez* oil spill was published in the Federal Register (57 FR 12473). This notice stated that public meetings would be held throughout the EVOS area to solicit comments on the Restoration Plan and possible effects on resources and services.

The DEIS is a requirement under Federal law (NEPA, 1969) for the Federal actions that will take place under the Restoration Plan. The State of Alaska is cooperating in this DEIS because the Trustee Council will implement actions that are jointly funded.

As a programmatic DEIS, this document does not address site-specific situations, proposals, or regulations which are dealt with in Annual Work Plans. Site-specific actions by the Trustees may be subject to review under ANILCA Section 810 and NEPA.

A brief discussion of the environmental impact statement (EIS) process follows.

## Notice of Intent

On April 10, 1992, a Notice of Intent to prepare an EIS for the development of a restoration plan following the March 24, 1989, Exxon Valdez oil spill was published in the Federal Register (57 FR 12473). This notice stated that public meetings would be held throughout the EVOS area to solicit comments on the Restoration Plan and possible effects on resources and services.

On January 14, 1994, a Revised Notice of Intent to prepare an EIS was published in the Federal Register (59 FR 2352). An opportunity to submit additional comments was opened through February 1994, and a public meeting was held in Anchorage on January 27, 1994.

## Scoping

The Council on Environmental Quality defines scoping as "an early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action" (40 CFR 1501.7). It is a means for early identification of important issues deserving analysis in an EIS. The scoping process for this EIS is discussed in greater detail later in this chapter.

## Preparation of the Draft Environmental Impact Statement (DEIS)

The DEIS has several parts. It describes the proposed action and alternatives and the potentially affected physical, biological, and human environments; provides an analysis of potential adverse effects; describes mitigating measures to reduce adverse effects; and presents a record of consultation and coordination with others during the DEIS preparation. The DEIS is filed with the Environmental Protection Agency (EPA), and its availability is announced in the Federal Register.

## Public Comment Period

A 45-day public comment period follows the release of the DEIS. During this period, public meetings and at least one hearing are held, and oral and written comments are requested from the public. Specific dates and locations for the public meetings and hearing(s) are announced.

## Preparation of the Final EIS (FEIS)

Oral and written comments on the DEIS are addressed in the FEIS. Any needed revisions are made to the FEIS before it is filed with EPA and made available to the public by announcement in the Federal Register.



# 1 Purpose and Need

## Record of Decision (ROD)

Following the release of the FEIS, there is a 30-day waiting period before any action can be taken on the proposal. Then, a ROD documenting the final decision is issued. The decisionmaking process on the Restoration Plan ends with a final decision by the Trustees regarding the final Restoration Plan. The ROD is publicly released and announced in the Federal Register.

## Implementation

The selected alternative for the final Restoration Plan are implemented after a final ROD has been signed.

## Scoping Process

### Public Involvement

#### Roles of the Agencies

The Trustee Council selected the USDA Forest Service to act as the lead agency in developing the EIS for the Restoration Plan (see 40 CFR 1501.5-7, 1503.1, and 1508.16). The USDO, the NMFS, the Alaska Department of Natural Resources (ADNR), the ADEC, and the ADF&G are acting as cooperative agencies with the Forest Service in preparing the EIS and scoping the action but are technically joint agencies in making the final decision.

The lead agency is responsible for coordinating the public scoping process, which is required by 40 CFR 1501.7. During the scoping process, the Forest Service coordinated with affected Federal, State, and local agencies and other interested parties, including the public; determined the scope and significance of issues to be analyzed in the DEIS; identified and eliminated issues that were not germane to the analysis; and oversaw development of the DEIS. As required by the Council on Environmental Quality (CEQ) regulations at 1506.6(f), the planning record for the Restoration Plan DEIS includes the data and information used in the analysis of the alternatives, scoping records, a chronology, and other relevant information. The planning record is available for public review on request.

#### Role of the Public

The MOA between the Federal and State governments requires meaningful public involvement. Toward that end, all decisions made by the Trustee Council have been made in an open public forum with opportunity for public comment. Public comments received on the Restoration Framework document also were used to identify significant issues related to implementing a restoration program. A Summary of Alternatives for Public Comment on the Draft Restoration Plan was released in April 1993. Public comments on the Summary of Alternatives, the Draft Restoration Plan, and the DEIS will be used to refine the final Restoration Plan.

To ensure that the public had the opportunity to identify issues related to the proposed action to be addressed, the Trustee Council had five periods for public comment. The first was in January and February 1992, to solicit input for the formation of a Public Advisory Group. The second occurred in May 1992, when the public was invited to comment on the Restoration Framework at meetings in Seldovia (teleconferenced to Port Graham), Homer,

Kodiak, Juneau, Tatitlek, Valdez, Seward, Whittier, Chenega Bay, Anchorage, Cordova, and Fairbanks. These comments were used to identify issues related to implementing a restoration program. The third period for public comment was in November 1992, when agencies and individuals were invited to an "open house" held in Anchorage to discuss input for the DEIS. In the fourth period, a round of meetings was held in April 1993 to collect public comments on the Summary of Alternatives for Public Comment, released in April 1993. These meetings were held in Chignik Lagoon, Chignik Lake, Chenega Bay, Kodiak, Port Graham, Ouzinkie, Port Lions, Seldovia, Larsen Bay, Homer, Akhiok, Old Harbor, Nanwalek (English Bay), Anchorage, Valdez, Seward, Tatitlek, Juneau, Cordova, Fairbanks, and Whittier. A fifth period for public comment was held in late January and early February 1994 after the publication of the Draft Restoration Plan and the Revised Notice of Intent to prepare an EIS. A public meeting was held in Anchorage at that time.

The DEIS and the Draft Restoration Plan will be available for public comment for 45 days. The comments received from the public will be used to create the final EIS.

In addition, a Public Advisory Group, formed in October 1992, was established to provide comment to the Trustee Council on all matters relating to planning, evaluating, and allocating funds, as well as planning, evaluating, and conducting injury assessments and restoration activities. This group is made up of 15 members who represent a cross-section of the interest groups and the public affected by and concerned about the spill. Additionally, there are two ex officio members representing the Alaska Legislature.

The Trustee Council has sought public comment on the following questions concerning the Draft Restoration Plan:

- Which resources and services should be targeted for restoration efforts?  
  
Should restoration actions address all injured resources and services, or should they address only those biological resources whose populations declined measurably as a result of the spill?
- How long should restoration actions last?  
  
Should they be undertaken until a resource or service has recovered, then stopped? Or should they continue beyond that determined point of restoration?
- Which restoration actions should be undertaken?  
  
Should the Restoration Plan include only those actions that are expected to produce substantial improvement over the rate of natural (unaided) recovery? Or should actions believed to produce at least some improvement over the rate of unaided recovery be included as well?
- In what geographic area should restoration actions be taken?  
  
Should actions be limited to the spill area, or should they be taken in any area where there is a link to injured resources or services?



# 1 Purpose and Need

- To what extent, if any, should restoration actions create opportunities for human use?

Should human use of, and access to, the spill area be decreased? Protected? Increased? Or should new opportunities for human use be considered?

## Issues

The interdisciplinary team (IDT) assigned to write the DEIS reviewed and analyzed the concerns and ideas expressed in the public involvement and interagency scoping. The following issue statements describe those concerns and ideas in general terms. The issue statements were evaluated to decide which issues were significant and should be addressed in the DEIS.

The public, agencies, community leaders, and other knowledgeable individuals and organizations raised many issues during the scoping process. The agencies identified the significant issues based on "reviews of similar actions, knowledge of the area or areas involved, discussions with community leaders, and/or consultations with experts and other agencies familiar with such actions and their effects" (Forest Service Handbook 1909.15 [11.5]). These issues are addressed in this document.

### Issues Addressed in the EIS

Five of the issues raised during scoping were determined to be relevant to the environmental impact analysis and will be used to evaluate each alternative. Brief explanations of these issues are presented below.

*Issue 1:* How would restoration activities contribute to restoring injured resources and services?

This issue is central to the analysis performed in the EIS and the evaluation of restoration option effectiveness presented in the Draft Restoration Plan. In particular, the public is interested in how the rate of recovery of the resources affected by the spill will be affected by implementation of the restoration activities. The rate and degree of recovery could be measured by changes in population or distribution of species, the time required for recovery, or other factors. Besides changes in population and diversity, habitat conditions, and acreage or sites protected from development or other physical encroachment, changes in human use or management or changes in aesthetic quality also could affect the rate and degree of recovery.

*Issue 2:* How would activities directed at injured resources and services affect other resources and services?

Each of the proposed restoration options aims to aid a particular resource or service; however, the potential exists for other resources and services to be affected as well. Although an action could be designed to improve recovery of a specific resource, the same action also could indirectly affect other resources and services. Potential impacts include changes in the number or structure of other species populations as a result of restoration-associated changes in the amount or quality of available habitat or food sources.

There would be no adverse impacts to these other resources from any of the alternatives under consideration in this DEIS other than those shown in the economic analysis. The benefits to these other resources would be in the nature of restoring or protecting their habitat as a secondary benefit of restoring or protecting the habitat of an injured resource.

*Issue 3: What ecological change would occur in the spill area as a result of restoration activities?*

Ecological recovery in the spill area is the intent of the proposed restoration activities. The anticipated result of the combined restoration efforts is recovery of the ecosystem to pre-spill conditions and overall biodiversity levels.

*Issue 4: How would restoration activities affect land uses, local economies, and communities?*

Some proposed restoration activities may result in the creation or elimination of jobs; and the number and kinds of new jobs, as well as the income associated with them, are of interest to the public. A concern is that employment could be reduced in some resource development industries that may be adversely affected by some restoration options. The effect of increased or decreased employment on the economy and services of the local communities also concerns the public, as well as government agencies and private industry.

For example, the public has anticipated that changes in land use could result from land acquisition for protection of habitat. Ownership of some land could move from the private sector to the public sector. Increased protection of lands already under public management may be considered. Some changes in existing land management strategies could decrease opportunity for such activities as logging and mining; others could increase access to recreation sites and maintain opportunities for commercial tourism. The economic and infrastructure implications of these changes are considered in this document.

*Issue 5: What changes to subsistence uses would occur as a result of restoration activities?*

Some of the proposed restoration options are directed at restoring subsistence uses of resources in the spill area. Subsistence use was affected by contamination of resources used for subsistence and by users' perception of contamination. Restoration activities may focus on increasing the abundance of natural resources in the area used for subsistence. Subsistence use also may be affected by the implementation of options that are not intended to specifically address subsistence use; this potential for secondary impact is considered in the analysis of the alternatives.

There are continuing human health and safety concerns that certain resources used for subsistence may have been contaminated. Eating oil-contaminated food is harmful to humans, as is direct physical contact with crude oil. To avoid injury to humans, fisheries were closed and harvesting of affected species was discouraged immediately after the spill occurred. Some of the restoration activities aim to decrease the levels of harmful hydrocarbons in resources used for subsistence. Others focus on obtaining information to determine the level of persistent contamination, if any, in harvested resources.



# **1 Purpose and Need**

## **Issues Not Addressed in this EIS**

The public raised many issues during the various public comment periods and public meetings that were relevant to developing the Draft Restoration Plan but are not relevant to analyzing the effects of the proposed action and alternatives. Those issues are identified in the Restoration Framework document published in April 1992 and in the Draft Restoration Plan (November 1993). Those issues relate to planning and were dealt with in those documents. They were determined to not address issues which would have a significant effect on the human environment.

## **Impact Topics Studied by the EIS**

During the scoping process for the DEIS and the Draft Restoration Plan, many resources and services were named as having been injured or reduced as a result of the EVOS. Tables 1-1 and 1-2 show all the resources and services that were identified at some point in the scoping. The injury status of these resources and the services they provide was evaluated in the development of the Draft Restoration Plan and was displayed in Appendix B, Tables B-4, B-5, and B-6 (pp. 35-55). Some resources identified in Table 1-1 showed no oil spill mortality. This was especially true of most of the terrestrial mammals. Several other resources showed mortality but no measured population decline because of spill injury. Other resources identified by the public are believed to be recovering. Table B-1, in Appendix B of the Draft Restoration Plan, shows the latest information on the status of the injured resources and services.

The brochure published in April 1993 listed the resources and the services they provide that were reduced or injured by the oil spill and categorized the natural resources by whether a population decline had occurred. In the Draft Restoration Plan released on November 28, 1993, Table B-1, the injured biological resources were grouped by recovery status, not by population decline. The other resources and human uses injured or reduced also were shown.

- The Regional Comprehensive Salmon Enhancement Plans for:  
Prince William Sound, 1983, 1986, and 1994;  
Cook Inlet, 1982; and,  
Kodiak, 1984 and 1992.

### Findings

**Chugach National Forest Land and Resource Management Plan.** The Forest Planning Staff reviewed the relationship between the Chugach Forest Plan and EVOS activities and reached the following conclusions:

1. Current Forest Plan management direction allows for implementation of EVOS restoration activities identified in the Draft Restoration Plan.
2. Habitat protection and acquisition are compatible and consistent with Forest Plan direction. Much of the Chugach National Forest has a protective management prescription and is naturally protected because of remoteness or topography.
3. The Forest Plan does not need to be amended to achieve the goals of the Draft Restoration Plan.
4. Restoration activities approved to date are appropriate and consistent with the current Forest Plan management prescriptions section where appropriate management practices and activities are identified.
5. The goals and objectives of the proposed EVOS Monitoring and Research programs are fully compatible with those outlined in the Forest Plan.
6. If funded and implemented, many of the scheduled Chugach National Forest projects will provide incidental benefits toward reaching EVOS restoration objectives.

**Prince William Sound Plan for State Lands** The areawide land management policies outlined in Chapter 2 of the Forest Plan consist of goals and management guidelines for coordination and public notice; fish and wildlife habitat and harvest areas; floating residential and commercial facilities; forestry; instream flow; mariculture; materials; public and private access; recreation, tourism cultural and scenic resources; settlement; shoreline development; subsurface resources; and transportation and utilities. Many of the management guidelines presented in the Forest Plan compliment restoration objectives outlined in the Draft Restoration Plan. While some of the activities that could be carried out on State land within Prince William Sound could conflict with restoration objectives, the Forest Plan itself does not conflict with the Draft Restoration Plan.

**Alaska Coastal Management Program Statutes and Regulations** The pertinent section of the ACMP is 6 AAC Chapter 80. This chapter details the standards used by State agencies in carrying out their responsibilities under the Alaska Coastal Management Act. Standards have been established for activities related to coastal development; geophysical hazard areas; recreation; energy facilities; transportation and utilities; fish and seafood processing; timber harvest and processing; subsistence; habitats; air, land, and water quality; historic, prehistoric, and archaeological resources; and areas that merit special attention.



# 1 Purpose and Need

All of the standards in the Alaska Coastal Management Act are designed to minimize conflicts between resource use and resource protection. The intent of the standards appears to be maintaining a healthy functioning ecosystem. Objectives of the ACMP, under which fall the coastal management programs of all borough, city, or Areas Meriting Special Attention (AMSA's) are outlined below.

- The use, management, restoration, and enhancement of the overall quality of the coastal environment;
- the development of industrial or commercial enterprises that are consistent with the social, cultural, historic, economic, and environmental interests of the people of the State;
- the orderly, balanced utilization and protection of the resources of the coastal area consistent with sound conservation and sustained yield principals;
- the management of coastal land and water uses in such a manner that, generally, those uses that are economically or physically dependent on a coastal location are given higher priority when compared to uses that do not economically or physically require a coastal location;
- the protection and management of historic, cultural, natural, and aesthetic values and natural systems or processes within the coastal area;
- the prevention of damage to or degradation of land and water reserved for their natural values as a result of inconsistent land or water usages adjacent to that land;
- the recognition of the need for a continued supply of energy to meet the requirements of the State and the contribution of a share of the State's resources to meet National energy needs; and
- the full and fair evaluation of all demands on the land and water in the coastal area.

The ACMP policies, standards, and objectives are not in conflict with the goals and objectives of the Draft Restoration Plan. The Draft Restoration Plan is consistent with the ACMP to the maximum extent practicable.

**Eyak Lake AMSA Cooperative Management Plan.** The policies and guidelines of the Eyak Lake AMSA Cooperative Management Plan are designed to protect to the maximum extent possible resource values important to the community and it does not appear there is any conflict between the Draft Restoration Plan and the Eyak Lake AMSA.

**Kenai River Comprehensive Management Plan.** The goals and objectives section is the pertinent section of the Kenai River Management Plan. The plan is designed to protect and perpetuate the fish and wildlife and their habitats along the Kenai River while protecting and enhancing public use and enjoyment of the river. These goals and objectives are in harmony with the Draft Restoration Plan goals and objectives and there are no apparent conflicts between the two plans.

**Valdez Coastal Management Program.** This program covers the Valdez Municipal Boundary and roughly extends from the mouth of Valdez Narrows on the west to Keystone

Canyon on the east. The goals of the program are designed to facilitate reasonable community expansion and development while meeting resource protection laws and regulations. The goals dealing with industrial, commercial, and residential development could be construed to be in conflict with the Draft Restoration Plan. However, this development is focused in areas already receiving high human use or on lands with low value as habitat for injured resources. Other coastal program goals are designed to protect coastal habitats and scenic beauty and therefore compliment the objectives of the Draft Restoration Plan.

**Cordova Coastal Management Program.** The Cordova Coastal Management Program covers the city limits of Cordova. The objectives outlined in the program are to be used in evaluating plans or permit applications for development within the program boundaries. They are designed to minimize impacts to the coastal zone while allowing for water-related or water-dependent uses. These objectives do not appear to conflict with the goals and objectives of the Draft Restoration Plan.

**Port Graham/Nanwalek AMSA.** This AMSA covers most of the Port Graham and Nanwalek Village Corporation lands to the west of Kachemak Bay State Wilderness Park. The AMSA includes Windy Bay, Port Chatham and the Chugach Islands. The area was designated as an AMSA to 1) protect traditional human subsistence needs; 2) maintain the high quality and productivity of important coastal habitats and resources; 3) minimize conflicts between uses of coastal resources and development activities; and 4) preserve unique cultural values, lifestyles, sites of historic and archaeological significance, and areas of outstanding scenic beauty. The goals for water quality, coastal erosion, fish and wildlife habitat, subsistence, commercial fishing, mariculture, cultural resources, transportation, recreation and tourism, navigation obstruction, timber harvest, fish and seafood processing, and oil spill emergency preparedness and response--and the enforceable policies developed to further those goals--go beyond the Kenai Peninsula Borough Coastal Management Program in providing protection to resources. There does not appear to be any conflict between the goals and policies of this program and the Draft Restoration Plan.

**Kenai Peninsula Borough Coastal Management Program.** The Kenai Peninsula Borough Coastal Management Program covers the entire Kenai Peninsula Borough up to the 1,000-ft contour. It is tiered off the ACMP and provides more specific direction on review of uses and activities requiring permits and approvals within the coastal zone. Broad goals, specific objectives, and enforceable policies are spelled out for coastal development; geophysical hazards; recreation and public access; energy and industrial development; transportation and utilities; fishing and seafood processing; mariculture; timber management; mining and mineral processing; subsistence; fish and wildlife habitat; air, land, and water quality; and archaeological and historic resources.

The goals, objectives and policies are designed to allow for compatible development while maintaining a quality environment. There does not appear to be a conflict between the Kenai Peninsula Borough Coastal Management Program and the Draft Restoration Plan.

**Kodiak Island Borough Coastal Management Program.** The Kodiak Island Borough Coastal Management Program covers the entire Borough, from sea level to the tops of the mountains. The Borough boundary is the Kodiak Archipelago. Goals, objectives, and policies that address coastal development; recreation; energy facilities; transportation;

# 1 Purpose and Need

utilities; fisheries; timber harvesting and processing; agriculture; and mining and mineral processing provide direction in reviewing and approving activities and uses of the coastal zone. These goals, objectives, and policies are tiered off of the ACMP. There does not appear to be any conflict between this coastal management program and the Draft Restoration Plan.

**Regional Comprehensive Salmon Enhancement Plans.** These documents provide comprehensive plans for the management, rehabilitation and enhancement of salmon resources according to State of Alaska Legislative mandate (Chapter 113 SLA 1971) that directed the Alaska Department of Fish and Game to "develop and continually maintain a comprehensive, coordinated long-range plan for the orderly present and long-range rehabilitation... of all aspects of the state's fishery." Projects that may be proposed and funded as a result of this programmatic EIS will be reviewed according to this established plan to assure that they will be consistent projects identified in that plan. The goals and objectives of the restoration Plan are consistent with those of the Regional Comprehensive Salmon Enhancement Plans.

NOTE  
FORWARDED

The National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), and the Bureau of Indian Affairs (BIA) were contacted for their analysis of conflicts between the Draft Restoration Plan and plans for parks, refuges, and restricted Native allotments.

Their replies were as follows:

CCP's  
&  
GNP's

- The NPS reply, dated March 29, 1994, stated they are not aware of any conflicts between the Draft Restoration Plan and plans for parks in the spill area.
- The March 25, 1994, letter from the USFWS stated that certain specific actions that could be undertaken in implementing the Restoration Plan, such as developing new facilities or employing habitat manipulation techniques, could be in conflict with refuge plans. However, the Draft Restoration Plan does not identify where any actions will occur and requires that all actions be in compliance with Federal and State laws and regulations. There is no provision or direction in the Draft Restoration Plan to conduct activities on any Federal, State or private land when the land manager is not in agreement with the action. Therefore, it is unlikely that actions implementing the Restoration Plan would not be in compliance with refuge plans when undertaken on refuges.
- The ~~March 30, 1994, letter from the~~ BIA stated that there are no conflicts between the proposed action and land use plans for restricted Native allotments managed by the Bureau. They went on to say that they will continue to work with the affected tribes to ensure subsistence activities and resources are restored and protected.

## Impacts and Alternatives Considered But Not Analyzed in Detail in the EIS

The following are those impact topics and alternative elements considered but not analyzed in detail in the development of this DEIS. The topics and elements are briefly described and the reasons for not pursuing them further are given.



## Impact Topics Not Analyzed

Resources and the services they provide that currently are recovering and are not the subject of proposed restoration actions under any of the proposed alternatives, except that monitoring and research may be done to ensure that the resources do recover fully. These resources are as follows:

- Bald eagle--recovering,
- black oystercatcher--recovering,
- intertidal organisms (other than clams and *Fucus*)--no actions proposed,
- killer whale--recovering, and
- subtidal organisms--no actions proposed.

The status of recovery of the following resources and services is unknown at this time. Impacts on these resources and services will not be analyzed in the DEIS, except as noted. They represent a minor portion of the various alternatives and thus would have few actions associated with them other than monitoring.

### Biological Resources:

- Cutthroat trout--no actions proposed (except creating or enhancing runs for sport fishing, which is an injured service),
- Dolly Varden--no actions proposed (except creating or enhancing runs for sport fishing, which is an injured service),
- river otter--no actions proposed, and
- rockfish--no actions proposed.

### Services:

- Sport hunting--Sport hunting is most directly affected by specific agency regulations of the ADF&G.
- Passive uses--Injuries to passive uses are tied to public perceptions of injured resources. Any restoration objective that aids recovery of injured resources, or prevents further injuries, will help recovery of passive-use values. Passive uses will have recovered when people perceive that aesthetic and intrinsic values associated with the natural resources injured by the spill area are no longer diminished.

## Alternative Elements Not Considered in Detail

### Agency Management Actions

The Trustee Council uses funds from the civil settlement for activities to restore injured resources and the services they provide. The Trustee Council *does not* manage fish and wildlife resources or manage land. Fish and game management decisions are made by fish and game boards, or by appropriate Federal or State agencies. The Trustee Council may fund research necessary for restoration. The analysis in the DEIS is limited to those actions funded by the Trustee Council that impact (positively or negatively) the resources identified as the subject of some action (impact topics).

### Monitoring and Research

The alternatives analyzed in this DEIS consist of four categories of restoration activities: administration and public information, monitoring and research, general restoration, and habitat protection. Of the anticipated activities that may occur under each of these categories, only some activities in the general restoration and habitat protection categories have the

# 1 Purpose and Need

potential to produce environmental effects to be analyzed in this DEIS. Other activities, especially monitoring and research, could result in projects that would be only informational in nature but extremely beneficial to the restoration of injured resources or the services they provide. These benefits either depend on the results of research that is not yet completed or require an agency management action that is outside the jurisdiction of the Trustee Council. Therefore, the impacts of these actions will not be analyzed in this DEIS.

For example, the restoration program may include research projects designed to determine if changes in the forage fish populations are contributing to the long-term decline or slow recovery of the injured marbled murrelet populations. The implementation of research projects is not likely to produce an environmental effect, although this will be determined during the project-specific NEPA assessment at the time the research is undertaken. In this example, there are at least two possible outcomes from the research:

1. Key forage fish populations are stable and readily available in important marbled murrelet foraging areas, or
2. Forage fish populations are lower than expected in important marbled murrelet foraging areas.

Either of these findings provide valuable information in the restoration effort to help marbled murrelets. In the first case, scientists and managers would know to focus their restoration efforts on other possible explanations, such as disease or habitat loss. In the second case, efforts could be made to improve the forage fish populations. Some of these activities, such as management changes to commercial fisheries, are outside the jurisdiction of the Trustee Council. In this example, the decision to implement management changes that could cause a change in the forage fish population and, subsequently, a change in the recovery of marbled murrelets may be made by the State Board of Fish and Game or appropriate federal agency and is outside the authority of the Trustee Council.

Because it is impossible to predict the outcome of potential research activities that may be a part of the restoration program alternatives, these activities are not included in the analysis of effects in this DEIS. Similarly, monitoring and general restoration projects that are designed to improve our ability to manage an injured resource but require action outside the authority of the Trustee Council is beyond the scope of this DEIS.

# **Chapter 2**

## **Alternatives, Including The Proposed Action**



## Chapter 2

## Table of Contents

Page

|  |    |
|--|----|
| Introduction . . . . .   | 1  |
| Program Elements Common to All Alternatives . . . . .                    | 2  |
| Alternative 1: No Action . . . . .                                       | 3  |
| Assumptions Used for Impact Assessment . . . . .                         | 5  |
| Alternative 2: Habitat Protection . . . . .                              | 5  |
| Policies . . . . .   | 5  |
| Assumptions Used for Impact Assessment . . . . .                         | 6  |
| Alternative 3: Limited Restoration . . . . .                             | 6  |
| Policies . . . . .   | 6  |
| Assumptions Used for Impact Assessment . . . . .                         | 7  |
| Typical Actions Assumed Under Alternative 3 . . . . .                    | 7  |
| Habitat Protection and Acquisition . . . . .                             | 7  |
| General Restoration . . . . .  | 7  |
| Alternative 4: Moderate Restoration . . . . .                            | 8  |
| Policies . . . . .   | 8  |
| Assumptions Used for Impact Assessment . . . . .                         | 9  |
| Typical Actions Assumed Under Alternative 4 . . . . .                    | 9  |
| Habitat Protection and Acquisition . . . . .                             | 9  |
| General Restoration . . . . .  | 9  |
| The Proposed Action - Alternative 5: Comprehensive Restoration . . . . . | 10 |
| Policies . . . . .   | 10 |
| Assumptions Used for Impact Assessment . . . . .                         | 11 |
| Typical Actions Assumed Under Alternative 5 . . . . .                    | 11 |
| Habitat Protection and Acquisition . . . . .                             | 11 |
| General Restoration . . . . .  | 11 |
| Other Alternatives Considered and Rejected . . . . .                     | 12 |
| Comparison of Alternatives . . . . .                                     | 12 |

# Chapter 2

## Alternatives, Including The Proposed Action

### Introduction

This chapter describes the array of management alternatives considered in the development of the *Exxon Valdez* Restoration Plan. It covers the five alternatives for restoration, including the "no action" alternative. The injured resources and services (human uses) that would likely be affected by implementation of each of the alternatives are summarized below under the Comparison of Alternatives section. For more detailed information about the alternatives, please refer to the Draft *Exxon Valdez* Oil Spill Restoration Plan Summary of Alternatives for Public Comment (EVOS Trustee Council, April 1993; hereafter referred to as the brochure) and the Draft *Exxon Valdez* Oil Spill Restoration Plan (EVOS Trustee Council, November 1993).

Each of the alternatives addresses policies for selecting possible restoration activities. Each of the alternatives is made up of variations of four basic categories of activities: (1) Habitat Protection and Acquisition; (2) General Restoration of resources and services; (3) Monitoring and Research; and (4) Administration and Public Information. The General Restoration category contains general types of actions designed to achieve a particular objective in relation to an injured resource. ("Actions" is the term used to refer to site-specific projects to be implemented to achieve the goals of the alternative.) The analysis in this draft environmental impact statement (DEIS) pertains to the alternatives and the their associated action patterns but does not consider individual actions. Appropriate site-specific environmental analysis will be conducted by the appropriate agencies for all future actions.

## 2 Alternatives

Alternative 5 contains an element not present in the other alternatives. In response to public comments that a fund should be set aside for long-term restoration and research activities, the proposed action includes the establishment of a Restoration Reserve.

### Program Elements Common to All Alternatives

There are several program elements that are common to all of the proposed alternatives. They are as follows:

- The restoration program will take an ecosystem approach.

Recovery from the oil spill involves restoring the ecosystem as well as restoring individual resources. An ecosystem includes the entire community of organisms that interact with each other and their physical surroundings, including people and their relationship with other organisms. The ecosystem will have recovered when the population of flora and fauna are again present, healthy, and productive; there is a full complement of age classes; and people have the same opportunities for the use of public resources as they would have had if the oil spill had not occurred.

For General Restoration activities, preference is given to projects that benefit multiple species rather than to those that benefit a single species. However, effective projects for restoring individual resources will also be considered. This approach will maximize benefits to ecosystems as well as injured resources and the services they provide.

Habitat Protection and Acquisition emphasizes protection of multiple species, ecosystem areas, such as entire watersheds or areas around critical habitats. This approach will be more likely to ensure that the habitat supporting an injured resource or service is protected. In some cases, protection of a small area will benefit larger surrounding areas, or provide critical protection to a single resource or service.

Monitoring and Research activities include an ecosystem monitoring and research program. The ecosystem monitoring and research program will provide an understanding of the physical and biological interactions that affect an injured resource or service. This understanding will facilitate restoration and management.

- Competitive proposals for restoration projects will be encouraged.

Most restoration projects have been undertaken by State or Federal agencies. However, the number of competitive contracts awarded to nongovernmental agencies has increased each year and are expected to continue to increase.

This policy encourages active participation from individuals and groups in addition to the trustee agencies and may generate innovation and cost savings. This approach may be inappropriate for some restoration projects, but, where appropriate, competitive proposals will be sought for new project ideas and to implement the projects themselves.



- Restoration projects will be subject to open, independent scientific review before Trustee Council approval.

This policy continues an already existing practice. Independent scientific review gives an objective evaluation of the scientific merits of the project. It also assures the public that scientific judgements are without bias.

- Meaningful public participation in restoration decisions will be actively solicited.

Public participation has been an important part of the restoration process and a public concern since the spill occurred. This policy continues existing practices. Public review and user group participation will continue to play a key role in future Trustee Council activities, such as developing work plans, and will precede Trustee Council decisions.

- Government agencies will be funded only for restoration work that they do not normally conduct.

Many public comments have expressed concern that restoration funds will support activities that government agencies would do anyway. This policy addresses that concern. It also affirms the practice that has been in effect since the beginning of the restoration process. To determine whether work is normally conducted by agencies, the Trustee Council will consider agency authority and the historic level of agency activities.

## Alternative 1: No Action

The "no action" alternative required by the National Environmental Policy Act (NEPA) consists entirely of normal agency management activities, which are described below. If this alternative were implemented, current management would continue, no new activities or programs would be instituted as a result of the oil spill, and the scope of present activities and programs would not change. Agency monitoring of natural recovery would remain at present levels, and agency responsibilities would remain unchanged. None of the remaining funds from the civil settlement would be spent if this alternative were implemented.

The following text briefly summarizes the normal agency management activities that would apply to the EVOS area. The U.S. Forest Service manages the Prince William Sound portion of the Chugach National Forest with a primary management emphasis on recreation and fish and wildlife. No timber harvesting is planned within the Prince William Sound area at this time. Recreation management is primarily directed at providing marine-based recreation, cabins, and wilderness experience. Wildlife and fish management is directed at improving habitat for sport and commercial species and subsistence use and of maintaining wild stock habitat.

## 2 Alternatives

The National Oceanic and Atmospheric Administration's (NOAA) normal agency management activities for living marine resources in Alaska occur principally under three statutes: The Magnuson Fisheries Conservation and Management Act, which calls for NOAA to manage the commercial fisheries in Federal waters by developing and implementing Fishery Management Plans; the Endangered Species Act, which requires the protection of, and promotes the recovery of, endangered and threatened species; and the Marine Mammal Protection Act, which requires the conservation, protection, and management of species of whales, porpoises, and pinnipeds from adverse human activities. All of these management activities are implemented through regulation, enforcement, and research.

The U.S. Fish and Wildlife Service (USFWS) manages the national wildlife refuges to accomplish the following purposes:

- To conserve fish and wildlife populations and habitats in their natural diversity, including but not limited to marine mammals; marine birds and other migratory birds; the marine resources upon which they rely; and bears, caribou, and other mammals.
- To fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats.
- To provide the opportunity for continued subsistence uses by local residents.
- To provide a program of national and international scientific research on marine resources.
- To ensure, to the maximum extent practicable, water quality and necessary water quantity within refuges under its management.

There are currently no plans to change any USFWS management activities in response to the oil spill.

The Alaska Department of Environmental Conservation (ADEC) regulates activities that could directly affect resources because of pollution or other environmental injury. It formulates regulations limiting the amount, kind, and location or other restrictions necessary to protect the resources and environment. The ADEC is involved in education efforts and technology transfer directed at reducing pollution.

The Alaska Department of Natural Resources (ADNR) manages State land and resources and regulates timber harvest on private and State land under the Alaska Forest Practices Act. In the spill area, the ADNR manages Shuyak State Park (Afognak Island), Kachemak Bay State Park (Kenai Peninsula), and several marine parks in Prince William Sound; conducts an active oil and gas leasing program in Cook Inlet; and authorizes use of public waters, for example, for hatcheries and glacier ice harvesting. Management of State-owned lands in the spill area also includes such actions as authorizing aquatic farming, timber transfer facilities, or shore fishery leases on tidelands; selling certain designated uplands; transferring uplands to municipalities to fulfill their entitlements; issuing rights-of-way across State lands; and entering into land exchanges or cooperative management agreements beneficial to the State.

The Alaska Department of Fish and Game (ADF&G) is charged with managing, protecting, and enhancing the fish, game, and aquatic plant resources of the State. Functions include managing harvests to ensure sustained yields of wild stocks of fish and game, granting permits for activities in anadromous fish streams, administering ADF&G Special Areas, overseeing and coordinating fisheries enhancement activities, and collecting data on subsistence harvest activities. In addition, the Department reviews and comments on a variety of permit applications and plans that potentially impact State-managed species and habitats. The ADF&G also makes management recommendations to the State Board of Fisheries and Game, which is responsible for determining fish and wildlife allocation issues and establishing harvest regulations. The ADF&G has the authority to order emergency harvest openings and closures.

## Assumptions Used for Impact Assessment

One aspect of significance to the analysis of the alternatives in this EIS is the assumption that under Alternative 1 - the No Action alternative the private lands in the EVOS area are subject to private use and as a result could be used for some purposes that could effect the habitat and possibly the resources that were injured by the spill itself. Since this is the case, it was assumed for purposes of analysis in this EIS that those lands would be put to such uses and would result in adverse impacts to the injured resources and services being analyzed.

The specific parcels of land assumed to be most critical to the injured resources and the services they provide are the 863,100 acres considered in the Comprehensive Habitat Protection Process; Large Parcel Evaluation and Ranking Volumes I and II (EVOS Restoration Team, 1993). These parcels are shown in Figures 2-1 through 2-3. Appendix A, Table A-1 shows the specific benefits associated with protecting each of these parcels.

## Alternative 2: Habitat Protection

The goal of Alternative 2 is to provide maximum protection of strategic lands and habitats important to the long-term recovery of injured resources and the services they provide. Monitoring and Research and Habitat Protection and Acquisition are the only restoration actions included in this alternative. The primary means of protection in this alternative is the acquisition of private land interests or changes in the management of currently held public lands. Monitoring and Research would be conducted to evaluate the effectiveness of protection measures and to track the recovery of damaged resources and services. Actions that may be undertaken under this alternative would be confined to the area affected by the oil spill.

## Policies

Habitat of injured resources and the services they provide within the spill area will be protected from degradation or disturbance.

Restoration actions will address all injured resources and the services they provide.



## 2 Alternatives

Restoration actions for recovered resources will continue even after a resource has recovered.

The location of restoration actions will be limited to the spill area.

Habitat Protection will be used to protect or increase existing human use of the spill area.

### Assumptions Used for Impact Assessment

Of the remaining balance of approximately \$620 million, it is assumed for purposes of this analysis that approximately \$564 million, would be used to acquire and protect lands within the spill area, \$31 million would be spent on Monitoring and Research, and \$25 million would be spent on Administration and Public Information. This does not represent a commitment of actual resources, but is illustrative only for purposes of analysis.

The implementation of this alternative means that most if not all of the remaining funds, apart from those spent on Administration and Public Information and Monitoring and Research, would be spent on Habitat Protection.

In this alternative, it is assumed that sufficient funds will be dedicated to Habitat Protection to protect all of the parcels shown in Figures 2-1 through 2-3. The specific benefit that would accrue for each resource and service for each parcel is shown in Table A-1, Appendix A.

Habitat Protection and Acquisition may include purchase of private land or interests in land such as conservation easements, mineral rights, or timber rights. Different payment options are possible, including multi-year payment schedules to a landowner. Acquired lands would be managed to protect injured resources and the services they provide. In addition, cooperative agreements with private owners to provide increased Habitat Protection are also possible.

### Alternative 3: Limited Restoration

Alternative 3 focuses on accelerating recovery of the resources and services most severely injured by the oil spill. This alternative targets resources whose populations declined as a result of the spill and that have not yet recovered. Only actions determined to be most likely to produce significant improvements over unaided natural recovery are included in this alternative. All restoration actions included in Alternative 3 will be confined to the spill area. Habitat Protection is a major part of this alternative; none of the proposed actions would substantially increase human use within the spill area. Monitoring and Research are also included in Alternative 3.

### Policies

The most effective actions will be taken within the spill area to protect and restore all injured resources and thereby the services they provide except those biological resources whose populations did not measurably decline. The existing character of the spill area will be maintained.

- Restoration actions would address all resources except those biological resources whose populations did not measurably decline.
- Restoration actions for recovered resources will cease once a resource has recovered.
- Restoration actions will be conducted that provide substantial improvement over natural recovery.
- The location of restoration actions will be limited to the spill area.
- Restoration actions will be used to restore injured resources and thereby protect existing human use of the spill area.

## Assumptions Used for Impact Assessment

Although the majority of the funds will be used to acquire and protect lands within the spill area, this alternative also includes funding for General Restoration activities. Of the remaining balance of approximately \$620 million, it is assumed for purposes of this analysis that approximately \$465 million will be used for Habitat Protection and Acquisition, \$75 million will be used for General Restoration, \$43 million will be used for Monitoring and Research, and \$37 million will be used for Administration and Public Information. This does not represent a commitment of actual resources, but is illustrative only for purposes of analysis.

### Typical Actions Assumed Under Alternative 3

#### Habitat Protection and Acquisition

In this alternative, it is assumed that funds are sufficient to protect all of the parcels shown in Figures 2-1 through 2-3 if land or easement prices are low. It is also assumed that since prices and rights negotiated will vary widely that a smaller portion of the parcels shown could still be protected. This smaller range of parcels is shown in Figure A-1, Appendix A. The specific benefit that would accrue for each resource and the services they provide for each parcel is shown in Table A-1, Appendix A.

#### General Restoration

##### Marine Mammals:

- Cooperative programs with subsistence users
- Cooperative programs with fishermen

##### Food testing for subsistence users

##### Fish:

- Salmon egg incubation boxes
- Net pens
- Hatchery rearing
- Create new fisheries (sport and commercial)



## 2 Alternatives

Enhance or create replacement runs (sport and commercial)

### Birds:

Predator control

Clean mussel beds - 60 potential sites have been identified thus far in Prince William Sound. The other regions of the EVOS have not been surveyed.

### Recreation/Tourism:

Stabilize existing recreation opportunities

### Intertidal Resources:

Transplant *Fucus* (seaweed)

Archaeology:- 24 sites have been identified as injured

Salvage sites

Implement site stewardship program

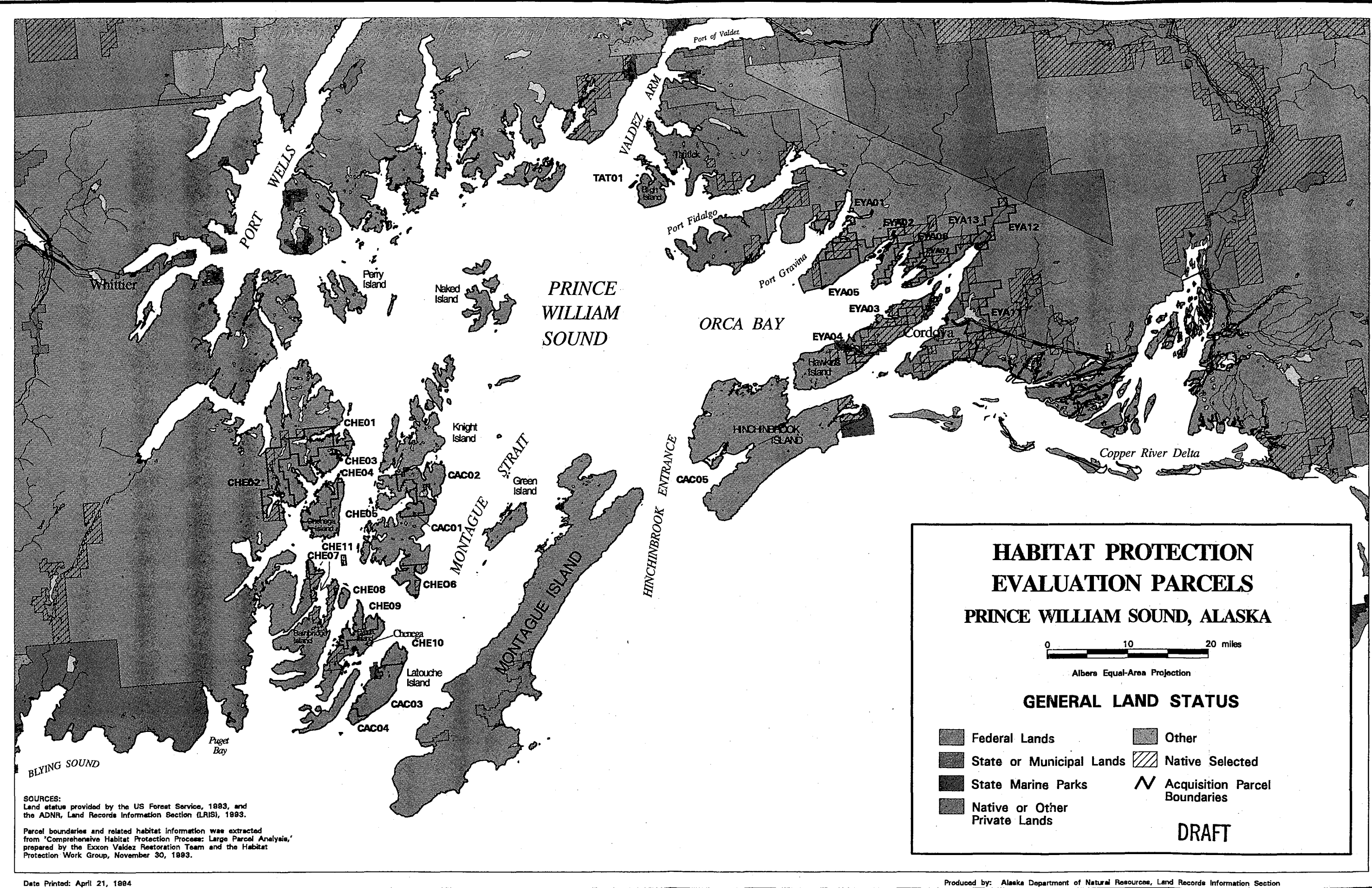
Preserve sites (stabilize)

## Alternative 4: Moderate Restoration

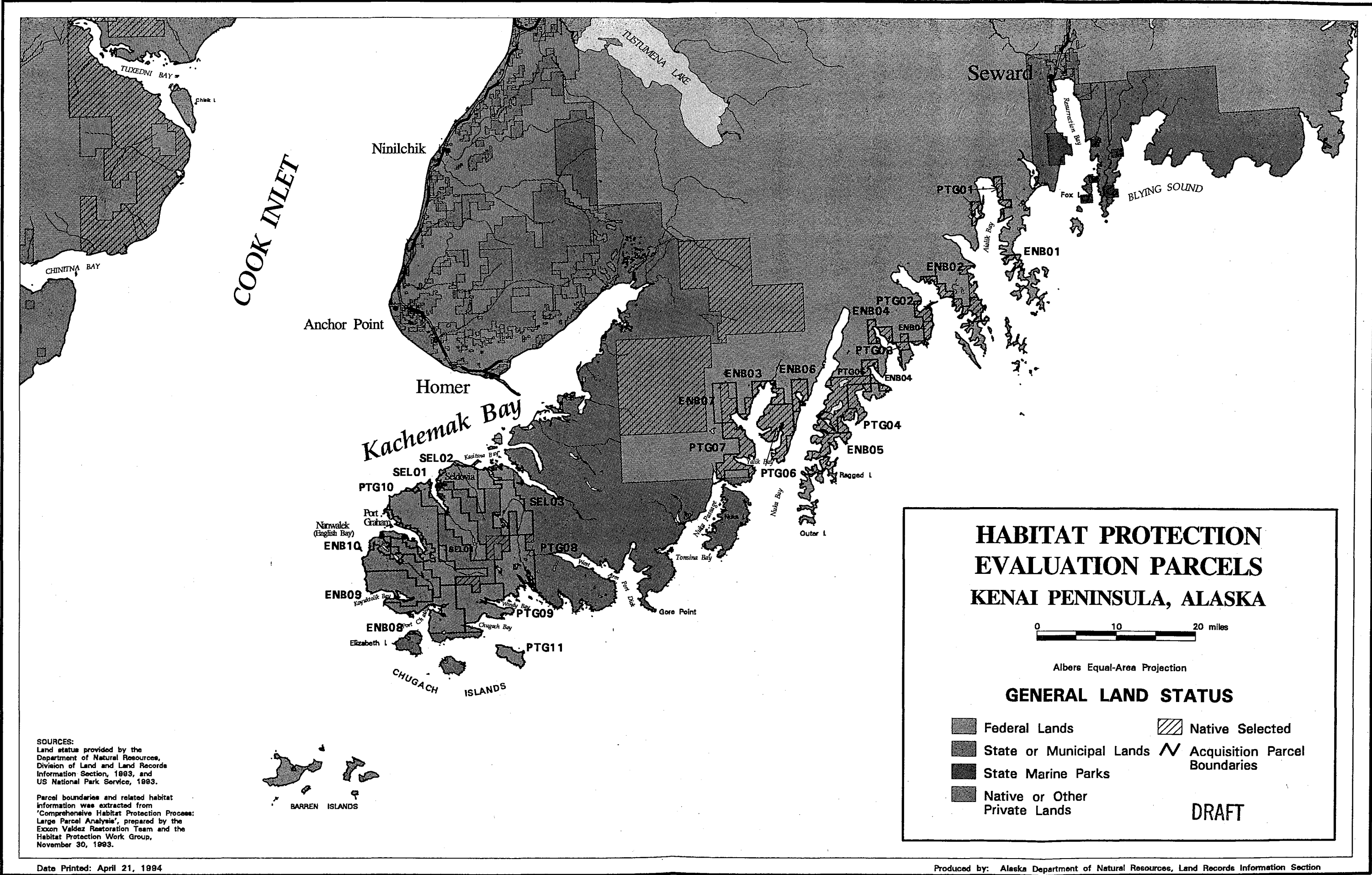
This alternative is broader than Alternative 3 in that it aims to aid recovery of all injured resources and the services they provide, not only those with population level injuries. Restoration actions included in Alternative 4 address only those resources and services that have not yet recovered from the oil spill. It is also broader than Alternative 3 in terms of the resources addressed; in Alternative 4, measures would be taken to aid recovery of resources that sustained sublethal injuries. Actions that are judged to provide substantial improvements over unaided recovery would be implemented. The actions in this alternative would be confined to Alaska but could extend beyond the spill area. Habitat Protection is included in this alternative, but to a lesser extent than in Alternatives 2 and 3. This alternative may increase opportunities for human use to a limited extent. Monitoring and Research may be conducted.

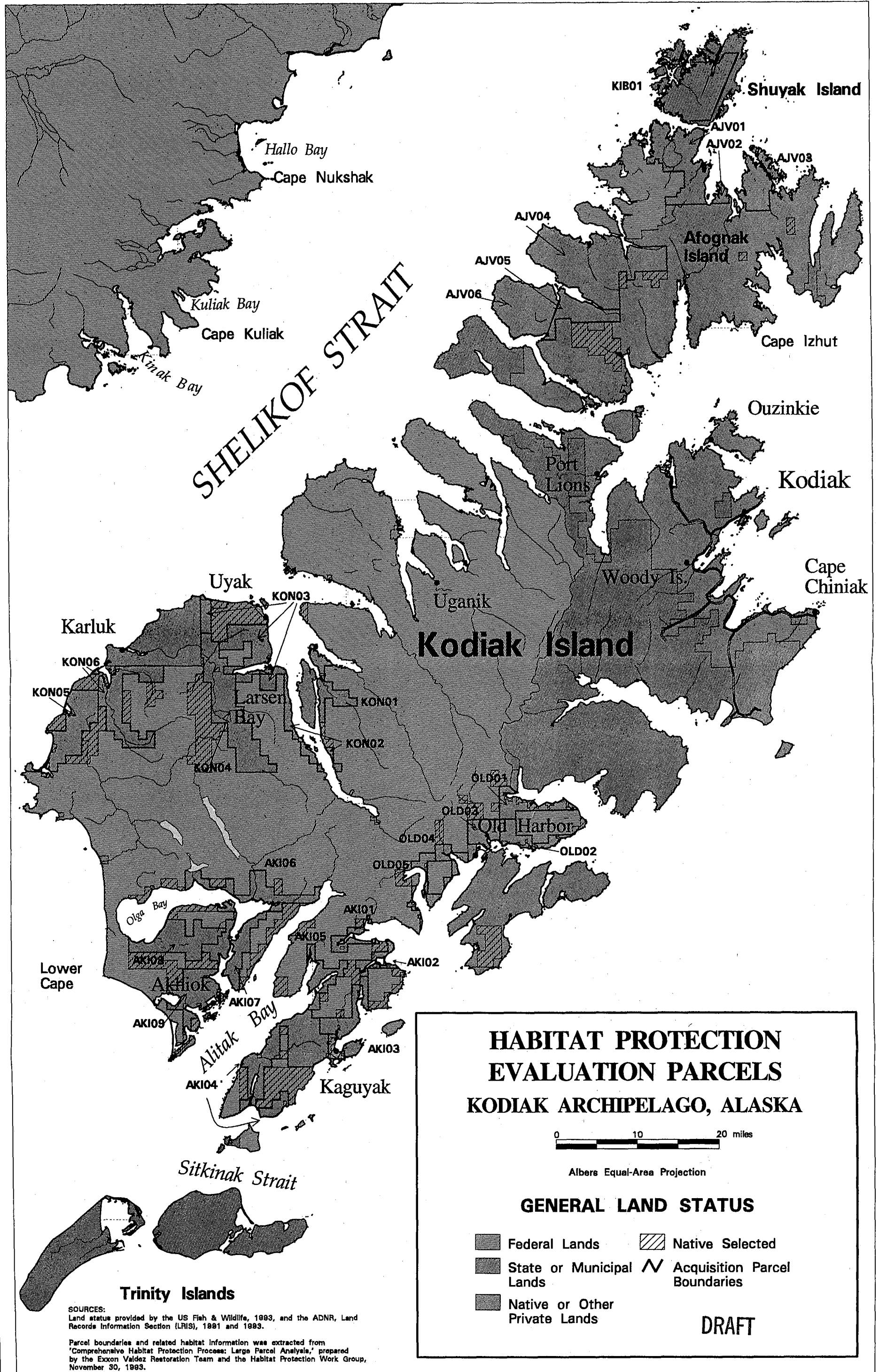
### Policies

- The most effective actions to protect and restore all injured resources and thereby the services they provide will be taken. Opportunities for human use of the spill area will be increased to a limited extent.
- Restoration actions will address all injured resources.
- Restoration actions for recovering resources will cease once a resource has recovered.
- Restoration actions will be conducted that provide substantial improvement over natural recovery.
- Restoration actions could occur anywhere there is a link to injured resources.











Restoration actions would be used to restore injured resources and thereby protect or increase existing human use of the spill area.

## Assumptions Used for Impact Assessment

About half of the settlement funds would be used for Habitat Protection and Acquisition. A significant portion of funds would go to General Restoration; and monitoring and administration funds would be slightly increased over Alternative 3.

Of the remaining balance of approximately \$620 million, it is assumed for purposes of this analysis that approximately \$310 million will be used for Habitat Protection and Acquisition, \$217 million will be used for General Restoration, \$50 million will be used for Monitoring and Research, and \$43 million will be used for Administration and Public Information. This does not represent a commitment of actual resources, but is illustrative only for purposes of analysis.

### Typical Actions Assumed Under Alternative 4

#### Habitat Protection and Acquisition

In this alternative, it is assumed that funds are sufficient to protect all of the parcels shown in Figures 2-1 through 2-3 if land or easement prices are low. It is also assumed that since prices and rights negotiated will vary widely that a smaller portion of the parcels shown could still be protected. This smaller range of parcels is shown in Figure A-1, Appendix A. The specific benefit that would accrue for each resource for each parcel is shown in Table A-1, Appendix A.

#### General Restoration

##### Marine Mammals:

- Cooperative programs with subsistence users
- Cooperative programs with fishermen

##### Food testing for subsistence users

##### Fish:

- Salmon egg incubation boxes
- Net pens
- Hatchery rearing
- Nutrient enrichment
- Create new fisheries (sport and commercial)
- Enhance or create replacement runs (sport and commercial)
- Enhance existing runs of uninjured pink and sockeye salmon
- Relocate hatchery runs of pink salmon

##### Birds:

- Predator control - 18 islands have been identified.

## 2 Alternatives

Clean mussel beds - 60 potential sites have been identified thus far in Prince William Sound. The other regions of the EVOS have not been surveyed.

### Recreation/Tourism:

- Improve existing recreation opportunities
- Stabilize existing recreation opportunities

### Intertidal Resources:

- Transplant *Fucus* (seaweed)

### Archaeology: - 24 sites have been identified as injured.

- Salvage sites
- Implement site stewardship program
- Preserve sites (stabilize)
- Acquire replacement artifacts

## The Proposed Action Alternative 5: Comprehensive Restoration

Alternative 5 is the broadest in scope of the proposed alternatives. This alternative will help all injured resources and the services they provide within the spill area and, under specific circumstances, in other parts of Alaska. Unlike Alternatives 3 and 4, this alternative will allow actions to aid resources that have already recovered, as well as those that have not. Actions likely to produce some improvement over unaided recovery will be allowable under this alternative. Habitat Protection is the largest part of this alternative. Alternative 5 also allows for expansion of current human use and encourages appropriate new uses through the restoration of natural resources. Monitoring and Research will be at the highest levels in this alternative.

Alternative 5 contains an element not present in the other alternatives. In response to public comments that a fund should be set aside for long-term restoration and research activities, the proposed action includes the establishment of a Restoration Reserve.

## Policies

Restoration activities may be considered for any injured resource.

Restoration activities will occur primarily within the spill area. Limited restoration activities outside the spill area, but within Alaska, may be considered under the following conditions:

- 1) when the most effective restoration actions for an injured migratory population are in a part of that population's range outside the spill area, or
- 2) when the information acquired from research and monitoring activities outside the spill area will be significant for restoration or understanding injuries within the spill area.



- Restoration activities will emphasize resources that have not recovered.
- Resources may be enhanced, as appropriate, to promote restoration. Restoration projects may not adversely affect the ecosystem.
- Projects designed to restore or enhance an injured service:
  - 1) must have a sufficient relationship to an injured resource,
  - 2) must benefit the same user group that was injured, and
  - 3) should be compatible with the character and public uses of the area.

## Assumptions Used for Impact Assessment

Of the remaining balance of approximately \$620 million, it is assumed for purposes of this analysis that approximately \$279 to \$310 million will be used for Habitat Protection and Acquisition, \$62 to \$93 million will be used for General Restoration, \$124 to \$155 million will be used for Monitoring and Research, \$19 to \$31 million will be used for Administration and Public Information, and \$93 to 124 million will be placed in a Restoration Reserve account. This does not represent a commitment of actual resources, but is illustrative only for purposes of analysis.

### Typical Actions Assumed Under Alternative 5

#### Habitat Protection and Acquisition

In this alternative, it is assumed that funds will be sufficient to protect all of the parcels shown in Figures 2-1 through 2-3 if land or easement prices are low. It is also assumed that since prices and rights negotiated will vary widely that a smaller portion of the parcels shown could still be protected. This smaller range of parcels is shown in Figure A-1, Appendix A. The specific benefit that would accrue for each resource and service for each parcel is shown in Table A-1, Appendix A.

#### General Restoration

##### Marine Mammals:

- Cooperative programs with subsistence users
- Cooperative programs with fishermen
- Reduce disturbance to harbor seals

Food testing for subsistence users \ \

##### Fish:

- Salmon egg incubation boxes
- Net pens
- Hatchery rearing
- Nutrient enrichment
- Fish migration corridor improvements (blockage removal and fish passes)
- Habitat improvements (spawning channels, etc.)
- Relocation of hatchery runs
- Create new fisheries (sport, subsistence, and/or commercial)

## 2 Alternatives

Enhance or create replacement runs (sport, subsistence, and/or commercial)  
Enhance existing runs of uninjured pink and sockeye salmon

### Birds:

Predator control - 15 islands have been identified  
Clean mussel beds - 60 potential sites have been identified thus far in Prince William Sound. The other regions of the EVOS have not been surveyed.  
Reduce disturbance to common murre  
Reduce disturbance to pigeon guillemots

### Recreation/Tourism:

Improve existing recreation opportunities  
Stabilize existing recreation opportunities  
Create new recreation opportunities  
Promote public land recreation use

### Intertidal Resources:

Transplant *Fucus* (seaweed)  
Mariculture clams

### Archaeology: - 24 sites have been identified

Salvage sites  
Implement site stewardship program  
Preserve sites (stabilize)  
Acquire replacement artifacts

Restoration Reserve for future restoration needs

## Other Alternatives Considered and Rejected

An alternative that consisted only of natural recovery monitoring was considered but rejected from detailed consideration. This alternative was similar to Alternative 1 except that some of the settlement funds would be spent on monitoring the recovery of the resources. This aspect of the alternative is contained in the other alternatives and did not require a new alternative.

## Comparison of Alternatives

Table 2-1 identifies and compares how each of the proposed alternatives addresses the five restoration issues posed in Chapter 1. Alternative 1 is not included because it would have a very limited effect on these issues. The alternatives cannot be rank-ordered as to their relative effectiveness because this judgment is tied to the values assigned to the issues.

Each alternative in the Draft Restoration Plan is structured to give varying degrees of emphasis among four categories of activities: (1) Habitat Protection and Acquisition; (2) General Restoration; (3) Monitoring and Research; and (4) Administration and Public

Information. The no action alternative (Alternative 1) does not contemplate any activities in the categories above and beyond normal agency management actions.

The comparative emphasis on categories of actions for Alternatives 2 through 5 as illustrated by the variations in budget emphasis is shown in Table 2-2. The essential variation among the alternatives has to do with the balance between Monitoring and Research, Habitat Protection, and General Restoration activities. Alternative 2 principally consists of Habitat Protection with no restoration activities. Alternative 4 places the greatest emphasis on General Restoration activities. Alternative 5 proposes a greater emphasis on Monitoring and Research than the other alternatives while still emphasizing Habitat Protection.

Alternatives 3, 4, and 5 vary in terms of the scope of restoration activities proposed. Restoration in Alternative 3 would be limited to actions that would significantly aid natural recovery of the most injured resources; all actions would be taken only in the spill area.

Alternative 4 envisions actions that would aid recovery of all injured resources and services, not just the most injured. These actions could take place within or outside the spill area; none would occur outside the State of Alaska. Alternative 5 is the most comprehensive in its approach in that all injured resources and services could be aided, regardless of the degree of initial injury or recovery status. As in Alternative 4, actions could take place within the spill area or elsewhere in the State of Alaska. Under the Alternative 5 approach, not only would assistance to recovery of injured resources occur, but also actions to expand current uses and to encourage new uses would be taken.

Table 2-3 is a comparison of the impacts of the various alternatives on the impact topics analyzed in this EIS. The complete discussion of these impacts is found in Chapter 4. Table 2-4 contains the definitions of the various levels of impact.

Table 2-1.

## ISSUES ADDRESSED BY ALTERNATIVES

| Issues   | Alternatives  |  |   |   |
|--|---|--|---|---|
|  | 2   | 3  | 4   | 5   |
| 1. How would restoration activities contribute to restoring injured resources and services?                  | Largest percent of allocation for Habitat Protection of all alternatives, could enhance natural rate of recovery.   | Second highest allocation of restoration funding for Habitat Protection. Only high rate of recovery options selected under this alternative.   | Third highest allocation of restoration funding for Habitat Protection. Would include only those resources and services that have not recovered from <i>EVOS</i> .                      | Least amount allocated to Habitat Protection. Would include all injured resources and services. Largest amount allocated to Monitoring and Research.                                    |
| 2. How would activities directed at injured resources and services affect non-target resources and services? | Habitat Protection would greatly enhance ecosystem management and the consideration of nontarget species.   | Habitat Protection would greatly enhance ecosystem management and the consideration of nontarget species.  | Habitat Protection would moderately enhance ecosystem management and the consideration of nontarget species.  | Habitat Protection would moderately enhance ecosystem management and the consideration of nontarget species.  |
| 3. What ecological change would occur in the spill area as a result of restoration activities?               | Habitat Protection would enhance the ecological integrity of the <i>EVOS</i> area and therefore promote beneficial ecological change to the largest degree. | Habitat Protection would enhance the ecological integrity of the <i>EVOS</i> area to the second largest degree and General Restoration could enhance recovery of natural ecological conditions for selected species. | Habitat Protection would enhance the ecological integrity of the <i>EVOS</i> area and General Restoration could enhance recovery of natural ecological conditions for selected species. | Habitat Protection would enhance the ecological integrity of the <i>EVOS</i> area and General Restoration could enhance recovery of natural ecological conditions for selected species. |



Table 2-1

ISSUES ADDRESSED BY ALTERNATIVES

| Issues  | Alternatives   |  |  |   |
|---|--|--|--|---|
|   | 2  | 3  | 4  | 5   |
| 4. How would restoration activities affect land uses, local economies, and communities? | Habitat Protection could preclude areas from resource extraction. Tourism and fishing economies may benefit. | Habitat Protection may preclude areas from resource extraction. Tourism and fishing economies could benefit. Short-term disruption of fishing. | Habitat Protection may preclude areas from resource extraction. Tourism and fishing economies could benefit. Short-term disruption of fishing.         | Habitat Protection may preclude areas from resource extraction. Tourism and fishing economies may benefit. Short-term disruption of fishing.        |
| 5. What changes to subsistence uses would occur as a result of restoration activities?  | Habitat Protection would protect subsistence uses on certain lands.  | Habitat Protection would protect subsistence uses on certain lands. General Restoration could enhance opportunities for subsistence use.       | Habitat Protection would protect subsistence uses on certain lands. General Restoration could substantially enhance opportunities for subsistence use. | Habitat Protection would protect subsistence uses on certain lands. General Restoration could moderately enhance opportunities for subsistence use. |

## 2 Alternatives

**Table 2-2**  
**Comparative Budget Emphasis of Restoration Categories by Alternative**

| Category                            | Projected Budget (in millions of dollars) |      |      |      |         |
|-------------------------------------|---|------|------|------|---------|
|                                     | Alternatives                              |      |      |      |         |
|                                     | 1   | 2    | 3    | 4    | 5       |
| Administration & Public Information | \$0                                       | \$25 | \$37 | \$43 | \$19-31 |
| Monitoring & Research               | 0   | 31   | 43   | 50   | 124-155 |
| General Restoration                 | 0   | 0    | 75   | 217  | 62-93   |
| Habitat Protection                  | 0   | 564  | 465  | 310  | 279-310 |
| Restoration Reserve                 | 0   | 0    | 0    | 0    | 93-124  |

Note: Reimbursements of 3 to 5 percent of the remaining approximately \$650 million were subtracted leaving an assumed budget balance of approximately \$620 million which is the basis for the figures shown above.

**Table 2-3**  
**Comparison of the Impacts of the Alternatives**

| Resource                     | Alternatives |                   |                                  |                                  |                                  |
|------------------------------|--------------|-------------------|----------------------------------|----------------------------------|----------------------------------|
|                              | 1            | 2                 | 3                                | 4                                | 5                                |
| Intertidal organisms         | -            | Moderate          | Unknown<br>(moderate protective) | Unknown<br>(moderate protective) | Unknown<br>(moderate protective) |
| Harbor Seals                 | -            | Low-Moderate      | Moderate                         | Moderate                         | Moderate                         |
| Sea Otters                   | -            | Low               | Moderate                         | Moderate                         | Moderate                         |
| Harlequin Duck               | -            | High              | High                             | High                             | High                             |
| Common Murre                 | -            | Moderate          | Moderate                         | Moderate                         | Moderate                         |
| Pigeon Guillemot             | -            | Moderate          | Moderate                         | Moderate                         | Moderate                         |
| Marbled Murrelet             | -            | High              | High                             | High                             | High                             |
| Pink Salmon                  | -            | Moderate          | Moderate                         | Moderate                         | High                             |
| Sockeye Salmon               | -            | Moderate          | High                             | High                             | High                             |
| Pacific Herring              | -            | Moderate          | Moderate                         | Moderate                         | Moderate                         |
| Cultural Resources           | -            | Moderate          | Moderate                         | Moderate to High                 | Moderate to High                 |
| Subsistence                  | -            | Low To Moderate   | Moderate                         | Moderate to High                 | Moderate to High                 |
| Recreation /Tourism.         | -            | Moderate          | Moderate                         | Moderate to High                 | Moderate to high                 |
| Wilderness                   | -            | Negligible to Low | Moderate                         | Moderate                         | High                             |
| Commercial Fishing           | -            | Moderate          | Moderate                         | Moderate                         | Moderate                         |
| Sport Fishing                | -            | Moderate          | High                             | High                             | Moderate                         |
| Economy (Forestry)           | -            | Negative Moderate | Negative Moderate                | Negative Moderate                | Negative Moderate                |
| Economy (Commercial Fishing) | -            | Moderate          | Moderate                         | Moderate                         | Moderate                         |
| Economy (recreation)         | -            | Moderate          | Moderate                         | Moderate                         | Moderate                         |

Note: Impacts are beneficial unless otherwise stated.

| Table 2-4<br>DEFINITIONS OF IMPACT LEVELS |   |   |  |   |
|---|---|---|--|---|
| Resource                                  | NEGLIGIBLE  | LOW   | MODERATE   | HIGH  |
| <b>Intertidal organisms</b>               | Little or no improvement in the resource's ability to recover, or in the quality of its habitat. Little or no reduction in impacts from human interactions. | Proposed restoration actions may reduce negative impacts from the spill or from some anticipated, or current, human activities. These reduced negative effects do not create an improvement in the ability of the injured population to recover either locally or regionally. | Proposed restoration actions have a high potential to reduce negative impacts from the spill or from anticipated, or current, human activities. These reduced negative effects could improve the ability of the injured population to recover more rapidly but measurable increases would only occur in localized areas. | Proposed restoration actions have a high potential to change the ability of the injured population to recover, so that the expected time period to reach recovery is reduced on a regional basis. |
| <b>Marine Mammals</b>                     | Little or no improvement in the resource's ability to recover, or in the quality of its habitat. Little or no reduction in impacts from human interactions. | Proposed restoration actions may reduce negative impacts from the spill or from some anticipated, or current, human activities. These reduced negative effects do not create an improvement in the ability of the injured population to recover either locally or regionally. | Proposed restoration actions have a high potential to reduce negative impacts from the spill or from anticipated, or current, human activities. These reduced negative effects could improve the ability of the injured population to recover more rapidly but measurable increases would only occur in localized areas. | Proposed restoration actions have a high potential to change the ability of the injured population to recover, so that the expected time period to reach recovery is reduced on a regional basis. |
| <b>Birds</b>                              | Little or no change expected in population level, productivity rate, or sub-lethal injury.  | Unlikely to affect regional recovery of population level, productivity rate, or sub-lethal injury, but may enhance recovery of local segment of population.   | Likely to enhance to a measurable degree the regional recovery of population level, productivity rate, or to reduce sub-lethal injury, and may substantially enhance recovery of local segment of population.  | High probability of substantially enhancing population level, productivity rate, or for reducing sub-lethal injury throughout EVOS region.  |



Table 2-4 (cont.)

## DEFINITIONS OF IMPACT LEVELS

| Resource                  | NEGLIGIBLE   | LOW   | MODERATE  | HIGH   |
|---------------------------|--|---|---|--|
| <b>Fish</b>               | Little or no increase or recovery of the injured resource sooner than by natural recovery; or, little or no protection of the habitat from disturbance.  | Unlikely or small increase or recovery of the injured resource sooner than by natural recovery; or, limited protection of the habitat from disturbance.   | Moderate increase or partial recovery of the injured resource or service sooner than by natural recovery; or, high benefits in limited area(s); or, moderate protection of the habitat from disturbance.  | Recovery of the injured resource sooner than by natural recovery; or, recovery of the injured resource to a greater than pre-spill amounts; or, substantial protection of the habitat from disturbance.  |
| <b>Cultural Resources</b> | Little or no protection for archaeological or historic sites; or little or no improvement of the understanding or appreciation of cultural resource values within the EVOS area.   | Small increase in protection for archaeological or historic sites; or small improvement of the understanding or appreciation of cultural resource values in limited locations within the EVOS area.   | Moderate increase in protection for archaeological or historic sites; or moderate improvement of the understanding or appreciation of cultural resource values throughout the EVOS area; or substantial improvement of the understanding or appreciation of cultural resource values in limited locations within the EVOS area.                             | Substantial increase in protection for archaeological or historic sites; or substantial improvement of the understanding or appreciation of cultural resource values throughout the EVOS area.   |
| <b>Subsistence</b>        | Little or no change in populations of subsistence harvest species injured by EVOS; or small increase in confidence levels that subsistence users in affected communities have in lack of contamination in subsistence foods. | Small increase in populations of subsistence harvest species injured by the EVOS; or small increase in confidence levels that subsistence users in affected communities have in the lack of contamination in subsistence foods. Increases may be localized or throughout the EVOS area. | Moderate increase in populations of subsistence harvest species negatively affected by EVOS; or moderate increase in the confidence levels that subsistence users in affected communities have in the lack of contamination in subsistence foods throughout the EVOS area; or substantial increases in populations or confidence levels in localized areas. | Substantial increase in populations of subsistence harvest species negatively affected by EVOS; or substantial increase in the confidence levels that subsistence users in affected communities have in the lack of contamination in subsistence foods throughout the EVOS area. |

**Table 2-4 (cont.)**  
**DEFINITIONS OF IMPACT LEVELS**

| <b>Resource</b>                               | <b>NEGLIGIBLE</b>  | <b>LOW</b>   | <b>MODERATE</b>  | <b>HIGH</b>  |
|---|--|--|--|--|
| <b>Recreation &amp; Tourism</b>               | Little or no change in numbers of users, or on the quality of their experience.  | Small increase in numbers of users, or small increase in protection or improvement of recreation quality in localized areas within the EVOS area.      | Moderate increase in numbers of users, or moderate increase in protection or improvement of recreation quality throughout the EVOS area; or substantial increase in numbers of users or substantial improvement of recreation quality in localized areas within the EVOS area. | Substantial increase in numbers of users, or substantial increase in protection or improvement of recreation quality throughout the EVOS area.   |
| <b>Wilderness</b>                             | Little or no reduction of residual oil and materials left from clean-up activities, and no change in public perception of injury to Wilderness.        | Small reduction of residual oil and materials left from clean-up activities, or small change in public perception of injury to Wilderness.             | Moderate reduction of residual oil and materials left from spill clean-up activities, or moderate change in perception of injury to Wilderness.  | Substantial reduction of residual oil spill and materials left from clean-up activities and substantial change in perception of injury to Wilderness.  |
| <b>Commercial Fishing &amp; Sport Fishing</b> | Little or no increase or recovery of the injured service sooner than by natural recovery; or, little or no protection of the habitat from disturbance. | Unlikely or small increase or recovery of the injured service sooner than by natural recovery; or, limited protection of the habitat from disturbance. | Moderate increase or partial recovery of the injured service sooner than by natural recovery; or, high benefits in limited area(s); or, moderate protection of the habitat from disturbance.   | Recovery of the injured service sooner than by natural recovery; or, recovery of the injured resource to a greater than pre-spill amounts; or, substantial protection of the habitat from disturbance. |
| <b>Economy</b>                                | Barely measurable contribution to employment and economic output over a 10-year period or longer.  | Less than a substantial contribution to employment and economic output over a 10-year period or longer.  | Moderately substantial contribution to employment and economic output over a 10-year period or longer.   | Very substantial contribution to employment and economic output over a 10-year period or longer.   |

# **Chapter 3**

## **Affected Environment**

|  |    |
|--|----|
| Introduction . . . . .                           | 1  |
| Physical Setting . . . . .                       | 1  |
| Greater EVOS Ecosystem . . . . .                 | 3  |
| Marine Ecosystem . . . . .                       | 4  |
| Coastal Ecosystem . . . . .                      | 4  |
| The Subtidal Zone . . . . .                      | 5  |
| The Intertidal Zone . . . . .                    | 5  |
| Fucus . . . . .                                  | 6  |
| Clams . . . . .                                  | 6  |
| Mussels . . . . .                                | 6  |
| Terrestrial (Upland) Ecosystem . . . . .         | 7  |
| Biological Resources . . . . .                   | 8  |
| Marine Mammals . . . . .                         | 8  |
| Harbor Seals . . . . .                           | 9  |
| Sea Otters . . . . .                             | 10 |
| Birds . . . . .                                  | 11 |
| Background Information/Species Account . . . . . | 11 |
| Harlequin Duck . . . . .                         | 11 |
| Murre . . . . .                                  | 15 |
| Pigeon Guillemot . . . . .                       | 16 |
| Marbled Murrelet . . . . .                       | 18 |
| Fish . . . . .                                   | 19 |
| Pink Salmon . . . . .                            | 20 |
| Sockeye Salmon . . . . .                         | 21 |
| Pacific Herring . . . . .                        | 22 |
| Rockfish . . . . .                               | 23 |
| Dolly Varden . . . . .                           | 24 |
| Cutthroat Trout . . . . .                        | 24 |
| Social and Economic Environment . . . . .        | 25 |
| The Sociocultural Context . . . . .              | 25 |
| Cultural Heritage Resources . . . . .            | 30 |
| Subsistence . . . . .                            | 33 |
| Recreation and Tourism . . . . .                 | 39 |
| Recreation . . . . .                             | 40 |
| Commercial Recreation (Tourism) . . . . .        | 43 |
| Wilderness . . . . .                             | 44 |
| Commercial Fishing . . . . .                     | 45 |
| Recreational Fishing . . . . .                   | 50 |
| Economy . . . . .                                | 51 |



# Chapter 3

## Affected Environment

### Introduction

This chapter describes the areas within the Gulf of Alaska from Prince William Sound to the Alaska Peninsula directly affected by the *Exxon Valdez* oil spill (EVOS). The first part of the chapter

- describes the physical and biological environment including the physical setting; marine, coastal, and terrestrial ecosystems; and individual biological resources; and
- summarizes injury to the birds including results of the natural resource damage-assessment studies.

The second part of the chapter

- describes the social and economical environment in the affected area before and after the spill and
- gives the historical background of the affected regions, as well as information about the socioeconomic and cultural impacts of the spill on affected communities.

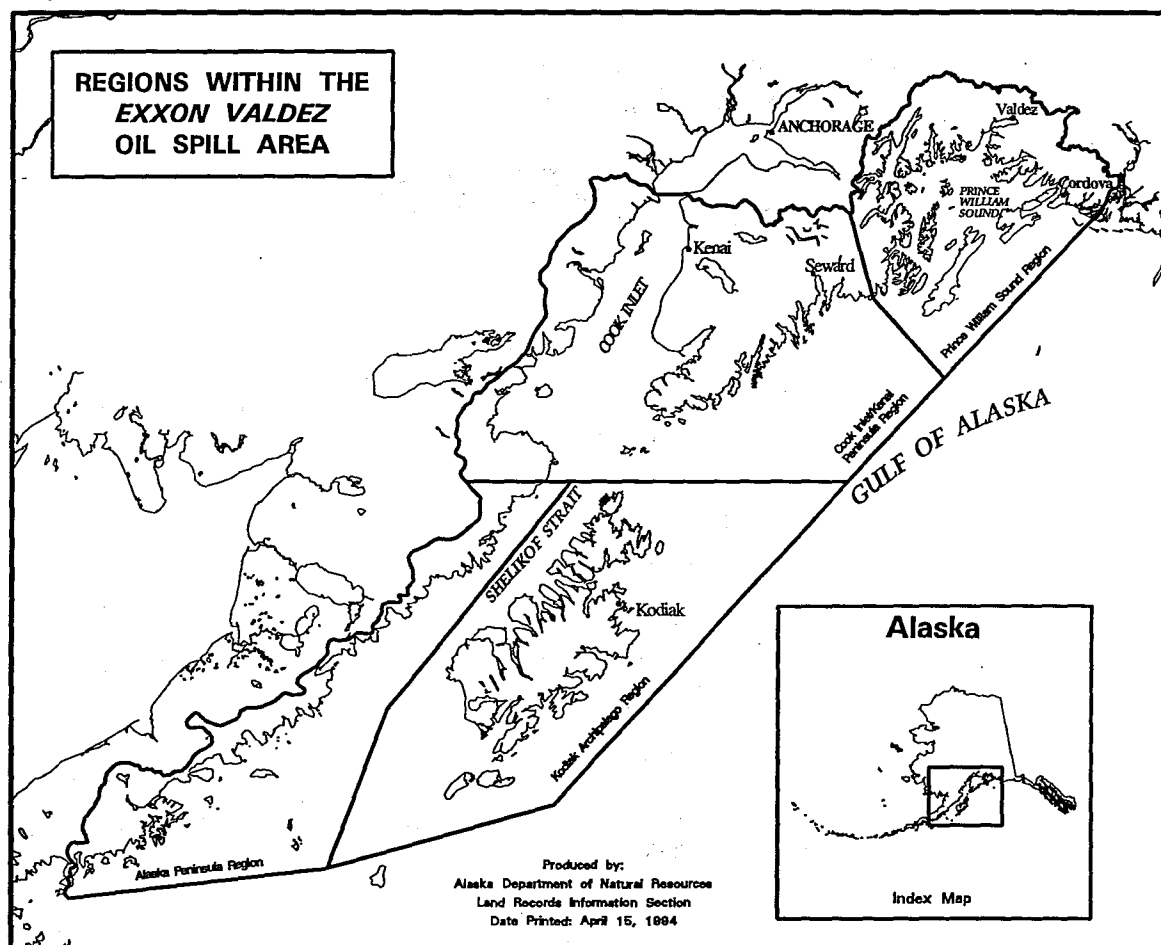
### Physical Setting

The EVOS area is located in southcentral Alaska, including the northern and western portions of the Gulf of Alaska, and encompasses a surface area of approximately 75,000 square miles. The EVOS area is divided into 4 regions as shown in Figure 3-1. At the northeastern edge of the EVOS area is Prince William Sound, which is about the size of Maryland's Chesapeake Bay or Washington State's Puget Sound (Mickelson,

### 3 Affected Environment

1988). Southwest of Prince William Sound are the Kenai Peninsula and Kodiak Island. South of the Kenai Peninsula is the Shelikof Strait, which lies between Kodiak Island and the Alaska Peninsula. The Alaska Peninsula narrows into the Aleutian islands. The EVOS area contains 15 major islands, 19 minor islands; and 150 lesser islands.

Figure 3-1



The geology of the region is young and relatively unstable; glaciers, earthquakes, and active volcanoes are common. In March 1964, an earthquake with an epicenter west of Columbia Glacier in Prince William Sound shook for approximately 5 minutes and destroyed the towns of Valdez, Kodiak, Seward, and Chenega. Winter winds in the Gulf of Alaska generally are easterly or southeasterly and interact with currents to push waters into Prince William Sound. This produces complex flow patterns that result in strong downwelling and an outflow of surface waters to the southwest. Most of the EVOS area has a maritime climate with heavy precipitation that averages 150 inches annually in Prince William Sound. Much of the area is snow covered in the winter, with up to 21 feet of snowfall per year in Valdez. In Prince William Sound, 15 percent of the total area, mostly in the mountains, is covered with permanent ice and snow (Mickelson, 1988).

## Greater EVOS Ecosystem

The Draft EVOS Restoration Plan (November 1993) states that ecosystems include the entire community of organisms that interact with each other and their physical surroundings, including people and their relationship with other organisms. The greater EVOS ecosystem could be divided into numerous smaller ecosystems based on differing vegetative communities, amounts of rainfall, human activities, or countless other factors. For the purposes of this document, there are three primary ecosystem divisions within the oil spill area: the terrestrial (upland), the coastal (shoreline), and the marine (pelagic) ecosystems. In addition to describing of these ecosystems, this chapter also describes the particular resources and services (human uses) that were most affected by the oil spill. Table 3-1 illustrates how these individual resources and services relate to the three ecosystem subdivisions.

**Table 3-1**  
**Distribution of Resources by Ecosystem Category**

| <b>Resource</b>          | <b>Terrestrial</b> | <b>Coastal</b> | <b>Marine</b> |
|--------------------------|--------------------|----------------|---------------|
| <b>Natural Resources</b> |                    |                |               |
| Harbor Seal              | -                  | x              | x             |
| Sea Otter                | -                  | x              | -             |
| Sockeye Salmon           | x                  | x              | x             |
| Pacific Herring          | -                  | x              | x             |
| Pink Salmon              | x                  | x              | x             |
| Common Murre             | -                  | x              | x             |
| Harlequin Duck           | x                  | x              | -             |
| Marbled Murrelet         | x                  | x              | x             |
| Pigeon Guillemot         | -                  | x              | x             |
| Intertidal Organisms     | -                  | x              | -             |
| <b>Other Resources</b>   |                    |                |               |
| Archaeological Resources | x                  | -              | -             |
| Designated Wilderness    | x                  | -              | -             |

# 3 Affected Environment

## Marine Ecosystem

The marine ecosystem in the EVOS area is characterized by deep water (hundreds of meters) and cold temperatures. Most of the marine waters within the oil spill area are located above the continental shelf and are less than 200 m deep. The offshore waters of the Gulf of Alaska strongly influence the ecology of the shallower coastal waters. This deeper, open water region is not directly affected by wave action, terrestrial runoff, or other near-shore processes. In general, water flows throughout the Gulf of Alaska in a counterclockwise pattern. The Alaska Coastal Current dominates the shelf waters from Prince William Sound around the coast to the beginning of the Aleutian Islands (Reed and Schumacher, 1986). Waters in Prince William Sound and Cook Inlet have lower salinity than the rest of the Gulf due to meltwater from glaciers and snow covered mountains, and from high rainfall in the summer (Reed and Schumacher, 1986). High winds and strong currents provide mixing of waters and the important plankton communities.

The EVOS area includes some of the most productive high-latitude shelf waters in the world (Sambrotto and Lorenzen, 1986). Phytoplankton blooms occur in the late spring and decline during the summer. Zooplankton follow the distribution of phytoplankton and peak 1 to 2 months later. Copepods, euphausiids, and other zooplankton are the major food source for many marine species, including whales and salmon (Cooney, 1986). Polychaete annelids and mollusks dominate a diverse benthic community of more than 200 species to depths of 200 m (O'Clair and Zimmerman, 1986).

Diverse and abundant communities of finfish and shellfish are present in the EVOS region, especially in Prince William Sound, Cook Inlet, and Shelikof Strait. Five species of Pacific salmon (chinook, coho, pink, chum, and sockeye) leave the open ocean to spawn in the intertidal zones and rivers of the region. Abundant saltwater finfish include halibut, sole, flounder, sablefish, pollock, mackerel, and Pacific Ocean perch. King, tanner, and Dungeness crabs are abundant and, in summer months, move to shallower water for spawning. Shrimp, clams, and scallops also are important shellfish in the region (Alaska Department of Fish and Game [ADF&G], 1985).

Large populations of marine mammals are an important component of the marine ecosystem. The most abundant species are sea lions, harbor seals, sea otters, and whales. It is estimated that 100,000 individual marine mammals annually reside in or migrate through the Gulf of Alaska. Many areas within the oil spill region contain large concentrations of marine mammals, e.g., sea otters in Prince William Sound, sea lions on the Barren Islands, and seals throughout the bays and river deltas of the mainland and Kodiak Island.

## Coastal Ecosystem

The coastal ecosystem is vital to the health of the greater EVOS area ecosystem. It connects the highly productive marine ecosystem to the rugged terrestrial ecosystem and provides food and shelter for marine and terrestrial organisms. Tectonic and glacial influences have produced an extremely irregular coast characterized by long beaches and dune ridges backed by high marine terraces. Short meltwater streams and large river deltas add to the diversity of the coastal topography. The coastal ecosystem includes the terrestrial and aquatic areas dominated by near-shore processes such as tidal movement, salt spray, intertidal and shoreline vegetation, marshes, and beach areas where salt and shoreline processes dominate, as well as shallower offshore waters that are greatly influenced by near-shore processes. It



also includes narrow fjords and channels that occur in the spill area. The coastal ecosystem has two distinct zones: the subtidal and the intertidal.

#### The Subtidal Zone

The nearshore, shallow subtidal zone provides the transition area between the marine, deep-water environment and the intertidal zone. The subtidal zone extends from the low tide boundary of the intertidal zone into the open-water area. Because the nearshore subtidal community is similar in many respects to the intertidal community, it is considered separately from the marine ecosystem. Monitoring and research are the most likely restoration actions to focus on the subtidal communities. Because monitoring and research are not likely to produce environmental impacts (see the discussion on Monitoring and Research in Chapter 1, pg 19) organisms in the subtidal community are not analyzed in this DEIS. However, clams occur in both intertidal and subtidal zones and may be affected by some of the proposed actions. Therefore, the impacts on clams will be analyzed along with other intertidal organisms.

#### The Intertidal Zone

The intertidal zone is the environment located between the extent of high and low tides. Because of the rise and fall of the tides, the area is not always covered with water. The size of the intertidal area is determined by the slope of the shore and the extent of the rise and fall of the tides (Newell, 1979). Inhabitants of the intertidal zone consist of algae (e.g., *Fucus*), mussels, clams, barnacles, limpets, amphipods, isopods, marine worms, and certain species of fish. The intertidal zone is used as a spawning or rearing area for many species of fish (EVOS Trustee Council, 1992) and serves as a feeding ground for marine consumers (e.g., sea otters, Dungeness crabs, juvenile shrimps, rockfish, cod, and juvenile fishes), terrestrial consumers (e.g., bears, river otters, and humans), and birds (e.g., black oystercatchers, harlequin ducks, numerous other species of ducks, and shorebirds) (Peterson, 1993). Because of the nature of the intertidal environment, the intertidal zone is especially vulnerable to initial and continued contamination in the event of an oil spill, as well as to the effects of cleanup operations (EVOS Trustee Council, 1992).

The oil spill caused population declines and sublethal injuries to the community of plants and animals living in the intertidal zone. Portions of 1,500 miles of coastline were oiled (350 miles heavily oiled), resulting in significant impacts to intertidal habitats, particularly in the upper intertidal zone. With tidal action, the 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 (mussel beds which were avoided during the cleanup).

Direct oiling killed many organisms, but beach cleaning, particularly high-pressure, hot-water washing, had a devastating effect on intertidal life. Several studies have documented the combined effects of oiling and cleanup on beaches and now track the course of recovery. Because of little or no prespill data, these studies have relied on comparisons of oiled and nonoiled sites. Because of our ability to measure effects on common organisms, these comparisons have been emphasized in the injury studies.

### 3 Affected Environment

#### *Fucus*

The most significant impacts occurred in the upper and middle intertidal zones on sheltered rocky shores, where the greatest amounts of oil stranded. In the upper and middle intertidal zones of rocky shores, the algae *Fucus gardneri* (rockweed or popweed), barnacles, limpets, periwinkles, clams, amphipods, isopods, and marine worms were less abundant at oiled than nonoiled sites. Although there were increased densities of mussels in oiled area, they were significantly smaller than mussels in the nonoiled areas; and the total biomass was significantly lower. While the percentage of intertidal areas covered by *Fucus* was reduced following the spill, the coverage of opportunistic plants (ephemeral algae) that characteristically flourish in disturbed area was increased. The average size of *Fucus* plants was reduced, as was the reproductive potential of those plants surviving the initial oiling. The lower and middle intertidal zones have recovered to a large extent, but injuries persist most strongly in the upper intertidal zone, especially on rocky sheltered shores. Natural recovery of the upper intertidal zone will occur in stages as the different species in the community respond to improved environmental conditions.

Recovery in the upper intertidal appears to depend on the return to this zone of adult *Fucus* in large numbers. In the absence of a well-developed canopy of adult plants, eggs and developing propagules of *Fucus* lack sufficient moisture to survive. The reduced canopy of rockweed in the upper intertidal zone also appears to have made it easier for oystercatchers to prey on limpets. Accordingly, the recovery of limpets and other invertebrates also is linked to the recovery of rockweed. Existing adult plants will act as centers for the outward propagation of new plants, and it is estimated that recovery of *Fucus* may take a decade. Full recovery of the intertidal community may take more than a decade, because it may take several years for invertebrate species to return after *Fucus* has recolonized an area.

#### Clams

The magnitude of measured differences varied with degree of oiling and geographic area. On sheltered beaches, the data on abundance of clams in the lower intertidal zone strongly suggest that little neck clams and, to a lesser extent, butter clams were significantly affected by the spill. During the 1993 public meetings, people throughout the oil spill area, but especially in Kodiak and Alaska Peninsula communities, said they are still finding clam beds that are contaminated with oil. Clams are an important resource for subsistence and recreational use within the oil spill area, and they are preyed upon by a wide variety of other resources.

#### Mussels

Within the United States, the subspecies of blue mussel called *Mytilus trossulus* is distributed from Oregon to Alaska (Moore, pers. comm., 1993). It is found along rocky coastlines, in bays, and in estuaries. Blue mussels are harvested for bait and for food. Mussels are suspension feeders and feed on dinoflagellates, organic particles, small diatoms, zoospores, ova and spermatozoa, flagellates, unicellular algae, and detritus.

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 ducks, 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 and continue to be investigated.

## Terrestrial (Upland) Ecosystem

The EVOS area can be divided into three biogeographic regions: Prince William Sound, Kenai Peninsula, and Kodiak Archipelago/Alaska Peninsula. The landforms and vegetation present in each region vary dramatically, but all are heavily influenced by a history of glaciation. Glaciers still are present at high elevations in all three regions. At lower elevations, ecological conditions vary between the mountainous fjord and glacier-dissected rainforest areas and the flat coastal deltas of large rivers.

Because of the dramatic relief throughout the region, distinct vegetation zones are common. Terrestrial vegetation adjacent to coastal ecosystems is centered around alder thickets, devil's club, willow, mountain ash, and berries. Successive upland zones include shrubland, deciduous woodland, coniferous forest, moist tundra, alpine tundra, and barren areas. Alder predominates in the shrubland and deciduous zones while Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*) dominate the coniferous forest. Interior forests may include white and black spruce with birch. At higher elevations, these trees are replaced first by dwarf shrubs, grasses, and sedges and later by lichens and moss.

Terrestrial habitats can be classified into riparian, wetlands, old-growth forest (200-years plus), mature forest (70-200 yrs), intermediate stage forest (40-70 yrs), early stage forest (0 to 20 yrs), lowland shrub, mud flats/gravel/rock, subalpine shrub, alpine shrub-lichen tundra, cliffs, islands in lakes, and snow/ice/glaciers (United States Fish and Wildlife Service [USFWS], 1983). Inland aquatic habitats include anadromous fish streams, anadromous fish lakes, resident fish streams, and resident fish lakes.

Of the 15 million acres within the oil spill area, 1.8 million are private lands (Fig. 3-2). Most of these lands were converted from public to private ownership during the last 20 years as a result of the Alaska Native Claims Settlement Act (ANCSA). Lands chosen for conversion to private uses primarily were commercially valuable timber lands. Publicly owned lands include a diverse number of designations, both State and Federal. The 5.9-million-acre Chugach National Forest surrounds Prince William Sound and is managed by the USDA Forest Service predominantly for recreation and fish and wildlife. There have been no timber harvests on the forest since the mid 1970's, and no harvests currently are planned. Nine other large Federal land-management areas are contained wholly or partially within the EVOS area. The National Park Service (NPS) administers 9 million acres in the Kenai Fjords National Park, Lake Clark National Park and Preserve, Katmai National Park and Preserve, and the Aniakchak National Monument and Preserve. Both the Kenai Fjords and Katmai National Parks consist of large areas of federally designated wilderness or wilderness study areas. The western portion the Chugach National Forest is also a wilderness study area. The Fish and Wildlife Service administers million of acres in the Kenai National Wildlife Refuge (NWR), Kodiak NWR, Alaska Peninsula NWR, and Alaska Maritime NWR. The Becharof NWR also includes federally designated wilderness areas. Numerous State classifications--including parks (such as Kachemak Bay State Park), critical habitat areas, game refuges, and marine parks--exist in the oil spill area. All of these areas are afforded some degree of protection from land uses that could adversely affect or slow the recovery of injured resources and services. Wilderness areas in particular provide strict protection against future

### 3 Affected Environment

degradation of the ecosystem, but they also preclude enhancement activities within their boundaries.

One of the issues in forest land management within the oil spill area is the prevalence and impact of infestations of bark beetles and other insects on forest health and survival. At present, these pests are not expected to be a major factor affecting forest management or limiting habitat acquisition options designed to protect ecosystems in the oil spill area. The spruce beetle (*Dendroctonus rufipennis*) is an endemic pest affecting older conifer stands in southcentral Alaska. Although this species can effectively kill all trees over large areas (the natural 100 to 150-year cycle of these infestations may have been shortened with the suppression of fire), they are most devastating to white spruce and Lutz spruce. The Sitka spruce that dominate the forested regions of the oil spill area can be affected, but serious infestations are not expected within Sitka spruce stands (Holsten, 1990).

## Biological Resources

The EVOS area supports a diverse collection of wildlife. The *Exxon Valdez* oil spill occurred in March, just before the most biologically active season of the year. The spill coincided with the migration of birds and the primary breeding season for most species of birds, mammals, fish, and marine invertebrates in the spill's path. Oil from the spill affected each species differently. For some species, the population measurably declined. For example, an estimated 3,500 to 5,500 sea otters were killed by the spill, and the population is not expected to recover for many generations. Other species were killed or injured by the spill, but the injury did not measurably decrease the overall population. The populations of some species, such as marbled murrelets, pigeon guillemots, and harbor seals, were declining before the spill. Their rate of decline was accelerated by the spill, but other factors such as variations in climatic conditions, habitat loss, or increased competition for food also may have influenced long-term trends in their health and populations. Still other species may have been indirectly affected by changes in food supplies or disruption of their habitats.

The availability of population and habitat data varies from species to species. Federal and State environmental agencies had conducted baseline surveys of some native species prior to the oil spill, documenting selected species' populations and critical habitats, but some species (e.g., invertebrates such as clams and barnacles) never have been inventoried. Others, such as the brown bear and the bald eagle, are counted annually for management purposes; and a great deal is known about species that have played a significant historic or economic role in the region, such as sea otters and salmon. The following discussion summarizes the baseline conditions for species and resources found in the oil spill area. It will be used in evaluating the potential impacts, either direct or indirect, of the various restoration options.

### Marine Mammals

The following section discusses the relevant population status, lifecycle requirements, and oil spill injuries, including relevant information for harbor seals and sea otters.



### Harbor Seals

The harbor seal (*Phoca vitulina richardsi*) is a protected species under the MMPA, which placed a moratorium on the taking of harbor seals except for subsistence use by Alaska Natives. The harbor seal is under the management of the National Marine Fisheries Service (NMFS).

Harbor seal prespill populations in Prince William Sound have been estimated to be between 2,000 and 5,000 individuals. The harbor seal population has been declining by approximately 11 to 14 percent annually for unknown reasons (Frost and Lowry, 1993). In portions of its geographic range, the harbor seal is in direct competition with human subsistence, recreational, and commercial resource users for fish. Bycatch of harbor seals from commercial fishing has been estimated to cause 2,800 seal deaths a year (Lentfer, 1988). The harbor seal also is harvested by Alaska Natives for subsistence use. Natural predators of harbor seals include killer whales and sharks.

Harbor seals usually occupy coastal waters less than 60 m deep. Haulout areas are especially important for harbor seals during pupping and molting. Rocks, isolated beaches with protective cliffs, ice floes, and sand or mud bars are used for resting, pupping, and nursing young (ADF&G, 1985). Harbor seals are opportunistic predators and consume a wide variety of fish and invertebrates. Walleye pollock, herring, salmon, eulachon and cephalopods are important prey for seals in the Gulf of Alaska (Pitcher, 1980).

Harbor seals breed annually once they reach sexual maturity (3 to 7 yrs), and a single pup usually is born between late May and mid-July. Pups generally are nursed for 3 to 6 weeks (ADF&G, 1985). During pupping and molting periods, harbor seals are very susceptible to disturbance and are prone to stampeding. Stampeding can cause injuries and deaths, as well as weaken the mother-pup bond, resulting in higher pup mortality (Johnson et al., 1989).

The oil spill caused population declines and sublethal injuries to harbor seals in Prince William Sound. Many were directly oiled, and an estimated 300 died. The prespill population of harbor seals in Prince William Sound was estimated to be between 2,000 to 5,000 animals. While some dead seals were recovered from the Kenai Peninsula, the extent of injury outside Prince William Sound is unknown.

Many seals were exposed to oil in 1989. At 25 haulout areas in Prince William Sound that have been regularly surveyed since 1984, 86 percent of the seals seen in the postspill spring (April) survey were extensively oiled; a further 10 percent were lightly oiled. This included many pups. By late May, 74 percent of the animals continued to be heavily oiled. Tissues from harbor seals in Prince William Sound contained many times the concentrations of aromatic hydrocarbons than did tissues from seals in the Gulf of Alaska. This trend persisted in 1990, when high concentrations of petroleum hydrocarbons again were found in the bile of surviving seals. In addition, pathology studies revealed damage to nerve cells in the thalamus of the brain, which is consistent with exposure to relatively high concentrations of low molecular weight aromatic (petroleum) hydrocarbons.

### 3 Affected Environment

#### Sea Otters

The sea otter is a protected species under the MMPA, which placed a moratorium on the taking of sea otters except for subsistence use by Alaska Natives. The sea otter is under the management of the ADF&G and the USFWS. Prespill and postspill management of sea otters by these agencies has focused on population monitoring through surveys and monitoring of Native harvest.

The sea otter prespill population for the entire State of Alaska was estimated at 150,000 animals, and the population in Prince William Sound prior to the oil spill was estimated at 10,000 animals (EVOS Trustee Council, 1992). The sea otter population within the oil spill area was likely at or near an equilibrium density and was limited by prey availability when affected by the oil spill. The sea otter population in portions of its geographic range is in direct competition with recreational and commercial resource users for crabs, clams, and other benthic organisms.

Sea otters prefer shallow coastal waters that generally are less than 40 m deep. They use kelp beds as resting areas, but their geographic distribution is not dependent on kelp. Some otters use intertidal rocks, exposed beaches, and algal covered rocks. The importance of haulout sites is poorly understood. They are not considered to be essential for otter survival in California but may be very important for otters in northern climates (Jameson, 1989).

Sea otters eat a wide variety of prey and can greatly influence prey availability. They prefer benthic invertebrates, but in some areas they prey heavily on benthic fishes (Riedman and Estes, 1990). There is considerable variation in individual diets. Females with pups tend to forage in shallower areas where smaller mussels and clams are available in short dives from the surface (Reidman and Estes, 1990).

Mating and pupping can occur throughout the year, although in Prince William Sound most otters mate in September and October with pups born in May and June. Once otters reach reproductive maturity (4 to 7 years) they are capable of reproducing annually, although the reproductive period varies among individuals and areas. Sea otters give birth to a single pup, rarely twins. Pups generally are weaned by mid-November (EVOS Trustee Council, 1992).

The oil spill caused declines in populations of sea otters in Prince William Sound and possibly in the Gulf of Alaska. Sea otters were the most abundant marine mammal in the path of the spreading oil slick and were particularly vulnerable to its effects. Their estimated population before the spill included as many as 10,000 in Prince William Sound and 20,000 in the Gulf of Alaska. The total population in the State is estimated to be 150,000 otters.

During 1989, 1,013 sea otter carcasses were collected. Veterinarians determined that up to 95 percent of the deaths were attributable to oil. It has been estimated that 3,500 to 5,500 sea otters were killed in the first few months following the spill.

Studies conducted in 1990 and 1991 indicated that sea otters still were being affected by the spill. Carcasses found in these years included an unusually large proportion of prime-age adult otters. A study of survival of recently weaned sea otters also showed a 22-percent higher death rate during the winter of 1990-1991 and spring of 1991 in areas affected by the spill. In 1992 and 1993, juvenile mortality rates had decreased dramatically but still were higher in oiled than in nonoiled areas.

## Birds

### Background Information/Species Account

The *Exxon Valdez* oil spill (EVOS) killed an estimated 100,000 to 300,000 birds of over 90 species within the entire spill zone (Piatt et al., 1990). Perhaps as many as 25 percent of the total birds wintering in the oiled zone of Prince William Sound were killed directly by the spill, or 10 percent of Prince William Sound's entire population (Klowsiewski and Laing, written comm., 1993). In subsequent EVOS studies through 1992, six species had not yet recovered from the effects of the spill. These were bald eagles, black oystercatchers, harlequin ducks, murres, pigeon guillemots, and marbled murrelets (Draft EVOS Restoration Plan, 1993). However, by 1993, populations of bald eagles and black oystercatchers were recovering in Prince William Sound (Draft EVOS Restoration Plan, 1993), although their status outside of Prince William Sound remained unknown. This section gives background information on the four species whose populations have either not recovered from the EVOS, or whose recovery status is uncertain.

All migratory birds are included under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]). This Act gives the U. S. Fish and Wildlife Service (USFWS) statutory responsibility to protect and manage the four bird species that are not recovering from the EVOS. Knowledge of population size is basic to wildlife management, and population monitoring is a normal function of wildlife management agencies. The USFWS's Alaska Maritime National Wildlife Refuge (AMNWR) has a long-range plan to monitor selected species at selected colonies on AMNWR land throughout Alaska. East Amatuli Island in the Barren Islands, where major injury to murres occurred, was a designated monitoring site in the refuge monitoring plan for storm-petrels and tufted puffins, but not murres. Prior to the oil spill, murres were not targeted at this site due to the difficulty and expense of monitoring murres there (V. Byrd, oral comm., 1994). The Migratory Bird Management section of the USFWS is responsible for monitoring marine birds on non-refuge lands in Alaska, including Prince William Sound. However, there is no set schedule for monitoring in Prince William Sound or elsewhere in the EVOS area.

Another factor that affects the USFWS' ability to routinely monitor marine birds is that available funds simply do not allow the agency to do everything that is required by statute. Funds are allocated by the U. S. Congress annually, and Congress' funding agenda is often different from that requested by USFWS. Historically, non-game migratory birds such as seabirds have been of a lower funding priority than funding for game birds. For example, the USFWS conducted their first waterbird population survey the entire Sound in 1972-73, but then not again until 1984-1985. Additional studies were done on selected seabird species at Naked Island, Shoup Bay, and other locations since 1978, but the entire Sound was not again monitored for all waterbirds until 1989.

### Harlequin Duck

The harlequin duck is a small boreal diving duck with a disjunct distribution on the east and west coasts of North America (Bellrose, 1980; American Ornithological Union [AOU], 1983). Like many species of sea ducks, the harlequin uses both marine and inland habitats (Bellrose, 1980). Harlequins nest near freshwater streams, and nonbreeders and juveniles utilize nearshore marine habitats for feeding and roosting.

### 3 Affected Environment

Harlequin ducks breed in western North America south of the Arctic Circle, from northwestern Canada and Alaska, south to the Aleutian Islands and through southeastern Alaska to the Pacific Northwest (AOU, 1983; Bellrose, 1980).

Within its world range, harlequins may be the most abundant in the Aleutian Islands (Bellrose, 1980). Islieb and Kessel (1973) considered harlequins to be common to abundant in Prince William Sound and they estimated populations for the entire north Gulf coast - Prince William Sound region at a few 10,000's. In 1979 and 1980, an estimated 9,600 harlequins wintered in the Kodiak Archipelago, with the highest concentrations off of southeastern Kodiak Island (Forsell and Gould, 1981). An estimated 1,600 to 5,600 harlequin ducks were in Prince William Sound in July 1972 (Klosiewski and Laing, written comm., 1993).

Harlequins winter in small flocks along exposed, rocky coasts where they feed on benthic prey (see below) in intertidal and subtidal areas. In Prince William Sound, harlequins use a wider range of habitats during the winter and are dispersed throughout the nearshore area (Patten pers. comm. to Klinge). Populations of harlequins that winter in the EVOS area include both local breeders and birds that breed in interior Alaska (Bellrose, 1980). An estimated 9,200 to 15,800 harlequins were in Prince William Sound in March 1972, and 10,300 to 21,300 in March 1973 (Klosiewski and Laing, written comm., 1993; Agler, Seiser, Kendall and Irons, written comm., 1993).

Harlequin ducks migrate back and forth between inland nesting habitat and coastal marine foraging habitat, which are often only a few km apart. Only a few km may separate their nesting and marine habitats, so their migration can be very short. Harlequins begin arriving on their wintering grounds in the Aleutian Islands in mid-September and remain there until May (Bellrose, 1980). In Prince William Sound, the breeding season lasts for about 2½ months between May and July (Patten, 1991), and broods are common in the coastal marine area in late July and August (Islieb and Kessel, 1973). Birds that winter and breed in south-central Alaska congregate near the mouths of suitable breeding streams in late April and early May (Patten, oral comm., 1993).

Coastal habitats are used from late summer through early spring by all sex and age classes of harlequins. Paired breeders are found in the intertidal area at the mouths of streams before they move inland to nest. Coastal habitat is used throughout the summer by nonbreeding birds, breeding males after the pair bonds are broken, and by failed-nesting females (Bellrose, 1980; Dzinbal and Jarvis, 1982). In July, males congregate in large flocks in protected bays with good foraging habitat. Nonbreeders of both sexes and failed-nesting females begin molting in August and in many of the same areas as males.

Harlequin ducks become sexually mature in their second year (Delacour, 1959; Bengtson, 1972; Bellrose, 1980). Nests are composed of thin layers of grass, twigs, and leaves and are lined with white down (Bellrose, 1980). Harlequins begin laying between May 10 and May 30 in Alaska (Bellrose, 1980), and lay at 2 - 4-day intervals until 3 to 7 eggs accumulate. The female incubates the eggs for 28 to 30 days and breaks to feed every other day (Bellrose, 1980).

Harlequin ducks generally nest along shallow (0.5 - 1.0-m deep), fast mountain streams (Bengtson, 1972). The width, turbidity, and current velocity vary considerably, but most nests are usually concealed beneath dense vegetation within 5 m of a stream, in areas with good nest-site availability and abundant macroinvertebrates (Bengtson, 1972). Harlequins



are tenacious to their nest sites, often returning to within 100 m of previous years' sites, and females may use the same nest site in successive years. Harlequins are not colonial nesters, although several nests may be close together (Delacour, 1959). In Prince William Sound, Patten (oral comm., 1993) located 20 streams that were used by nesting harlequins by 1991. Many streams were turbulent, sometimes only 1-m wide, and located in timbered areas at about 1000 ft elevation (Patten, oral comm., 1993).

Little is known about the brood rearing period. Given the duration of incubation, broods would be expected to hatch in early to mid-July. Islieb reported seeing broods in Prince William Sound in July and August (Islieb and Kessel, 1973). Patten (1991) reported seeing 3.1 ducklings per hen in nonoiled areas in late summer, compared with a mean of 2.8 fully grown ducklings per breeding female in Iceland over a 4-year period (Bengtson, 1972). Bengtson (1972) described a 30 to 40 percent duckling mortality rate during the first 2 weeks.

Predation is not believed to be a major source of mortality of adult harlequin ducks, but young are taken by a variety of predators, including ravens, mink, Arctic skua, and Arctic fox (Bengtson, 1972). Duckling mortality may be as high as 30 to 40 percent in the first 2 weeks after hatching (Bengtson, 1972).

Harlequin ducks are mostly carnivorous. Birds in Iceland ate mostly insects and their aquatic larvae (Bengtson, 1972). Young broods feed mostly on surface insects and on insects from overhanging vegetation, while older broods feed like the adults. Stream bends where the current slows are used by broods for feeding and resting. Outlets from lakes, beneath waterfalls and turbulent, shallow stretches of streams are favorite feeding locations for adults.

Once salmon begin spawning, harlequins eat roe (Delacour, 1959; Dzinbal and Jarvis, 1982). Near the coast, breeding harlequins may fly from nesting areas to the mouths of the rivers to feed (Bengtson, 1972; Dzinbal and Jarvis, 1982). Harlequins feed in the intertidal area of Prince William Sound on a wide variety of prey, including limpets, snails, clams, mussels, and crabs (Patten, 1991).

Dzinbal and Jarvis (1982) studied the summer-feeding ecology of harlequins at Sawmill Bay, southwestern Prince William Sound. Harlequins studied by Dzinbal and Jarvis (1982) fed mainly in the intertidal deltas of small streams and in the intertidal areas of protected bays, and less near small rock islands and in lee waters of bays. In July, harlequins moved into the lower portions of suitable streams to feed on salmon roe. Five harlequins collected by Dzinbal and Jarvis (1982) had eaten a variety of crustaceans and invertebrates, while five others from lower Cook Inlet in 1977 had all eaten gastropods (Sanger, 1986).

Wintering harlequins forage mostly in small groups, and closer to shore than other sea ducks, and they eat mostly crustaceans and mollusks, and some insects, starfish, and fishes (Delacour, 1959; Bellrose, 1980; Dzinbal and Jarvis, 1982).

Harlequin ducks are not hunted much by humans. The annual take of harlequins in Prince William Sound is unknown, but is probably small since most harvesting is associated with using males as decorative mounts (Patten, oral comm., 1993).

### 3 Affected Environment

#### EVOS Damage Assessment and Current Status in Spill Area

The EVOS killed an estimated 1,000 harlequin ducks outright (Piatt et al., 1990), and has caused sublethal injuries (Patten, 1991). Two different sets of EVOS studies are available to help evaluate injury to harlequin ducks in Prince William Sound. Patten (1991) suggested that there had been little or no breeding by harlequin ducks within the Prince William Sound spill area since the spill through 1991. He captured no adult breeders in mist nets set across 14 potential nesting streams and found no duckling broods during late summer shoreline censuses. He counted a total of 220 harlequins during shoreline censuses in the spill area, which he described as an "...apparently remnant population...". Comparative control studies at nonoiled sites in eastern Prince William Sound captured breeding adults in mist nets and located duckling broods, which indicated normal breeding.

Bird Study 2 (Klosiewski and Laing, written comm., 1993; Agler et al., written comm., 1994) surveyed all of Prince William Sound for 4 years after the spill; they derived population estimates for all bird species, including harlequin ducks, and they compared their estimates with prespill data collected in 1972 and 1973. Estimated harlequin numbers in 1990 and 1991 in the spill area were only 23 percent of those expected, based on comparisons with prespill surveys (Klosiewski and Laing, written comm., 1994). They concluded that the reduced numbers were an oil spill effect. The July 1993 survey (Agler et al., written comm., 1994) revealed the highest estimate (1,100 - 3,300) yet for the spill area, but a trend for population recovery is not yet indicated. The July 1990 and 1991 estimates of harlequin numbers in the spill area were 266 to 3,302, and 299 to 1,035, respectively. Current data from Bird Study 2 (S. Kendall, written comm., 1994) indicate a July 1993 estimate of 5,700 to 11,000 harlequin ducks in all of Prince William Sound. There is very little information on harlequins in the spill area outside of Prince William Sound.

In sum, data from Bird Study 2 indicate that the Prince William Sound-wide July harlequin population increased from a range of 1,600 to 5,600 in 1972, to approximately 5,100 to 11,000 in 1989, and 5,800 to 12,800 in 1990, 1991, and 1993. These data have a bearing on understanding the current population status of harlequin ducks in Prince William Sound because (1) even though numbers dropped an estimated 77 percent in the oiled area, because the Sound-wide population increased, any population decrease in the oiled area was more than offset by an increase in the nonoiled area; (2) July data for 1990, 1991, and 1993 suggest that the Sound-wide population is stabilizing at a significantly higher level than it was in 1972; and, (3) the most recent (July 1993) estimate for all of Prince William Sound indicated a population of about 5,700 to 11,000.

Patten's studies indicate sublethal injury (i.e., lack of breeding) within the areas he studied within the spill area of Prince William Sound. His report (1991) painted a bleak picture of a "remnant" population of 220 harlequins in the oiled area. However, subsequent population surveys (Klosiewski and Laing, written comm., 1993; Agler et al., written comm., 1993) support a conclusion that the overall population of harlequins in Prince William Sound is stabilizing at a significantly higher level than before the spill. Within the oiled area, the population estimates have fluctuated widely, but the most recent estimate from Bird Study 2 (July 1993) estimated a minimum of 3,703 harlequins, a figure far greater than Patten's (1991) estimate of 220 in 1991.

In sum, lack of evidence of breeding in the spill area and population reduction compared with nonoiled areas indicate that the populations of harlequin ducks in the oiled area still show little signs of recovery. However, this evidence needs to also be tempered with the fact that

harlequin populations in oiled and nonoiled areas alike appear to be stabilizing at a higher level than the latest prespill estimate.

### **Murres**

The common murre is a circumpolar species of boreal and low Arctic habitats (Nettleship and Birkhead, 1985; AOU, 1983). On the Pacific Coast of North America, common murres breed in dense colonies from mainland northwestern Alaska, on Bering Sea islands, and in the Aleutians, and thence south and east to central California (AOU, 1980). The thick-billed murre is a circumpolar Arctic and low Arctic species (Nettleship and Birkhead, 1985) that has a more restricted range than the common murre, which in Alaska is centered in the Aleutians and the Bering Sea.

About 1.4 million common and thick-billed murres nest in the Gulf of Alaska, with common murres comprising about 80 to 85 percent of the total (Sowls et al., 1978; USFWS, 1993). Where both species nest at the same colonies, thick-billed murres prefer cliff ledges, and common murres favor larger, flatter areas (Tuck, 1960). Thick-billed murres make up a small portion of Barren Islands murre populations, and they are not found elsewhere within the EVOS area. About 1.2 million murres nest in the western Gulf of Alaska on the Semidi Islands, which were not directly impacted by the EVOS. The largest colonies in the EVOS area include approximately 6,500 murres on the Chiswell Islands near Seward, approximately 130,000 on the Barren Islands at the mouth of Cook Inlet, and approximately 120,000 total at three colonies on the Alaska Peninsula (USFWS, 1993).

There are a few very small colonies of murres on the east side of Kodiak Island and at Gull Island, Kachemak Bay. The closest murre colony to the initial spill site, at Porpoise Rock, Hinchinbrook Entrance, was upstream from the spill and not directly affected by it.

Common murres form breeding colonies on seaward-facing cliffs, where they are highly social and lay single eggs (Tuck, 1960). Timing of breeding is highly synchronized. The resulting sudden abundance of eggs and chicks presents predators with the opportunity to eat a small proportion, while the large majority of chicks grows to a size too large for most predators. Breeding success is variable, with maxima of 70 to 80 percent of young fledged per breeding pair (Birkhead, 1977; Hedgren, 1980). Birkhead (1974) estimated a 6-percent annual-mortality rate for adults, which translates to an average life expectancy of 16 years. However, banded murres have lived as long as 32 years.

In spring and summer, common murres are distributed in Alaska mainly over the continental shelf (Gould et al., 1982). In late fall and winter, they often migrate into protected coastal bays and fjords of the Gulf of Alaska, including Kodiak Island (Forsell and Gould, 1981) and Prince William Sound (Agler et al., written comm., 1993). However, this winter migration is highly variable, and there were apparently very few common murres in Prince William Sound at the time of the spill. In contrast, common murres were extremely abundant in nearshore waters of the Gulf of Alaska in winter 1992-1993, when an unknown but apparently small proportion died from unknown causes and washed ashore at several locations (Piatt and Van Pelt, 1993). An unprecedented 220,000 murres were estimated in Prince William Sound alone in March 1993 (Agler et al., 1993), perhaps attracted by large numbers of juvenile herring (Sanger, personal observations, 1993).

### 3 Affected Environment

In summer, common murres in the Gulf of Alaska forage mainly on fish over the continental shelf (Sanger, 1987a). The presence of mysid and pandalid shrimps in their winter diet in Kachemak Bay (Sanger, 1987b) and at Kodiak (Krasnow and Sanger, 1986) shows that they capture some prey very near the bottom, thus linking themselves to a detrital food chain. Common murres have been caught in crab pots at 125 m at Kodiak (Forsell and Gould, 1981).

#### **Effects of Spill and Current Status in Spill Area**

Murres are particularly vulnerable to floating oil (King and Sanger, 1979), and the EVOS killed an estimated 120,000 to 134,000 breeders, mostly from the Chiswell Islands and the Barren Islands (Piatt et al., 1990). The oil arrived in early April just as birds began congregating at the colonies before breeding. If the mortality rate from the EVOS is adjusted for birds feeding at sea, away from their colonies, the mortality increases to an estimated 170,000 to 190,000 breeding birds. An estimated 35 to 70 percent of the breeding adults at the above colonies could have been killed by the spill. The effect of the EVOS on prebreeding juveniles is unknown.

At the Chiswell Islands, no laying was seen in 1989, ....laying was late in 1990. Also, through 1992, laying was a month late at Puale Bay and in the Barren and Chiswell Islands. The resulting chicks may not have had time to accumulate sufficient energy reserves before the first fall storms. Conservatively, lost production associated with delayed reproduction could have exceeded an estimated 300,000 chicks per year through 1992. Although productivity rates were near normal in 1992 and 1993 at the Barren Islands, populations were still down in 1993 (D. Roseneau, oral comm., 1994).

The EVOS also affected the timing of reproduction at oil-impacted colonies (Nysewander et al., 1993). At the Barren Islands and at Puale Bay, egg laying was about a month late in 1989, 1990, and 1991. There were indications that breeding was returning to normal at the Barren Islands in 1992, and by 1993, productivity averaged over 0.5 chicks per nest (D. Roseneau, oral comm., 1994). The recovery status of common murres remains uncertain, and restoration to prespill levels could take decades.

#### **Pigeon Guillemot**

The pigeon guillemot is a medium to small diving seabird that nests in rocky coastal habitat on the Asian and North American sides of the subarctic-temperate North Pacific (AOU, 1980). In North America, pigeon guillemots are found from mainland northwestern Alaska (Cape Lisburne), on Bering Sea islands and the Aleutians, and thence south to central California (AOU, 1980; Sowls et al., 1978), resulting in one of the widest distributions of any seabird species on the Pacific coast of North America.

An estimated 26,000 pigeon guillemots nested in the eastern Gulf of Alaska in the early 1970's (Sowls et al., 1978), with an estimated 15,000 in Prince William Sound alone (Islieb and Kessel, 1973). Since then, however, the population in Prince William Sound has declined markedly. A minimum of 3,028 breeding guillemots were counted in Prince William Sound in July 1993 (Sanger and Cody, written comm., 1993), and the entire population of breeders and juveniles was estimated at no more than 4,900 (Klowsiewski and Laing, written comm., 1993).



The EVOS killed perhaps as many as 10 percent of the guillemots in Prince William Sound, but the population undoubtedly was declining before the spill (Oakley and Kuletz, written comm., 1994). In oiled and nonoiled areas alike, maximum numbers of guillemots at colonies in 1993 were only about 20 to 50 percent of the maxima of the 1970's and 1980's (Sanger and Cody, written comm., 1994). Except for Afognak Island (Cody et al., 1993), current population sizes within the EVOS area outside of Prince William Sound are unknown. However, the same factors that have caused a population decline in Prince William Sound since the 1970's could also be influencing EVOS area populations outside Prince William Sound.

In the Gulf of Alaska, as many as 25 percent of the pigeon guillemot population may occur over the continental shelf in summer (June - August) (Sanger, 1987, as adapted from Gould et al., 1982). In fall and spring, and presumably in winter, a few guillemots were seen in the Gulf of Alaska as far offshore as the shelf break (Gould et al., 1982). Some investigators (Scott, 1973; Oakley, 1981; Ainley and Boekelheide, 1990) speculate that guillemots leave exposed coastlines for sheltered inshore waters in winter. This conclusion is not supported by population estimates from Prince William Sound, however, which suggest just the opposite, i.e., Kłowsiewski and Laing, written comm., (1993) and Agler et al. (written comm., 1993) report March population levels in Prince William Sound at 20 - 70 percent lower than the preceding July.

Pigeon guillemots nest in natural cavities in cliffs and among boulders, and occasionally in earthen burrows or man-made structures (Oakley and Kuletz, written comm., 1994; Sanger and Cody, written comm., 1994; Campbell, 1977). Their extremely dispersed nesting distribution (Oakley and Kuletz, written comm., 1994) is atypical of most seabirds. For example, a 1993 survey (Sanger and Cody, written comm., 1993) located 184 guillemot colonies in Prince William Sound, with an average of only 11 guillemots per colony. Also, 1,012 guillemots were seen away from colonies, many of which were no doubt isolated nesting pairs. Guillemots lay a clutch of one or two eggs, and chicks remain in the nest for just over a month after hatching (Drent, 1965; Oakley and Kuletz, written comm., 1994). While the chicks are in the nest, both parents deliver single whole fish to the nest throughout the day (Thoreson and Booth, 1958; Drent, 1965; Oakley and Kuletz, written comm., 1994).

Predation on guillemot eggs and chicks is sometimes heavy, mainly by glaucous-winged gulls and northwestern crows (Drent et al., 1964; Emms and Morgan, 1989; Vermeer et al., 1993), and by mink (Oakley, 1990; Ewins et al., 1993). Adult pigeon guillemots are occasionally taken by bald eagles, peregrine falcons and killer whales (Vermeer et al., 1989; Nelson, 1991; Stacey et al., 1990).

Guillemots in the EVOS area feed on demersal or epibenthic prey mostly in near-shore waters shallower than 40 m (Kuletz, 1983; DeGange and Sanger, 1986). Fish form the bulk of guillemots' diet, but they also eat shrimp, crabs, and occasionally bivalves (Sanger, 1987a; Krasnow and Sanger, 1986). Kuletz (1983) found that guillemots at Naked Island tended to forage more over underwater rises and shelfbreaks than over even-bottom topography, and that individual birds tended to forage in the same area. Some guillemots tend to specialize on pelagic schooling fishes, while others specialize on bottom fishes like blennies (Kuletz, 1983).

### 3 Affected Environment

#### Effects of Spill and Current Status in Spill Area

The population of guillemots in Prince William Sound after the spill was significantly lower than it was in the early 1970's (Klosiewski and Laing, written comm., 1993), and counts at colonies in 1993 were considerably lower than they were in the 1970's and 1980's in both oiled and nonoiled areas (Sanger and Cody, written comm., 1993). After the spill, guillemot populations in the oiled area of Prince William Sound were comparatively lower than in nonoiled areas (Klosiewski and Laing, written comm., 1993). Population counts at Naked Island also declined for 4 years after the spill, and the decline along oiled shorelines was more pronounced than along nonoiled shorelines (Oakley and Kuletz, written comm., 1994; Sanger and Cody, written comm., 1994).

Reasons for the decline are unclear, although a decreased food base and increased predation are possibilities. With a clutch size of two eggs, guillemots have the potential to rebuild their population at a faster rate than many other seabird species.

#### Marbled Murrelet

The marbled murrelet is a small, diving seabird that ranges from central California north to the Gulf of Alaska (AOU, 1980; SOWLS et al., 1978), and westward to the western Aleutians (Kessel and Gibson, 1978; Mendenhall, 1992). Nesting marbled murrelets are widely dispersed and secretive, so their breeding population sizes are conjectural (Carter and Morrison, 1992). Recent population estimates throughout their range (Carter and Morrison, 1992) relied on counts of birds at sea.

Perhaps as high as 95 percent of all marbled murrelets nest in Alaska (Mendenhall, 1992). The Alaskan population is centered from the southeastern panhandle to Kodiak where the vast majority of the population flies inland to nest on moss-covered branches of large conifers (Piatt and Ford, 1993). A small part of the population, possibly as low as 3 percent (Mendenhall, 1992; Piatt and Ford, 1993), nests on the ground in alpine and coastal tundra, and all murrelets are ground nesters west of the limits of the conifer area on Kodiak Island.

Piatt and Ford (1993) used counts at sea from the late 1970's to estimate an Alaskan population of at least 160,000 marbled murrelets. However, this estimate included very few observations in Prince William Sound and southeastern Alaska (Gould et al., 1982), so it is likely too low. The current Alaska-wide population could be at least 250,000 (M. McAllister, pers. comm., in Mendenhall, 1992).

A July 1972 survey (Islieb and Kessel, 1972) estimated the Prince William Sound population at 206,000 to 403,000 (Klosiewski and Laing, written comm., 1993). Elsewhere in the EVOS area, estimates of murrelet populations in the Kodiak Archipelago range from 21,000 to 21,900 (Piatt and Ford, 1993; Forsell and Gould, 1982).

In the Gulf of Alaska, as high as 30 percent of the marbled murrelet population may occur over the continental shelf in summer (June - August) (Sanger, 1987a; Gould et al., 1982). From fall through spring, a few murrelets were seen in the Gulf of Alaska as far offshore as the shelfbreak (Gould et al., 1982). Klosiewski and Laing, written comm., (1993) and Agler et al. (written comm., 1993) report March population levels in Prince William Sound significantly lower than the preceding July, showing that most murrelets in Prince William Sound migrate offshore for the winter. It was this behavior that saved the large majority of the Prince William Sound population from destruction from the EVOS (Kuletz, 1993).

Throughout most of their range, very little is known about the breeding biology of marbled murrelets (Carter and Morrison, 1992). Several nests have been located in Alaska (Mendenhall, 1992), but virtually nothing is known about murrelets' productivity rates or other aspects of their breeding biology.

Marbled murrelets in the EVOS area feed mostly on pelagic fish within the water column, most of which they capture in nearshore waters shallower than 40 m (Sanger, 1987a; DeGange and Sanger, 1986). In winter, however, their diet in Kachemak Bay (Sanger, 1987b) and at Kodiak (Krasnow and Sanger, 1986) includes pandalid and mysid shrimps (demersal species), thus linking themselves to a detrital food web.

#### Effects of Spill and Current Status in Spill Area

Applying the model derived by Ford et al. (1991) to carcass counts, Kuletz (1993) estimated the direct mortality of murrelets from the EVOS to be within a range of 10,200 to 22,000, with a best approximation of 12,700 to 14,800. The latter range is about 6 to 13 percent of the most recent population estimate for Prince William Sound (Agler et al., written comm., 1993). On midbay transect counts at Naked Island, there were significantly fewer murrelets in 1989 compared with the 1978-1980 period, but similar transect counts in 1990 were comparable to prespill numbers. Shoreline counts of murrelets in the Naked Island group were also lower in 1989 than before the spill, but had rebounded to prespill levels in the 1990-1992 interval (Kuletz, 1993; Kuletz, oral comm., 1994). In Kachemak Bay, Kuletz (1993) found no difference in transect counts from 1988 to 1989. There are no similar data from elsewhere in the EVOS area, although by the time surface oil from the EVOS left Prince William Sound, it could have impacted murrelets downstream from Prince William Sound (Kuletz, Marks, and Naslund, written comm., 1993).

The July population level as a whole declined from 1972 to after the spill (Klosiewski and Laing, written comm., 1993). However, these investigators did not find an oil-spill effect for lower populations in the oiled area compared with the nonoiled area of Prince William Sound, such as they found with pigeon guillemots and other species. Indeed, estimates for all of Prince William Sound (Klosiewski and Laing, written comm., 1993; Agler et al., written comm., 1993) suggest that the estimated July population in Prince William Sound may be stabilizing; i.e., since the spill, population estimates have been within the range of 90,000 to 125,000 in 1989; 64,000 to 99,000 in 1990; 86,000 to 127,000 in 1991; and 117,000 to 201,000 in 1993. These estimates for 1989 through 1991 are not statistically different. It is noteworthy that the 1993 estimate is significantly higher than the 64,000 to 99,000 estimated for 1990, and that this estimate is approaching the low end of the 206,000 to 403,000 prespill estimate for 1972.

These 4 years of postspill estimates suggest that the population may be stabilizing, or even increasing. However, more years of data are needed to determine if there is a trend in the population size of marbled murrelets in Prince William Sound.

#### Fish

The waters of the area encompassed by the EVOS include a large assemblage of fish populations. Fish habitats range from upland wetlands to deep benthic marine waters. Fishes present include sport, subsistence and commercially-important species as well as

### 3 Affected Environment

forage fish for other fish species, marine mammals, and birds. Of these, the most apparent are those that are valuable to the subsistence, commercial, or sport fishers.

Fish stocks, including both hatchery-reared salmon and wild stocks, are managed by the ADF&G in freshwaters and within a 3-mile limit in marine waters. The North Pacific Fishery Management Council (NPMFC) prepares management plans, which become Federal law, and applies them to marine waters for the 3-mile limit to the 200-mile limit. The International North Pacific Fisheries Commission provides conservation measures that limit location, time, and number of fishing days beyond the 200-mile limit.

Although often it is difficult to differentiate between natural population variability and oil-spill-induced changes, a summary of injuries to the fish species that may have been affected by the EVOS has been presented by the Exxon Valdez Oil Spill Trustee Council (1992).

#### Pink Salmon

Pink salmon (*Oncorhynchus gorbuscha*) are the most abundant of all the species of Pacific salmon, and they have the simplest and least variable life cycle. After they emerge from the redd, the fry migrate quickly to the sea where they grow rapidly. Pink salmon mature after approximately 18 months and return to their natal streams to spawn and die.

Because of this simple life cycle, populations spawning during odd-number calendar years are effectively isolated from populations spawning during even-number years; therefore, no gene flow occurs between the alternate-year populations (Heard, 1991). As adults, pink salmon return to their natal spawning grounds to reproduce, typically within several miles from the sea (Morrow, 1980). As much as 75 percent of Prince William Sound pink salmon populations, however, spawn in the intertidal zone (ADF&G, 1985). Spawning generally occurs between mid-July and October, and hatching requires 61 - 130 days, depending on water temperature. Emergence is in April and early May (Morrow, 1980).

The diet of pink salmon fry primarily consists of invertebrate eggs, amphipods, and copepods. Juveniles primarily feed on larger invertebrates and small fishes. Young pink salmon are preyed on by other fishes, invertebrates, marine mammals, and birds (Morrow, 1980; Heard, 1991).

After the *Exxon Valdez* went aground, sublethal injuries were measured among the populations of both wild and hatchery-produced pink salmon. Bue, et al. (1993) reported that pink salmon egg mortality was significantly greater in oiled streams than in nonoiled (control) streams in 1989, 1990, and 1991. Most of the mortalities were observed in the intertidal zone, where most of the pink salmon spawning occurs. The authors did not expect these results to persist in 1991, and they hypothesize that the continued and increased mortality resulted from genetic damage to the incubating eggs and alevins in oiled streams during the winter of 1989-1990. In addition, Weidmer, et al. (1993) found that pre-emergent pink salmon fry in oiled streams had elevated concentrations of an enzyme, Cytochrome P450A, aids in the metabolism of hydrocarbons; and, when present, it indicates that the fish was exposed to petrochemicals. Fry from 38 percent of these samples (and 17 % of the samples from nonoiled streams) had histopathological lesions on internal organs. These could cause increased physiological stress and reduced survival and may affect future reproductive success.

Pink salmon fry released from hatcheries as well as wild pink salmon fry that left their natal streams in spring 1989 were also exposed to oil in the open water (Willette, 1993). Both pink salmon and chum salmon larvae were exposed to sufficient amounts of oil to induce production of the Cytochrome P450A enzymes that metabolize oil. In addition, tagged pink salmon larvae released from the hatcheries and collected in oiled areas were smaller than those collected in unoiled areas, even after accounting for the effects of food supply and temperature. The rate of return of pink salmon adults depends on conditions during the fry stage; lower food supply, water temperature, and growth of the fry will result in a lower return of adults the following year (Willette, 1993). Wertheimer et al. (1993) also concluded that the reduction in growth rate of pink salmon fry in 1989 was caused by oil contamination, and that this would reduce their potential survival to the adult stage.

The mean survival rate of wild pink salmon fry to the adult stage from oiled spawning streams was lower than the survival rate of fry migrating from nonoiled streams. (Peckham et al., 1993). These authors also reported that survival rates of pink salmon fry released from two fish hatcheries after the oil spill were lower than the survival rates of fry released before the oil spill. They were, however, unwilling to attribute this to the oil spill.

#### Sockeye Salmon

Sockeye salmon (*Oncorhynchus nerka*) exhibit a greater variety of life-history patterns than any other Pacific salmon (Burgner, 1991). Spawning usually occurs between July and October. The female builds a redd in graveled areas that will provide sufficient waterflow and dissolved oxygen for the eggs and alevins. Typically, spawning occurs in streams or rivers associated with a lake; however, some populations spawn extensively in lakes and occasionally some populations spawn in streams without lakes (Burgner, 1991; Morrow, 1980). Development usually requires 6 to 9 weeks for hatching and emergence from the gravel is usually from April to June (Morrow, 1980). Sockeye salmon fry usually use lake-rearing habitat for 1 to 3 years before they migrate to the sea as smolts. Sockeye salmon remain in the marine environment 1 to 4 years (usually 2 or 3 years) before they return to spawn (Burgner, 1991).

Adults feed primarily on euphausiids, amphipods, copepods, and young fishes. Growth in the ocean is rapid and the usual size at maturity is 3 to 5 kg (Morrow, 1980). Adults are preyed on by marine mammals and predatory fishes (Pauley et al., 1989).

Kenai River and Kodiak Island sockeye salmon stocks may have suffered population declines as well as sublethal injuries. This potential injury is unique, because it is due in part to a decision to close commercial fishing in 1989 in portions of Cook Inlet and in Kodiak waters. As a result, there were higher than usual returns (i.e., "overescapement") of spawning fish to the Kenai River and Kodiak Island systems in 1989.

The effect of spawning by large numbers of sockeye salmon is to produce a large number of fry that, in turn, consume a large amount of their food--zooplankton--from the nursery lakes. Excessive numbers of fry deplete their food supply which results in a reduction in their survival rate to the smolt stage. Schmidt et al. (1993) reported overescapements of sockeye salmon into the Kenai River system during 1987, 1988, and 1989, a pattern of declining plankton production numbers and sizes of rearing fry, and a pattern of declining numbers of sockeye salmon smolts. These observations support the hypothesis that overescapements of



### 3 Affected Environment

sockeye spawners have adversely affected sockeye salmon smolt production. These results also forecast a reduction of the numbers of adult sockeye salmon returning during 1994 and 1995. The zooplankton population composition and biomass in Akalura Lake on Kodiak Island has been following a pattern of low density, small-sized individuals and a shift in species composition, apparently because of the overescapement of sockeye salmon in 1989 (White, L., ADF&G, 1994 personal comm.).

#### Pacific Herring

Pacific herring (*Clupea harengus pallasii*) mature between 2 and 4 years of age and spawn annually. They live offshore but spawn in nearshore coastal waters, usually over vegetation such as eelgrass or seaweed or other submerged structures. Spawning in Alaskan waters begins when the seawater temperature rises to about 4° C. Their greatest mortality occurs during the egg to juvenile stages, when mortality may be 99 percent. Adults may have a lifespan of approximately 19 years (Morrow, 1980; Pauley et al., 1988). Juvenile herring feed on euphausiids, planktonic crustaceans, and fish larvae. Pacific herring eggs are preyed upon by shorebirds, diving birds, gulls, invertebrates, and fishes. Pacific herring larvae are eaten by jellyfish, amphipods, and other fishes. Adults are a prey base for large finfishes, sharks, and marine mammals and birds (Pauley et al., 1988).

Within 2½ weeks after the start of the EVOS, Pacific herring began spawning in Prince William Sound (McGurk and Biggs, 1993). Over 40 percent of the areas used by the Prince William Sound stocks for spawning and over 90 percent of the nearshore nursery areas were exposed to the spilled crude oil (Biggs and Baker, 1993). Studies performed in 1989 demonstrated that the mean mortality of Pacific herring eggs and larvae was three times higher in the oiled sites than in the nonoiled sites although environmental conditions confounded the interpretation of these results. Hose et al. (1993), however, reported that the incidence of malformed Pacific herring embryos and larvae and evidence of genetic damage (i.e., chromosome breakage) was higher from oiled study sites than from nonoiled sites. Norcross et al. (1993) observed that the evidence of genetic damage which was related to jaw deformities and small size in herring larvae captured one to three months following hatch in 1989. This impact combined with the elevated embryonic mortality and severe post-hatch abnormalities, indicated that the mortality of herring larvae was increased because of oil exposure in 1989. Elevations in post-hatch larval deformities, both genetic and morphological, continued to occur in oiled areas in 1990, but to a much lesser degree and no differences were observed by 1991. Kocan, et al. (1993) performed an experiment to evaluate the reproductive potential of individual female Pacific herring that had been present as one-year olds in Prince William Sound at the time of the oil spill. This study demonstrated that hatching success was halved and abnormalities among larvae were doubled in offspring of fish spawning in previously-oiled sites versus nonoiled sites which suggests a possible reproductive impairment through genetic damage to the adults. This was, however, only a pilot study and the data are not yet conclusive.

It is not known the extent that the juvenile herring were exposed to oil in 1989. Marty et. al. (1992) documented that 20 percent of adult herring captured in oiled areas suffered severe internal lesions compared to 0 percent in unoled areas. Moles, Rice and Okihiro (1993) found that the herring captured in the oiled areas were devoid of gut parasites. The observations of lesions and absence of parasites were recreated in adult herring exposed to oil in controlled laboratory settings.

There also was an outbreak of viral hemorrhagic septicemia (VHS) in herring returning to Prince William Sound in 1993. It is known that previous exposure to toxins can affect the immune system of fish making them more susceptible to disease, but without an accurate estimate of level of exposure, it is not known if the oil spill caused this outbreak. The missing information relating to cause and effect is a common problem in oil spill damage assessment (Brown, E., ADF&G, 1994, oral comm.; Meyers et al., 1993).

### **Rockfish**

There are more than 50 species of rockfish (*Sebastes* spp. and *Sebastolobus* spp.), including yelloweye rockfish (*Sebastes ruberrimus*), quillback (*S. maliger*), and copper rockfish (*S. caurinus*), that are found in Prince William Sound, Cook Inlet, and the Gulf of Alaska. Life histories of rockfish are highly variable and not well understood. Yelloweye rockfish are live bearers and release live planktonic larvae into the water column between April and June in southeastern Alaska (Carlson and Straty, 1981). Very little is known about the early life history of larvae and juveniles; however, the yelloweye rockfish range extends from Cook Inlet in Alaska south to Baja California (Hart, 1973). Rockfish grow very slowly and reach sexual maturity between 14 and 19 years of age. Rockfish breed annually thereafter but produce few offspring. They can live up to 114 years. It is not known whether or how rockfish migrate, but older fish tend to move to deeper water (Carlson and Straty, 1981).

Yelloweye rockfish are opportunistic feeders. They feed primarily on a variety of crabs, shrimp, snails, and fishes. Small yelloweye rockfish are preyed upon by larger rockfish and other fishes (Carlson and Straty, 1981).

The oil spill may have caused sublethal injuries to rockfish, but it is unknown if population declines occurred. There is little prespill data on rockfish in the spill area. Many dead rockfish were reported to have been sighted after the spill, although only 20 adult yelloweye rockfish were recovered by biologists. Of these, only 5 were in good enough condition to chemically analyze. All 5 fish were determined to have died from oil ingestion. Samples collected from oiled areas in Prince William Sound and the outer Kenai coast indicated there was evidence of exposure to oil (in bile) in 1989 and higher than normal incidences of organ lesions in 1989, 1990, and 1991 (Hoffman, et al., 1993). There also is evidence that the incidence of organ lesions was higher in 1991 than in previous years (Marty et al., 1993).

An additional unknown is the degree to which postspill increases in fishing pressure may be impacting rockfish. Partially because of numerous spill-related commercial-fishing closures (salmon, herring) in 1989, commercial fishers increased their take of rockfish. Rockfish harvests in Prince William Sound increased from approximately 93,000 pounds in 1989 to over 489,000 pounds in 1990. Harvests decreased since 1990, but harvests are still higher than the historic average. While population levels are unknown, concerns have arisen about possible overfishing. Rockfish are a slow growing species, produce relatively few young, and do not recover rapidly from overfishing.

### 3 Affected Environment

#### Dolly Varden

Dolly Varden (*Salvelinus malma*) are found in fresh- and saltwater in western North America and eastern Asia. Their range extends from southern British Columbia to the Arctic coast of Alaska. There are both anadromous and nonanadromous populations in Alaska, and they may occupy five different types of habitats, with behavioral and biological modifications for each (Morrow, 1980).

Dolly Varden commonly mature between 4 and 7 years of age. As adults, they live near their natal streams in nearshore areas of marine environments during the summer, and they migrate to freshwater lakes to overwinter. Dolly Varden return to their natal streams to spawn, usually in September and October. The eggs hatch in approximately 4 to 5 months. After they emerge, the fry remain close to the bottom for the first few days but commence active feeding soon after and begin growing rapidly. The young remain in freshwater for 3 to 4 years before moving seaward. They are found near logs and undercut banks, where they seek protection from predation (Morrow, 1980; ADF&G, 1985).

The primary diet for marine adult Dolly Varden consists of smelt, herring, juvenile salmonids, and other small fish as well as invertebrates. In the freshwater habitat, invertebrates and other small fishes are the main diet. Dolly Varden may live to be 12 or more years old (Morrow, 1980).

Both Dolly Varden and cutthroat trout feed extensively in the nearshore marine habitat and are particularly vulnerable to the effects of oil spills. Measurement of oil in the bile of Dolly Varden following the spill in 1989 showed that this species had the highest oil concentration of any fish species studied (Collier et al., 1993). Dolly Varden and cutthroat trout were captured at weirs on five streams after overwintering in 1989, 1990 and 1991 in an attempt to understand the effects of oiling. Studies of injury were not carried out in 1992. Growth and survival rates of Dolly Varden returning to oiled streams in 1990 were significantly lower than those returning to nonoiled streams (Hepler et al., 1993).

#### Cutthroat Trout

Cutthroat trout (*Oncorhynchus clarkii*) range from northern California to Prince William Sound, Alaska (Pauley et al., 1989). Both anadromous and nonanadromous populations are found in Alaska (Morrow, 1980).

Sea-run cutthroat trout mature at 2 to 3 years of age. Males typically mature at an earlier age than females. Cutthroat trout are "repeat spawners" but postspawning mortality may approach 90 percent (Morrow, 1980). They return to their natal streams to spawn in the spring between February and May, depending on the geographic area. After spawning, adults and smolts migrate to the sea between March and July. They remain nearshore in the vicinity of the natal stream to feed, and they return to freshwater lakes to overwinter (Morrow, 1980).

Adult cutthroat trout feed primarily on small fish and shrimp and eat more fish as they increase in size. Fry and juveniles feed primarily on insects and crustaceans, but they also begin to feed on smaller fish such as sticklebacks and other salmonids as they increase in size. In the marine environment, they feed on gammarid amphipods, sphaeromid isopods, callinassid shrimp, immature crabs, and other salmonid fishes (Pauley et al., 1989). Fry and juveniles are preyed on by rainbow trout, brook trout, Dolly Varden, ~~short head sculpin~~, and

adult cutthroat trout, as well as a various bird species such as great blue herons and kingfishers. In the marine environment, cutthroat are preyed on by Pacific hake, sharks, marine mammals, and adult salmon (Pauley et al., 1989).

The oil spill caused some injury to the anadromous populations of cutthroat trout in Prince William Sound. Large cutthroat trout had a higher mortality rate in oiled areas than in unoiled areas. There was a 57-percent greater mortality rate in oiled streams in 1989 - 1990 and a 65-percent greater rate in 1990 - 1991 compared to unoiled streams. In addition, growth rates of cutthroat trout in oiled areas were reduced compared to unoiled areas (Hepler et al., 1993).

## Social and Economic Environment

This section describes the social, cultural, and economic conditions of the communities affected by the *Exxon Valdez* Oil Spill (EVOS). It includes discussion of the sociocultural context of the region, some of the laws that pertain to the contemporary social, economic, and political environment, the composition of the affected communities and their socioeconomic bases, the impact of the spill on traditional Native and non-Native subsistence activities, cultural heritage (archaeology and culture history), recreation (commercial and noncommercial), commercial fishing, sport fishing, and designated wilderness.

### The Sociocultural Context

Glaciers covered much of Alaska until the end of the last ice age, some 10,000 years ago. As they receded, the glaciers left, like plowshares, a vast land ripe for animal and plant life. As the new ecosystems took root and flourished, people were soon to follow. Native Americans early and extensively inhabited the lands affected by the EVOS. The people followed the great herds of game animals across this newly greening land and pursued sea mammals across the adjacent resource-rich waters. They fished in the oceans and streams and gathered other available resources, developing intricate and complex societies and refining their relationships to the land and waters. Indigenous peoples have thrived in Prince William Sound for over 5,000 years, on the Kodiak Archipelago and Alaska Peninsula for over 8,000 years, and on the Kenai Peninsula for perhaps as long as 10,000 years.

The first contact with Europeans followed the Russian-sponsored expedition of Bering and Chirikov, members of which set foot on Kayak Island in southeastern Prince William Sound in 1741. As Russians used Native hunters to find and acquire sea otters for trade in the China market, the societies, cultures, economies, and genetic makeup of the communities of the spill area changed rapidly, though never entirely.

Today, even though the languages and cultural traditions of the Aleuts of the Aleutian Islands are historically quite different from those of the people in the spill area, Natives of traditionally Alutiiq (or Sugpiaq) and Eyak communities often refer to themselves as "Aleuts."

### 3 Affected Environment

After the United States acquired what title Russia had to Alaska in 1867, relatively slow but immense change enveloped the area. Increasing numbers of Westerners (Americans and others) moved into the area in search of commercial resources and a pioneering lifestyle. Several communities grew as more non-Natives moved to the area and as Native communities merged into fewer communities. The consolidation of the Native communities occurred because so many people had died of introduced diseases, and because of the greater importance of the cash economy. Commercial fishing, commercial whaling, fox farming, logging, and mining were important to the area's economy by the first half of the 20th century. The military buildup during World War II produced transportation, communication, and facilities infrastructures. This further integrated rural Alaska into the American cash economy.

Parts of the Alaska Peninsula and the Kodiak Archipelago were devastated by heavy ash fallout from the 1912 eruption of Novarupta, the second-largest volcanic eruption in recorded history. The Good Friday Earthquake of 1964 was centered in Prince William Sound and greatly affected all of southcentral Alaska. The villages of Chenega and Valdez were destroyed by the quake and the resulting tsunamis. Kodiak was badly damaged, as were almost all other communities of the area.

The EVOS affected many of the same communities, disrupting families and other social relationships, livelihoods, and the resources on which the people depended. Though the cumulative effects of natural and human disasters and disease are massive, many of the affected communities still depend heavily on subsistence for their livelihoods, cultural identities, and spiritual expression, much as their ancestors did for thousands of years prior. The effects on the commercial economies of the spill area likewise have been extreme and, similarly, have proved resilient.

#### Relevant State History

The Alaska Statehood Act (48 U.S.C. note prec. 21) admitted Alaska to the Union in January 1959. Section 6 of the Act empowered the State to choose about 103 million acres (an area of public lands larger than the State of California) from unreserved U.S. lands. Oil exploration and development increased after statehood was declared. A major windfall came soon after statehood, when in 1968 a discovery well at Prudhoe Bay on the North Slope tapped into the largest known oil field in the U. S. The North Slope oil lease of 1969 granted oil rights to an oil consortium and brought more than \$900 million in bonuses to the State treasury.

The Alaska Native Claims Settlement Act (ANCSA) of 1971 (P.L. 92-203; 33 U.S.C. 1601-1624) attempted to settle aboriginal rights and establish the legal claims to lands in Alaska made by indigenous peoples of Alaska. It established 13 Regional Native Corporations and nearly 200 village corporations. It further provided a compensatory award of \$962.5 million and an award of 40 million acres of land. This Act addressed public-land withdrawals and established a Joint Federal State Land Use Planning Commission, which began land-selection procedures that resulted in the existing pattern of Federal, State, Native, and private ownership of lands in Alaska. It also paved the way for construction of the Trans-Alaska Pipeline System from Prudhoe Bay to Valdez.

To allow transportation of oil from the North Slope to a shipping point, Congress passed the Trans-Alaska Pipeline Authorization Act in 1973. During the same year, Congress passed a bill to waive certain provisions of the National Environmental Policy Act to expedite pipeline



construction. The pipeline was completed in 1977. Now the pipeline daily moves almost 2 million barrels of crude oil from Prudhoe Bay to Valdez. Since 1977, the Port of Valdez has shipped the bulk of the crude oil extracted from Prudhoe Bay (Alaska State Libraries, 1992).

In 1976 the USDOL's Minerals Management Service held Lease Sale 39, the first oil and gas lease sale for the right to drill on the outer continental shelf (OCS) of the northern Gulf of Alaska. Sale CI for Lower Cook Inlet was held in 1977, Sale 55 for the eastern Gulf of Alaska in 1980, and Sale 60 for Lower Cook Inlet-Shelikoff Strait in 1981. Although Valdez and Prince William Sound have little or no known oil or gas potential, Lease Sales 88 (canceled) and 114 (delayed indefinitely) included this area. Ironically, the first commercial oil venture in Alaska occurred in Prince William Sound--at Katalla, near Cordova--just after the turn of the 20th century.

The Alaska National Interest Lands Conservation Act (ANILCA) of 1980 (P.L. 96-487; 16 U.S.C. § 3111 et seq.) in part implemented provisions of the ANCSA (Sec. 17.d.2) and the Statehood Act (Sec. 6). That is, it enacted into law the recommendations of the Joint Federal-State Land Use Planning Commission on (1) which lands should be included in the rest of the State's 103-million acre entitlement and (2) which lands should be included in 80 to 100 million additional acres of Federal reservations, national forests, parks, wildlife refuges, and wilderness areas. Congress also recognized through the ANILCA that it was in the national interest to regulate, protect, and conserve fish and wildlife on public lands and that an administrative structure should be established for the continuation of the opportunity for subsistence uses.

#### Affected Communities

The communities affected by the *Exxon Valdez* spill are grouped into four regions: the Kenai Peninsula Borough, the Kodiak Island Borough, the Lake and Peninsula Borough, and the Valdez-Cordova Census Area. There are 68 "communities" in the four regions (Alaska Department of Community and Regional Affairs [DCRA], 1994), though many of these are best described as "localities" rather than cities, towns, or villages.

Access to communities affects the variety and quantity of interaction with other communities, markets, and governments. Many of the communities are quite remote, with access by air or boat only. Others are connected to the Alaska road system and are therefore easier to access. Ease of access equates to some degree with how expensive it is to live in the community. The easier the access, the more opportunity residents have to purchase goods at less expensive prices.

Modes of access to communities within the oil spill region are varied but not extensive. The southwest system of the Alaska Marine Highway System provides ferry service to the majority of the oil spill area, carrying 43,500 passengers and 15,600 vehicles in 1989 (Alaska State Libraries, 1992). Road access is available from Anchorage to Homer and Seward on the Kenai Peninsula, and to Valdez in the EVOS Prince William Sound area. The Alaska Railroad connects Seward, Portage, and Anchorage, with a branch to Whittier. Air transport is used for locations not served by the ferry or road systems. Charter air services are available to each community. Commercial cargo barges serve all of the coastal communities.

### 3 Affected Environment

#### Profiles of Affected Communities

The effects of the spill differ for each region and its communities. This is a function of the communities' locations relative to the oil spill, ease and types of access, and local economic, social, and political conditions. The following discussion was developed from 1994 DCRA data files; and, while it considers larger communities like Kenai and Seward, it concentrates primarily on the smaller, predominantly Native villages. In general, these communities have mixed economies based on both cash and subsistence and have experienced the most disruption.

#### **Kenai Peninsula Borough**

The Kenai Peninsula Borough (formed in 1964) lies south of Anchorage and includes both sides of Cook Inlet from the southern tip of the Kenai Peninsula north to the Knik Arm-Turnagain Arm split. The Kenai Peninsula cities of Seward, Soldotna, Kenai, and Homer contain most of the area's development because they are linked by roads to Anchorage. Nearly all of the borough's 44,000 people live on the Kenai Peninsula, with 63 percent in the cities of Kenai and Soldotna in the central part of the peninsula. This central area is economically dependent on the oil and gas industry, commercial fishing, agriculture, tourism, government, and commercial offices.

The southern Kenai Peninsula contains the cities of Homer and Seldovia and the Native villages of Port Graham and Nanwalek. Homer is the economic and population hub of that part of the peninsula, with revenues from commercial fishing, tourism, government, commercial offices, and agriculture. In contrast, the Native villages are largely dependent on subsistence hunting and fishing.

The Kenaitze Indians, Dena'ina Athapaskans, occupied the central and upper peninsula when Europeans first came to the area; the lower peninsula had been occupied by Alutiq Natives. The city of Kenai was founded in 1791 as a Russian fur trading post. In the late 1800's and early 1900's, gold mining was a major industry on the peninsula. Also in the early 1900's, cannery operations and construction of the railroad spurred development. The Kenai Peninsula was the site of the first major Alaska oil strike, in 1957, and has been a center for exploration and production since that time.

The population of the borough is primarily non-Native, though several communities are predominantly Native and some others have significant proportions of Natives. The Kenai River is a major sport fishing location for Anchorage residents as well as tourists from elsewhere in Alaska and beyond. Because the river is world-famous for trophy king and silver salmon, the peninsula is overwhelmed by sportsmen during the summer months. The borough economy is highly diverse, with employment provided by oil industry services and supplies, commercial and sport fishing and fish processing, transportation, timber, tourism, government, and retail services. Kenai, Soldotna, Seward, and Homer are accessible by the Sterling Highway from Anchorage, Fairbanks, Canada and the lower 48 states. Scheduled and charter airlines and helicopter services are provided. Ocean-going freighters are tendered at the city docks in Seward, Kenai, and Homer. The State ferry system regularly serves Seward and Homer.

#### **Kodiak Island Borough**

The Kodiak Island Borough includes the city of Kodiak and the six Native villages of Port Lions, Ouzinkie, Larsen Bay, Karluk, Old Harbor, and Akhiok. The borough population of about 15,245 includes Natives of Alutiiq heritage, other Natives, and non-Natives. Among the non-Natives are people of European descent, as well as immigrants from the Philippines, Central America, and Meso-America. The borough includes the islands of the Kodiak Archipelago and parts of the adjacent Alaska Peninsula. As in other parts of Alaska, Kodiak Island's population grows significantly in the summer. The economy is heavily dependent on commercial fishing. The city of Kodiak also collects revenues from the U.S. Coast Guard base, government offices, and the tourism and livestock industries. In the smaller communities, residents (mostly Native) largely depend on subsistence hunting and fishing. The borough provides some social, cultural, and economic services to villages; and the Kodiak Area Native Association provides medical and social services through the tribal governments in each village.

A paved State-run airport, a gravel municipal airport, and a float-plane facility at Lily Lake serve air traffic in the city of Kodiak. Each of the villages has runways for scheduled and charter flights. The Alaska Marine Highway System operates a ferry service from Seward and Homer to Kodiak and Port Lions. Boat harbors serve commercial and transient vessels in Kodiak, and several of the other communities have dock facilities. Approximately 140 miles of State roads connect communities on the east side of the island.

#### **Lake and Peninsula Borough**

Lake and Peninsula Borough, incorporated in 1989, is located on the Alaska Peninsula in southwest Alaska. It is comprised of 17 communities, including 5 incorporated cities, with a combined population of 1,789. These communities (Chignik, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville) are primarily Alutiiq, with a mixture of Eskimos and Athapascans.

Yupik Eskimos and Athapaskan Indians have jointly occupied the area for at least the past 6,000 years. The late 1800's first brought an influx of non-Native fishermen and cannery operations. An influenza epidemic in 1918 drastically reduced the Native population. Reindeer were introduced to assist the survivors, but the experiment to provide a food source and bolster the cash economy for the survivors failed. During World War II, Fort Morrow was built at Port Heiden.

During the peak commercial fishing season, the borough population increases sharply. Commercial fishing, fish processing, tourism, and sport fishing are the mainstays of the borough's economy. Government services also provide employment. Subsistence hunting and fishing are important to year-round residents. Iliamna Lake offers trophy rainbow trout and thus attracts tourists and sportsmen. Scheduled and charter air services as well as barge and ferry services provide transportation of passengers and goods in this area of the state. Travel to Dillingham, Kodiak, and Anchorage is frequent.

### 3 Affected Environment

#### Valdez-Cordova Census Area (Prince William Sound)

For the purpose of this study, the region includes five communities: Chenega Bay, Cordova, Tatitlek, Valdez, and Whittier. The population of the area is about 10,000 people (Alaska State Libraries, 1992). Each community is accessible by air or water, and all have dock or harbor facilities. Only Valdez is accessible by road from the State's main road system.

Prince William Sound was occupied prehistorically by Chugach Alutiiq, Eyak, and Tlingit Natives; and it was in this area that the first Europeans to reach Alaska put to shore in 1741. The sea otter fur trade, commercial fishing, and the influx of non-Natives transformed the traditional cultures to incorporate the cash economy.

The present economic base of the five communities is diverse. Cordova's economy is based on commercial fishing, primarily for red salmon. As the terminus of the Trans-Alaska Pipeline, Valdez is dependent on the oil industry; but commercial fishing and fish processing and government also are important to the local economy. Whittier residents work as government employees, longshoremen, commercial fishermen, and service providers to tourists. The people of Chenega Bay and Tatitlek (predominantly Native) augment commercial fishing and other cash-based activities with subsistence fishing, hunting, and gathering.

#### Cultural Heritage Resources

While it is recognized that archaeological resources were injured as a result of the EVOS, this report incorporates various aspects of cultural resources relating to the physical remains of indigenous and historic inhabitants of the EVOS area and the values inherent in those remains for contemporary and future members of the public. Restoration actions are oriented toward physical remains because those were directly injured by the EVOS. The values of these remains for local communities, whose ancestors lived and are buried at some of these sites, would be addressed through actions relating to those remains. Archaeological sites and artifacts themselves are important kinds of cultural resources, but other cultural resources such as stories associated with specific sites or artifact types, or traditional techniques used to construct traditional items, add immense value to objects that may otherwise would provide limited insight and information. These other types of cultural resources may benefit from actions on archaeological remains, extending the positive impacts of the restoration efforts.

The greater the degree to which local community members become involved in restoration of these resources, the more fully the restoration will be completed. Some actions may be implemented in local communities as a logical extension of projects accomplished on archaeological sites. While restoration of archaeological resources is important at the local level, it is also important to the cultural patrimony of Alaska and of the United States. In keeping with that importance, all projects will be completed in compliance with applicable historical and archaeological resource protection laws.

The study of historic and prehistoric cultures of the northern Gulf of Alaska began in the late 19th century with Johan Jacobsen's archaeological excavations in lower Cook Inlet (Jacobsen, 1977). While long-running, the amount of study has not been extensive. Research into basic cultural chronology is normally a first focus of investigation, but even that has been reconstructed only partially for the EVOS area. Destruction of any part of the

archaeological record for the area is therefore of the gravest concern simply because the importance of individual parts has not been established (Reger et al., 1992).

There is a regional unity of cultural interaction and change throughout much of southern Alaska for perhaps as long as 11,000 years. William Workman proposes that cultural sequences for various areas of the southern Alaskan coast are part of a larger North Pacific Maritime co-tradition. This includes the Pacific coast of the Alaska Peninsula, the Kodiak area, Cook Inlet, and Prince William Sound -- all part of the Pacific Eskimo (or Alutiiq) region (W. Workman, 1980). Coastal sections of parts of the EVOS area also were inhabited within the past millennium by Dena'ina Athapaskan and Eyak Indian groups.

Early coastal sites on either side of the EVOS area show that the southern Alaska coast was settled by at least 9,000 years ago, but archaeological evidence from interior southern Alaska and evidence for potentially earlier maritime adaptations suggest occupation in the area perhaps 11,000 years ago. This earliest occupation around the North Pacific Rim, in interior Alaska, and possibly in Southeast Alaska and British Columbia, includes a cultural complex known as the Paleoarctic tradition, which continued to around 7,500 years ago.

Beginning sometime between 6,500 and 7,000 years ago, the Ocean Bay Period continued to about 3,500 years ago. Ocean Bay sites have been identified on Kodiak Island, the Pacific coast of the Alaska Peninsula, and the southern Kenai Peninsula. No artifacts or other features definitely associated with Ocean Bay people have been found in Prince William Sound or Cook Inlet, but recently obtained dates show possible temporal overlap at least in Prince William Sound (cf. Yarborough and Yarborough, 1993). The Kachemak Period spanned from about 3,500 years ago to about 1,000 years ago over almost all of the EVOS area. There is a widespread similarity among Kachemak sites, though regional and temporal changes have been well demonstrated.

By about 1,000 years ago, local manifestations of cultures were quite diverse and clearly represent the ancestors of the various cultures encountered by the earliest Europeans to visit the area. The Koniag culture of Kodiak, the Alaska Peninsula, and perhaps the southern Kenai Peninsula was well developed. The Chugach culture of Prince William Sound and the gulf coast of the Kenai Peninsula is similar to the culture of the Koniag. Together, these peoples are considered part of the Alutiiq tradition.

In lower Cook Inlet, the archaeological record for the late prehistoric time period is made more complex by the movement into the area by Dena'ina Athapaskan Indians who adopted Alutiiq patterns of subsistence and material culture.

Native populations in the EVOS area were decimated following Russian contact in 1741, mainly through the introduction of European diseases. Warfare, subjugation and enslavement, economic dependence, and new values and technological systems disrupted traditional economic, social, and religious patterns. Many Native villages were abandoned as the populations consolidated to retain their economic and social viability. Many of these early locations are still important to local Native communities as subsistence-resource areas and as sources of connection with their long and rich cultural heritage.

As more non-Natives arrived in the EVOS area, and as the Native communities took part in an increasingly commercial, European-style economy in the 19th and 20th centuries, many



### 3 Affected Environment

new types of cultural-resource sites were created. These include sites from both the Russian and American periods and from both non-Native and Native cultures. Some of the site types are: trading posts, churches, mines, fox farms, canneries, military installations, roads and trails, and homes.

All of these sites are important for understanding and appreciating the cultural heritage of the EVOS area. All historic and prehistoric sites located on public lands in Alaska are protected by historic preservation laws. These laws include the National Historic Preservation Act, the Archaeological Resources Protection Act, and the Alaska Historic Preservation Act (Alaska Statutes 41.35).

#### Impacts on Historic Properties

Important Alaskan cultural properties were injured by the oil spill and by the cleanup response, mainly by increasing human activity. While the exact number of important historical properties damaged is unknown, Jespersion and Griffin (1992) have documented effects on 35. Injuries included vandalism, erosion, and oiling (Dekin, 1993:1). The major sources of potential impact were (1) direct impacts resulting from oil in direct contact with artifacts or features; (2) treatment methods employed to remove oil; and (3) human activities incidental to the response actions. Twenty-four sites have been considered for restoration efforts, with a total estimated restoration cost of nearly \$872,000 (McAllister, 1992).

The types and locations of archaeological and historic sites made them particularly vulnerable to disturbances related to the oil spill. The 1964 Good Friday Earthquake and previous tectonic movements had submerged some archaeological remains below the mean-high-tide level. This placed many archaeological sites in the intertidal zone affected by the EVOS (cf. Reger et al., 1992). Sites found in the intertidal zone include stone and wooden fish weirs, petroglyphs, shipwrecks, piers, and pilings associated with historical domestic and commercial facilities, and potentially the full range of features found in the uplands. Cultural resources are known to occur in adjacent uplands, where modified deposits, villages, rock shelters, culturally modified trees, historical domestic and commercial facilities, and other features are present. The range of cultural materials includes tools, structural remains, middens, and architectural remains. The range of materials includes stone, bone, shell, various metals, wood, textiles, leather, and other organic items.

One major potential physical impact of oiling is the obscuring of intertidal artifacts from observation. Not only do the artifacts become impossible to see, their relationship to other, unobscured artifacts is lost. There also is the possibility that solidification of oil could immobilize artifacts in the intertidal zone. Both of these effects would be temporary, as wave and tidal action would remove the oil over a period of months or years. The chemical impacts of oiling are subject to debate. Some scientists have raised questions about whether contaminated organic items can still be dated using radiocarbon techniques. Laboratory studies about the effects of crude oil on radiocarbon dating with datable samples suggest that significant skewing of dates occurred (Mifflin and Associates, 1991), but others believe that the oil can be removed from crucial samples so that they may be successfully dated. Investigations at four sites in 1991 indicate that there appears to be no effect on the ability to obtain radiocarbon dates in the normal manner from oiled sites. These investigators caution, however, that their results can be applied only to these specific sites. The sites may not have been subject to the type of oiling that would contaminate them; or the oil may not have penetrated the samples, and the cleaning pretreatment successfully removed the contaminant (Reger et al., 1992).

Historical properties located in the uplands adjacent to treated shorelines were at risk when people visited those uplands. Although a blanket restriction on upland access by cleanup crews was in effect throughout the shoreline-treatment phase, some degree of access was required to efficiently undertake treatment activities. Shoreline-treatment techniques included manual removal, bioremediation, and mechanical treatment (Haggarty et al., 1991).

A variety of pedestrian upland crossings during the cleanup process resulted in damage to cultural resources, especially surface features. Vandalism and looting of cultural sites occurred as a result of uncontrolled or unsupervised access to the immediate uplands, particularly where rock shelters, historic cabins, mine sites, and other surface features or subsurface deposits were exposed. Most of the areas affected by the EVOS had not been adequately surveyed for cultural resources before the spill. Increased activity in these areas resulted in more people knowing the whereabouts of many more historic properties. This in turn resulted in looting and vandalism (Mobley et al., 1990).

Vandalism resulted from the activities of people interested in artifacts but unaware of the damage caused by uncontrolled collecting. Vandalism results in an irretrievable loss of information from sites, and damage to sites often invites further damage. Sites cannot be repaired (Corbett and Reger, 1993). This increase in knowledge of site presence and location continued after the EVOS cleanup, resulting in higher rates of potential and documented vandalism. "At many archeological sites, the damage is actually an increased threat of disruption due to wider public knowledge of the sites" (ADEC, 1993:180). Without additional education and interpretation to increase public awareness of the effect of vandalism on historic properties, and without the additional presence of stewards, monitors, or law enforcement personnel, the trend of site damage appears likely to continue in the future.

## Subsistence

Alaska is the only state in which a significant proportion of the population lives off the land or practices a subsistence lifestyle (Campbell, 1991). Subsistence is critical to supporting the incomes and cultural values of many Alaska residents. However, the relatively small, predominantly Native communities had a larger percentage of residents greatly affected than did larger, predominantly non-Native communities (Palinkas et al., 1993).

### Subsistence Definitions

While there are a variety of cultural, popular, and sociological definitions and interpretations of subsistence, Congress defined subsistence in Section 803 of the ANILCA as:

...the customary and traditional uses by rural Alaska residents of wild renewable resources for direct, personal or family consumption as food, shelter, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade.

Court rulings on the State's interpretation of ANILCA requirements have resulted in radical changes in State and Federal roles and responsibilities regarding subsistence management in Alaska. The State of Alaska operated a program that met Federal requirements until the

### 3 Affected Environment

1989 Alaska Supreme Court's *McDowell* decision (785 P2d 1[1989]). The court ruled that the laws used by the State to provide a subsistence priority for rural Alaskans violated the Alaska Constitution. On July 1, 1990, the Federal Government took over management of subsistence activities on Federal public lands in the State (Federal Subsistence Board, 1992). The State retains control over sport hunting and fishing on all public lands and also manages subsistence for all eligible Alaskans on State public lands.

The term "subsistence" refers to a particular pattern of activities and values associated with harvesting and using naturally occurring renewable resources. The ethnic composition of communities is important for considerations of subsistence because as the percentage of Natives in a community increases, subsistence production also increases (Wolfe and Walker, 1987). Subsistence hunting, fishing, trapping, and gathering activities represent a major focus of life for many EVOS communities; and the values associated with subsistence are different for Native communities than for non-Native communities (cf. Case, 1991).

Generally, subsistence systems are characterized by a few important attributes:

- Subsistence activities are seasonal. Fishing, hunting, and gathering follow the natural rhythm of the tides, wildlife and fish migration, and plant life cycles.
- Subsistence activities are localized. Productive, accessible sites are established for various subsistence activities.
- Subsistence is regulated by a system of traditional, locally recognized rights, obligations, and appropriated behaviors. The use of sites, division of the catch or harvest, and assignment of responsibilities are determined by tradition.
- Subsistence is opportunity-based. The subsistence resource must be harvested when and where it is available. Generally, the harvesting of each resource must be completed within a finite period.

Individuals -- both Native and non-Native -- participate in subsistence activities to supplement personal income and provide needed food; to perpetuate cultural customs and traditions; and to pursue a lifestyle reflecting deeply held attitudes, values, and beliefs centered on self-sufficiency and nature. In addition to its economic importance in rural households, the opportunity to participate in subsistence activities reinforces a variety of cultural values in both Native and non-Native communities. The distribution of fish and wildlife contributes to the cohesion of kinship groups and to community stability through sharing of resources derived through harvest activities.

Subsistence resources provide the foundation for Native culture, ranging from the totem basis of clan divisions, to norms governing the distribution of wealth, to reinforcement of basic values of respect for the earth and its resources. "Subsistence is a core cultural institution in Native communities. Damage to subsistence resources and to the meaningful activities that are part of this core institution thus damages the whole culture" (Impact Assessment, Inc., 1990). The cultural systems include kinship-based subsistence-production units; a seasonal cycle of activities tied to resource availability; complex sharing networks; traditional systems of land use; and systems of beliefs, knowledge, and values associated with resource uses that are passed between generations as cultural and oral traditions of the community (Wolfe, 1983; ICF Technology Incorporated [ICF], 1993).

The harvest of fish and game also plays important sociocultural roles in non-Native communities. It contributes to self-reliance, independence, and the ability to provide for oneself -- values that are important reasons why many people emigrate to Alaska.

Both Alaska Natives and non-Natives experience a relationship with the environment that is unique in the United States. Many of those who choose to live in Alaska and in the EVOS area forego the steady income of a city job and assign great value to the rural, subsistence-based way of life. When the environment is harmed, the basis of subsistence -- the harmonious relationship of humans to their environment -- is threatened.

#### **Economic Implications of Subsistence**

The socioeconomic environment of the EVOS area has been dominated by resource-related industries such as mining, commercial fishing, timber harvesting, and tourism. Employment in these industries is highly seasonal. Salmon return to spawn in the late spring, summer, and early fall. Snow and darkness limit timber harvesting and mineral exploration during winter months. The tourism season runs from May through early September. The EVOS-area residents who work in the resource-extraction and tourist industries often experience high levels of unemployment during the "off" seasons.

Within this context of seasonal and cyclical employment, subsistence harvests of fish and wildlife resources take on special importance. The use of these resources may play a major role in supplementing cash incomes during periods when the opportunity to participate in the wage economy is either marginal or nonexistent. Due to the high prices of commercial products provided through the retail sector of the cash economy and the limited availability of commercial products in some rural areas, the economic role of locally available fish and game is significant.

The economic aspects of the subsistence system are dependent on the availability of untainted natural resources. In the subsistence system, food and other material resources are bartered, shared, and used to supplement supplies from other sources. Subsistence resources are the foundation of the area's mixed subsistence/cash economy.

None of the rural communities in the spill area is so isolated or so traditional as to be totally uninvolved in the modern market economy. Most communities are characterized by a mixed subsistence/market economy. This label recognizes that a subsistence sector exists alongside a cash system, and that the socioeconomic system is viable because the sectors are complementary and mutually supportive. Even the most traditional subsistence hunter uses the most modern rifles, snow machines, boats, boat motors, nets, and traps that he can afford. These goods cannot be acquired without cash.

Although some food is imported into spill-area communities, a substantial subsistence harvest is hunted, fished, and gathered locally. For some residents, subsistence is the primary source of food and supplies. For others, subsistence supplements resources available from other sources. Overall, the high cost of transporting supplies combines with the cultural values of subsistence to make subsistence harvests an indispensable foundation of the communities' food supplies (ICF, 1993).

### 3 Affected Environment

The communities affected by the oil spill are small, relatively isolated, and economically dependent on local fish and wildlife. Before the spill, subsistence harvests in these communities were relatively large and diverse, with harvests of many kinds of fish, marine invertebrates, land mammals, marine mammals, birds, and eggs, and wild plants (Fall, 1993). The noncommercial transfer and exchange of wildlife products are important institutions. The prevalence of direct consumption and nonmonetary transfer and exchange of fish, wildlife, and other natural resources and services makes it difficult to determine their economic value in terms of the value system of the cash economy.

Our beaches and waters provide us with deer and fish and game which helps offset the high cost of food here (Kodiak Island). This is not simply a recreational question, it is everyone's livelihood and food resource that is affected (National Wildlife Federation et al., 1990).

Within Alaska Native communities, not all households participate in every subsistence harvest; but food is often shared among households. Sharing subsistence resources occurs both within and among EVOS villages.

Estimates vary widely on the percentage of subsistence foods in the diet, but studies indicate that subsistence may provide 70 to 80 percent of the total protein consumed within the less accessible EVOS households. Estimates place the share of subsistence meats and fish at 200 to 600 pounds per person per year (Scott et al., 1992). As Fall (1991) points out, these are substantial harvests, considering that the average family in the western United States purchases about 222 pounds of meat, fish, and poultry per person each year. Subsistence foods provide a large portion of the diet -- a portion that families can ill afford to replace with imported substitutes.

#### Effects of the Spill on Subsistence

As indicated above, subsistence is the basis of a whole way of life in the oil spill area. Recognition of this perspective is essential to understanding the significance of subsistence activities, as well as the far-reaching impacts of the *Exxon Valdez* oil spill on subsistence, for Natives and non-Natives alike.

The oil spill fouled the waters and beaches used for subsistence hunting, fishing, and gathering by the EVOS communities. Destruction and contamination of subsistence resources contributed to the sense of cultural dislocation experienced by some Alaska Natives in the area.

Real and perceived habitat contamination resulted in a decline in subsistence resource harvesting ranging from 12.3 percent (in Akhiok) to 77.1 percent (in Ouzinkie) as compared to the 2 years before the spill (Fall, 1991b). It appears that as long as residents of the Native communities of the areas affected by the EVOS believe that oil remains in their environment, many will continue to refrain from using subsistence foods (Fall, 1991c). The EVOS residents have been forced to seek food from outside the local environment. Subsistence harvesting was disrupted, which in turn disrupted the traditional cultural patterns of social interaction surrounding the harvesting of local natural resources. In 1989, the subsistence fishery was banned as a precaution against the possible health-threatening effects of the oil spill on fish in Prince William Sound. In several Native villages, shortages of traditional foods resulted and persist. Figure 3-3 illustrates the persistence of this reduction in use for

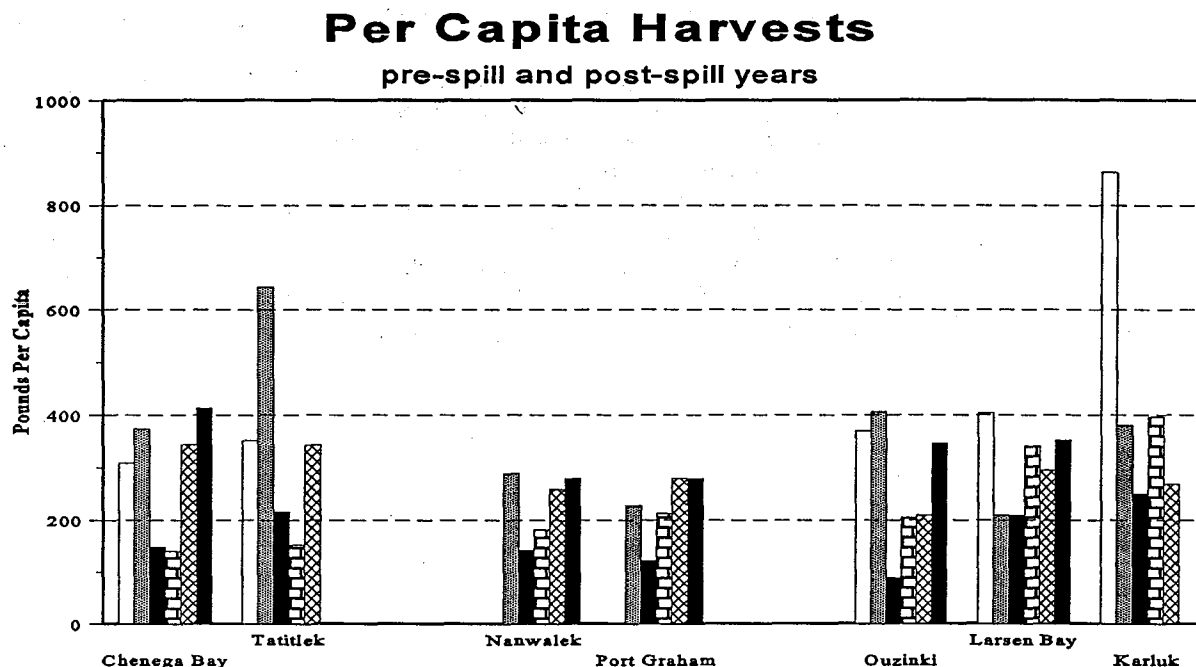


selected villages in Prince William Sound, the Kenai Peninsula, and Kodiak Island. Communities on the Alaska Peninsula appear to be back up to prespill harvest levels.

In addition to damaging the physical environment of the EVOS area, the oil spill had psychological effects on the EVOS population. Disruption of the sociocultural systems on which subsistence is based created psychological stress in EVOS communities. Disruption of the social infrastructure provided by traditional subsistence-harvest patterns and practices left many Alaska Natives dislocated from their traditional lifestyle. In some cases, oil spill-related stress contributed to social tensions that erupted into open disagreements among villagers. Some of these disagreements continue unresolved. Moreover, the sociocultural system on which the traditional Alaska Native lifestyle is based was threatened by the influx of cleanup crews and the unfamiliar demands of a cash economy.

# 3 Affected Environment

Figure 3-2



|                                      | Chenega Bay | Tatitlek |  | Nanwalek | Port Graham |  | Ouzinki | Larsen Bay | Karluk |
|--------------------------------------|-------------|----------|--|----------|-------------|--|---------|------------|--------|
| Pre-spill year one <sup>1</sup>      | 308.8       | 351.7    |  |          |             |  | 369.1   | 403.5      | 863.2  |
| Pre-spill year two <sup>2</sup>      | 374.2       | 643.5    |  | 288.8    | 227.2       |  | 405.7   | 209        | 381    |
| Spill year <sup>3</sup>              | 148.1       | 214.8    |  | 140.6    | 121.6       |  | 88.8    | 209.9      | 250.7  |
| Post-spill year one <sup>4</sup>     | 139.2       | 152      |  | 181.3    | 214         |  | 205.3   | 341.8      | 396.2  |
| Post-spill year two <sup>3</sup>     | 343.9       | 343.9    |  | 258.8    | 280.4       |  | 209.3   | 294.6      | 268.7  |
| Post-spill year three <sup>3,4</sup> | 412.5       |          |  | 279.5    | 279.6       |  | 347.1   | 353.3      |        |

1. Pre-spill year one is 1984/85 for Chenega Bay; 1987/88 for Tatitlek; and 1982/83 for Kodiak Borough communities.
2. Pre-spill year two is 1985/86 for Chenega Bay; 1988/89 for Tatitlek; 1987 for Nanwalek and Port Graham; and 1986 for Kodiak Borough communities.
3. "Years" are 12 month study years from April through March, except for 1989, when the study year was a calendar year for all communities except Chenega Bay and Tatitlek. The April through March study year was used there.
4. Preliminary data.

Source: Scott et al. 1993; Alaska Department of Fish and Game, Division of Subsistence Household Survey 1993.

Although a number of fisheries were closed immediately following the spill and reopened once it had been determined that local fish were safe to eat, some Alaska Natives are unwilling to eat them for fear of contamination. Spot shrimp fisheries were closed in 1989 and 1990. Clams, an important part of the Native diet, were shown to be contaminated after the spill. Fish, bear, moose, deer, and other Native meats were deemed safe to eat by Federal and State health officials; but not all Prince William Sound subsistence users were willing to go back to harvesting them.

While subsistence users were being told that the fish were safe to eat, Federal Agencies banned the commercial sale of fish that showed any level of hydrocarbon contamination. The confidence that subsistence users had in the information they were given by health officials was shaken by this inconsistency (ICF, 1993).

Throughout the restoration process, it is important to consider the effects of perceptions of contamination as well as actual contamination, because it is the perceptions that affect the decision on whether or not to harvest subsistence resources in the EVOS area.

## Recreation and Tourism

Recreation use in the EVOS area is diverse, with a variety of opportunities available for both commercial (tourism) and noncommercial users. Commercial recreation includes uses by clients and operators of tourism services such as boat tours, fishing charters, and flightseeing services. Noncommercial recreational users engage in many of the same activities as commercial users but do not purchase or pay for the services of tourism businesses. Common recreational activities for all users include kayaking, camping, hiking, boating, sightseeing, photography, scuba diving, beachcombing, flying, sport fishing, hunting, gathering food, and investigating the history of an area. Recreation use occurs year round, but the majority of use from in-state and out-of-state residents occurs during the summer months from May through November (PWSRWG Draft 1994). Because of the remoteness of many of the recreational opportunities in the EVOS area, there is a blending of commercial and noncommercial recreation. That is, noncommercial recreation often entails commercially obtained services, especially transportation. For instance, to kayak in Prince William Sound, many recreationists will take the train to Whittier and charter a boat to access the more remote areas of the Sound. Sport hunters will often use charter aircraft to land them in a remote area to hunt.

Many recreational activities are nonconsumptive. Kayaking, photography, motorboating, flightseeing, and these types of nonconsumptive activities do not remove parts of the environment as an integral part of their practice. Recreational hunting, fishing, and plant gathering are, in contrast, consumptive. Animals and plants are taken from within the area for consumption. These may be consumed while recreationists are in the area or be removed from the area to be consumed in (often) urban areas. Recreational hunting will not be addressed in this document because no restoration plans are likely to be submitted which would affect populations of animals hunted for sport.

### 3 Affected Environment

#### Recreation

The oil spill area offers tremendous opportunities for outdoor recreation. Much of land in the oil spill area is in public ownership and is designated as parks, refuges, or forest lands. These areas provide developed and nondeveloped recreational opportunities including: wildlife viewing, camping, sightseeing, fishing, hunting, hiking, sailing, motorboating, kayaking, flightseeing, staying in a lodge, and taking a boat (tourboat, ferry, or cruiseship) tour (PWSRWG Draft 1994). These recreational opportunities have helped create a growing tourism industry in the region.

Hiking and camping, being relatively inexpensive and easily available, are by far the preferred modes of outdoor recreation for the majority of Alaska's residents and visitors. Although there are few trails, the vast taiga and tundra terrain (along with the perpetual daylight during hiking season) offers considerable flexibility to hikers. The abundant wildlife adds the possibility of animal watching while hiking. Photographing scenery, plants, and animals goes hand in hand with hiking and camping.

For the purposes of this section, the spill area is divided into two regions: the Southcentral region which includes Anchorage, the Kenai Peninsula, and Prince William Sound; and the Southwest region which includes Kodiak Island and the Alaska Peninsula. Large tracts of private land, especially Native corporation-owned lands, exist within the EVOS area. Because the focus of this document is on public lands, those private lands will not be considered.

Chugach National Forest, the second largest national forest in the U.S., encompasses much (5.8 million acres) of the Southcentral region. The U.S. Forest Service operates and maintains 37 public recreation cabins and 16 campgrounds within the Chugach National Forest. There are over 200 miles of trail, including two National Recreation Trails. In addition, there are 149 recreation special use permit facilities, including six resort facilities. Forty-six percent of all visitors to Alaska make the trip to the Begich-Boggs Visitor Center, at Portage Glacier, making it the most visited attraction in the State (Alaska State Libraries, 1992). The Russian River, located on the upper Kenai Peninsula, is also one of the most visited spots in Alaska. Approximately 90 percent of the recorded recreational activities in the Chugach National Forest occurs on the Kenai Peninsula. The most popular activities are camping, hiking, skiing, and fishing.

Alaska's second-largest State park, Chugach State Park, located within this region, encompasses nearly half a million acres (Alaska State Libraries, 1992). Hiking is the main recreational activity in the park with about a dozen well-maintained, well-used, moderate-to-difficult trails. Along with hiking, photography and wildlife watching are popular recreational activities.

Southcentral Alaska includes some of the world's premier kayaking areas. Kayaking trips are taken from Valdez, Kodiak, Homer, Whittier, and Seward to the western portion of the Prince William Sound and the bays along the Kenai Peninsula and Kodiak Island. Kayaking trips usually involve charter boat transportation to a site some distance from the port and include both kayaking and wilderness camping.

The Kenai Peninsula is the most often viewed landscape in Alaska with the Seward/Anchorage highway being the most heavily used travel route in the State. Captain Cook State Recreation Area, Kenai National Wildlife Refuge, Kenai Fjords National Park,

Alaska Maritime National Wildlife Refuge, Kachemak Bay State Park, and Chugach National Forest are some of the areas affording a variety of recreational opportunities on the Kenai Peninsula. The Kenai Fjords National Park, under the management of National Park Service, encompasses 669,000 acres of ice fields and a deep-water fjord coastline providing opportunities to see whales, sea otters, and various types of birds. At locations in the western and southern parts of the peninsula, the Alaska Department of Natural Resources maintains public access and recreation areas (including the Kachemak Bay State Park) totaling several thousand acres.

Besides the public lands, some EVOS area communities also offer recreational opportunities, and their economies, to some extent, are based on recreation and tourism. The city of Seward, located at the head of a deep-water inlet known as Resurrection Bay, offers fishing and sightseeing opportunities. The city of Soldotna, located in the central peninsula region, offers salmon fishing in the Kenai River and scenic views across Cook Inlet. The city of Kenai sits on a bluff where the Kenai River meets Cook Inlet and where some of the greatest tidal ranges in Cook Inlet occur, providing whale watching opportunities. Incoming tides actually reverse the flow of the river, influencing the movement of fish and the white beluga whales that follow them. Homer, located on the southern tip of the Kenai Peninsula, provides charter boat tours to Gull Island and other locations for viewing thousands of birds. Homer is also visited for halibut fishing.

Several communities located within the Prince William Sound area offer recreational opportunities and services. The city of Cordova offers a variety of lodging options and recreational services, including flightseeing, several boat charter services, and recreation centers. The city of Valdez, surrounded by mountains, provides a variety of local tours and sightseeing opportunities. Numerous scheduled cruises to Columbia and Shoup Glaciers start here. In addition, several guided walking and bus tours showing historic Valdez and the Alyeska Pipeline Terminal are also available.

The Southwest region includes the Kodiak Island group and the Alaska Peninsula. Katmai National Park and Preserve, Alaska Peninsula National Wildlife Refuge, Becharof National Wildlife Refuge, Kodiak National Wildlife Refuge, and Aniakchak National Monument and Preserve are located in this region, and all these areas experienced effects of the EVOS.

Kodiak Island is the largest island in Alaska and the second largest island in the U.S. Kodiak has Alaska's largest fishing fleet and its biggest brown bear population. Kodiak Refuge, established in 1941 to protect the habitat of brown bear and other wildlife, occupies about two-thirds (about 50,000 acres) of the island. Rearing and spawning habitat for five species of Pacific salmon is provided within the refuge. With over 200 species of birds, as well as large brown bear, bald eagle, red fox, river otter, Sitka black-tailed deer, snowshoe hare, mountain goat, beaver, and other wildlife populations, the refuge is ideal for wildlife viewing. Other recreational activities include photography, rafting, canoeing, camping, backpacking, hiking, hunting, and fishing. A visitor center and a limited number of recreational cabins are also located within the refuge.

The town of Kodiak, where the majority of the Kodiak Island population lives, is accessible by air and the Alaska Marine Highway System. Recreation includes fishing, hunting, sightseeing, hiking, boating, and other activities. The communities of Larsen Bay and Port



### 3 Affected Environment

Lions on Kodiak Island are visited for hiking, fishing, and hunting opportunities and their economies to a large extent are dependent on tourism.

At 4 million acres, Katmai National Park, on the Alaska Peninsula adjacent to Kodiak Island, is one of the nation's largest National Parks. Yearly, people from all over the world visit the Brooks River to fish for salmon and trout, and to view the large concentration of brown bears. The Katmai coast offers spectacular wild and rugged scenery and the opportunity to view many species of marine mammals.

About 125 miles southwest of Katmai is Aniakchak National Monument and Preserve, a 600,000-acre parcel of remote wildlands. Relatively little recreation use occurs within the preserve, but the coastal area is rich in plant and animal life.

Becharof National Wildlife Refuge encompasses 1.2 million acres on the Alaska Peninsula and is home to the second largest lake in Alaska (Becharof Lake). The lake is the primary nursery for the second largest salmon run in the world (Mobley et al., 1990). The fish, brown bear, caribou, moose, wolves, wolverines, river otters, red fox, and beavers comprise the species that attract visitors for recreational viewing, photography, hunting, or fishing. Sea mammals are common in the rich coastal waters, and the wetlands, coastal estuaries, rugged shorelines, and offshore islands provide a wide range of habitats for many different species of birds.

The Alaska Peninsula National Wildlife Refuge includes some 3.5 million acres and offers many of the same attractions to recreationists as the Becharof Refuge.

The Alaska Maritime National Wildlife Refuge includes more than 2,400 islands, headlands, rocks, islets, spires, and reefs along the Alaska coastline. In the spill area, islands of importance for bird viewing include the Barren Islands at the mouth of Cook Inlet, the Pye Islands near Kenai Fjords National Park, and the Chiswell Islands, outside of Resurrection Bay near Seward.

#### EVOS Effects on Recreation

The oil spill affected the entire spectrum of recreational activities and opportunities in the area. The nature and extent of injury varied by user group and by area of use. Although few actual recreation facilities were injured as a result of the spill, the disruption of the whole ecosystem caused a reduction in recreation quality. The primary characteristic that attracts people to recreate in Prince William Sound (and the affected EVOS area by analogy) is the area's wilderness-like setting. This entails the values of solitude, unmodified scenery, and nondevelopment. Loss of wildlife, oiled beaches, disturbance of wilderness settings (in designated wilderness and wilderness-like, nondesignated areas), and even increased use in some areas have resulted from the spill (PWSRWG Draft 1994). Resources important for wildlife viewing include killer whale, sea otter, harbor seal, bald eagle, and various seabirds. Residual oil exists on some beaches with a high value for recreation and may decrease the quality of recreational experience and discourage recreational use of these beaches (Trustee Council, 1993). Respondents to a survey of recreation users in Prince William Sound revealed a strong concern that recreational uses may be further impacted if "restoration activities" commence (PWSRWG Draft 1994). That is, developing additional or enhanced recreation facilities may increase the quantity of recreation opportunities, but at the same time actually decrease the quality of the recreation experience.

### Commercial Recreation (Tourism)

Tourism is Alaska's third-largest industry behind petroleum production and commercial fishing. Tourism was, and is, an industry of growing economic importance to the State. Once regarded as a stepchild of the major traditional resource industries, the growth of commercial recreation in the 1980's gave it legitimacy as a major industry. Visitors from outside the State provide the major impetus to the industry, though Alaska residents also contribute substantially.

A visitor survey conducted by the Alaska Division of Tourism under the Alaska Visitors Statistics Program II (AVSP) revealed that more than 750,000 people visited Alaska in 1989 from around the world (McDowell Group, 1989), and of this number, 521,000 people visited in summer, generating \$304 million in summer revenue alone. The Southcentral region was the major beneficiary of visitor spending, capturing 44 percent of the \$304 million (Alaska State Libraries, 1992). Sixty-nine percent of the total summer visitors was vacation/pleasure visitors. Southcentral Alaska accommodated more visitors per year than any other region, including two-thirds of the vacation/pleasure tourism market. Southwest Alaska was visited by only 6 percent of the total vacation/pleasure visitors. The EVOS affected the Alaska trip planning of one in six visitors (McDowell Group, 1989).

Anchorage, Seward, Kenai/Soldotna, Homer, Valdez/Prince William Sound, and Whittier were among the most visited communities in the Southcentral region, with Portage Glacier being the number one destination in the entire State. In addition, cultural attractions and museums were popular among Southcentral visitors. The most visited attractions on the Kenai Peninsula were Kenai River, Kenai National Wildlife Refuge, Resurrection Bay, Kachemak Bay, and Kenai Fjords National Monument. In the Prince William Sound area, the most visited attractions were Columbia Glacier, Valdez Pipeline Terminal, and College Fjord. In the Southwest region the most visited attractions were Kodiak Russian Orthodox Church, Katmai National Park, and Kodiak National Wildlife Refuge (McDowell Group, 1989).

Among the wide variety of recreational opportunities offered in Alaska, wildlife viewing was the most common activity in every region among the vacation/pleasure visitors. Bird watching was also common in all regions. Rafting was most popular in Southeast Alaska and Denali. Hiking was also popular, especially among the Southwest Alaska and Denali visitors. Fishing was most popular in Southwest Alaska, with twice the participation of the next leading fishing region, Southcentral (McDowell Group, 1989).

The visitors of Southcentral region rated flightseeing and day cruises highly in the tour list while rafting, hiking, and canoeing/kayaking lead the activities list in satisfaction. Southwest vacation/pleasure visitors give that region's activities the highest marks in the State. Southwest was rated highly by the vacation/pleasure visitors for fishing (fresh water more than salt water), hunting, rafting, and canoeing/kayaking. It also was rated the best for flightseeing activity in the State (McDowell Group, 1989).

### Effects on Commercial Recreation

Although the nature and extent of injury varied, approximately 43 percent of the tourism businesses surveyed in 1990 felt that they had been significantly affected by the oil spill

### 3 Affected Environment

(McDowell Group, 1990). Millions of dollars were lost in 1989 due to reduced visitor spending in Southcentral and Southwest Alaska. By 1990, only 12 percent felt that their businesses were affected by the spill. Respondents also reported seeing less oil now than in 1989 and subsequent years; a slow but discernible increase in wildlife sightings; and each year a slight increase in people using the spill area for recreation activities (PWSRWG, 1993).

Overall, tourism was a major factor in business declines. Businesses in the spill-impacted area sustained a significant decline in business (up to 50%) from 1988 to 1992. Fifty-nine percent of businesses surveyed by the Prince William Sound Recreation Working Group received cancellations in bookings in 1989 (PWSRWG Draft 1994). This injury continued through fewer tourists and bookings in 1989 and 1990 as a result of a loss in the natural setting. Many of the larger tour operations had experienced more tourists and bookings by 1991, but smaller businesses whose service relates directly to the natural or wilderness character of the area have recovered much more slowly (PWSRWG Draft 1994).

#### Wilderness

Prior to the oil spill, the EVOS area was considered a relatively pristine wilderness with bountiful environmental resources that made the area particularly valuable to Alaska residents. The relatively unpolluted environment enriched individual lives by simply existing. This perspective is somewhat less common in the lower 48 States. For many Alaskans, the spill spoiled a pure and irreplaceable resource, a place that was fundamental to their identities and values. This section deals specifically with designated wilderness areas and wilderness study areas. These tracts of land not only possess the pristine qualities people often associate with isolated locales, but which have been recognized by the U.S. Congress or by the Alaska Legislature and therefore require different management techniques than other State and Federal public lands.

Areas formally designated as wilderness within the spill area are: Katmai National Park, Becharof National Wildlife Refuge, and Kachemak Bay State Wilderness Park. Four Federal areas are currently being formally considered for wilderness designation: Kenai Fjords National Park, Lake Clark National Park, Aniakchak National Monument and Preserve, and the Nellie Juan/College Fjord area of the Chugach National Forest. Federal wilderness areas are managed according to the 1964 Wilderness Act and the Alaska National Lands Conservation Act (ANILCA) of 1980. State wilderness areas are managed according to enabling legislation and subsequent management plans. Generally, the areas are managed to maintain their natural landscape, their solitude, and their wild character. Evidence of human presence is generally limited to temporary uses. Various State and Federal lands not legislatively designated as wilderness or wilderness study areas are managed according to each agency's enabling legislation and subsequent regulations. These areas allow a broader range of uses and increased human development and thus have increased human presence.

The oil spill delivered oil in varying quantities to the adjoining waters of all designated wilderness areas, and oil was deposited above the mean high tide line in many areas. During the intense cleanup seasons of 1989-1990, 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.

Oil remains in isolated pockets in these wilderness areas. Although the oil is disappearing, it will be decades before the wilderness returns to its pristine condition. As a result, direct injury to wilderness and intrinsic values continues. The massive intrusion of people and equipment associated with oil-spill cleanup has now ended (Trustee Council, 1993).

The concern for wilderness touches on the concerns for all other affected resources and services. Wilderness is seen as a pristine, undisturbed natural setting that can best provide habitat for affected species, so it is important in considerations of fish (in terms of populations, commercial fishing, and subsistence), birds, and sea mammals. It is a building block of the ecosystem approach to restoration. People from all over the country and all over the world value this pristine setting, as do Alaska residents, for its ability to provide a setting generally unaffected by the human world, so wilderness is important in considerations of passive uses. Commercial recreation benefits from designated wilderness areas and wilderness study areas in the same way as noncommercial recreation: these areas provide a focus for wildlife viewing, spectacular natural scenery, and a range of recreation opportunities. Passive use, recreation, habitat preservation, subsistence, and other issues of concern relate inherently to the idea and reality of wilderness -- whether designated wilderness areas, designated wilderness study areas, or de facto wilderness.

For the Native communities, the interconnectedness of the natural and human worlds permeates life, understanding, and religion. This manifests itself in many ways, but runs as a common thread throughout the communities. There is probably no word in Alutiiq, Eyak, or Athapaskan that translates directly to the Wilderness Act definition of wilderness, even though these cultures have been for thousands of years intimately interwoven with the natural environment. The Western view of wilderness, as captured by the Wilderness Act, is of a landscape untrammelled by humans, where people are just visitors who come and go. The Native view is of people as part of the landscape and on par with the natural world. Their lives cannot theoretically or physically be separated from the lands -- including wilderness -- and waters on which they have always lived. (Van Zee et al., 1994).

## Commercial Fishing

Commercial fishing in Alaska has become a billion-dollar-per-year industry, and Alaska is considered the most important fishing State in the United States (Alaska Blue Book, 1994). The ex-vessel value of Alaska's commercial-fishing industry ranks first among all states in the Nation; and, in 1986, if the State of Alaska had been an independent nation, it would have ranked eleventh, worldwide, by volume of fish production. In 1986, Alaskan harvests constituted 46 percent of the total production of the United States. The ex-vessel value of fishery landings in Alaska is more than twice the combined landed values of Washington, Oregon, and California (McDowell, 1989). In 1988, the harvest was worth \$3 billion at the first wholesale level. The seafood industry is the largest nongovernmental employer in Alaska and provides the equivalent of approximately 16.4 percent of the State's jobs, including nearly 70,000 seasonal jobs and as many as 33,000 direct, indirect, and induced year-round jobs. Based on these figures, the 1987 estimated total seafood industry payroll was \$596 million (McDowell Group, 1989; Knapp, 1993; Royce, 1991).

In 1992, approximately 5.4 billion pounds of seafood worth \$1.6 billion in ex-vessel value were landed into Alaskan ports. Salmon accounted for approximately 37 percent of the total

### 3 Affected Environment

value (Alaska Blue Book, 1994). The value of the 1988 commercial-fish harvest in Prince William Sound alone for salmon fisheries totalled \$76 million; for herring it was \$12.2 million and for shellfish it was \$2.4 million (ADF&G, 1989).

The EVOS area includes portions of the commercial-fishing districts of Prince William Sound, Cook Inlet, Kodiak, and Chignik. The Prince William Sound commercial-fisheries-management area is subdivided into 11 commercial-fishing districts. In 1985, 845 limited entry permits were issued for commercial salmon fishing: 267 were for power purse seine, 548 were for drift gillnet, and 30 were for set gillnet (Prince William Sound Regional Planning Team, 1986). The Cook Inlet commercial-fisheries-management area that is subdivided into upper and lower Cook Inlet includes seven commercial-fishing districts. In 1981, there were 1,428 limited-entry commercial-fishing permits issued for salmon: 597 were for drift gillnet, 747 were for set gillnet, and 84 were for purse seine (Cook Inlet Regional Planning Team, 1981). The Kodiak Salmon Management Region includes eight management districts. In 1988, 600 limited-entry permits were issued for commercial fishing: 380 were for purse seine, 32 were for beach seine, and 188 were for set gillnet. The Chignik commercial salmon fishing management area is divided into five districts, and purse seine is the only legal gear type allowed in this area. In 1989, there were 101 limited-entry-permit holders in the area (Thompson and Fox, 1990).

During the most recent 10 years of record, salmon catches in the EVOS area generally have been above historic levels (Brennan et al., 1993; Bucher and Hammarstrom, 1993; Donaldson et al., 1993; Quimby and Owen, 1994; Reusch and Fox, 1993). The species composition of the salmon harvests in the spill area are dominated by large numbers of pink and sockeye salmon. In 1992, these two species comprised nearly 90 percent of the commercial salmon harvest in this area (Table 3-3). The average size of sockeye salmon, however, is nearly twice that of pink salmon and they are worth approximately ten times more per pound than pink salmon; consequently, their value to the commercial fishers is much greater.

**Table 3-2**  
**Commercial Salmon Harvests in the EVOS Area, 1992**

| Management Area         | Species       |                   |                  |                   |                  |
|-------------------------|---------------|-------------------|------------------|-------------------|------------------|
|                         | Chinook       | Sockeye           | Coho             | Pink              | Chum             |
| Prince William Sound    | 41,300        | 1,771,600         | 619,500          | 8,637,100         | 334,400          |
| Lower Cook Inlet        | 1,900         | 176,600           | 5,900            | 479,800           | 22,200           |
| Upper Cook Inlet        | 17,200        | 9,108,300         | 316,500          | 776,900           | 626,100          |
| Kodiak                  | 24,300        | 4,167,700         | 280,100          | 3,310,500         | 679,500          |
| Chignik                 | 10,800        | 1,277,500         | 310,900          | 1,554,100         | 222,100          |
| <b>Total</b>            | <b>95,500</b> | <b>16,501,700</b> | <b>1,532,900</b> | <b>14,758,400</b> | <b>1,884,300</b> |
| <b>Percent of total</b> | <b>0</b>      | <b>48</b>         | <b>4</b>         | <b>42</b>         | <b>5</b>         |

(Summarized from Brennan, Prokopowich, and Gretsich, 1993; Bucher and Hammarstram, 1993; Donaldson et al., 1993; Quimby and Owen, 1994; Reusch and Fox, 1993)

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|-------------------------|---------------|-------------------|------------------|-------------------|------------------|
|                         | Chinook       | Sockeye           | Coho             | Pink              | Chum             |
| Prince William          |               |                   |                  |                   |                  |
| Sound                   | 41,300        | 1,771,600         | 619,500          | 8,637,100         | 334,400          |
| Lower Cook Inlet        | 1,900         | 176,600           | 5,900            | 479,800           | 22,200           |
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Emergency commercial-fishery closures that caused large-scale disruptions in the fisheries were ordered throughout the EVOS area in 1989 to avoid the likelihood of marketing a tainted product and to avoid fouling of fishing gear (Barrett, 1990; Barrett et al., 1990; Brady et al., 1991; Schroeder and Morrison, 1990; Reusch, 1990). These closures affected salmon, herring, crab, shrimp, rockfish, and sablefish. The 1989 closures resulted in overescapement of sockeye salmon in the Kenai River drainage and in several systems on Kodiak Island. In



In the management areas of Prince William Sound and Cook Inlet in 1992, the estimated harvest of nearly 30,000 tons of herring was worth approximately \$14 million (Bucher and Hammarstrom, 1993; Donaldson et al., 1993; Reusch and Fox, 1993).

All spring Pacific herring fisheries in Prince William Sound were cancelled in 1989 as a result of the EVOS (Brady et al., 1991). The commercial harvest of Pacific herring in 1990 was excellent (Royce et al., 1991), and, although the 1989 herring-spawning population was the largest observed since the early 1970's, it also resulted in the poorest production ever observed. Consequently, the fishery managers are wary of lingering impacts of the oil spill on the Pacific herring populations (Biggs and Baker, 1993; Biggs et al., 1993).

### Hatcheries

Article VIII, Section 5, of the Alaska Constitution authorizes the State legislature to "provide for facilities improvements and services to assure further utilization and development of the fisheries". In 1974, the Private Nonprofit Hatcheries Act (Chapter III, SLA 1974) was enacted which "authorized private ownership of salmon hatcheries by qualified nonprofit corporations for the purpose of contributing by artificial means to the rehabilitation of the state's depleted and depressed salmon fishery." Since that time, the ADF&G, Division of Fisheries Rehabilitation, Enhancement and Development (FRED Division) and PNP groups have cooperated to build hatcheries throughout the State, including Prince William Sound, Cook Inlet, and Kodiak (Table 3-4). Although several were built and operated by the FRED Division, all presently are being operated by the PNP organizations to produce fish for the common property fisheries, primarily for the benefit of commercial fishermen.

The importance of hatchery-reared salmon was made apparent during the 1986 season, when approximately 11.5 million pink salmon were caught in Prince William Sound. Approximately 10.5 million fish were harvested in common property fisheries, and 909,219 fish were harvested in the special harvest areas of two major PNP hatcheries to provide operating revenue. Approximately 5.8 million fish in the common property harvest were of hatchery origin. The combined common property and sales harvests of hatchery-produced fish was 6.8 million fish. This marked the first time in the history of the fishery that hatchery fish constituted more than half of the pink salmon harvest in Prince William Sound (Sharr et

NUMBER 7

Emergency commercial-fishery closures that caused large-scale disruptions in the fisheries were ordered throughout the EVOS area in 1989 to avoid the likelihood of marketing a tainted product and to avoid fouling of fishing gear (Barrett, 1990; Barrett et al., 1990; Brady et al., 1991; Schroeder and Morrison, 1990; Reusch, 1990). These closures affected salmon, herring, crab, shrimp, rockfish, and sablefish. The 1989 closures resulted in overescapement of sockeye salmon in the Kenai River drainage and in several systems on Kodiak Island. In 1990, a portion of Prince William Sound was closed to shrimp fishing. Spill-related sockeye salmon overescapement is anticipated to cause low adult returns in 1994 and 1995. This may result in closure or harvest restrictions during these and, perhaps, subsequent years (Koenings et al., 1993). Injuries occurred to populations of rockfish, pink salmon, shellfish, and herring; but the status of their recovery remains uncertain (Anon., 1993; Exxon Valdez Oil Spill Trustee Council, 1992, 1993).

The Prince William Sound Area combined commercial salmon harvest for 1989 was approximately 24.4 million fish. This catch exceeds the average harvest over the past 10 years. However, an exceptionally large portion of this catch (33%) was composed of hatchery sales fish from the private nonprofit (PNP) hatcheries, leaving a common-property portion of the catch below the 10-year average (Brady et al., 1991). The value of the combined 1989 commercial salmon harvest in Prince William Sound was estimated at \$41.3 million, excluding hatchery sales (Brady et al., 1991).

Cohen (1993) estimated that the EVOS reduced the ex-vessel income for southcentral commercial fishers by between \$6.4 and \$41.8 million in 1989 and \$11.1 and \$44.5 million in 1990. Most of this reduction was from the loss of harvest of sockeye and pink salmon.

Pacific herring also are extremely valuable to commercial fishers where spawning populations are found. The Pacific herring is also an important species to the Alaskan fishing industry because herring eggs or roe are sold in large quantities, primarily to the Japanese market. Also, the herring is a vital part of the food chain and is consumed by larger commercial species of fish such as salmon and halibut (Royce, 1991). The fisheries for Pacific herring are short, but intense. In Alaska, there are four commercial herring fisheries. First, a small number of fish are caught for food and bait. Second, divers gather herring eggs or roe on kelp in shallow, open waters. Third, roe is gathered on kelp in manmade enclosures (known as the pound-kelp fishery). The fourth and most important commercial harvest is the purse seine and gillnet "sac-ro" fishery, in which herring are netted to collect the egg-filled sac, or ovary, from the mature females. Each year, the State limits the sac-ro harvest to 20 percent of the estimated herring stocks (ADF&G, 1991; Royce, 1991).

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### 3 Affected Environment

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The Prince William Sound hatcheries provide up to 40 percent of the salmon harvest in the Sound. In 1988, because of low natural runs of pink salmon, it is estimated that they contributed almost 90 percent of the Sound's total pink salmon harvest (ADF&G, 1989). Hatchery production in Prince William Sound contributed 83 percent of the pink salmon catch (18 million fish) in 1989, 70 percent (32 million fish) in 1990, and 84 percent (31 million fish) in 1991. Nevertheless, there is evidence that the EVOS had reduced the survival of pink salmon fry that were released from the hatcheries in 1989 (Peckham et al., 1993). During 1993, the preliminary estimated adult returns to the salmon hatcheries in the EVOS area exceeded 21 million fish. The greatest beneficiaries of these fish were the commercial fishers, although some of these fish were caught by sport, subsistence, and personal-use fishermen (ADF&G, 1994).

A shift in the composition of salmon in the harvest by the common-property fishery can be attributed to the hatchery system. Because recent wild-stock returns have been small relative to hatchery returns, it has been necessary to close the mixed-stock areas of the general districts and harvest a majority of the surplus hatchery returns in the hatchery-terminal-harvest areas to achieve minimum escapement goals for wild stocks, (PWSAC, 1990).

The EVOS disrupted the usual pattern of commercial salmon fisheries in 1989 in Prince William Sound; and, although the catch was above the previous 10-year average, an exceptionally large portion of this catch was pink salmon from the special-harvest areas at the PNP hatcheries. Consequently, the common-property commercial-fishery harvests fell below the 10-year average (Brady et al., 1991).

Table 3-3

**Salmon Hatcheries Located within the Exxon Valdez Oil Spill Area.**

| Management Area  | Hatchery            | Operator                                 | Approximate Location | Primary Fish Species      |
|------------------|---------------------|--|----------------------|---------------------------|
| PWS*             | Solomon Gulch       | Valdez Fisheries Development Association | Valdez               | pink, chum, coho          |
| PWS              | Cannery Creek       | PWS Aquaculture Corporation              | north PWS            | pink, chum                |
| PWS              | Armin F. Koerning   | PWS Aquaculture Corporation              | south PWS            | pink, chum                |
| PWS              | Wally H. Noerenberg | PWS Aquaculture Corporation              | northwest PWS        | pink, chum, coho, chinook |
| PWS              | Main Bay            | PWS Aquaculture Corporation              | west PWS             | sockeye                   |
| PWS              | Gulkana I, II       | PWS Aquaculture Corporation              | upper Copper River   | sockeye                   |
| Lower Cook Inlet | Tutka Bay Lagoon    | Cook Inlet Aquaculture Association       | lower Cook Inlet     | pink, chum                |
| Upper Cook Inlet | Crooked Creek       | Cook Inlet Aquaculture Association       | central Cook Inlet   | sockeye                   |
| Upper Cook Inlet | Trail Lakes         | Cook Inlet Aquaculture Association       | upper Cook Inlet     | sockeye, coho             |
| Kodiak           | Kitot Bay           | Kodiak Regional Aquaculture Association  | Afognak Island       | pink, chum, coho, sockeye |
| Kodiak           | Pillar Creek        | Kodiak Regional Aquaculture Association  | Kodiak               | sockeye                   |

\*Prince William Sound

Source:

In addition to fish hatchery production and fisheries management, ADF&G has worked with the U.S. Forest Service (USFS) and the PNP groups to implement management measures or in-stream projects to rehabilitate, if necessary, and increase salmon populations in the Prince William Sound area. Past efforts have included restoring wild stocks to former levels of abundance through stream improvements, fish ladders, and other activities that improve natural habitat conditions. Stream-rehabilitation projects have been carried out by the USFS in cooperation with the ADF&G, because many of the spawning streams are located in the

### 3 Affected Environment

Chugach National Forest, which surrounds Prince William Sound and the mouth of the Copper River. Since 1962, there have been more than 50 fish-habitat-improvement projects completed in western Prince William Sound (Prince William Sound Planning Team, 1986).

#### Salmon Management

Four Alaskan agencies are involved in operating and regulating Alaska's salmon fisheries: The Alaska Board of Fisheries sets policy and promulgates the regulations; the ADF&G manages the fisheries according to the policies and regulations of the Board and State law; the Alaska Commercial Fisheries Entry Commission controls the number of fishers; and the Alaska Department of Public Safety enforces the regulations (NPFMC, 1990).

The Alaska Board of Fisheries establishes the regulations that govern fisheries and allocate the resource. Actions considered by the Board include changes in timing and areas for the salmon fisheries and the allocation of harvests among the various groups of fishermen. In-season fisheries management is the responsibility of the ADF&G to determine when and where specific openings are allowed to ensure that adequate numbers of wild stocks escape to spawn. The primary management tool used by ADF&G for regulating salmon returns is emergency-order authority to open and close fishing areas. During years when the wild-stock returns are strong, a liberal weekly fishing schedule may be permitted. However, when the wild-stock returns are weak, fishing must be restricted to meet minimum spawning requirements.

The Alaska Commercial Fisheries Entry Commission is an independent, quasi-judicial State agency responsible for licensing, research, and adjudication. By regulating entry into the fisheries, they ensure the economic health and stability of commercial fishing.

The Fish and Wildlife Protection Division of the Alaska Department of Public Safety enforces the State regulations that are promulgated by the Board of Fisheries (NPFMC, 1990).

#### **Recreational Fishing**

Recreational fishing constitutes an important and distinct segment of the recreational activities in the oil-spill area region.

#### Sport Fishing

Sport fishing is one of the most popular recreational activities for both residents and visitors of Alaska. Marine and freshwater systems provide a variety of sport fishing opportunities in the EVOS area. Marine recreational fishing originates in all major towns on the Prince William Sound as well as Cook Inlet, Kodiak Island, and the Kenai Peninsula. Fishing trips are taken in several ways--from shore, from private boats, and from charter vessels--in both freshwater and saltwater. Within the EVOS area, several species of Pacific salmon, rockfish, halibut, Dolly Varden, rainbow trout and cutthroat trout provide important sport fisheries. Although sport fishing is popular throughout the State, over 70 percent of Alaska's sport fishing occurs in the Southcentral region (Mills, 1993). Most of this occurs on the Kenai Peninsula because access by car from Anchorage is relatively easy. Sport fishing throughout the State is conducted according to the Alaska Sport Fishing Regulations formulated by the Alaska Board of Fisheries. The fishing regulations specify bag, possession, and size limits for the fishes to be taken from different streams, rivers, lakes, and in saltwater.

Between 1984 and 1988, the number of anglers and fishing days, and the total fish harvest in the oil-affected area had been increasing at a rate of 10 to 16 percent per year. Since 1977, there has been a 4.5 percent average-annual increase in the number of residents who sport fish, while the number of nonresidents sport fishing has increased 16 percent annually. However, after the oil spill, between 1989 and 1990, a decline in sport fishing (number of anglers, fishing trips, and fishing days) was recorded for Prince William Sound, Cook Inlet, and the Kenai Peninsula. The decline occurred because of closures, fear of contamination, the unavailability of boats, and congestion at some sites outside the spill area (Carson and Hanemann, 1992). In 1992, an emergency order restricting cutthroat trout fishing was issued for western Prince William Sound because of low adult returns. The closure is expected to continue at least through 1993.

Because commercial fishing for sockeye salmon in Cook Inlet was curtailed in 1989 to avoid fouling fishing gear and processing tainted commercially caught fish, the number of sockeye salmon that spawned in the Kenai River was approximately three times the desired amount. Although sport fishers enjoyed this bounty in 1989, this spawning resulted in an overpopulation of sockeye salmon fry and a dramatic reduction in smolt production. Consequently, very weak returns are forecasted for 1994, 1995, and possibly later years as well. These weak returns are likely to lead to some sport fishing closures as well as commercial fishing closures (Koenings, Schmidt, Fried, Tarbox, and Brannian, 1993; Schmidt, Tarbox, Kyle, King, Brannian, and Koenings, 1993).

In 1986, the estimated expenditures by sport fishers in southcentral Alaska were \$127.1 million. These expenditures directly supported over 2,000 jobs in sport fishing-related businesses, and the equivalent of 2,840 full-time jobs were supported in all industries in Alaska by sport fishing activity in southcentral Alaska (Jones and Stokes, 1987). Carson and Hanemann (1992) calculated that there were 127,527 and 40,669 sport fishing trips lost during 1989 and 1990, respectively, in southcentral Alaska because of the EVOS. They also calculated that the lost economic value of these trips was \$31 million and ranged from \$3.6 million to \$50.5 million.

## Economy

The economy for the EVOS area and Anchorage for 1990 is described in summary in Table 3-3. Anchorage is added to the EVOS area because there are so many strong linkages from the economy of the EVOS area to Anchorage which is the closest large economic center to the EVOS area. This table has 12 economic sectors and six measures of economic performance. It is in the format of IMPLAN (IMPact PLANing) which is an economic model used for economic analysis.

IMPLAN's output classification system is based on systems defined by the Bureau of Economic Analysis, U.S. Department of Commerce, and the Standard Industrial Classification (SIC) used by the federal Office of Management and Budget. The analysis is conducted using 528 industries and the results are aggregated into 12 sectors. The 12 sectors are as follows:

1. Forestry - Forestry firms operating timber tracts, tree farms, forest nurseries or perform forestry services.



### 3 Affected Environment

2. Commerical Fishing - Commercial fishing, fish hatcheries, sports fishing.
3. Mining - Businesses extracting minerals occurring naturally.
4. Construction - Businesses constructing new buildings, additions, alterations and repairs.
5. Manufacturing - Businesses mechanically or chemically transform materials or substances into new products which are produced by other sectors (e.g., forests and fisheries) or other manufacturers.
6. Communication and utilities - Businesses providing to the public or to other businesses communication services, electricity, gas, steam, water, sanitary or mail services.
7. Recreation related - Local transit, water transportation, air transportation, transportation not elsewhere classified, hotels, auto rental, and recreation services not elsewhere classified.
8. Trade - Businesses selling retail merchandise to households or wholesale merchandise.
9. Finance, Insurance and Real Estate - Businesses engaging in the fields of finance, insurance and real estate.
10. Services - Businesses providing a variety of services for individuals, businesses, governments, and other organizations; for example, amusements, health, legal, engineering and other professional services.
11. Government - Government agencies carrying out legislative, judicial, administrative and regulatory activities of Federal, State, local and international governments.
12. Miscellaneous - Businesses not classified in any other industry.

The six measures of economic performance in Table 3-3 are described as follows. Final demand represents regional purchases of goods and services. Industry output represents the regional supply of goods and services. The difference between regional supply and demand is accounted for by regional imports and exports. Value added represents the costs added within the region to produce industry output. Employee compensation and property income are its two key components. Employment is the number of person-year equivalents to produce industry output.

Table 3-3.  
The Economy - EVOS Area and Anchorage 1990 in 1990\$  
Millions

| Economic Sector                 | Final Demand<br>\$ | Industry Output<br>\$ | Employee Comp.<br>\$ | Property Income<br>\$ | Value Added<br>\$ | Employment<br># |
|---------------------------------|--------------------|-----------------------|----------------------|-----------------------|-------------------|-----------------|
| Forestry                        | 135                | 156                   | 22                   | 31                    | 55                | 3245            |
| Commercial Fisheries            | 206                | 306                   | 6                    | 120                   | 134               | 4846            |
| Mining                          | 6051               | 6199                  | 502                  | 2835                  | 4745              | 6335            |
| Construction                    | 1246               | 1420                  | 495                  | 364                   | 862               | 11751           |
| Manufacturing                   | 949                | 1072                  | 227                  | 82                    | 320               | 7655            |
| Recreation Related              | 693                | 731                   | 332                  | 59                    | 423               | 12782           |
| Communication & Utilities       | 1429               | 1744                  | 308                  | 753                   | 1129              | 7039            |
| Trade                           | 1126               | 1253                  | 753                  | 138                   | 1035              | 33790           |
| Finance, Insurance, Real Estate | 968                | 1137                  | 245                  | 337                   | 734               | 11329           |
| Services                        | 1830               | 2305                  | 849                  | 502                   | 1362              | 42753           |
| Government                      | 2106               | 2152                  | 1934                 | 77                    | 2011              | 46428           |
| Miscellaneous                   | 45                 | 12                    | 0                    | 33                    | 33                | 0               |
| Total                           | 16812              | 18488                 | 5673                 | 5333                  | 12843             | 187953          |

Source: IMPLAN Economic Model. See text for methodology.

# **Chapter 4**

## **Environmental Consequences**

|  |     |
|--|-----|
| Introduction . . . . .   | 1   |
| Alternative 1 - No Action . . . . .  | 10  |
| Biological Resources . . . . .   | 10  |
| Social and Economic Impacts . . . . .  | 20  |
| Alternative 2: Habitat Protection . . . . .  | 28  |
| Impacts on Biological Resources . . . . .  | 28  |
| Social and Economic Impacts . . . . .  | 35  |
| Alternative 3: Limited Restoration . . . . .   | 42  |
| Impacts on Biological Resources . . . . .  | 42  |
| Social and Economic Impacts . . . . .  | 55  |
| Alternative 4: Moderate Restoration . . . . .  | 67  |
| Impacts on Biological Resources . . . . .  | 67  |
| Social and Economic Impacts . . . . .  | 82  |
| The Proposed Action-Alternative 5: Comprehensive Restoration . . . . .                         | 95  |
| Impacts on Biological Resources . . . . .  | 95  |
| Social and Economic Impacts . . . . .  | 117 |
| Cumulative Effects . . . . .   | 131 |
| Biological Resources . . . . .   | 132 |
| Social and Economic Resources . . . . .  | 137 |
| Unavoidable Adverse Impacts . . . . .  | 141 |
| Impact on Biological Resources . . . . .   | 141 |
| Impact on Social and Cultural Resources . . . . .  | 141 |
| Impact on the Economy . . . . .  | 141 |
| Relationship Between Local Short-Term Uses and Enhancement of Long-Term Productivity . . . . . | 142 |
| Impact on Biological Resources . . . . .   | 142 |
| Impact on Social and Cultural Resources . . . . .  | 142 |
| Impact on the Economy . . . . .  | 142 |
| Irreversible and Irretrievable Impacts . . . . .   | 143 |
| Impact on Biological Resources . . . . .   | 143 |
| Impact on Social and Cultural Resources . . . . .  | 143 |
| Impact on the Economy . . . . .  | 143 |
| ANILCA Section 810(a) Evaluation and Finding . . . . .   | 144 |
| Impacts on Subsistence Uses and Needs . . . . .  | 144 |
| Availability of Other Lands to Fulfill the Purpose of the Program . . . . .                    | 145 |
| Other Alternatives . . . . .   | 145 |
| Finding . . . . .  | 145 |
| Notice and Hearings . . . . .  | 146 |
| Preliminary Determination . . . . .  | 147 |
| Final Determination . . . . .  | 148 |



# Chapter 4

## Environmental Consequences

### Introduction

This chapter contains the analysis of the environmental consequences that could result from implementing the five alternatives described. In many environmental impact statements (EIS's) the analysis focuses on the numbers or degree of loss to various resources. It is an important distinction of this EIS that with few exceptions, the impacts estimated to occur under the various alternatives are increases in populations or services from some existing injured level.

The analysis of impacts is based in large part upon what has been learned from studies carried on since the *Exxon Valdez* Oil Spill (EVOS). Much of this research has focused on the area of Prince William Sound. As a result, most of the estimated impacts from actions in the alternatives are based on what we have learned from the Prince William Sound studies and extrapolated for analysis in the other areas of the EVOS.

The current situation provides the basis for comparing the effects of the action alternatives. In this programmatic document, it should be noted that the No Action Alternative consists of normal agency management activities and the assumptions that (1) natural recovery will be the only restoring agent at work and (2) private land owners will harvest their commercial timber lands in the long term.

If the No Action Alternative were implemented, current management would continue, no new activities or programs would be instituted as a result of the oil spill, and the scope of present activities and programs would not change. Agency monitoring of natural recovery would remain at present levels, and their responsibilities would remain unchanged. None of the remaining funds from the civil settlement would be spent at this time on restoration activities if this alternative were implemented.

## 4 Environmental Consequences

Monitoring and research, as actions, generally do not impact resources and services and therefore are analyzed only for their economic impacts. It is recognized that the general restoration category also includes such actions as data gathering, surveys, and analysis that would not impact the resources--thus these activities would not be included in the EIS analysis except for the impacts on the economy.

### "Recovery"

The definition of the term recovery has a significant bearing on the discussion of the various alternatives described in this chapter. The settlement funds may be used for the purpose of, "... restoring, replacing, enhancing, rehabilitating, or acquiring the equivalent of natural resources injured as a result of the Exxon Valdez oil spill and the reduced or lost services provided by such resources." The goal of restoration is recovery of all injured resources and services. For some resources, little is known about their injury and recovery, so it is difficult to define recovery or develop restoration strategies.

In the analysis of impacts to the various resources in the EIS, it may be that an action will accelerate the rate of recovery and not measurably impact the number of individuals in the population for several years. This is still viewed as having a significant beneficial impact on the resource analyzed.

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, such as marbled murrelets, recovery may consist of stabilizing the population at a lower level than before the spill.

Where there were little prespill data, injury is inferred from comparison of oiled and unoiled areas, and recovery usually is 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 definitions of recovery based on these differences often are less certain than in those cases where prespill data exist. However, there also can be some uncertainty associated with interpreting the significance of prespill population data because 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.

### Birds

The following factors and assumptions were considered when evaluating alternatives and actions concerning injured bird resources: (1) valuations of land that may be acquired for habitat were based on criteria and a process developed by the EVOS habitat group; (2) pre-spill baseline data are meager or nonexistent for most species; (3) population size depends on many biological, ecological, and environmental factors, and population size changes as a result of lifespan, productivity, and survival rate; (4) populations cycle in response to environmental cycles; (5) it is unknown whether or how a 19-year climatic cycle in the Gulf of Alaska has affected populations; (6) migrants may be influenced by environmental factors far from the EVOS area; (7) population cycles are barely known for most species; and (8) the influence of commercial-fishing activities on seabird populations in the EVOS area are unknown, but could be substantial. For example, fishery harvests and hatchery programs could influence seabird populations in three ways: (1) prey may become less available to seabirds because fish species that occupy the same trophic levels may outcompete seabirds;



- (2) an increase in abundance of salmon fry and smolts may increase seabirds' prey base; and,
- (3) offal and discarded bycatch may increase the food base of scavenging seabirds.

## Fish

Fishery resources that are included for analysis in this EIS are pink and sockeye salmon and Pacific herring. Related services that are included are sport and commercial fishing. Actions that may be proposed as general restoration projects as part of the programs described for each alternative will have a benefit for restoring or replacing for one or several of the fishery resources or services. Forecasted feasibility, results, benefits and costs from each of these actions, however, are highly site specific, vary annually, and are difficult to quantify. Consequently, analyses and predicted impacts presented here must be general in nature. The proposed actions are intended primarily to benefit wild-stock fishery resources, either directly by habitat or population manipulations or indirectly by providing an alternate opportunity for user groups to reduce pressure on the wild stocks to allow them to recover.

Each proposed action for these fishery restoration or replacement projects is based on the basic premise that some factor or habitat need in the life history of a fish either limits the size of the population or is missing. For example, if spawning habitat is absent, there can be no fish; if spawning habitat is present (and no other factor constrains the size of the population), the number of fish will depend on the amount of spawning habitat, but it will vary annually according to environmental conditions. The basic concept for each proposed action, therefore, is to identify and overcome a limiting factor or "bottleneck" that will result in an increase in the total number of adult fish that will return to a particular home stream.

## Economy

The economic analysis for the five alternatives is a combination of qualitative and quantitative approaches. The economic analysis is focused on three sectors of the economy of most concern: forestry, commercial fisheries, and recreation. Taking timberlands in or out of production is quantified in terms of dollars and jobs. However, studies and data on the economic effect of the types of actions proposed in the alternatives on the commercial fisheries and recreation are not adequate to make quantitative projections.

The Forest Service's IMPLAN (IMPact PLANning) economic computer model was used in the quantitative analysis of the economic impacts of implementing each of the proposed EVOS Restoration Plan alternatives. Alternatives 1 through 5 are compared to the "baseline" economic conditions in 1990 found in Table 3-3, Chapter 3.

An attempt has been made to quantitatively analyze the recreation sector of the economy in the tables generated by IMPLAN. Discrete data are not available for the recreation industry. For example, data are available for hotels, but a differentiation is not made between recreational visitors and business visitors. The recreation-related sector shown in the tables on economics are composed of several IMPLAN subcategories: local transit, water transportation, air transportation, transportation not elsewhere classified, hotels, auto rental, and recreation services not elsewhere classified. Where the term recreation is used in economic analysis, it includes tourism.

The IMPLAN as applied to this analysis for the forestry sector shows the negative effects in output and employment when timberlands are purchased and timber is not harvested. There

## 4 Environmental Consequences

is a corresponding increase in the services sector output and employment because of expenditures in that sector by the owners of the timberlands. Restoration expenditures have a direct effect on the construction sector.

The descriptions of the alternatives are general. This, combined with the lack of data to quantify the economic effects for the commercial fisheries and recreation sectors, results in an inability to distinguish the economic effects among the alternatives.

The IMPLAN is an economic model that is the best economic tool for analyzing the economic effects of the alternatives analyzed in this draft environmental impact statement (DEIS). However--as with any tool of economic projection--even when quantified data is available for analysis, IMPLAN is not perfect. While exact numbers of various economic measures are the outputs of the model, the results are not intended to be precise measurements. The projections from the model represent approximations of the economic future.

The IMPLAN estimates in income and employment change as the product of the demand changes (e.g., an alternative) and a multiplier. Estimating multipliers requires data and a description of the regional economy. The data are the National input-output matrices that show the dollar volume of transactions among industries and final demand. The National matrices are stepped down to the borough and census-area level by using borough population and employment data and ratios of employment to output. The boroughs and census areas aggregated in this assessment are the Municipality of Anchorage, Kenai Peninsula Borough, Kodiak Island Borough, and the Valdez-Cordova Census Area. This area encompasses the EVOS area and the closest major economic center (Anchorage). The Municipality of Anchorage was included to ensure that the flow of goods and services in and out of the oil spill area is adequately accounted for in the IMPLAN economic model.

The key assumptions in the IMPLAN economic assessment are as follows: each industry has an output, and this output does not experience short-term variation; there is a fixed formula for making commodities, and there can be no substitutions; there are only constant returns to scale (i.e., to make twice as much of something, all inputs are doubled); adjustments are instantaneous, and timeliness and technology do not change.

For each Restoration Plan alternative, the amount of funds allocated for each expenditure is divided among restoration activities and the economic sector participating in those activities, as shown in Table 4-1 Allocations for Economic Analysis.

See Appendix D for a further description of the methodology of economic analysis.

### Archaeological/ Cultural Resources

While it is recognized that archaeological resources were injured as a result of the EVOS, this report incorporates various aspects of cultural resources relating to the physical remains of indigenous and historic inhabitants of the EVOS area and the values inherent in those remains for contemporary and future members of the public. Restoration actions are oriented toward physical remains because those were directly injured by the EVOS. The values of these remains for local communities, whose ancestors lived and are buried at some of these sites, would be addressed through actions relating to those remains. Archaeological sites and artifacts themselves are important kinds of cultural resources, but other cultural resources such as stories associated with specific sites or artifact types, or traditional

techniques used to construct traditional items, add immense value to objects that may otherwise would provide limited insight and information. These other types of cultural resources may benefit from actions on archaeological remains, extending the positive impacts of the restoration efforts.

The greater the degree to which local community members become involved in restoration of these resources, the more fully the restoration will be completed. Some actions may be implemented in local communities as a logical extension of projects accomplished on archaeological sites. While restoration of archaeological resources is important at the local level, it is also important to the cultural patrimony of Alaska and of the United States. In keeping with that importance, all projects will be completed in compliance with applicable historical and archaeological resource protection laws.

### **Cumulative Effects Scenario**

The Council on Environmental Quality (CEQ) regulations define cumulative effects as "... the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal, or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). The discussions of cumulative effects on the various resources are based on the interrelationship of the alternatives with other major current and proposed projects and other conditions creating impacts. The projects considered were:

- Whittier road access
- Whittier harbor expansion
- Cordova road access
- Lower Cook Inlet oil development
- Shepard Point harbor development (Cordova)
- Trans-Alaska Gas Pipeline
- Childs Glacier recreation development
- Previously approved EVOS projects (Fiscal Years 1992-1994)

# 4 Environmental Consequences

**Table 4-1**  
**Allocations for Economic Analysis**

| Restoration Category/<br>Economic Sector | Alternatives |          |          |          |          |
|--|--------------|----------|----------|----------|----------|
|  | 1            | 2        | 3        | 4        | 5        |
| Administration <sup>1</sup>              | \$0          | \$2,178  | \$3,267  | \$3,911  | \$1,000  |
| Federal Government                       | 50%          | 50%      | 50%      | 50%      | 50%      |
| State & Local Gov't.                     | 50%          | 50%      | 50%      | 50%      | 50%      |
| Monitoring <sup>1</sup>                  | \$0          | \$2,722  | \$3,811  | \$4,356  | \$11,621 |
| Federal Government                       | 33%          | 33%      | 33%      | 33%      | 33%      |
| State & Local Gov't.                     | 34%          | 34%      | 34%      | 34%      | 34%      |
| Universities                             | 33%          | 33%      | 33%      | 33%      | 33%      |
| Restoration <sup>1</sup>                 | \$0          | \$0      | \$6,534  | \$19,056 | \$5,534  |
| State & Local Gov't.                     | -            | -        | 33%      | 33%      | 33%      |
| Fisheries Services                       | -            | -        | 34%      | 34%      | 34%      |
| Construction                             | -            | -        | 33%      | 33%      | 33%      |
| Habitat Protection <sup>1</sup>          | \$0          | \$34,900 | \$31,285 | \$26,331 | \$26,420 |
| Real Estate                              | -            | 0.5%     | 0.4%     | 0.3%     | 0.3%     |
| Forestry                                 | -            | 99.5%    | 99.6%    | 99.7%    | 99.7%    |
| Restoration Reserve <sup>1</sup>         | \$1,906      | \$0      | \$0      | \$0      | \$329    |
| Banks                                    | 100%         | -        | -        | -        | 100%     |
| Responding by Landowners <sup>1</sup>    | \$0          | \$29,418 | \$23,296 | \$13,433 | \$13,300 |
| Securities                               | -            | 13%      | 13%      | 0%       | 0%       |
| Construction                             | -            | 29%      | 29%      | 40%      | 40%      |
| Social Services                          | -            | 29%      | 29%      | 40%      | 40%      |
| Household Spending                       | -            | 29%      | 29%      | 20%      | 20%      |

<sup>1</sup> 1990 Dollars (X 1,000)

**Table 4-2**  
**Definitions of Impact Levels**

| Resource                    | NEGLECTIBLE   | LOW   | MODERATE   | HIGH  |
|-----------------------------|---|---|--|---|
| <b>Intertidal organisms</b> | Little or no improvement in the resource's ability to recover, or in the quality of its habitat. Little or no reduction in impacts from human interactions. | Proposed restoration actions may reduce negative impacts from the spill or from some anticipated, or current, human activities. These reduced negative effects do not create an improvement in the ability of the injured population to recover either locally or regionally. | Proposed restoration actions have a high potential to reduce negative impacts from the spill or from anticipated, or current, human activities. These reduced negative effects could improve the ability of the injured population to recover more rapidly but measurable increases would only occur in localized areas. | Proposed restoration actions have a high potential to change the ability of the injured population to recover, so that the expected time period to reach recovery is reduced on a regional basis. |
| <b>Marine Mammals</b>       | Little or no improvement in the resource's ability to recover, or in the quality of its habitat. Little or no reduction in impacts from human interactions. | Proposed restoration actions may reduce negative impacts from the spill or from some anticipated, or current, human activities. These reduced negative effects do not create an improvement in the ability of the injured population to recover either locally or regionally. | Proposed restoration actions have a high potential to reduce negative impacts from the spill or from anticipated, or current, human activities. These reduced negative effects could improve the ability of the injured population to recover more rapidly but measurable increases would only occur in localized areas. | Proposed restoration actions have a high potential to change the ability of the injured population to recover, so that the expected time period to reach recovery is reduced on a regional basis. |
| <b>Birds</b>                | Little or no change expected in population level, productivity rate, or sub-lethal injury.  | Unlikely to affect regional recovery of population level, productivity rate, or sub-lethal injury, but may enhance recovery of local segment of population.   | Likely to enhance to a measurable degree the regional recovery of population level, productivity rate, or to reduce sub-lethal injury, and may substantially enhance recovery of local segment of population.  | High probability of substantially enhancing population level, productivity rate, or for reducing sub-lethal injury throughout EVOS region.  |

Table 4-2 (cont.)  
**Definitions of Impact Levels**

| Resource                  | NEGLIGIBLE   | LOW   | MODERATE  | HIGH   |
|---------------------------|--|---|---|--|
| <b>Fish</b>               | Little or no increase or recovery of the injured resource sooner than by natural recovery; or, little or no protection of the habitat from disturbance.  | Unlikely or small increase or recovery of the injured resource sooner than by natural recovery; or, limited protection of the habitat from disturbance.   | Moderate increase or partial recovery of the injured resource or service sooner than by natural recovery; or, high benefits in limited area(s); or, moderate protection of the habitat from disturbance.  | Recovery of the injured resource sooner than by natural recovery; or, recovery of the injured resource to a greater than pre-spill amounts; or, substantial protection of the habitat from disturbance.  |
| <b>Cultural Resources</b> | Little or no protection for archaeological or historic sites; or little or no improvement of the understanding or appreciation of cultural resource values within the EVOS area.   | Small increase in protection for archaeological or historic sites; or small improvement of the understanding or appreciation of cultural resource values in limited locations within the EVOS area.   | Moderate increase in protection for archaeological or historic sites; or moderate improvement of the understanding or appreciation of cultural resource values throughout the EVOS area; or substantial improvement of the understanding or appreciation of cultural resource values in limited locations within the EVOS area.                             | Substantial increase in protection for archaeological or historic sites; or substantial improvement of the understanding or appreciation of cultural resource values throughout the EVOS area.   |
| <b>Subsistence</b>        | Little or no change in populations of subsistence harvest species injured by EVOS; or small increase in confidence levels that subsistence users in affected communities have in lack of contamination in subsistence foods. | Small increase in populations of subsistence harvest species injured by the EVOS; or small increase in confidence levels that subsistence users in affected communities have in the lack of contamination in subsistence foods. Increases may be localized or throughout the EVOS area. | Moderate increase in populations of subsistence harvest species negatively affected by EVOS; or moderate increase in the confidence levels that subsistence users in affected communities have in the lack of contamination in subsistence foods throughout the EVOS area; or substantial increases in populations or confidence levels in localized areas. | Substantial increase in populations of subsistence harvest species negatively affected by EVOS; or substantial increase in the confidence levels that subsistence users in affected communities have in the lack of contamination in subsistence foods throughout the EVOS area. |



**Table 4-2 (cont.)**  
**Definitions of Impact Levels**

| <b>Resource</b>                               | <b>NEGLIGIBLE</b>  | <b>LOW</b>   | <b>MODERATE</b>  | <b>HIGH</b>  |
|---|--|--|--|--|
| <b>Recreation &amp; Tourism</b>               | Little or no change in numbers of users, or on the quality of their experience.  | Small increase in numbers of users, or small increase in protection or improvement of recreation quality in localized areas within the EVOS area.      | Moderate increase in numbers of users, or moderate increase in protection or improvement of recreation quality throughout the EVOS area; or substantial increase in numbers of users or substantial improvement of recreation quality in localized areas within the EVOS area. | Substantial increase in numbers of users, or substantial increase in protection or improvement of recreation quality throughout the EVOS area.   |
| <b>Wilderness</b>                             | Little or no reduction of residual oil and materials left from clean-up activities, and no change in public perception of injury to Wilderness.        | Small reduction of residual oil and materials left from clean-up activities, or small change in public perception of injury to Wilderness.             | Moderate reduction of residual oil and materials left from spill clean-up activities, or moderate change in perception of injury to Wilderness.  | Substantial reduction of residual oil spill and materials left from clean-up activities and substantial change in perception of injury to Wilderness.  |
| <b>Commercial Fishing &amp; Sport Fishing</b> | Little or no increase or recovery of the injured service sooner than by natural recovery; or, little or no protection of the habitat from disturbance. | Unlikely or small increase or recovery of the injured service sooner than by natural recovery; or, limited protection of the habitat from disturbance. | Moderate increase or partial recovery of the injured service sooner than by natural recovery; or, high benefits in limited area(s); or, moderate protection of the habitat from disturbance.   | Recovery of the injured service sooner than by natural recovery; or, recovery of the injured resource to a greater than pre-spill amounts; or, substantial protection of the habitat from disturbance. |
| <b>Economy</b>                                | Barely measurable contribution to employment and economic output over a 10-year period or longer.  | Less than a substantial contribution to employment and economic output over a 10-year period or longer.  | Moderately substantial contribution to employment and economic output over a 10-year period or longer.   | Very substantial contribution to employment and economic output over a 10-year period or longer.   |

## 4 Environmental Consequences

### Alternative 1 - No Action

#### Introduction

The No Action Alternative is required by NEPA to provide a basis for comparing the impacts of the other proposed alternatives. In this DEIS, the No Action Alternative describes what would happen to the resources and services injured by EVOS if no restoration actions were implemented. Because none of the civil settlement funds would be spent to aid recovery, the only actions undertaken within the spill area would be the result of normal agency management or private enterprise. For biological resources, recovery from oil spill injuries would be unaided (natural recovery) and could be complicated by other human activities that could cause further injuries or habitat loss. The recovery of other resources or services also may be influenced by other nonoil spill-related actions.

#### Biological Resources Impact on Intertidal Resources

The intertidal zone was especially vulnerable to injury from the EVOS and from the subsequent cleanup operations. The oil spill caused population declines and sublethal injuries to the plants and animals of the intertidal zone. Portions of 1,500 miles of coastline were oiled (350 miles were heavily oiled), resulting in significant impacts to intertidal habitats, particularly in the upper intertidal zone. Direct oiling killed many organisms, but beach cleaning, particularly high-pressure, hot-water washing, had a devastating effect on intertidal life (Houghton, Lees, and Driskall, 1993).

Coastal habitat studies documented changes in many species of algae, invertebrates, and fish; the injuries were highly variable between species, regions, and habitats (Highsmith et al., December 1993). For most of the intertidal zone, the effects of the oil spill were probably short term. Studies in 1992 and 1993 showed that many of the differences in habitats and organisms that were documented in 1989 and 1990 were recovered (Houghton, Lees, and Driskall, 1993; Highsmith et al., December 1993). However, some areas had not yet begun to recover or were recovering very slowly. This was especially evident in the upper 1 meter vertical drop (MVD) of sheltered rocky habitats where the algae *Fucus gardneri* is the dominant plant species (Highsmith et al., December 1993; Highsmith et al., October 1993; Houghton, Lees, and Driskall, 1993). This discussion focuses on the organisms and habitats that are the least likely to have recovered.

#### *Fucus*

This algae, or rockweed, is an important component of the upper intertidal zone because it provides food for many invertebrates, as well as shelter from predation and desiccation for many plants and animals (Highsmith et al., October 1993). The oil spill and subsequent cleanup destroyed many of the plants in the upper meter and reduced the reproductive capacity of the adult plants that survived (Highsmith et al., October 1993). These injuries were documented in all regions of the spill area but were highly variable between tidal elevations (MVD) and habitats (Highsmith et al., December 1993).

The Herring Bay Experimental and Monitoring study (Highsmith et al., October 1993) provided information on the recovery of plants and invertebrates in the intertidal zone.

Recovery in the upper intertidal appears to depend on the return of adult *Fucus* in large numbers to this zone. In the absence of a well-developed canopy of adult plants, eggs and developing propagules of *Fucus* lack sufficient moisture and shelter to survive. Existing adult plants act as centers for the expansion of the community. *Fucus* plants in the sample sites were estimated to take 3 to 4 years to become fully mature. Because eggs generally settle within 0.5 m of the parent plant, the Herring Bay study estimated that *Fucus* communities are able to expand at a rate of 0.5 m every 3 to 4 years (Highsmith et al., October 1993). It is unknown how these results would vary in areas outside of Herring Bay where habitat conditions differ.

## Limpets, Barnacles, and Other Invertebrates

The recovery of limpets, barnacles, and other invertebrates also is linked to the recovery of rockweed. Because there were no baseline data for intertidal communities, the exact composition of the community structure is unknown. Full recovery, based on the community structure of comparable nonoiled sites, of the intertidal community may take more than a decade because it may take several years for some invertebrate species to return after *Fucus* has recolonized an area.

## Mussels

The oil spill injured mussels throughout the EVOS area. Coastal habitat studies documented changes in the presence of large mussels and in total biomass of mussel communities between oiled and nonoiled areas (Highsmith et al., October 1993, and Highsmith et al., December 1993). Oil was found in the sediments beneath mussels (Rounds et al., 1993) and hydrocarbons were identified in mussel tissues (Babcock et al., 1993). Mussels can be found in loose aggregations attached to intertidal rocks, or they can be found in dense aggregations (mussel beds) over pea gravel and silt sediments. Because mussels form a dense mat over the sediments and rocks, oil that was trapped beneath the mussels was not exposed to weathering and still remains toxic. Feasibility studies to develop techniques to clean the sediments beneath mussel beds are under way in the EVOS area. The results of these studies are still preliminary but suggest it may be possible to clean the mussel beds without destroying the community.

In this alternative, no further attempts would be made to clean mussel beds. It is not known how long the trapped oil would remain volatile. Because mussels are an important prey species for many other organisms--including sea otters, harlequin ducks, and black oystercatchers that were injured by the spill--it is possible that the trapped oil will be a continuing source of contamination to the coastal ecosystem in the EVOS area. The consequences of this source of contamination is unknown; however, mussel beds are known to be one of several locations where *Exxon Valdez* oil still may be transmitted into the environment. For instance, oil also is trapped beneath mussel aggregations that are not classified as "mussel beds," and no techniques that would clean these areas without killing the mussels have been proposed.

## Clams

Marginal declines in clam populations were noted in 1989. Native littleneck and butter clams were impacted both by oiling and cleanup, particularly high-pressure, hot-water

## 4 Environmental Consequences

washing. Littleneck clams transplanted to oiled areas in 1990 grew significantly less than those transplanted to nonoiled sites. Reduced growth rates were recorded at oiled sites in 1989, but not in 1991 (EVOS Trustee Council, November 1993), suggesting that the effects of the spill on growth rates were diminishing. It has been suggested that the availability of substrates suitable for clams were reduced as a consequence of cleanup activities (EVOS Trustee Council, December 1993).

The magnitude of measured differences in the abundance of clams varied with the degree of oiling and geographic area. On sheltered beaches, the data on abundance of clams in the lower intertidal zone suggest that littleneck clams and, to a lesser extent, butter clams were significantly affected by the spill (EVOS Trustee Council, November 1993). During the 1993 public meetings, people throughout the oil spill area, but especially in Kodiak and Alaska Peninsula communities, said they still are finding clam beds that are contaminated with oil (EVOS Trustee Council, August 1993). Clams are an important resource for subsistence and recreational use within the oil spill area, and they are preyed upon by a wide variety of other resources.

### Conclusions for the Intertidal Zone

With the exception of certain habitats and specific organisms, the intertidal zone has largely recovered from the effects of EVOS. *Fucus* and the organisms associated with the rockweed, still have not recovered in the upper intertidal zone. With no intervention, it may take over a decade before the algal based communities resemble the prespill condition. The oil that is trapped beneath mussels is likely to remain unweathered for many years. The consequences of the presence of these sources of relatively fresh oil is unknown, but they may have negative impacts on other organisms that rely on mussels for prey.

### Impact on Marine Mammals

#### Harbor Seals

Harbor seals are protected from commercial harvesting, harassment, and indiscriminate killing by the Marine Mammal Protection Act of 1972 (MMPA). Traditional subsistence harvest by Alaska Natives is exempted from the MMPA. The MMPA also allows for some loss from incidental take by commercial fishermen.

Harbor seal populations have responded to the protection that outlawed indiscriminate killing and commercial harvesting by increasing in many parts of their range (Harvey et al., 1990). Documented rates of increase have been as high as 22 percent per year (5-22% range) (Stewart et al., 1988; Harvey, Brown, and Mate, 1990; Olesiuk, Bigg, and Ellis, 1990). Most of these increases have been from populations that were exploited prior to the MMPA and show a response to reduced mortality. There have been no long-term studies to document changes to harbor seal populations as a result of oil spills (Stewart, Yochem, and Jehl, 1992) or from other habitat perturbations.

In contrast to harbor seal populations in other areas, seals in the central and western regions of the Gulf of Alaska have been declining since the mid-1970's (Pitcher, 1990). Population trend indices, based on counts at haulout sites, have shown a drastic decline (about 85%) in the population near Tugidak Island, in the Kodiak Archipelago. Similar declines, approximately 11 percent per year since 1984, were documented in Prince William Sound prior to the oil spill. Why these populations show decreases when other populations are

increasing puzzles scientists and complicates understanding the effects and potential recovery from the *Exxon Valdez* oil spill.

Subsistence harvest and interactions with commercial fisheries (e.g., entanglement and drowning in gear, or through being shot to protect catch) may be contributing to the decline but are not thought to be the cause (Pitcher, 1990; Frost and Lowry, 1993). Records of subsistence harvest at Tatitlek and Chenega Bay, the two largest seal harvesting communities in Prince William Sound, have been gathered only intermittently; but from April 1990 to March 1991, 133 seals were harvested (ADF&G Division of Subsistence, unpublished data). This represents approximately 5 percent of the population counted during molting surveys (Loughlin, 1992, in Frost and Lowry, 1993). Although this level of harvest is unlikely to cause the decline in seal numbers, any additional mortality may slow recovery.

Interactions between harbor seals and commercial fisheries also may affect the recovery of the seal population. Seals can become entangled and drown in lost gear, or they may become injured or killed as fishermen attempt to protect their catch and nets. In 1990 and 1991, a marine mammal observer program documented interactions between the Prince William Sound salmon driftnet fishery and harbor seals. The results showed that although encounters were frequent, the number of harbor seals injured or killed were low (Wynne, Hicks, and Munro, 1992). Because this study focused on only one of the fisheries operating in the Sound, and because the sample size of documented injuries and death was very small, it is impossible to predict total interactions between seals and the commercial fisheries in Prince William Sound. However, the study does indicate that interactions with commercial fisheries within Prince William Sound are unlikely to be the cause of the long-term decline in the local seal population.

Disturbance has been documented as adversely affecting harbor seals and other pinnipeds in other parts of their range (Allen, et al., 1984; Esipenko, 1986; Johnson, et al., 1989). These studies have shown that the greatest impacts from disturbances are at haulout sites during pupping and molting. During pupping, disturbance can result in higher pup mortality caused by abandonment, or from being crushed as the adults panic and return to the water (Johnson, 1977). The greatest disturbance is caused when people walk near or through haulout sites (Johnson, et al., 1989), but disturbance also can be caused by low-flying aircraft and by boats that approach too close to the haulouts. Within the EVOS area, there have been no studies to document the amount or effects of disturbance. Without these data, it is impossible to determine if current activities, or activities likely to occur in the future, will hamper the recovery of the population. However, it is reasonable to assume that increasing disturbance at haulouts used for pupping and molting could cause additional stress and mortality.

The *Exxon Valdez* oil spill killed an estimated 300 harbor seals from the Prince William Sound population. Recent population-trend counts indicate that the population may be stabilizing from the long-term decline (Frost et al., in press); however, until the population begins to increase, it will be impossible to predict how long it will take the population to recover. In Prince William Sound, there are at least three possible ways to define recovery from the oil spill for the local harbor seal populations.

- Recovery could occur when the population has increased by 300 individuals (to compensate for the 300 lost in the oil spill) in the oiled areas.

## 4 Environmental Consequences

- Recovery could occur when the population has returned to its 1970's levels of abundance. This would show recovery not only from the spill, but also whatever was causing the long-term decline.
- Recovery could occur when the trend in population is similar to those of nonoiled areas.

There are no data on injury in other regions of the oil spill area, although oiled seals were observed, and the impacts on harbor seals in these areas are unknown. However, recent trend counts near Tugidak Island give no indication that the long-term decline is abating (Frost and Lowry, in press). Until research is conducted to determine what is causing the long-term decline, or until monitoring shows that the populations are increasing, any estimates of recovery will be speculative.

**Conclusions.** At this time, there is too little information available to predict when the populations within the EVOS area will recover. Recovery is unknown for all regions of the spill area.

### Sea Otters

Sea otters are expected to eventually recover to prespill numbers in all regions of the spill area. The amount of time needed before the populations have recovered from the effects of the spill will vary between regions because the level of injury differed greatly between areas. Approximately 1,000 carcasses were recovered throughout the oil spill area in 1989, but the largest numbers were collected from western Prince William Sound. As the oil moved farther from Prince William Sound, fewer otters apparently died from direct oiling. Because otters in Prince William Sound experienced the highest mortality, the subsequent Natural Resource Damage Assessment (NRDA) studies focused on Prince William Sound. There are no data on recovery or the current status of otters in other regions of the spill area; although surveys in 1989 could not document any population loss (Ballachey and Bodkin, pers. comm.). For the purposes of this analysis, it is assumed that the oiled portions of the Prince William Sound population represent the worse-case scenario for populations throughout the spill area.

Damage assessment studies in 1990 through 1992 indicated higher than usual mortality in prime aged animals (Monson, 1993), -- which typically is the age group least susceptible to mortality. It also was apparent that young sea otters just weaned from their mothers were not surviving well (Monnett and Rotterman, 1992). The causes of these continuing signs of injury are unknown, but one hypothesis is that the otters are continuing to be exposed to oil through their prey. In 1992 and 1993, the prime aged mortality rates were closer to normal (Ballachey and Bodkin, pers. comm., 1994). The weanling survival rates were improving but still were different than in the nonoiled areas of the Sound (Ballachey and Bodkin, pers. comm., 1994).

There are several ways to define recovery for the injured sea otter populations. For the purposes of this DEIS, sea otters will have recovered when the populations in the oiled portions of the EVOS area have returned to their prespill numbers with no unusual additional mortality. For Prince William Sound, recovery will occur when the population in the western sound has recovered the 2,500 (approximately) individuals estimated to have been lost from the spill (Garrott, Eberhardt, and Burn, 1993).



Once the sea otter population begins to increase in the oiled area, the rate of recovery depends on the growth rate of the injured population and on the number of otters that move into the oiled areas from the nearby unoiled regions (immigration rate) or vice versa (emigration rate). The population growth rate for sea otters depends largely on the size of the existing population and on the condition of the habitat and the available prey. Sea otters are notorious for altering their habitat through heavy predation on certain prey species (Kvitek et al., 1989; Riedman and Estes, 1990). In the absence of otters, prey species such as sea urchins, crabs, and clams become plentiful again. Sea otters were exterminated from much of their historic range, including most of the EVOS area, from overharvesting for their fur. Over the last century, they have recolonized many parts of their historic range.

Research has shown that when otters move into an area with abundant prey, they can increase their population by as much as 20 percent per year (Estes, 1990). For sea otter populations already established in an area like Prince William Sound, it is reasonable to assume that the growth rate would be less than the theoretical maximum of 20 percent. For any population growth to occur, the habitat must be able to support more sea otters. None of the NRDA or restoration research studies have specifically examined the carrying capacity of the oiled areas for sea otters; however, studies of the subtidal and mid- to lower intertidal zones are encouraging and suggest that portions of these important areas are on their way towards recovery (Highsmith et al., December 1993).

The immigration and emigration rate of otters to and from nonoiled areas also will influence the recovery of the injured sea otter population. Because the boundaries of the spill area extend beyond the areas immediately oiled, there are populations of otters within the spill area that were not directly affected by the oil spill and that may help to recolonize the oiled areas. Based on information from a telemetry study of female and weanling sea otters in Prince William Sound, there were no signs of movements between oiled (western Prince William Sound) and nonoiled (eastern Prince William Sound) areas (Monnett and Rotterman, 1992). Hinchinbrook Entrance is a deep-water area with strong tidal fluxes and may serve as a substantial barrier for migrating otters (Monnett and Rotterman, 1992). This analysis assumes that the patterns also apply to the movements of male otters and that the immigration rate equals the emigration rate and will, therefore, be zero.

Another factor that will influence the rate of recovery is the level of subsistence harvest. Although sea otters are protected from commercial harvest and harassment under the MMPA, there is an exemption that allows for subsistence harvest by Alaska Natives. At this time, reported subsistence harvest of sea otters within the spill area is fairly low but is increasing throughout the area. Sea otters are not harvested for food, but some are harvested to use their fur for subsistence, crafts, and artwork. In the mid-1980's, a ruling broadened the interpretation of what types of products could be made from sea otter pelts and increased the list of products that could be sold. After this ruling, sea otter harvests increased significantly. Within the oil spill area, records of reported sea otter harvests showed that before the ruling (1972 to 1987), approximately 250 otters were harvested in 14 communities within the spill area. Records for 1988 through 1993 show that the harvest increased to approximately 700 animals for the spill area (USFWS, unpublished data).

So what type of an estimate of recovery can be made for sea otters in Prince William Sound? Current estimates of the number of sea otters that died as a result of the oil spill in the western portion of Prince William Sound range between 2,000 and 3,000 (Garrot, Eberhardt,

## 4 Environmental Consequences

and Burn, 1993). For purposes of illustration, assume a constant growth rate that can be as high as 10 percent or as low as 2 percent and that the subsistence harvest remains low; then, regaining the 2,500 individuals lost could take from 7 to 35 years. There are no signs that the population in the western Sound is beginning to increase; therefore, the 7- to 35-year estimates are delayed until the population shows signs of increasing. These estimates assume that the subsistence harvest remains low in the affected areas. If harvest rates rise substantially in the oiled areas, then the recovery estimates based on a 10-percent growth rate are unlikely, and it is possible that the more conservative estimate of 35 years would be extended.

Otters in other regions of the oil spill area are believed to have suffered lower mortality than otters in Prince William Sound. For the Kenai Peninsula, the highest mortality estimates are approximately 500 individuals (DeGange et al., 1993). Based on a population of approximately 2,200 and the same assumptions used for Prince William Sound, the recovery estimates would vary between 3 and 12 years. For Kodiak and the Alaska Peninsula, it is reasonable to assume that once populations begin to increase, which already may have begun, they will return to their prespill populations more quickly.

**Conclusions.** Assuming moderate growth rates, a low immigration rate, and that the subsistence level remains negligible, sea otters in Prince William Sound could recover in 7 to 35 years after the population begins to increase. For other regions in the EVOS area, the populations should return to their prespill levels in less time.

### Birds

#### **Impact on Ecosystem**

What effect would a change in injured bird populations have on the ecosystem? It is reasonable to assume that July populations of harlequin ducks, common murre, and pigeon guillemots will remain stable or increase over the next 2 to 3 years as they have since the spill (Bird Study 2 data, B. Agler and S. Kendall, written comm., 1994). Marbled murrelet numbers actually may be increasing, because the 1993 estimate was the highest since the spill, and it was significantly higher than the 1990 estimate. It is likely that stable or slowly increasing populations of injured birds would have a negligible change in their effects on the EVOS area ecosystem.

Under Alternative 1 - No Action, habitat would not be acquired that would help injured resources recover by protecting the habitat from any development that would further assault injured populations. Without monitoring, it is not likely that one would know the recovery status of injured bird populations, nor be able to enact recovery projects. Therefore, this alternative would result in long-term ecosystem degradation through development of upland habitat.

#### **Harlequin Duck**

The July postspill population of harlequin ducks in Prince William Sound has been significantly higher since the spill than before it occurred. However, a substantial portion of the harlequin population was killed by the EVOS, and there still is little evidence of breeding in the oiled zone. Not acquiring upland habitat likely would put segments of the population at risk from logging or other development, thus further assaulting the injured population. Oil still is buried in the sediments beneath several mussel beds in the oiled area of Prince

William Sound. Cleaning these mussel beds would not be possible under this alternative, resulting in possible continuing sublethal injury to harlequin ducks. Harlequin duck populations need to be monitored at regular intervals to determine their recovery status, but monitoring would cease under this alternative, and there would be no way of knowing the recovery status of the injured population.

**Conclusions.** In the short term through 1995, populations likely will remain stable at 1990-1993 levels in both oiled and nonoiled areas. However, if reproductive failure continues in harlequin ducks in the oiled area, natural mortality would cause the population to decrease. No measures to restore the injured harlequin duck population would be taken, nor would the status of the injured population be known. The long-term effects of this alternative would be a loss of critical nesting habitat in forested riparian habitat and subsequent reduction of reproduction capacity by harlequin ducks in the EVOS area.

## Murres

Under this alternative, restoration measures to replace common murres lost to the EVOS would not be taken, and the status of the injured population would remain unknown. Murre populations and productivity need to be monitored regularly to determine their recovery status, but agency funding will not be available to monitor injured murre populations.

Although common murres reproduced at a normal rate at the Barren Islands in 1992 and 1993, the earliest that post-EVOS young from the Barren Islands may reproduce is 1995. Therefore, the Barren Islands population should start growing slowly in 1995 or 1996 as young birds begin joining the breeding population. Immigration of young murres from colonies not affected by the EVOS would accelerate population recovery over natural productivity at the colony. However, there is little information about immigration, and it seems unlikely that it would add much to natural population recovery. Introduced foxes that still are on seabird colonies outside the EVOS area are likely to continue to keep murre populations depressed at those colonies.

**Conclusions.** Over the long term, this alternative could take the Barren Islands population 20 to 80 years to recover fully. However, recent insight on population recovery of common murre populations, based on 20 years of data from the Bering Sea, suggests that the population at the Barren Islands may recover within 20 years (D. Roseneau, oral comm., 1994).

## Pigeon Guillemot

Numbers of pigeon guillemots were declining throughout Prince William Sound--from about 15,000 birds in the 1970's--up to the time of the EVOS. Population estimates since the spill indicate a continued depressed pigeon guillemot population in the spill area compared with the nonoiled area, although the Prince William Sound-wide population may be stabilizing at about 5,000 birds. Pigeon guillemot populations and productivity need to be monitored at regular intervals to determine their recovery status, but this will not occur under this alternative.

Pigeon guillemot colonies occur in a narrow band immediately adjacent to tidewater in steep, rocky habitat, and they rarely extend more than 50 m inland. Thus, unless this narrow zone is



## 4 Environmental Consequences

developed correctly at pigeon guillemot colonies within land parcels being considered for acquisition, this action may not enhance guillemot population recovery. Also, guillemots are known to nest in and near man-made structures, so coastal development would not necessarily mean the demise of a given colony even if the development happened right at a colony. However, there is little information about the effects of specific kinds of developments on guillemot colonies.

Lack of predator control under this alternative may result in predators helping to keep the population depressed, thus slowing recovery of the injured pigeon guillemot population.

**Conclusions.** The short-term effects of this alternative on the injured pigeon guillemot population in Prince William Sound through 1995 are expected to be negligible; effects outside Prince William Sound are unknown. The local population at Naked Island may continue to decrease slowly on the short term, but on the long term through 2001, the guillemot population for all of Prince William Sound should stabilize or slowly increase. This alternative would have a low overall effect on recovery of the pigeon guillemot population.

### Marbled Murrelet

The EVOS directly killed an estimated 8,400 marbled murrelets. Studies that detected reduced populations of other bird species in the oiled zone compared with the nonoiled zone did not detect a similar reduction in marbled murrelet numbers. Numbers of marbled murrelets had declined from the 1970's up to the time of the EVOS, although July population estimates since the spill indicate that the Sound-wide population may be stabilizing, and counts at Naked Island are now similar to prespill levels.

Clear-cut logging of private land in eastern Prince William Sound in the Port Fidalgo area since 1991, and on the outer coast of Montague Island (Patton Bay) since 1993, has reduced murrelet nesting habitat in the EVOS area. Continued development of private land will put additional segments of the murrelet population at risk from logging or other development, thus further assaulting the injured Prince William Sound murrelet population.

**Conclusions.** This alternative should not affect marbled murrelet recovery through 1996. However, projected logging with the accompanying loss of nesting habitat, on the long term, will prevent restoration of the injured murrelet population.

### Fish

#### Pink Salmon

If actions are not implemented to restore or rehabilitate populations of injured pink salmon resources in the EVOS area, this resource will recover to prespill levels or stabilize at a new level only because of natural processes of time and because of a continuation of normal resource management activities by the responsible agencies. Monitoring studies and activities would not be performed to document the rate, level, or time of recovery. Wild stocks of pink salmon populations, however, may never recover to prespill conditions because there is evidence that stocks that spawn in oiled spawning habitat have developed an inheritable character that reduces egg survival. This increase in egg mortality may result in as much as a 10-percent decline in the entire run in Prince William Sound (Spies, 1994).

The long-term natural recovery of pink salmon to prespill conditions or a new stable condition will require an estimated 20 years (EVOS Trustee Council, April 1993). This would amount to 10 generations of pink salmon.

Habitat protection for this resource will depend only on those measures that are included as part of the normal planning and permitting activities of State and Federal agencies (Appendix C). Any potential developmental activities that may be proposed on either private or public lands must be reviewed as part of the permitting process before it is allowed to proceed. Although this affords substantial protection for anadromous streams and coastal waters, the protection is incomplete. Various activities that may occur outside a prescribed buffer zone also may cause damage to streams in the drainage basin.

## Conclusions.

- short-term benefits: Negligible. No change is expected within one lifecycle.
- long-term benefits: Moderate. It is likely that there will be a 10-percent reduction of the population of pink salmon in Prince William Sound, but the reduction of pink salmon populations throughout the spill area will be less.

## Sockeye Salmon

If actions are not implemented to restore or rehabilitate injured populations of sockeye salmon, recovery will be slow, aided only by natural processes and very conservative management activities of the responsible agency. Monitoring studies would occur only as part of the normal annual monitoring activities of the management agencies. In the Kenai River drainage and Akalura Lake, on Kodiak Island, recovery will occur only after the zooplankton populations have recovered and the sockeye salmon fry populations have become reestablished at prespill levels without any other complications (Burgner, 1991). This long-term natural recovery rate may have begun and may be completed within 10 years (2 generations), or it may require as much as 50 years (10 generations) (EVOS Trustee Council, April 1993).

## Conclusions.

- short-term benefits: Negligible. No benefits can be expected to accrue in one lifecycle.
- long-term benefits: Moderate. Within 10 to 50 years, the injured populations are expected to recover to prespill conditions; however, there also is a moderate risk that the prey populations of zooplankton and predator populations of sockeye salmon fry may never achieve the same balance of prespill conditions.

## Pacific Herring

If there are no actions implemented to improve the injured Pacific herring populations, recovery to prespill conditions can occur only through long-term natural processes and



## 4 Environmental Consequences

normal conservative management approaches by the responsible agency. Although sublethal impacts by the oil have been documented, it still is unclear if the population has been injured because Pacific herring have a long generation time, complex population dynamics, and a widely fluctuating natural population (Brady et al., 1991). In addition, there is evidence that the oil may have affected their reproductive capability. Although Pacific herring runs in 1992 and 1993 were low, it still is uncertain if this was caused by the impact of the oil; however, only about 5 to 10-percent of the Pacific herring spawning areas were affected (Spies, 1994).

### Conclusions.

- short-term effects: **None.** No benefits are expected to accrue within one life-cycle.
- long-term effects: **Moderate.** Recovery can be expected through the natural process although some populations may not recover to prespill conditions and some populations will recover sooner than others.

### Social and Economic Cultural Resources Impacts

Injury to cultural resources resulted from oiling, from cleanup activities, and from postcleanup activities. Physical damage to archaeological and historic sites occurred through erosion, looting, and vandalism, all of which were exacerbated by the response to the oil spill. This damage is ongoing at some locations and will continue unless specific types of actions are taken. It is estimated that the oil spill area contains between 2,600 and 3,137 cultural properties, including 1,287 known archaeological sites as recorded by the Alaska Heritage Resources Survey. The extent of damage to 24 sites has been documented and can serve as a base from which to infer the trajectory of site degradation should the No Action Alternative be selected. The exact number of injured archaeological sites is unknown, but estimates suggest that 113 sites were damaged. Damage to the cultural heritage values associated with archaeological and historical sites is hard to measure, and no assessment data is available. It is assumed here that restoration actions that address damage to archaeological and historical sites also will assist in recovery of cultural heritage values damaged by the spill.

Archaeological and historical sites cannot recover in the same sense as biological species or organisms. They represent a category of finite, nonrenewable resources. Their importance was emphasized in over 100 public comments received from throughout the State of Alaska.

The effects of oil on carbon for radiocarbon dating remains uncertain. Archaeologists will remain leery of dates obtained from oiled sites without further research on these effects. Destruction of any part of the archaeological record for the area is of serious concern simply because the importance of individual parts has not been established. Besides the artifacts and archaeological associations lost through these injuries, the loss of cultural properties has a deleterious effect on local communities and the cultural patrimony of the Nation. The Native peoples of Prince William Sound, the Kenai Peninsula, the Kodiak Archipelago, and the Alaska Peninsula see these sites as a tangible connection to their ancestral heritage. Among these sites are burial areas where the human remains and associated objects remain an important cultural and spiritual link between contemporary people and their ancestors. To lose these sites affects the connection these people have with the past, their sense of cultural continuity, and their community cohesiveness. Losing these sites also would be an affront to



the Nation's spirit of religious protection, historic preservation, and archaeological knowledge as expressed in numerous laws and their implementing regulations.

In their current state, cultural properties in the spill area are in danger of vandalism, looting, and erosion. Erosion destroys the context by which archaeologists identify, classify, and explain sites, sometimes leaving only a few artifacts as clues. This has occurred largely as a result of disturbance to vegetation that stabilizes deposits exposed to the ocean or streams. These exposed artifacts are then subject to weathering and may be completely destroyed or carried off by casual visitors or looters. Exposure of artifacts also may spark the interest of visitors otherwise unaware of archaeological remains at a site, prompting unpermitted and damaging digging or collecting.

Vandalism already has seriously affected some sites. Key diagnostic artifacts have been illegally taken, ancient burial sites have been violated, and potholes dug by looters have destroyed critical evidence contained in the layered sediments. The exact extent of the vandalism as compared with the effect of the oil spill response on cultural resources has been determined only in a few cases, but it is documented that vandalism is a serious threat to cultural properties.

Should the No Action Alternative be selected, injuries will not be repaired to any degree through stabilization of eroding sites, nor would eroded artifacts be removed, restored (if oiled), and stored in an appropriate facility. Sites and artifacts would not be protected from further injury from looting and vandalism. The actual extent of damage would not be known because no monitoring would be done. Sites would not be excavated in order to retrieve scientific and cultural knowledge before irreparable damage ensued.

Short-term effects would include the loss of all or part of at least 24 sites within 10 years. In the long term, 10 years and beyond, increased public knowledge of site locations (knowledge spread as a result of the oil spill response) will escalate the level of looting and vandalism. For the purposes of this analysis, 10 years will be considered long term because the available information does not allow for reasonable estimates of effects beyond that time. The estimated long-term effects of this alternative are expected to extend to beyond the estimated 113 sites already damaged because of increased knowledge of site location. Also, a documented increase in numbers of visitors will translate to increased impacts on sites, whether or not such impacts are intentional.

**Conclusions.** Under this alternative, cultural resources in the spill area would not be protected, enhanced, or understood better than at present. Over the long term, this would constitute a low level of negative impact to archaeological and historical sites and to the understanding and appreciation of cultural resource values as they apply to the spill area. Over the short term, the impacts of this alternative would be negligible. Benefits to cultural resources would be negligible in the short term and in long term.

## Subsistence

If no projects are funded that would facilitate either (1) the recovery of species on which subsistence users depend or (2) the recovery of subsistence users' confidence in the lack of health risk associated with subsistence use, present trends in subsistence use will continue. In the short term, the effect of this alternative would be negligible. The level of subsistence

## 4 Environmental Consequences

harvest, as measured in pounds per person, would continue rising to, or beyond, prespill levels in some communities. Harvest levels would remain at below prespill levels in other communities, with the Native villages of Tatitlek, Chenega Bay, and Ouzinki at most risk of continued lowered harvest levels. Under this alternative, lands in the spill area that now provide important habitat for some subsistence species would remain unprotected from extractive economic activities like logging and mining. Should those activities happen in environmentally sensitive areas, the ensuing degradation of habitat would cause additional instability in the populations of species important for subsistence, possibly leading eventually to reduced populations of target species and reduced levels of subsistence activities. This would be a long-term high-level negative effect. Long term, for the purposes of this analysis, is considered 10 years because present information does not allow a reasonable projection of conditions beyond that length of time.

A major long-term effect of this alternative to subsistence is the continued uncertainty of the safety of subsistence foods. There is a persisting fear of remaining contamination in traditional foods. This would cause continued stress to community members and further degradation of subsistence lifestyle as younger people (1) are not taught the methods and attitudes that accompany subsistence activities and (2) become more dependent on imported foods.

Even if species on which subsistence users depend were to recover unassisted over the long term, the negative effect of the hiatus in subsistence as it relates to reintegration of cultural values into the communities would be high. These cultural values are intertwined with stories, lessons, techniques, history, place names, and so on that are relevant only in the context of subsistence activities. They are not passed on outside of that context and are impossible to fully reconstruct if not passed down.

**Conclusions.** In the No Action Alternative, the existing trends in subsistence harvest species populations and subsistence use are likely to continue over the long term. A continued hiatus in subsistence activities would have a long-term, potentially permanent negative effect on the perpetuation of cultural values within some of the villages in the spill area. Short-term and long-term benefits to subsistence species or subsistence use would be negligible.

### Recreation and Tourism

The No Action Alternative would have negligible effect on recreation or tourism in the short term. Present trends of increased levels of tourism and shifts in recreation locations and activities would continue. These trends include higher visitor rates, especially tourist user groups such as cruise ship passengers, State Ferry passengers, and lodge guests. They also include shifting of recreation activities away from oiled beaches.

Damage to tourism came from two main sources: damage to natural resources negatively affecting people's desire to visit the area and displacement of usually tourist-oriented services to spill-oriented services.

The oil spill is estimated to have caused the potential loss of 9,400 visitors for the summer of 1989, representing \$5.5 million in in-State expenditures. However, strongly spill-related business in some of the major cleanup areas such as Kodiak, Homer, Seward, Valdez, and Anchorage gained business as a result of the oil spill. Business sectors like hotels/motels, car/RV rentals, and air taxi and boat charters were among those to benefit. For these

businesses, business otherwise lost through lack of vacation/pleasure visitors was offset through cleanup-related business. The large decline in business for tourism associated with 1989 were less severe in 1990, with 12 percent of businesses indicating negative impacts. Negative impacts continued through 1990, with fewer bookings as a result of the spill, particularly among fishing lodges in Southwest Alaska (McDowell Group, 1990). The No Action Alternative would not cause a reduction in the trend of tourism-related business regaining prespill service levels and so is likely to have no effect.

Because oil fouled beaches, there was and still is a reduction of quality destinations available to some recreation users. There also was a reduction in quality and quality of remote destinations in the spill area because cleanup activities inserted people, noise, and large motorized equipment throughout the spill area and disturbed the area's undeveloped and normally sparsely occupied landscape. This is no longer a significant effect in the spill area because the level of cleanup activity has decreased dramatically. However, some materials used during cleanup remain dispersed throughout the spill area, and the effects of having so many people on the shores and adjacent uplands remain visible in many places. In the No Action Alternative, no funds would be expended to conduct activities that would reduce these effects.

Public-use cabin rentals and visitor-use data from the State of Alaska, Chugach National Forest, and Kenai Fjords National Park show fewer visits in some of the spill area in 1989 and 1990. Decreased use is an injury to those who would like to have used the area but avoided it because of the spill. Some recreation users were temporarily or permanently displaced from their customary or preferred sites due to spill-related changes such as crowding, presence of oil, or other factors. As a result of the oil spill, others changed the type or location of recreation use in which they historically engaged. While fewer people visited some areas, other areas experienced increased use. In some cases, increased use is causing additional resource damage and decreased enjoyment of overused areas.

Under the No Action Alternative, no actions would be taken to readjust shifted use patterns. In the short term, this would have negligible effect. However, in the long term, continued decreased use in some areas would continue. Also in the long term, overuse of some areas would lead to further shifting of recreation activities as overuse areas become no longer desirable. This would decrease visitor satisfaction and place greater stress on land owners (both public and private) to reduce impacts to new, potentially unauthorized areas. New areas may be on or near sensitive locations: habitat for recovering or protected species, traditional subsistence use areas, or cultural sites.

The oil spill caused injury to the way people perceive recreation opportunities in the spill area. Public comment indicates that people experienced an increased sense of vulnerability of the ecosystem in regard to future oil spills and erosion of wilderness character. There is a continued sense of permanent change, including unknown or unseen ecological effects and complete disruption of the ecosystem and contamination of the food chain.

People who used the spill area before the oil spill occurred generally have greater perceptions of injury than first-time recreation users of the spill area. Perceptions are changed more often for shore-based recreation users than those who remain on vessels. The No Action Alternative will not, in the short term, affect people's perceptions of recreation opportunities in the spill area. Over the long term, people's perceptions of recreation

## 4 Environmental Consequences

opportunities are tied to the recovery of natural resources in the spill area. Some displaced users are returning to the spill area, and if more species recover and evidence of oil and cleanup dissipate, then perceptions of opportunities for recreation in the spill area will be enhanced. The converse is true as well—if natural resources do not recover, perceptions of injury to recreation opportunities likely will not improve.

If this alternative is selected, logging and/or mining is likely to occur throughout the spill area. This would have a long-term negative effect on recreation and tourism. The effect would be twofold, including more direct and less direct aspects. The direct aspects are those that reduce the immediate recreation quality. These include such things as reducing the visual quality of relatively undeveloped landscape (the uncut and unscarred hillsides, wildlife viewing opportunities), and the insertion of people and machinery into the natural setting (mechanical action and noise). The indirect effects on recreation are those that affect the ecosystem on which these services depend, including reduction in wildlife habitat.

There are some long-term effects that differ between user groups. Tourist user groups (cruise ship passengers, ferry passengers, lodge guests, and boaters who do not often put to shore) will experience low to zero level of impact from the residual effects of the EVOS. Tourist services will continue to increase as new facilities are developed, adding time to long-term recovery unless extensive mining and logging occur. This is in contrast to remote and dispersed recreation (those activities like kayaking, beachcombing, and motor boating, where people spend considerable time in the intertidal and adjacent coastline zones), which are likely to experience continued negative impact in the long term. Shifting of recreation activities from oiled to nonoiled areas is likely to continue on a long-term basis, thereby impacting specific areas and facilities through continued human use.

Some recreation facilities were injured by the spill, most from overuse or misuse during 1989 and 1990. The No Action Alternative will not affect this injury in the short term, but the long-term scenario would be of continued damage, leading to closure or destruction of affected facilities.

**Conclusions.** The short-term impacts—negative or positive—of the No Action Alternative on recreation and tourism would be negligible. Long term, there would be low negative impacts to tourism and moderate negative impacts to recreation. Long-term benefits to recreation and tourism would be negligible.

### Wilderness

Designated Wilderness and Wilderness Study areas will have recovered when oil is no longer encountered in these areas and the public perceives them to be recovered from the spill. This alternative will develop no means to address the presence of oil or public perceptions of recovery in Wilderness areas. This will accrue a negligible short-term effect. The long-term effect will be persistence of oil in designated Wilderness areas and Wilderness Study areas, although these pockets of oil are expected to eventually weather to a level of insignificance. Public perception of damaged Wilderness will persist as well.

**Conclusions.** The short-term negative impact to Wilderness and Wilderness Study areas would be negligible. The long-term persistence of oil and public perceptions of damage would be a moderate-level negative impact. The long-term benefit to Wilderness would be negligible.



## Commercial Fishing

If there is no action to develop new alternate commercial fisheries or to augment injured commercial fisheries, the recovery of these fisheries will depend solely on the natural recovery of the injured pink salmon, sockeye salmon and Pacific herring populations and normal conservative management practices of the responsible agency. Most commercial fisheries in the *Exxon Valdez* oil-spill area will most likely be managed very conservatively by the resource manager until the injured resource populations are demonstrated or are believed to be recovered. This attitude may persist for 10 to 50 years depending on the injured resource and the specific population and any real or perceived uncertainty about the status of the recovery of these populations by the management agency will be reflected in a more conservative approach to the management of the resource. Fish habitat protection to maintain normal rates of production will rely solely on protective actions of normal resource agency planning and permitting procedures (Appendix C).

### Conclusions.

short-term. Negligible. No observable improvements within one life cycle.  
long-term. Moderate. Recovery can be expected through the natural process although some areas or commercial fisheries may not recover to pre-spill conditions and some populations will recover sooner than others.

## Sport Fishing

If there is no action to restore lost sport fishing opportunities, provide new opportunities or augment existing opportunities, the recovery of this service will depend upon natural rates of population and ecosystem changes and natural rates of recovery of the injured populations of cutthroat trout, Dolly Varden, and sockeye and pink salmon and normal management activities of the responsible management agency. Any uncertainty by the fishers or the resource manager about the recovery of these resources will result in more conservative actions.

### Conclusions.

short-term effects. Negligible. No improvements are expected within one life cycle.  
long-term effects. Moderate. Some resources and some populations will recover sooner than others, and some resources or populations may never recover to pre-spill levels. Confidence in the rates of recovery will be low without monitoring. Real or perceived recovery of the injured resources and services may require 10 to 20 years.

## Impacts on the Economy

Qualitative analysis indicates that Alternative 1 will result in moderate negative economic effects in commercial fisheries and recreation and moderate economic benefits in forestry as a result of timber harvesting. Quantitative analysis reflects effects resulting from habitat acquisition on forestry and other sectors but not effects on commercial fishing and recreation because data are not available to quantify in these sectors. The quantitative analysis follows.

## 4 Environmental Consequences

The title "No Action Alternative" is somewhat misleading with respect to economic impacts. Under Alternative 1, no lands would be purchased for habitat or facilities would be constructed or services purchased for restoration. However, it is assumed for the purpose of economic analysis for this alternative that the \$620 million would be invested. Therefore, as indicated in Table 4-3, Alternative 1, the most significant economic effects are in the finance, insurance, and real estate sector, for which there is a \$1.6 million increase, and in the services sector, for which there is a \$76 million increase. The total increase in output is \$3 million. The employment increase is 21 in finance, insurance, and real estate and 15 in services. The total increases for all sectors are \$3.04 million for output and 47 jobs.

Habitat acquisition and general restoration expenditures will have economic benefits for the commercial fisheries and recreation sectors of the economy. However, these benefits are not reflected in the IMPLAN projections presented in Table 4-3. Therefore, this table does not quantify important economic benefits in commercial fishing and recreation because these benefits are not quantified. Of the three most important economic sectors for this analysis, only forestry is quantified. The typical projects in various combinations, such as fish ladders, fish hatcheries, and preservation of habitat will economically enhance the commercial fisheries and recreation sectors of the economy. However, because studies and data are not available that quantify in terms of dollars or employment, it is not possible to quantify the economic effects for these two sectors of the economy. In Table 4-3 the quantities for the commercial fisheries and recreation sectors are reflections of the indirect effects of other sectors of the economy only; they are not reflections of the anticipated but unquantified effects on those sectors.

See the introduction to economics in Chapter 4 and Appendix D, Economics Methodology, for a more detailed discussion of methodology.

**Conclusions.** Qualitative analysis indicates that Alternative 1 will result in moderate negative effects in commercial fisheries and recreation. Quantitative analysis reflects effects resulting in several sectors from investment but not effects on commercial fishing or recreation. Quantitative analysis indicates that Alternative 1 results in annual averages in output for a 10-year period in increases of \$1.6 million for the finance, insurance, and real estate sector; \$76 million in the services sector; and \$3 million for all other sectors. Employment increases jobs by 21 in the finance, insurance, and real estate sector; 15 in services; and 47 total.



Table 4-3. Alternative 1: 100% Invested, 0% Administration, 0% Monitoring, 0% Restoration, 0% Habitat Protection  
Change from Base in 1990\$ Millions

| Economic Sector                 | Final Demand \$ | Industry Output \$ | Employee Comp. \$ | Property Income \$ | Value Added \$ | Employment # |
|---------------------------------|-----------------|--------------------|-------------------|--------------------|----------------|--------------|
| Forestry                        | 0.0001          | 0.0004             | 0.0001            | 0.0001             | 0.0001         | 0.0          |
| Commercial Fisheries            | 0.0000          | 0.0001             | 0.0000            | 0.0000             | 0.0000         | 0            |
| Mining                          | 0.0047          | 0.0125             | 0.0010            | 0.0057             | 0.0096         | 0.01         |
| Construction                    | 0.0000          | 0.0190             | 0.0103            | 0.0035             | 0.0139         | 0.25         |
| Manufacturing                   | 0.0042          | 0.0182             | 0.0046            | 0.0025             | 0.0072         | 0.16         |
| Recreation Related              | 0.0336          | 0.0123             | 0.0048            | 0.0021             | 0.0072         | 0.22         |
| Communication & Utilities       | 0.0079          | 0.1073             | 0.0298            | 0.0395             | 0.0714         | 0.78         |
| Trade                           | 0.0381          | 0.0467             | 0.0276            | 0.0058             | 0.0337         | 1.22         |
| Finance, Insurance, Real Estate | 1.5109          | 1.6025             | 0.6277            | 0.3505             | 1.0329         | 21.17        |
| Services                        | 0.5790          | 0.7654             | 0.2975            | 0.2189             | 0.5124         | 14.97        |
| Government                      | 0.4460          | 0.4565             | 0.4502            | 0.0021             | 0.4522         | 8.39         |
| Miscellaneous                   | 0               | 0                  | 0                 | 0                  | 0              | 0            |
| Total                           | 2.5945          | 3.0409             | 1.4436            | 0.6407             | 2.1456         | 47.18        |

Source: IMPLAN Economic Model. See text for methodology.

## 4 Environmental Consequences

### Alternative 2: Habitat Protection

#### Introduction

This Alternative focuses on increasing the protection of the greater EVOS ecosystem through protecting strategic lands and habitats important to resources and services injured by the spill. In this alternative, 91 percent of the remaining settlement funds would be used for habitat acquisition and protection. Title acquisition, conservation easements, and other less-than-fee-simple methods would be used to provide protection to habitats on private lands. Increasing the protection of habitat throughout the oil-spill area will be beneficial to the entire ecosystem by reducing further habitat degradation that may compound the effects of the oil spill. Monitoring activities would follow the progress of natural recovery for the injured resources.

#### Impacts on Biological Resources

##### Impact on Intertidal Resources

In this alternative, the restoration program concentrates exclusively on habitat-protection actions that prevent or reduce habitat loss and disturbance to resources and services injured by the EVOS. This analysis considers the impacts of protecting the 81 upland parcels described in the Comprehensive Habitat Protection Process: Large Parcel Evaluation & Ranking Volume I and Volume II (EVOS Restoration Team, 1993). Smaller parcels that also may be considered for protection under this alternative currently are under evaluation and are not discussed in this analysis.

The habitat protection process used to evaluate the 81 parcels for their potential benefits to injured resources and services combined intertidal and subtidal biota and used the following criteria for ranking the parcels:

- "High" for parcels adjacent to areas with a known high species abundance and diversity; high quality habitat for intertidal and subtidal biota;
- "Moderate" for parcels adjacent to extensive intertidal habitat with observed or probable moderate species diversity and abundance; and,
- "Low" for parcels with little intertidal habitat with low species abundance (EVOS Restoration Team, 1993).

Of the 81 parcels evaluated using these criteria, 25 of the parcels were ranked High, 33 were ranked Moderate, 19 were ranked Low, and 4 were not associated with the coastline and had no rating for intertidal/subtidal organisms (EVOS Restoration Team, 1993).

The benefits to intertidal and subtidal organisms through the protection of upland habitats comes in two forms. First, the protection can prevent the intertidal and subtidal areas from being altered by the actions that may occur on the parcels. Some actions can cause indirect adverse effects through siltation or increased pollution, while other actions such, as the construction of a dock or creating a new harbor, directly could alter the intertidal and subtidal

habitats. The second type of protection reduces the disturbance caused by increased human activity (e.g., more people walking through the intertidal area; more pollution from littering or from bilge discharge). Obviously, the type of activity that may occur on a given parcel can substantially change the degree of benefit that is gained from protecting upland parcels adjacent to the intertidal and subtidal zones.

The overall benefit from protecting all of the 81 parcels identified in the large parcel process is Moderate based on the evaluation criteria, but the actual benefit gained by the intertidal and subtidal organisms depends on the type and location of the activities that may occur. In areas where construction activities are anticipated in the intertidal zone, the protection would be especially effective. If the parcels correspond to areas of the intertidal zone that are still not recovering from the effects of the oil spill, the benefits could be even greater.

## Conclusions.

- short-term benefits: Negligible. A change in ownership would not necessarily translate into a change in current activities.
- long-term benefits: Moderate. The protection can span a large portion of the intertidal zone, but the potential for reducing disturbance or preventing additional injury would vary substantially between parcels.

## Impact on Marine Mammals

### **Harbor Seals**

In this alternative, the restoration program concentrates exclusively on habitat protection actions that prevent or reduce habitat loss and disturbance to resources and services injured by the EVOS. This analysis considers the impacts of protecting the 81 upland parcels described in the Comprehensive Habitat Protection Process: Large Parcel Evaluation & Ranking Volume I and Volume II (EVOS Restoration Team, 1993). Smaller parcels that also may be considered for protection under this alternative, currently are under evaluation and are not discussed in this analysis.

Harbor seals use haulout sites that are either in the intertidal zone or immediately adjacent to the intertidal zone; therefore, actions that occur on the uplands are not likely to destroy the habitat. However, it is possible that habitat changes to the uplands may increase the amount of disturbance currently experienced at haulout sites on or near the parcel. Disturbance has been documented as adversely affecting harbor seals and other pinnipeds in other parts of their range (Allen et al., 1984; Esipenko, 1986; Johnson et al., 1989). These studies have shown that the greatest impacts from disturbances are at haulout sites during pupping and molting. During pupping, disturbance can result in higher pup mortality caused by abandonment, or from being crushed as the adults panic and return to the water (Johnson, 1977). The greatest disturbance is caused when people walk near or through haulout sites (Johnson, et al., 1989), but disturbance also can be caused by low-flying aircraft and by boats that approach too close to the haulouts.

## 4 Environmental Consequences

Habitat-protection criteria for parcels that may benefit harbor seals include ratings of:

- "High" for parcels known to have a haulout of 10 or more seals on or immediately adjacent to the parcel;
- "Moderate" for parcels with known haulouts with sporadic use and less than 10 seals, or probable haulouts in the vicinity of the parcel or probable feeding in nearshore waters; and,
- "Low" for possible feeding sites located in nearshore waters adjacent to the parcel (EVOS Restoration Team, 1993).

Of the 81 parcels evaluated in the large parcel process, 25 of the parcels were ranked High, 19 of the parcels were ranked Moderate, 35 were ranked Low, and 2 parcels were ranked as having no benefit to harbor seals. The overall value of these parcels, based on these rankings, is moderate, although individual parcels may have exceptional value.

The actual impact that development on these parcels will have on harbor seals depends on, among other things, the type of disturbance caused, the length and duration of the disturbance, and whether or not the haulout area is used for pupping or molting. Within the EVOS area, there have been no studies to document the amount or effects of current activities that may cause disturbance to harbor seals, so baseline data are unavailable. However, it is reasonable to assume that protection of upland habitats near haulout sites will reduce the risk of disturbance to the injured population.

### Conclusions.

- short-term benefits: Negligible. Compared to the existing condition of the habitat, the protection of upland parcels is not expected to produce any notable change in disturbance.
- long-term benefits: Low to Moderate. Of the 81 parcels included in this analysis, over half include haulout sites near or on the parcels. Although the type of use at these haulout sites is not known, many of them may be used during pupping and molting.

### Sea Otters

In this alternative, the restoration program concentrates exclusively on habitat-protection actions that prevent or reduce habitat loss and disturbance to resources and services injured by the EVOS. This analysis considers the impacts of protecting the 81 upland parcels described in the Comprehensive Habitat Protection Process: Large Parcel Evaluation & Ranking Volume I and Volume II (EVOS Restoration Team, 1993). Smaller parcels that also may be considered for protection under this alternative, currently are under evaluation and are not discussed in this analysis.

As with harbor seals, the benefit to sea otters of habitat-protection actions on upland parcels is through reducing potential or actual disturbance. Sea otters appear to have a high tolerance to certain human activities, as evidenced by their abundance in highly travelled areas such as Orca Inlet near Cordova; however, their response to large-scale disturbances has not been studied. Large-scale disturbances, such as log-transfer sites, may force resident

otters to leave the immediate area and may cause a long-term change in food availability as debris from the logs covers the substrate. Disturbance is more likely to cause adverse effects to females with pups that concentrate in high-quality habitats with abundant prey in the intertidal zones.

Habitat-protection criteria for parcels that may benefit sea otters include ratings of:

- "High" for parcels adjacent to known pupping concentrations;
- "Moderate" for parcels adjacent to concentration areas for feeding and/or shelter or potential pupping areas; and,
- "Low" for feeding sites located in adjacent waters (EVOS Restoration Team, 1993).

Of the 81 parcels evaluated in the large parcel process, 20 of the parcels were ranked High, 16 of the parcels were ranked Moderate, 42 were ranked Low, and 3 parcels were ranked as having no benefit to sea otters. The average value of these parcels for sea otters, based on these rankings, is low to moderate, although individual parcels may be near habitat of exceptional value.

## Conclusions.

- short-term benefits: Negligible Compared to the existing condition of the habitat, the protection of upland parcels is not expected to produce any notable change in disturbance or in the health of the population.
- long-term benefits: Low, assuming that adverse effects of disturbance are likely to be most notable when large-scale disturbances are near concentrations of females and pups. Of the 81 parcels included in this analysis, 25 percent of the identified parcels are near known pupping concentrations. Of these, several are in areas where there is less risk of large-scale disturbances. However, because the effects of disturbance are unknown, the benefits may be greater than anticipated here.

## Birds

Under this alternative, nesting habitat of harlequin ducks and marbled murrelets will receive maximum protection, thus enhancing their productivity and subsequent recovery of their populations. The effect on the ecosystem of larger populations of these two species likely would be negligible increases in predation on bottom fauna of the intertidal and shallow subtidal zones by harlequin ducks and increased predation on forage fish by marbled murrelets, mainly nearshore. Habitat acquisition would appear to have minimal impact on size of injured murre and pigeon guillemot populations and, therefore, no additional impact on the ecosystem.



## 4 Environmental Consequences

### Harlequin Duck

**Habitat Protection.** Potential nesting habitat of harlequin ducks will be receive maximum protection under this alternative, thus enhancing productivity and recovery of their depleted populations. However, there is very little information available on use of specific land parcels by harlequin ducks, so it is difficult to determine the significance of acquisition of specific parcels on harlequin duck population recovery.

**Conclusions.** The short-term effects through 1995 of land acquisition on harlequin duck recovery are likely to be negligible, and populations likely would remain stable at 1990 to 1993 levels in both oiled and nonoiled areas. The long-term effects of this alternative would be to maximize the reproductive potential of harlequin ducks in the EVOS area.

### Murres

**Habitat Protection.** Acquisition of habitat would have little benefit to the injured murre population, because there are no sizeable colonies and very few smaller colonies that are not already protected. A seabird colony on privately owned Gull Island in Kachemak Bay has a small number of common murres, and it is a tourist attraction that several commercial tour boats visit daily in summer.

**Conclusions.** Acquisition of Gull Island would ensure protection of this popular tourist attraction, and thus may have a moderate long-term benefit to murres. However, because there appears to be no imminent plans to develop this small, rocky island, there would be little short-term benefit.

### Pigeon Guillemot

**Habitat Protection.** In Prince William Sound, the large majority of pigeon guillemot colonies are on U. S. Forest Service (USFS) land (Sanger and Cody, written comm., 1994) that is not slated for logging (Frey, written comm., 1994). Two of the largest colonies in Prince William Sound, at The Pleiades and on Bligh Island, totaling approximately 3 percent of the 1993 breeding population, are on private land (Sanger and Cody, written comm., 1994). In the 1970's, both of the latter colonies probably harbored larger numbers of nesting guillemots than at present. There are two colonies adjacent to private land that currently is being logged on the eastern, nonoiled portion of Prince William Sound, but they had very few guillemots in 1993; it is unlikely that they were affected by the inland logging operations (Sanger and Cody, written comm., 1994). Outside of Prince William Sound, the Seal Bay area on Afognak Island has low numbers of pigeon guillemots and has already been acquired; little is known about the current status of guillemot colonies elsewhere in the EVOS area (USFWS, 1993).

**Conclusions.** Habitat acquisition would have little effect on pigeon guillemot population recovery on the short term, because there appears to be no development slated for private land with known colonies. On the long term, acquiring habitat where two of the largest colonies in Prince William Sound are located would have a moderate benefit in allowing population recovery and in preventing further inroads to the injured population through habitat degradation.



#### Marbled Murrelet

**Habitat Protection.** Details of habitat use by marbled murrelets are being clarified, and studies in Prince William Sound are showing that large, moss-covered limbs of old-growth conifers comprise prime nesting habitat. Current and possible future logging of such habitat on private land is the single greatest threat to population recovery of marbled murrelets, and it poses the additional threat of reducing the population more. Acquisition of prime nesting habitat would thus maximize the potential for the injured marbled murrelet population to recover while preventing further injury to the population.

**Conclusions.** Depending on the potential for imminent logging on land parcels that contain prime habitat, the short-term effects of land acquisition could be considerable. On the long term, acquisition of old-growth-forest habitat would have a high benefit for enhancing murrelet population recovery.

#### Fish

##### Pink Salmon

Alternative 2 includes only one restoration action to assist natural recovery of wild-stock pink salmon populations: habitat protection and acquisition (EVOS Trustee Council, 1993).

Habitat protection criteria for parcels that may benefit pink salmon include ratings of High for parcels with a high density of pink salmon streams or streams known to have exceptional value; Moderate for parcels with an average density of pink salmon streams or streams with average production, and, Low for parcels with few or no pink salmon streams or streams with no production (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit wild-stock pink salmon populations, according to Alternative 2, includes purchase of all available parcels. This is expected to provide low to moderate benefit for the pink salmon resource (Appendix A). Of the 81 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 0, 38, 25, and 18 have been rated as no, low, moderate, and high value, respectively, for pink salmon. Although the average value of forecasted habitat acquisition may not have a high overall rating for pink salmon, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

**Conclusions.** (for the pink salmon resource)

- short-term: Negligible. No benefits from habitat protection would be accrued within one lifecycle.
- long-term: Moderate. Habitat protection and acquisition actions would have a long-term value to pink salmon stocks in the EVOS area by helping to ensure maintenance of wild-stock production. More than half of the parcels that may be purchased have moderate or high value for pink salmon.

## 4 Environmental Consequences

### Sockeye Salmon

Alternative 2 includes only one restoration action to assist natural recovery of wild-stock sockeye salmon populations: habitat protection and acquisition (EVOS Trustee Council, 1993).

Habitat protection criteria for parcels that may benefit sockeye salmon include ratings of High for parcels with sockeye salmon streams or systems known to have exceptional value; Moderate for parcels with sockeye salmon streams or systems with average production; and, Low for parcels with few or no sockeye salmon streams or systems with low production (EVOS Restoration Team, November 1993).

Forecasted habitat protection that may benefit wild-stock sockeye salmon populations, according to Alternative 2, includes purchase of all available parcels. This is expected to provide an overall low benefit (Appendix A). Of the 81 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 16, 48, 8, and 9, have been rated as no, low, moderate, and high value; respectively, for sockeye salmon. Although the average value of forecasted habitat protection and acquisition may not have a high overall rating for sockeye salmon, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

Conclusions. for the sockeye salmon resource)

- short-term: Negligible. No benefits from habitat protection can be expected within one life cycle.
- long-term: Moderate. Habitat protection and acquisition actions would have a long-term value to sockeye salmon stocks in the EVOS area by helping to ensure maintenance of wild-stock production; however, fewer than half of the individual parcels that may be purchased are rated as moderate or high value for sockeye salmon. Some parcels, however, can be expected to have unique value.

### Pacific Herring

Alternative 2 includes only one restoration action to assist natural recovery of Pacific herring; habitat protection and acquisition (EVOS Trustee Council, 1993).

Habitat protection criteria for parcels that may benefit Pacific herring include ratings of High for parcels with a documented consistent annual Pacific herring spawning along the parcel shoreline, Moderate for parcels with occasional spawning along the parcel shoreline, and, Low for parcels with no documented Pacific herring spawning along the parcel shoreline, but a possible feeding area (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit Pacific herring populations includes the purchase of all available parcels and is expected to provide low to moderate benefit (Appendix A). Of the 81 parcels that may be purchased from the estimated budget that is forecasted according to this Alternative, 7, 30, 29, and 15, have been rated as no, low, moderate, and high value, respectively, for Pacific herring. Although the average value of

forecasted habitat acquisition may not have a high overall rating for pink salmon, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

## Conclusions. (for the Pacific herring resource)

- short-term: Negligible. No benefits would be accrued within one lifecycle.
- long-term: Moderate. Habitat-protection and -acquisition actions would have a long-term value to Pacific herring stocks in the EVOS area by helping to ensure maintenance of production. Over half of the parcels that may be purchased have moderate or high value for Pacific herring.

## Social and Economic Impacts Cultural Resources

It is assumed here that 81 large parcels, a total of 863,100 acres, would be purchased. These parcels contain low (no known or suspected cultural resources/sites on parcel), moderate (no significant cultural resources/sites on or adjacent to parcel), or high (documented concentration or significant cultural resources/sites on parcel) potential for benefiting cultural resources as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 1.9 (or slightly lower than moderate). These estimates reflect known sites in the EVOS area, not all of the sites present. Not all sites have been found, so the actual benefit to cultural resources may be greater than reflected in these estimates. This analysis does not take into consideration small-parcel acquisition, which is currently under evaluation.

A change in land status from private to public management would put these lands within the purview of historic preservation laws that are otherwise not applicable. Under the present situation, only laws protecting private lands in general from trespass and theft may be used to protect archaeological and historical resources. A selection of laws that would newly apply include: the National Historic Preservation Act, the Archaeological Resources Protection Act, the Alaska Historic Preservation Act, the Native American Graves Protection and Repatriation Act, and Executive Order 11593. Collectively, they afford a level of site protection not extended to private lands. Under these laws, historic properties must be inventoried and taken into consideration when activities could impact them. Also, penalties are prescribed for damaging the sites without appropriate permits and consultation, and the concerns of interested parties must be considered. Which laws apply depends on whether the lands are under management of the State of Alaska or the Federal Government. This would be an immediate benefit to the cultural resources on acquired parcels, and would remain in effect for the long term.

Under this alternative, lands otherwise open to extractive economic activities (like logging and mining) would be closed to those activities. This would increase the level of protection to archaeological sites and historical sites in the long term. The locations and types of



## 4 Environmental Consequences

archaeological properties are not fully known, so inadvertent damage or destruction to undiscovered sites would be reduced in this alternative.

There are 1,287 known archaeological or historical sites in the spill area. While it is estimated that between 2,600 and 3,137 sites are present, those estimates are based on a minimal inventory. While archaeological surveys were conducted along much of the shoreline of the EVOS area, very little work has been accomplished in the uplands before, during, or since the spill and resulting cleanup. Because there is so little knowledge about the cultural resources in the spill area, and because many of these sites contain human remains important to specific groups of people, any actions taken to significantly protect these resources from damage will be considered a high benefit to the resource. This alternative would affect all of the parcels and additionally could establish the basis for inventorying lands upland from the intertidal zone. This alternative would not in itself provide any new information about cultural resources in the spill area but would help ensure the potential for gaining new information in the future.

**Conclusions.** The short-term direct benefit of habitat protection and acquisition on cultural resources would be low. Long term, this alternative would provide moderate benefit to the protection of archaeological and historical resources on acquired parcels.

### Subsistence

It is assumed here that 81 large parcels, a total of 863,100 acres, would be purchased. These parcels contain low (status as a subsistence-use area is unknown); moderate (known historic subsistence-use area, which may be used again); or high (known current subsistence-use area) potential for benefiting subsistence as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.4 (or between moderate and high). Under this alternative, there will be no change in subsistence regulations, activities, or locations. This means there will be no direct short-term benefits. Indirect effects include further protection of habitat from potential degradation from extractive economic activities. As this alternative is intended to enhance the ability of the environment in the EVOS area to restore plants and wildlife, it also would enhance the area's capability to support plants and animals for subsistence harvest in the long term. The degree to which this is true depends on the location of acquired land. Some lands under consideration are excellent habitat for subsistence foods while others are less productive; so, effects are likely to be local enhancements of some species populations. Discussion of the effect of this alternative on each of the species important for subsistence is included elsewhere. Please refer to those sections for additional information. The perception of continued contamination of subsistence food resources will not be addressed by this alternative.

**Conclusions.** Short-term impacts to subsistence-harvest species and subsistence users would be negligible. Long term, the level of parcel acquisition possible in this alternative would allow for localized increases of populations of fish, wildlife, and intertidal resources important for the perpetuation of subsistence activities and their associated lifestyle in the spill area. This would be a long-term low to moderate benefit to subsistence.

## Recreation

It is assumed here that 81 large parcels, a total of 863,100 acres, would be purchased. These parcels contain low (low to no recreation use; access may be difficult); moderate (receives occasional public use; adjacent waters used for recreational boating; adjacent area receives high public use); or high (receives regular, high directed public use; highly visible to a large number of recreationists/tourists) potential for benefiting recreation and tourism as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 1.8 (or slightly lower than moderate).

Acquiring lands potentially available for logging and/or mining would allow for better protection of the condition of those lands that make them valuable for recreation and tourism. The benefit is twofold, including more or less direct aspects. The direct aspects are those that reduce the potential for negative impacts to immediate recreation quality. These include reducing the visual quality of relatively undeveloped landscape (the uncut and unscarred hillsides, wildlife viewing opportunities) and the insertion of people and machinery into the natural setting (mechanical action and noise). The indirect effects on recreation are those that affect the ecosystem on which these services depend, including reduction in wildlife habitat. It is estimated that this alternative would allow increased numbers of visitors, and that recreation quality would increase in some locations. Through protection of visual quality and by maintaining some degree of existing viable habitat for species important for recreation activities, this alternative would produce an overall moderate positive benefit to recreation and tourism in the long term. The benefits of this alternative would vary by parcel. These benefits would be negligible in the short term.

## Conclusions.

Short-term benefits to recreation and tourism would be negligible. Long-term benefits are likely to be moderate in terms of both direct effects on maintaining the quality of the landscape and indirect effects on maintaining stable ecosystems on which recreation and tourism depend in the spill area.

## Wilderness

It is assumed here that 34 parcels, a total of 478,500 acres, would be purchased. These parcels contain low (high/moderate evidence of human development and/or ongoing activities); moderate (area remote; evidence of human development and/or ongoing activities); or high (area remote; little or no evidence of human development) potential for benefiting wilderness as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.3 (or slightly higher than moderate). These rankings consider wilderness character, not Wilderness designation.

Habitat acquisition could increase the boundaries of designated wilderness, either actually or de facto. If inholdings within designated Wilderness were acquired, these lands could be subsumed as part of the Wilderness, thereby increasing management efficiency for those lands. If lands adjacent to designated wilderness were acquired, they would effectively



## 4 Environmental Consequences

extend the range of the Wilderness protection, though they would be outside of formal designation. Acquisition of lands within Wilderness Study areas would revert those acquired lands to Wilderness Study area status.

Acquiring these types of lands would increase protection for plants, animals, and visual quality and reduce the potential for impacts through logging and/or mining in the long term. Short term, there would be no significant benefits. Residual oil would not be removed, and public perception of damage to Wilderness would not be addressed. Long-term benefits to designated Wilderness and Wilderness Study areas would, therefore, be low.

There are large areas of wilderness-like land in the spill area that is not designated Wilderness. These are remote, relatively undeveloped areas that contain many of the same characteristics as designated Wilderness but that have no differentiating regulatory standing. A considerable amount of the private land being evaluated for habitat protection and acquisition fits this description. The effects on these areas under this alternative are essentially the same as for recreation. The benefit is twofold, including more or less direct aspects. The direct aspects are those that reduce the potential for negative impacts to wildland characteristics such as reducing the visual quality of relatively undeveloped landscapes (the uncut and unscarred hillsides, wildlife viewing opportunities); reducing the quality or quantity of recreation activities (hiking, sport fishing, sport hunting, and so on); and the insertion of people and machinery into the natural setting (mechanical action and noise). The more indirect benefits to wilderness settings are those that maintain the ecosystem on which the quality of those settings depend, including reduction in wildlife habitat.

### Conclusions.

Short-term and long-term benefits to Wilderness would be negligible both in terms of restoring Wilderness pristine appearance and public perception of damage. Long-term benefits to protecting the wilderness quality of much of the spill area would be moderate, causing negligible to low indirect benefit to Wilderness.

### Commercial Fishing

Alternative 2 includes only one restoration action, habitat protection and acquisition to assist recovery and maintenance sport-fishing activities. (EVOS Trustee Council, April 1993).

Habitat protection may benefit commercial-fishing opportunities by providing long-term protection for natural production and stability of wild stocks of pink and sockeye salmon and Pacific herring. This action is expected to provide low to moderate benefit because of the protection accorded to those stocks (Appendix A). In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

### Conclusions.

-short-term. Negligible. No benefits will be accrued within one life cycle of the protected species.

-long-term: Moderate. Habitat protection and acquisition actions will have a long-term value to salmon and Pacific herring stocks in the EVOS area by helping to ensure maintenance of wild-stock production to support the commercial-fishing industry.

## Sport Fishing

Alternative 2 includes only one restoration action, habitat protection and acquisition to assist recovery and maintenance sport-fishing activities. (EVOS Trustee Council, April 1993).

Habitat protection may benefit sport fishing by providing long-term protection and stability for production of pink and sockeye salmon, Dolly Varden, and cutthroat trout. Forecasted habitat acquisition that may benefit sport fishing is expected to provide low to moderate benefit for the long-term production of sport fishes (Appendix A). Although the average value of forecasted habitat acquisition may not have a high overall rating for sport fishing values, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C). In addition, some of the benefits accrued through habitat acquisition for recreation in the EVOS area also will benefit sport fishing by providing access to new fisheries and development of recreational sites and boat-launching facilities. Some habitat degradation will occur, however, wherever recreational sites are provided or new sport-fishing opportunities are developed.

## Conclusions.

- short-term: Negligible. No benefits will be accrued for sport fishing opportunities immediately upon a purchase.
- long-term: Moderate. Habitat protection and acquisition actions will have a long-term value to sport fishing activities in the EVOS area by helping to ensure maintenance of fish production and access for the sport-fishing activities.

## Economy

Qualitative analysis indicates that Alternative 2 will result in moderate economic benefits in commercial fisheries and recreation and moderate negative effects in forestry. Quantitative analysis reflects effects resulting from habitat acquisition on forestry and other sectors but not effects on commercial fishing and recreation, because data are not available to quantify in these sectors. The quantitative analysis follows.

The acquisition of lands for habitat removes them from timber production. This results in a negative quantity in forestry for each of the six economic measures of final demand, industry output, employee compensation, property income, value added, and employment. The negative effects on the economy first injected directly to the economy by purchasing habitat multiplies to positive and negative values in other sectors of the economy. Respending of money received from habitat acquisition on construction for general restoration projects has a direct effect in the amount of \$7.3 million in industry output, on the construction sector as shown in Table 4-4, but this is not enough to offset the negative effects in forestry. There

## 4 Environmental Consequences

also is spending, primarily from income received by timberland owners, in the services sector resulting in \$6 million in final demand and 959 employees. The net effect is shown in the total line, which has negative quantities for four out of the six economic measures; only employee compensation and number of employees are positive.

Habitat acquisition and general restoration expenditures will have economic benefits for the commercial fisheries and recreation sectors of the economy. However, these benefits are not reflected in the IMPLAN projections presented in Table 4-4. Therefore, this table does not quantify important economic benefits in commercial fishing and recreation because these benefits are not quantified. Of the three most important economic sectors for this analysis, only forestry is quantified. The typical projects in various combinations, such as fish ladders, fish hatcheries, and preservation of habitat will economically enhance the commercial fisheries and recreation sectors of the economy. However, because studies and data are not available that quantify in terms of dollars or employment, it is not possible to quantify the economic effects for these two sectors of the economy. In Table 4-4 the quantities for the commercial fisheries and recreation sectors are reflections of the indirect effects of other sectors of the economy only; they are not reflections of the anticipated but unquantified effects on those sectors.

See the introduction to Chapter 4 on economics and Appendix D, Economics Methodology, for a more detailed discussion of methodology.

### Conclusions.

Qualitative analysis indicates that Alternative 2 will result in moderate economic benefits in commercial fisheries and recreation and moderate negative effects in forestry. Quantitative analysis reflects effects resulting from habitat acquisition on forestry and other sectors but not effects on commercial fishing and recreation. Quantitative analysis indicates that Alternative 2 results, in annual averages for a 10-year period, in a loss of approximately \$38 million in forestry industry output, an increase of \$7 million in construction industry output, and \$3 million in services. The corresponding changes in employment are a loss of 440 jobs in forestry, an increase of 65 in construction, and an increase of 959 in services.

Table 4-4. Alternative 2: 4% Administration, 5% Monitoring, 0% Restoration, 91% Habitat Protection  
Change from Base in 1990\$ Millions

| Economic Sector                 | Final Demand \$ | Industry Output \$ | Employee Comp. \$ | Property Income \$ | Value Added \$ | Employment # |
|---------------------------------|-----------------|--------------------|-------------------|--------------------|----------------|--------------|
| Forestry                        | -31.9771        | -38.8225           | -8.2190           | -5.2362            | -14.6417       | -440.03      |
| Commercial Fisheries            | 0.0004          | 0.0007             | 0.0000            | 0.0003             | 0.0003         | 0.01         |
| Mining                          | 0.0652          | -0.0427            | -0.0034           | -0.0197            | -0.0328        | -0.04        |
| Construction                    | 8.0662          | 7.3758             | 2.7049            | 1.0998             | 3.8239         | 64.68        |
| Manufacturing                   | 0.0616          | -0.6095            | -0.0972           | -0.0279            | -0.1422        | -1.32        |
| Recreation Related              | 0.0620          | 0.0325             | 0.0146            | 0.0009             | 0.0197         | 0.84         |
| Communication & Utilities       | 0.1114          | 0.1429             | 0.0344            | 0.0706             | 0.1056         | 0.76         |
| Trade                           | 0.5303          | 0.2352             | 0.1158            | 0.0241             | 0.1489         | 9.08         |
| Finance, Insurance, Real Estate | 2.5631          | 2.3244             | 0.5857            | 0.1628             | 0.7877         | 52.09        |
| Services                        | 6.0258          | 2.8326             | 4.6201            | -1.1268            | 3.4974         | 959.08       |
| Government                      | 0.8094          | 0.6767             | 0.7299            | -0.0189            | 0.7109         | 13.75        |
| Miscellaneous                   | 0               | 0                  | 0                 | 0                  | 0              | 0            |
| Total                           | -13.7017        | -25.854            | 0.4856            | -5.1148            | -5.7223        | 658.88       |

Source: IMPLAN Economic Model. See text for methodology.

## 4 Environmental Consequences

### Alternative 3: Limited Restoration

#### Introduction

In this alternative, the general restoration program focuses only on the components of the ecosystem that were most injured by the oil spill. General restoration actions are sometimes able to help resources or services recover to their prespill conditions more rapidly than if the actions were not implemented. The general restoration program would be limited to the most effective actions in order to maximize the available funds for habitat protection activities. Habitat protection and acquisition can provide protective benefits to all resources and services injured by the spill as well as to other resources and human uses that are important to the greater EVOS ecosystem. Increasing the protection of habitat throughout the oil spill area would be beneficial to the entire ecosystem by reducing further habitat degradation that may compound the effects of the oil spill. The Monitoring and Research Program would evaluate the effectiveness of restoration actions and follow the recovery progress of the injured resources and services.

#### Impacts on Biological Resources

##### Impacts on Intertidal Resources

There are three actions that affect the intertidal zone that have been identified for this alternative--habitat protection, accelerating the recovery of *Fucus* in the upper intertidal zone, and cleaning oiled mussel beds.

Habitat Protection. Although there are several types of actions that apply under this restoration category, this analysis considers only the types of benefits that may be gained from protecting the 81 upland parcels identified in the Comprehensive Habitat Protection Process: Large Parcel Evaluation & Ranking, Volumes I and II (EVOS Restoration Team, 1993). Other aspects of the habitat protection category, such as the small parcels available for protection, are still being developed and cannot be analyzed in this DEIS.

The habitat protection process used to evaluate the 81 parcels for their potential benefits to injured resources and services combined intertidal and subtidal biota and used the following criteria for ranking the parcels:

- "High" for parcels adjacent to areas with a known high species abundance and diversity; high quality habitat for intertidal and subtidal biota;
- "Moderate" for parcels adjacent to extensive intertidal habitat with observed or probable moderate species diversity and abundance; and,
- "Low" for parcels with little intertidal habitat with low species abundance (EVOS Restoration Team, 1993).

Of the 81 parcels evaluated using these criteria, 25 of the parcels were ranked high, 33 moderate, and 19 low, and 4 were not associated with the coastline and had no rating for intertidal/subtidal organisms (EVOS Restoration Team, November 1993). If a higher cost per acre is assumed for the protection of these parcels, fewer of the parcels that were ranked



low in the overall ranking for multiple resources and services are likely to be protected. Because most of these parcels also were evaluated as being of low benefit to intertidal/subtidal, the differences between the more restrictive list and the total list are minimal.

The benefits to intertidal and subtidal organisms through the protection of upland habitats come in two forms. First, protection can prevent the intertidal and subtidal areas from being altered by the actions that may occur on the parcels. Some actions can cause indirect adverse effects through siltation, or increased pollution, while other actions, such as the construction of a dock or creation of a new harbor, could directly alter the intertidal and subtidal habitats. The second type of protection reduces the disturbance caused by increased human activity (e.g., more people walking through the intertidal area; more pollution from littering or bilge discharge). Obviously, the type of activity that may occur on a given parcel can substantially change the degree of benefit that is gained from protecting upland parcels adjacent to the intertidal and subtidal zones.

The overall benefit from protecting most or all of the 81 parcels identified in the large parcel process is moderate based on the evaluation criteria, but the actual benefit gained by the intertidal and subtidal organisms depends on the type and location of the activities that may occur. In areas where construction activities are anticipated in the intertidal zone, the protection would be especially effective. If the parcels correspond to areas of the intertidal zone that are still not recovering from the effects of the oil spill, the benefits could be even greater.

The other two actions that have been identified for this alternative can directly affect the intertidal zone. These actions affect specific organisms, *Fucus* and mussels, but are meant to provide broader benefits to the other organisms that live or feed in these communities.

Accelerate the recovery of the upper intertidal zone by re-establishing *Fucus*. The upper intertidal area, specifically the upper 1 meter vertical drop (IMVD), probably is the upper extent of suitable habitat for *Fucus* to grow. This means that the conditions are more extreme than in other habitats and would be more difficult to colonize. *Fucus* germlings that colonize in the upper intertidal area are subject to longer periods of high temperatures and dryness during low tides. Without the shelter and moisture that is provided by adult *Fucus* plants the germlings can become desiccated and die. Studies conducted in Herring Bay, Prince William Sound, suggest that it may take 3 to 4 years for *Fucus* communities to expand 0.5m beyond their existing boundaries (Highsmith et al., October 1993).

Feasibility studies of techniques for accelerating the recovery of *Fucus* were begun in 1992. Attempts to transplant adult *Fucus* plants were generally unsuccessful (Stekoll, pers. comm., 1994). Another technique that uses a biodegradable cloth to cover seeded areas is currently being tested (Stekoll, pers. comm., 1994). The results of this experiment will be known during summer 1994. In theory, the cloth will substitute for the adult *Fucus* by providing moisture and protection to the germlings during low tides. Because the technique is still being tested, it is impossible to know how successful the action may be or how easily it can be applied to the areas that could benefit from the action. If the technique is highly successful, the established germlings could become fully mature plants in 3 to 4 years; and the associated invertebrates also will recolonize in the upper intertidal zone. At this time,

## 4 Environmental Consequences

however, it is impossible to know the outcome of the research; therefore, any benefits from this action are unknown.

Cleanup of Oiled Mussel Beds. This has been considered as a possible method to reduce the hydrocarbon exposure for sea otters, harlequin ducks, and black oystercatchers. These animals depend on mussels for a large portion of their diet (Doroff and Bodkin, 1993). Mussels can be found in loose aggregations attached to intertidal rocks, or they can be found in dense aggregations (mussel beds) over pea gravel and silt sediments. Because mussels form a dense matt over the sediments and rocks, oil that was trapped beneath the mussels was not exposed to weathering and still remains toxic. It may be possible to clean mussels in mussel beds, but there are areas where it will be technically infeasible to remove the remaining oil.

One of the possible explanations of the continuing signs of injury to sea otters, river otters, harlequin ducks, and black oystercatchers is that they continue to be exposed to hydrocarbon contamination by eating oiled mussels. Concern over this possible continuing source of contaminations led to feasibility studies to develop techniques to clean the sediments beneath the oiled mussel beds. One technique to be tested in 1994 lifts sections of the mussel beds and replaces the contaminated sediments with clean sediments without serious damage to the mussel beds (Bodkin, pers. comm., 199\_). Other techniques are likely to damage the existing mussels in order to remove the contaminated sediments. Approximately 60 locations with oiled mussel beds have been identified in Prince William Sound.

The extent and distribution of oiled mussel beds is still being determined and will be important in understanding the potential benefits that can be gained for other organisms by this action. There have been no studies to determine whether eating contaminated mussels is causing injury to other animals. The intent of cleaning oiled mussel beds is largely to eliminate a source of continuing contamination to other organisms. Studies that examined the effects of oil on the mussel beds noted a reduction in the number of large mussels and overall biomass of the mussel beds, but there did not appear to be a shortage of new recruits (smaller mussels) to the mussel beds (Highsmith et al., December 1993). It is unknown whether the trapped oil beneath the mussel beds will ultimately cause further injury to the mussels; however, continued high levels of hydrocarbons have been found in mussel tissues, which indicates that the mussels may be continuing to be contaminated.

If techniques are developed to clean the oiled sediments without destroying a large amount of the mussel beds, this action is unlikely to cause an adverse effect and may provide tangible benefits to the mussels at the cleaned sites. It is reasonable to assume that the ability of this action to reduce the level of contamination beneath mussel beds is valid in all regions of the spill area. However, there is less information on the location of oiled mussel beds in areas outside of Prince William Sound.

### Conclusions.

- short-term benefits: Negligible.

- long-term benefits: For direct restoration actions are unknown because both of these actions are still being tested. The long-term benefits of the habitat protection actions for reducing disturbance or preventing additional injury to intertidal organisms are moderate and will vary substantially between parcels.

### Impacts on Harbor Seals

The greatest way to benefit the injured harbor seal populations is to determine what has caused the long-term decline of populations throughout the Gulf of Alaska. Such research activities cannot be analyzed in this DEIS because the environmental effects are dependent on the outcome of the research and how the results can be used for restoration. For this analysis we can consider only the effects of habitat protection and the two types of general restoration actions proposed in Chapter 2. Both of the proposed actions are information based programs that would be designed to change the impact of commercial fisheries or of subsistence harvest on the recovering seal populations.

Subsistence harvest is not believed to be the cause of the long-term decline of harbor seal populations in the Gulf of Alaska; however, any additional mortality may slow the recovery of injured populations. The subsistence harvest in Prince William Sound declined as a result of the oil spill; and in 1991, harvest levels probably were less than 5 percent of the population. A healthy seal population would be able to easily sustain that level of harvest. Depending on the distribution, sex, and age of the animals harvested, a 5-percent harvest could negatively affect an injured population.

**Cooperative Program.** One of the proposed actions would establish a cooperative program between subsistence users and research scientists or agency managers. The program would be designed to provide a two-way exchange of information that would provide benefits to all sides and could benefit the injured harbor seal population. For example, recent studies indicate that harbor seals may have a high site fidelity to molting and pupping areas (e.g., the same individuals consistently use the same areas) (Pitcher, 1990). If some of these areas show greater declines than other sites within Prince William Sound, redirecting harvest towards the healthier,--or the nonoiled, areas--could reduce any negative effects from the harvest without actually changing the number of animals harvested.

A similar cooperative program with commercial fishermen also could reduce pressure on the injured seal populations. This program would provide information on deterrent methods and regulations. Ideally it would provide information to the scientists on the extent of the interactions between the commercial fisheries and the seals, and it would reduce the number of seal mortalities. The interactions with commercial fisheries probably would result in fewer deaths than from the subsistence harvest and are unlikely to be the cause of the seal decline; however, the more that can be done to minimize the effects of human-caused injury and mortality, the more likely it will be that the population will stabilize and recover.

**Habitat Protection.** Harbor seals use haulout sites that are either in the intertidal zone or immediately adjacent to the intertidal zone; therefore, actions that occur on the upland are not likely to destroy the habitat. However, it is possible that habitat changes to the uplands may increase the amount of disturbance currently experienced at haulout sites on or near the parcel. Disturbance has been documented as adversely affecting harbor seals and other pinnipeds in other parts of their range (Allen et al., 1984; Esipenko, 1986; Johnson et al., 1989). These studies have shown that the greatest impacts from disturbances are at haulout sites during pupping and molting. During pupping, disturbance can result in higher pup mortality caused by abandonment, or from being crushed as the adults panic and return to the water (Johnson, 1977). The greatest disturbance is caused when people walk near or

## 4 Environmental Consequences

through haulout sites (Johnson et al., 1989), but disturbance also can be caused by low-flying aircraft and by boats that approach too close to the haulouts.

Habitat-protection criteria for parcels that may benefit harbor seals include ratings of:

- "High" for parcels known to have a haulout of 10 or more seals on or immediately adjacent to the parcel;
- "Moderate" for parcels with known haulouts with sporadic use and less than 10 seals; or, probable haulouts in vicinity of the parcel; or probable feeding in nearshore waters; and,
- "Low" for possible feeding sites located in nearshore waters adjacent to the parcel (EVOS Restoration Team, 1993).

Of the 81 parcels evaluated in the large parcel process, 25 of the parcels were ranked high, 19 moderate, and 35 low and 2 parcels were ranked as having no benefit to harbor seals. Based on these rankings, the overall value of these parcels is moderate, although individual parcels may have exceptional value. If a higher cost per acre is assumed for the protection of these parcels, fewer of the parcels that are ranked low for multiple resources and services are likely to be protected. Under this scenario there would be limited effect on the benefits to harbor seals because most highly or moderately ranked parcels are still included.

The actual impact that development on these parcels will have on the harbor seals depends on, among other things, the type of disturbance caused, the length and duration of the disturbance, and whether the haulout area is used for pupping or molting. Within the EVOS area, there have been no studies to document the amount or effects of current activities that may cause disturbance to harbor seals; so baseline data are unavailable. However, it is reasonable to assume that protection of upland habitats near haulout sites will reduce the risk of disturbance to the injured population.

Aside from monitoring and research activities, and assuming that the actions previously described are implemented, none of the other actions proposed under this alternative for other resources or services are likely to impact harbor seals.

### Conclusions.

- short-term benefits: Negligible. All of the proposed actions require some time after implementation before any changes could be expected.
- long-term benefits: Moderate. The proposed actions could reduce negative impacts on harbor seals and may result in increased recovery rates in local areas.

### Impacts on Sea Otters

There are three types of actions aside from research or monitoring that are considered in this alternative: habitat acquisition, cleanup of oiled mussel beds, and creation of a cooperative program between subsistence users and sea otter scientists and managers.

**Habitat Protection.** The benefit to sea otters of habitat protection actions on upland parcels is through reducing potential or actual disturbance. Sea otters appear to have a high tolerance to certain human activities, as evidenced by their abundance in highly travelled areas such as Orca Inlet near Cordova; however, their response to large-scale disturbances has not been studied. Large-scale disturbances, such as log-transfer sites, may force resident otters to leave the immediate area and may cause a long-term change in food availability as debris from the logs covers the substrate. Disturbance is more likely to cause adverse effects on females with pups that concentrate in high quality habitats with abundant prey in the intertidal zones.

Habitat-protection criteria for parcels that may benefit sea otters include ratings of:

- "High" for parcels adjacent to known pupping concentrations;
- "Moderate" for parcels adjacent to concentration areas for feeding and/or shelter; or, potential pupping areas; and
- "Low" for feeding sites located in adjacent waters (EVOS Restoration Team, 1993).

Of the 81 parcels evaluated in the large parcel process, 20 of the parcels were ranked high, 16 moderate, and 42 low, and 3 parcels were ranked as having no benefit to sea otters. Based on these rankings, the overall value of these parcels is low to moderate, although individual parcels may be near habitat of exceptional value. If a higher cost per acre is assumed for the protection of these parcels, fewer of the parcels that are ranked low for multiple resources and services are likely to be protected. Because most of these parcels also were evaluated as being of low benefit to sea otters, the differences in the potential benefit to sea otters would change very little because most highly or moderately ranked parcels are still included.

**Cleanup of Oiled Mussel Beds.** This has been considered as a possible method to reduce the hydrocarbon exposure. Sea otters, especially juvenile otters and females with pups, depend on mussels for a large portion of their diet (Doroff and Bodkin, 1993). Mussels are found in shallower areas and are easier to obtain than other prey. Mussels can be found in loose aggregations attached to intertidal rocks or in dense aggregations (mussel beds) over pea gravel and silt sediments. Because mussels form a dense matt over the sediments and rocks, oil that was trapped beneath the mussels was not exposed to weathering and still remains toxic. It may be possible to clean mussels in mussel beds, but there are areas where it will be technically infeasible to remove the remaining oil.

One of the possible explanations of the poor survival rate of post-weanling juveniles in the oiled areas is that they are continuing to be exposed to hydrocarbon contamination by eating oiled mussels. Concern over the possible continuing source of contaminations to otters and other higher order animals (e.g., black oystercatchers and harlequin ducks) led to feasibility studies to develop techniques to clean the sediments beneath the oiled mussel beds. One technique to be tested in 1994 lifts sections of the mussel beds and replaces the contaminated sediments with clean sediments without serious damage to the mussel beds (Babcock, pers. comm., 199 ). Approximately 60 locations with oiled mussel beds have been identified in Prince William Sound.



## 4 Environmental Consequences

The extent and distribution of oiled mussel beds is still being determined and will be important in understanding the potential benefit to sea otters that can be gained from cleaning. There have been no studies to determine whether eating contaminated mussels is causing injury to the sea otter population. However, it is possible to consider the potential benefit in terms of the level of risk to exposure. For example, the telemetry study by Monnett and Rotterman (1992) indicated that females and weanling otters did not range great distances between oiled and unoiled areas. If a group of otters spends many months feeding in bays that have several oiled mussel beds, they are at greater risk of exposure than otters that feed in areas with few or no oiled mussels. Of the oiled mussel beds identified so far, there are approximately 20 in Herring Bay off Knight Island; cleaning half or all of these mussel beds would greatly reduce the risk to the local population. If only 1 or 2 beds in the area were cleaned, it might not reduce the risk of exposure at all. Similarly, if the only source of oil in an entire bay was from one mussel bed, removing that contamination could eliminate the majority of the risk to the local otters.

Cleaning oiled mussel beds is likely to be a labor-intensive task that may last for several days at each location. Some short-term disturbance is likely to occur; however, it is not likely to permanently displace the local otters.

It is reasonable to assume that the ability of this action to reduce the risk of exposure is equally valid in other regions of the spill area. However, there is less information on the location of mussel beds and on the injury to the sea otter population.

**Cooperative Program.** Establishing a cooperative program between subsistence users and research scientists or agency managers is another action that is appropriate under this alternative. The program would be designed to provide a two-way exchange of information that would provide benefits to all sides and could benefit the injured sea otter population. Recent records of the subsistence harvest of sea otters in the oil spill area indicate that harvest levels are relatively low but increasing throughout the EVOS area. If subsistence levels increase in areas where the populations were affected by the spill, the additional harvest may slow or prevent localized recovery. For example, the densities of otters in some oiled areas is still very low (Bodkin and Ballachey, pers. comm., 199\_\_). If these areas are consistently harvested, redirecting harvest towards the healthier or the nonoiled areas could reduce any negative effects without actually changing the number of animals harvested. Likewise, sea otters can sustain a greater harvest of males and juveniles than of breeding females.

Without any restoration actions, it may be reasonable to estimate that sea otters in Prince William Sound will recover to their prespill abundance in 7 to 35 years once the population begins to increase. If subsistence harvest rates rise substantially in the oiled areas, recovery estimates based on a 10-percent growth rate are unlikely and it is possible that the more conservative estimate of 35 years would be extended. If a cooperative program can be established, it may be possible to sustain a higher harvest rate without changing the recovery rate of the injured population.

Actions implemented for other resources or services are not expected to impact the sea otter populations or their recovery.

## Conclusions.

- short-term effects. Negligible. All of the proposed actions will take time before any results could be expected.
- long-term effects. Moderate. The proposed actions improve the habitat quality through reducing the risk of exposure to oil, the potential for disturbance, and the impacts from subsistence harvest. These benefits could produce a change in abundance of otters in some areas but are not likely to produce a notable increase on a regional scale.

## Birds

Under this alternative, the nesting habitat of harlequin ducks and marbled murrelets would receive maximum protection, thus enhancing their productivity and subsequent recovery of their populations. The effect on the ecosystem of larger populations of these two species would likely be negligible increases in predation on bottom fauna of the intertidal and shallow subtidal zones by harlequin ducks, and increased predation on forage fish by marbled murrelets, mainly nearshore. Habitat acquisition would appear to have minimal impact on the size of injured murre and pigeon guillemot populations and, therefore, no additional impact on the ecosystem.

### Harlequin Duck

**Habitat Protection.** The Potential nesting habitat of harlequin ducks would receive maximum protection under this alternative, thus enhancing productivity and recovery of their depleted populations. However, there is very little information available on the use of specific land parcels by harlequin ducks, so it is difficult to determine the significance of acquisition of specific parcels on harlequin duck population recovery.

**Conclusions.** If specific land parcels known to have high value to harlequin duck reproduction were acquired, a positive population effect could be shown. However, the short-term effects through 1995 of land acquisition on harlequin duck recovery are likely to be negligible, and populations likely would remain stable at 1990-1993 levels in both oiled and nonoiled areas. The long-term effects of this alternative would have a high benefit for the reproductive potential of harlequin ducks in the EVOS area.

### Murres

**Habitat Protection.** Acquisition of habitat would have little benefit to the injured murre population because there are no sizeable colonies, and very few smaller colonies, that are not already protected. A seabird colony on privately owned Gull Island in Kachemak Bay has a small number of common murres; it is a tourist attraction that several commercial tour boats visit daily in summer.

**Conclusions.** Acquisition of Gull Island would assure protection of this popular tourist attraction and thus may have a moderate long-term benefit to murres. However, since there

## 4 Environmental Consequences

appear to be on imminent plans to develop this small, rocky island, there would be little short-term benefit.

### Pigeon Guillemot

**Habitat Protection.** In Prince William Sound, the large majority of pigeon guillemot colonies are on U. S. Forest Service (USFS) land (Sanger and Cody, written comm., 1994) that is not slated for logging (C. Frey, written comm., 1994). Two of the largest colonies in Prince William Sound, at The Pleiades and on Bligh Island, totaling approximately 3 percent of the 1993 breeding population, are on private land (Sanger and Cody, written comm., 1994). In the 1970's, both of the latter colonies probably harbored larger numbers of nesting guillemots than at present. There are two colonies adjacent to private land that is currently being logged on the eastern, nonoiled portion of Prince William Sound, but they had very few guillemots in 1993; it is unlikely that they were affected by the inland logging operations (Sanger and Cody, written comm., 1994). Outside of Prince William Sound, the Seal Bay area on Afognak Island has low numbers of pigeon guillemots and has already been acquired; little is known about the current status of guillemot colonies elsewhere in the EVOS area (USFWS, 1993).

**Conclusions.** Habitat acquisition would have little effect on pigeon guillemot population recovery in the short term because there appear to be no development plans for private land with known colonies. In the long term, acquiring habitat where two of the largest colonies in Prince William Sound are located would moderately benefit population recovery and prevent further inroads to the injured population through habitat degradation.

### Marbled Murrelet

**Habitat Protection.** Details of habitat use by marbled murrelets are being clarified, and studies in Prince William Sound are showing that large, moss-covered limbs of old-growth conifers comprise prime nesting habitat. Current and possible future logging of such habitat on private land is the single greatest threat to population recovery of marbled murrelets, and it poses the additional threat of reducing the population more. Acquisition of prime nesting habitat would thus maximize the potential for the injured marbled murrelet population to recover while preventing further injury to the population.

**Conclusions.** Depending on the potential for imminent logging on land parcels that contain prime habitat, the short-term effects of land acquisition could be considerable. In the long term, acquisition of old growth forest habitat would have a high benefit for enhancing murrelet population recovery.

### Fish

#### Pink Salmon

Alternative 3 would provide limited restoration actions to assist natural recovery of wild-stock pink salmon populations. The action that may be implemented to restore wild-stock pink salmon populations as part of Alternative 4 includes only habitat protection (EVOS Trustee Council, April, November 1993) (Appendix C).

**Habitat protection.** The criteria for parcels that may benefit pink salmon include ratings of high for parcels with a high density of pink salmon streams or streams known to have



exceptional value, moderate for parcels with an average density of pink salmon streams or streams with average production, and low for parcels with few or no pink salmon streams or streams with no production (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit wild-stock pink salmon populations according to Alternative 3 would depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 62 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide moderate value for the pink salmon resource (Appendix A). Of the 81 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 0, 38, 25, and 18 have been rated as no, low, moderate, and high value, respectively, for pink salmon. A total of 53 percent is rated as moderate or high value.

If only 62 parcels are purchased, the benefit is expected to provide moderate value for the pink salmon resource (Appendix A). Of the 62 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 0, 25, 20, and 17 have been rated as no, low, moderate, and high value, respectively, for pink salmon. A total of 60 percent is rated as moderate or high value.

Although the average value of forecasted habitat acquisition may not have a high overall rating for pink salmon, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

#### Conclusions.

- short-term effects: Negligible. No benefits from habitat protection would accrue within one lifecycle.
- long-term effects: Moderate. Habitat protection and acquisition actions would assist the recovery of the injured wild stocks of pink salmon. Long-term benefits, however, might accrue to only portions of the EVOS area.

#### **Sockeye Salmon**

Alternative 3 would provide limited restoration actions to assist natural recovery of wild-stock sockeye salmon populations. Actions that may be implemented to restore wild-stock sockeye salmon populations as part of Alternative 3 include habitat protection, and actions that may improve survival rates of sockeye salmon eggs by using egg incubation boxes, net-pen rearing or hatchery rearing (EVOS Trustee Council, April, November, 1993).

Habitat Protection. The criteria for parcels that may benefit sockeye salmon include ratings of high for parcels with sockeye salmon streams or systems known to have exceptional value, moderate for parcels with sockeye salmon streams or systems with average production, and low for parcels with few or no sockeye salmon streams or systems with low production (EVOS Restoration Team, 1993).

## 4 Environmental Consequences

Forecasted habitat protection that may benefit wild-stock sockeye salmon populations according to Alternative 3 would depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 62 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low value for the pink salmon resource (Appendix A). Of the 81 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 16, 48, 8, and 9 have been rated as no, low, moderate, and high value, respectively, for pink salmon. A total of 17 percent is rated as moderate or high value.

If only 62 parcels are purchased, the benefit is expected to provide low value for the sockeye salmon resource (Appendix A). Of the 34 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 16, 33, 6, and 7 have been rated as no, low, moderate, and high value, respectively, for pink salmon. A total of 21 percent is rated as moderate or high value.

Although the average value of forecasted habitat acquisition may not have a high overall rating for pink salmon, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

### General Restoration

Action 1: Egg incubation boxes. These boxes have been used highly successfully in the Copper River drainage to develop a small wild-stock population of sockeye salmon into an estimated annual total return of approximately 200,000 adult fish, with an estimated annual commercial harvest of over 100,000 fish (Roberson and Holder, 1993). Other experiments to incubate sockeye and chum salmon eggs in egg incubation boxes in Prince William Sound were less successful (Jackson, 1974), however, when properly installed, these units control the water flow, substrate type, sedimentation, and predation to provide egg-to-fry survival rates as high as 90 percent. This compares quite favorably with an expected survival rate of 20 percent in redds of naturally spawned sockeye salmon (Ref., ...).

The potential contribution of egg incubation boxes for the restoration of sockeye salmon stocks in the oil spill area would be limited to drainages with: (1) limited successful reproduction; (2) spring areas with appropriate physical features and water quality and quantity; and (3) underutilized rearing capacity for the sockeye salmon fry that are produced.

Although extensive surveys to locate potential sites at which to operate this technique have not been performed, if suitable locations can be identified within drainages that presently support small populations of sockeye salmon, this technique may be applied to help restore those populations without a major intrusion into the environment or the fish stock.

Action 2: Net-pen rearing. This practice has been widely applied to increase the survival rate of all salmon species. This technique, however, has only recently been applied successfully for sockeye salmon because most previous attempts failed due to sockeye salmon being particularly susceptible to the disease infectious hematopoietic necrosis virus (IHNV). (Mr. Terry Ellison, ADF&G, pers. comm., 199\_\_).

Although the net-pen rearing technique has been applied in both freshwater and saltwater, most success has been achieved with freshwater rearing because the early lifestages from



only a few stocks of sockeye salmon can survive in saltwater. Burke (1993), however, described a highly successful program for rearing juvenile sockeye salmon in saltwater net pens to the smolt stage, but only after they had been fed first in freshwater hatchery raceways. Consequently, although net-pen rearing of sockeye salmon in saltwater may have excellent potential for a hatchery-based application, it is of limited value for protection and restoration of wild stocks except where it may be used to create an alternate opportunity for commercial fishermen.

Juvenile sockeye salmon typically require rearing in freshwater for up to 3 years (Burgner, 1991). During this period, the mortality rate between the fry and smolt stages may range from 86 to 99 percent (Roberson and Holder, 1993); but fry held in net pens are largely protected from predators and food is provided, so the mortality rate is low while they are in the pens. Net-pen rearing of sockeye salmon fry in freshwater has not been widely applied; however, it appears to have been quite successful in English Bay lakes as a means to increase the freshwater survival rates (Schollenberger, 1993).

Net-pen rearing of sockeye salmon fry to increase their survival rate potentially may be employed in many systems throughout the EVOS area. Only two key ingredients are necessary: a source of fry and a suitable site to anchor and service the net pens. Fry may be captured from a spawning stream or transferred from a hatchery. Careful application of the net-pen rearing technique would increase the numbers of emigrating sockeye salmon smolts and returning adults with minimal undesirable effects on the population or the lake-rearing system. The magnitude of the benefit will depend on the numbers of captive fry that can be accommodated.

Whenever any organisms are held captive in high density, they become more susceptible to disease or other catastrophic loss and there is a risk of disrupting natural genetic selection; however, these risks have been successfully minimized with good fish cultural practices (Schollenberger, 1993) and by following appropriate planning and permitting procedures (Appendix C).

**Action 3: Hatchery Rearing.** This method of rearing sockeye salmon has had a long history in Alaska; however, during the last decade, this strategy has been improved and it has produced dramatic innovations and results (Ellison, 1993). In Alaska, cultured juvenile sockeye salmon have been released as fed fry, presmolts, and smolts. Each lifestage has its own particular logistical, biological, and fish cultural constraints and advantages. Fry are less expensive to rear, transport, and release; but they require at least 1 year of rearing in a lake before they smoltify, and they would not survive to the adult stage as well as presmolts or smolts. Fry that are retained and fed in hatchery raceways may be released in late fall as presmolts. These young fish require few resources from the lake system during the winter and emigrate as smolts in the spring. Smolts are expensive to rear and transport, but they will survive better to the adult stage; however, they can be released as migrants without reliance on freshwater rearing.

Injured wild stocks may be helped directly by a rearing and release program for those stocks; or the wild stocks may be helped indirectly by creating an alternate opportunity for the commercial fishers to divert fishing pressure away from the injured wild stocks. For direct restoration, fry-rearing programs would be limited to those drainages where the forage is

## 4 Environmental Consequences

underutilized by the naturally produced fry. Presmolt- and smolt-rearing programs, however, can provide direct restoration with little or no effect on plankton populations.

Whenever any organisms are held captive in high density, they become more susceptible to disease or other catastrophic loss and there is a risk of disrupting natural genetic selection; however, these risks have been successfully minimized with good fish cultural practices (Schollenberger, 1993) and by following appropriate planning and permitting procedures (Appendix C).

### Conclusions.

- short-term benefits. Low. Some benefits in some drainages may accrue within one lifecycle.
- long-term benefits. High. Certain actions may be useful in portions of the EVOS area and some populations may be restored.

### **Pacific Herring**

Alternative 3 includes only one restoration action to assist natural recovery of Pacific herring--habitat protection and acquisition (EVOS Trustee Council, April 1993).

Habitat protection. The criteria for parcels that may benefit Pacific herring include ratings of high for parcels with documented consistent annual Pacific herring spawning along the parcel shoreline, moderate for parcels with occasional spawning along the parcel shoreline, and low for parcels with no documented Pacific herring spawning along the parcel shoreline, but a possible feeding area (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit Pacific herring populations according to Alternative 3 would depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 62 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low to moderate value for the Pacific herring resource (Appendix A). Of the 81 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 7, 30, 29, and 15 have been rated as no, low, moderate, and high value, respectively, for Pacific herring. A total of 54 percent is rated as moderate or high value.

If only 62 parcels are purchased, the benefit is expected to provide moderate value for the Pacific herring resource (Appendix A). Of the 62 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 3, 20, 25, and 14 have been rated as no, low, moderate, and high value, respectively, for Pacific herring. A total of 63 percent is rated as moderate or high value.

Although the average value of forecasted habitat acquisition may not have a high overall rating for Pacific herring, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

## Conclusions.

- short-term benefits. Negligible. No benefits will accrue within one lifecycle.
- long-term benefits. Moderate. Habitat protection and acquisition actions would have a long-term value to Pacific herring stocks in the EVOS area by helping to assure maintenance of production. Some habitat areas would recover sooner than others.

## Social and Economic Cultural Resources Impacts

### Habitat Protection

It is assumed here that 62 large parcels, a total of 710,500 acres, would be purchased. These parcels contain low (no known or suspected cultural resources/sites on parcel), moderate (no significant cultural resources/sites on or adjacent to parcel), or high (documented concentration or significant cultural resources/sites on parcel) potential for benefiting cultural resources as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.1 (or slightly higher than moderate). These estimates reflect known sites--not all of the sites present--in the EVOS area. Not all sites have been found, so the actual benefit to cultural resources may be greater than reflected in these estimates. This analysis does not take into consideration small parcel acquisition, which is currently under evaluation. It also is possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels--possibly all 81 identified parcels (863,100 acres). Habitat acquisition and protection would have a low short-term benefit. Moderate long-term benefits from habitat acquisition would accrue primarily through (1) placing private lands under public management and application of Federal and State cultural resource-protection laws, and (2) reducing the likelihood of damage to cultural resources resulting from extractive economic activities, such as mining and logging.

**General Restoration.** The 12 percent of total funding available for general restoration under this alternative could fund projects that directly affect the cultural resources of the EVOS area. General-restoration actions may include activities on individual sites (site stabilization, site-salvage excavations, site monitoring and stewardship) or in local communities (archaeological repositories). On-site work often can be combined with community activities, as is envisioned in the site stewardship program. Each of the proposed actions considered here could be implemented independently or in combination with any of the others. The most effective approach is comprehensive, tailoring combinations of actions within each community whose cultural resources were injured by the spill.

**Stabilize Archaeological Sites.** Archaeological sites affected through erosion begun or worsened by oil spill activities may be stabilized to slow or stop the erosion. Stabilization may entail recontouring parts of the sites to cover up exposed archaeological deposits. This would reduce the visibility of artifacts and so reduce chances of looting or vandalism. This is

## 4 Environmental Consequences

a relatively nondestructive alternative when compared to archaeologically excavating the sites or allowing damage to continue.

Stabilization is a site-specific activity that may be accomplished through several different methods. Some sites are located along high-energy shorelines or in high-energy intertidal areas and may not be suited to stabilization. Also, stabilization techniques that contrast with surrounding terrain may serve as magnets for visitation rather than protection against visitation. The benefit of stabilization is to preserve the integrity of the site, that may be temporary (requiring periodic maintenance) or permanent. This would have an immediate benefit of moderate to high level in the short term but would have the potential to preserve sites and reduce damage at a high level over the long term.

**Excavate Archaeological Sites.** Not all sites can be stabilized, whether for physical or economic reasons. Ongoing vandalism, looting, and erosion of archaeological sites in the EVOS area can be mitigated through salvage excavation instead of stabilization. Excavation and stabilization can also be done on the same site. Scientific excavation of the sites most in danger of destruction can yield information important to understanding the history and prehistory of the EVOS area, a major element of Alaska's cultural heritage. Excavation can also remove human remains and funerary objects associated with the ancestors of contemporary people living in communities in the spill area. These remains could be moved to locations less likely to be disturbed by looters or vandals, or unearthed by ongoing erosion.

One effect of excavation is permanent destruction of the excavated portions of the sites. This destruction, however, is controlled and exactly delimited, allowing for the appropriate care and analysis of removed items and associations. Without archaeological excavation, damage to, and eventual destruction of, several of the sites would continue with neither the public nor the resource benefiting. The short- and long-term benefits of salvage excavation of highly endangered sites therefore would be high. This action both protects the sites from further looting and vandalism and mitigates the spill-related damage already incurred. Some salvage-excavation projects have already been funded by the Trustee Council.

**Site Monitoring and Stewardship.** Archaeological site-stewardship programs active in Arizona, Arkansas, and Texas have demonstrated the utility of public education and increased oversight of sites for reducing continuing vandalism. A site-stewardship program for the EVOS area would combine public education and site monitoring through recruitment, training, coordination, and maintenance of a corps of interested local citizens to watch over nearby archaeological sites. Sites to be monitored by local residents would be identified by landowners and managers on the basis of past and ongoing vandalism and erosion. Law enforcement officials may be involved during investigations or when called to sites to intercept active vandalism.

The benefits of site stewardship would be an increased knowledge and appreciation of archaeological methods of site monitoring and decreased site vandalism. These benefits would begin within the first year of implementation and continue for an indefinitely long term. The benefits of this action in the short term would be low but are potentially high in the long term as site stewards become better trained and knowledge of the program is disseminated among people who are or may be inclined to damage sites. The action has additional importance in its involvement of local individuals and communities in protecting cultural resources.

**Archaeology Repositories.** Communities within the spill-affected area increasingly express a desire that archaeological materials remain in (or at least are regularly returned to) their area of origin for display and interpretation. Local preservation of artifacts and interpreting of Native heritage is proposed as a means to offset the increasing loss of artifacts and disturbance of Native graves in the spill area.

Placing artifacts in a local repository and using that repository as a base for interpreting cultural resources could help better educate residents and area visitors about practices of the past and the continuity of that past with the present and the future. These repositories may be established through modifying existing structures or by building new structures to accommodate collections. These would be located in communities within the oil spill area and could serve as local foci for heritage-oriented activities. The short-term benefit of this action would be to restore a feeling of involvement with and oversight of the cultural heritage of which local communities are part. This would be immediate but moderate. Long-term benefits are high in terms of enhanced community involvement. It is this involvement that would address spill-related injury to the sense of cultural continuity and connectedness within the local communities.

### Conclusions.

Considered independently, habitat acquisition and protection and site monitoring and stewardship would likely have low, short-term benefits. Short-term benefits of site stabilization and artifact repositories would be immediate but moderate. Short-term benefits of salvage excavations would be immediate and high.

Long-term benefits are potentially moderate for each of the identified general restoration actions, but may vary between communities. The benefits would likely be high if actions were combined and village-based. Long-term benefits of habitat acquisition would be moderate, with the benefits derived primarily from (1) placing now-private lands with no legal protection for cultural resources into public ownership and under protection of applicable cultural resource protection laws, and (2) reducing the likelihood of damage to cultural resources resulting from extractive economic activities, such as mining and logging.

Overall, moderate short-term and long-term benefits to cultural resources are expected under this alternative.

### Subsistence

#### **Habitat Protection**

It is assumed here that 62 large parcels, a total of 710,500 acres, would be purchased. These parcels contain low (status as a subsistence-use area unknown), moderate (known historic subsistence-use area, which may be used again), or high (known current subsistence-use area) potential for benefiting subsistence as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.4 (or between moderate and high).



## 4 Environmental Consequences

The short-term benefits of habitat protection and acquisition on the recovery of subsistence species and subsistence use would be low, but the long-term benefits would likely be low to moderate. Protecting lands from the habitat degradation associated with extractive economic activities like mining and logging would help keep recovering subsistence resources from being further impacted and might help them recover more quickly.

This analysis does not take into consideration small-parcel acquisition, which is currently under evaluation. It also is possible that land prices would be lower than those assumed here. That would result in the purchase of more parcels--possibly all 81 identified parcels (up to 863,100 acres).

**General Restoration.** The additional funds allotted for general restoration could fund projects that directly affect subsistence resources and activities within the EVOS area.

Subsistence-harvest levels appear to be at or near prespill levels in most communities in the EVOS area. However, many subsistence users believe that subsistence food sources remain contaminated and are therefore dangerous to eat. The perception persists among village residents that subsistence species continue to decline or have not recovered from the oil spill. Health advisories against eating clams from obviously oiled beaches are still in effect. Shifting to noncustomary species or noncustomary subsistence locations also persists. The cultural values provided by gathering, preparing, and sharing food are not yet reintegrated into community life.

Several general restoration actions that meet the criteria for this alternative and that could directly and beneficially affect subsistence species have been identified. These proposed actions could be conducted independently from each other or in combination. The following summarizes some of the information from other resource-specific sections for this alternative as they apply to subsistence. Please refer to those sections concerning individual species elsewhere in the discussion of Alternative 3 for additional detail.

**Harbor Seals.** The decline in the subsistence harvest of harbor seals may have helped stabilize the population. The proposed action to implement cooperative programs between subsistence users and agencies to assess the effects of the subsistence harvest may help in sorting out which localities would be best utilized (or best left alone) for subsistence use in order to optimize natural recovery of the populations. This would be a moderate long-term benefit, taking as long as 5 to 10 years to establish a measurably significant benefit. This action has the advantages of relatively low cost and spinoff value in improving communication between agency biologists and subsistence users. Cooperative programs proposed for reducing incidental take of harbor seals during fishing likewise would have low short-term benefits but may have moderate long-term benefits in 5 to 10 years. Reducing disturbance at haulout sites in the oil spill area would have a negligible benefit in the short term and a moderate benefit in the long term.

**Sea Otters.** One of the proposed actions would establish a cooperative program between subsistence users and research scientists or agency managers. While subsistence harvests are not a significant impact on sea otter populations, both agency biologists and subsistence users would benefit from the additional interaction and information sharing that would grow from such an action. Traditional knowledge of sea otter behavior and their relation to other parts of the ecosystem may be more extensive than is presently recognized by agency biologists. Similarly, the present range and concentration of sea otters may be better understood by agency biologists than is presently recognized by many subsistence users.

This type of action would have little benefit immediately or in the short term on the recovery of sea otters, but the long-term benefit on management efforts--and so on the sea otter populations--could be significant.

**Intertidal Organisms.** *Fucus*, one of the central elements in intertidal ecosystems, is important to subsistence users as food and as habitat for other subsistence resources. A proposed pilot project would transplant *Fucus* to increase its population in the high intertidal zone. Recovery of *Fucus* is estimated at a decade. This would have insignificant short-term benefits but may have moderate long-term benefits to subsistence users.

**Sockeye Salmon.** The use of egg-incubation boxes has been proposed to restore or enhance sockeye salmon populations in the spill area. It is estimated that short-term benefits would be moderate, drainage-specific increases in populations. Long-term benefits would be low because of the scarcity of appropriate siting locations. If appropriate siting locations are found near villages, this technique has the potential for working very well locally to increase the amount of sockeye salmon available (in both the long and short terms) for subsistence use.

Net-pen rearing of sockeye salmon fry has been proposed to increase their survival rate. Since there are many appropriate locations for net pens in the EVOS, it is estimated that this technique would have strong short- and long-term benefits on the sockeye salmon populations. The advantage to subsistence users would be a corollary benefit.

Hatchery rearing of sockeye salmon has been proposed, with release possible as fed fry, presmolts, and smolts. A number of project types are applicable, using different combinations of biological, physical, logistical, and technological factors. The short-term benefit of this type of action is likely to be low because it would take some time to establish the populations. The long-term benefit to pink salmon populations is estimated to be high, as several generations of improved survival rates to the smolt stage leading to the increased numbers of returning adults. The benefit to subsistence users would increase as populations of sockeye salmon increased. The benefit to subsistence users would increase if wild stocks were separated from hatchery stocks. Concentration on hatchery stocks by commercial fisheries could reduce competition for wild stocks.

**Subsistence Food Testing.** One of the main elements in the damage to subsistence uses in the spill area is the fear that once-safe subsistence foods are no longer safe to eat. An action has been proposed to conduct tests on subsistence foods to determine the amount of contamination, if any, in various types of subsistence foods. This action would provide immediate information to subsistence users, providing short and long-term high level benefit to their sense of security.

## Conclusions.

Short-term benefits to populations of harvestable subsistence resources, and thus to subsistence users, would be low. Long-term benefits of habitat acquisition to subsistence species and subsistence users would be low to moderate. General restoration actions would likely produce moderate benefits.

## 4 Environmental Consequences

### Recreation and Tourism

#### **Habitat Protection**

It is assumed here that 62 large parcels, a total of 710,500 acres, would be purchased. These parcels contain low (low to no recreation use; access may be difficult), moderate (receives occasional public use; adjacent waters used for recreational boating; adjacent area receives high public use), or high (receives regular, high directed public use; highly visible to a large number of recreationists/tourists) potential for benefiting cultural resources as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 1.9 (or slightly lower than moderate). The benefit to recreation and tourism of habitat protection and acquisition would be low in the short term but moderate to high in the long term. These benefits would derive from protection of the scenic, wildlife, and undeveloped characteristics important for recreation values in the parcels being evaluated for acquisition. Extractive economic activities would reduce the recreational visual appeal of the landscape, shift or reduce wildlife-viewing possibilities, and eliminate the relative lack of developed (logged or mined) character, thereby reducing the overall utility of those and surrounding areas for recreation purposes.

**General Restoration.** General restoration strategies for recreation and tourism are to preserve or improve the recreation and wilderness values of the spill area, remove or reduce residual oil if it is cost-effective and less harmful than leaving it in place, and monitor recovery. In this alternative, the focus would be on removing residual oil and residual cleanup materials.

Recovery of recreation and tourism is largely dependent on the recovery of natural resources. Shifting of recreation use sites from injured to uninjured areas would continue as long as injured sites appear injured. Once sites are returned to an uninjured condition, they would again be used by recreationists. Removing residual oil and traces of cleanup activities is an integral part of re-establishing previous recreation and tourism use areas. In the meantime, sites not injured directly by the spill are being impacted through new or increased use. Use patterns continue to change in relation to the recovery of the resources, perceptions, and the benefits of restoration projects. Removing residual oil on beaches important for recreation use would have moderate short-term benefits. The long-term benefits of this action would be high locally, but are estimated to be moderate overall.

#### **Conclusions.**

The short-term benefits of both habitat protection and acquisition and general restoration actions would be low changes in numbers of visitors or locations of recreation/tourism activities. The long-term benefits of habitat protection and acquisition would be moderate protection for lands against extractive activities. The long-term benefits of general restoration actions would be moderate stabilization of existing recreation opportunities.

### Wilderness

#### **Habitat Protection**

It is assumed here that 62 large parcels, a total of 710,500 acres, would be purchased. These parcels contain low (high/moderate evidence of human development and/or ongoing activities), moderate (area remote; evidence of human development and/or ongoing

activities), or high (area remote; little or no evidence of human development) potential for benefiting Wilderness as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.4 (or somewhat higher than moderate). This analysis does not take into consideration small parcel acquisition, which is currently under evaluation. It also is possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels --possibly all identified parcels (up to 863,100 acres). Short term, there would be negligible change in the existing conditions of Wilderness Areas. Acquisition of parcels of land adjacent to or near designated Wilderness may extend protection to the wilderness character of those parcels, and so expand the Wilderness areas *de facto*, i.e., without extending the actual Wilderness designation. This would cause a long-term moderate level of protection to this expanded *de facto* wilderness, with benefits derived from protecting areas from extractive activities.

## **General Restoration.**

Some on-the-ground general restoration actions could be funded as general restoration projects. General restoration actions could include any that assist recovery of injured resources or that prevent further injury. Any of these would have spinoff effects that would improve wilderness values in the EVOS area.

Recovery of designated Wilderness areas hinges on removal of traces of oil, material left over from cleanup activities, and public perception that the areas are recovered. The concentration in this alternative would be on projects that remove residual oil and/or residual cleanup materials still existing in isolated pockets in Wilderness areas. Public information and marketing would not be funded. Short-term benefits would be immediate but low. Long-term benefits are estimated to be moderate, since actions could not be funded under this alternative to promote public education or marketing projects that explain how and where residual oil or materials were removed, i.e., public perception that the Wilderness areas are recovered would not be addressed.

## **Conclusions.**

Short-term benefits to Wilderness of habitat protection and acquisition, and of proposed general restoration actions would be low. Long-term benefits to Wilderness of habitat protection and acquisition and general restoration actions would be moderate.

## **Commercial Fishing**

Alternative 3 would provide restoration actions to assist replacement of harvest opportunities that were lost because of fishing closures or harvest restrictions that occurred as a result of the EVOS. Actions that may be implemented as part of Alternative 3 include habitat protection and acquisition and creation of new hatchery-produced runs (EVOS Trustee Council, April, November 1993) Appendix C).

Habitat protection may benefit commercial fishing opportunities by providing long-term protection for natural production and stability of wild stocks of pink and sockeye salmon and Pacific herring. The criteria for these parcels that may benefit commercial fisheries depend on the values assigned for those species (EVOS Restoration Team, 1993).

## 4 Environmental Consequences

Forecasted habitat protection that may benefit replacement of lost opportunities for commercial fishing according to Alternative 3 will depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 62 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low to moderate value for commercial fisheries. If only 62 parcels are purchased, the benefit is expected to provide low to moderate value (Appendix A).

Although the average value of forecasted habitat acquisition may not have a high overall rating for commercial fisheries, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

### General Restoration

For commercial fishing resources, the primary action considered under Alternative 3 would replace lost opportunities by creating new hatchery-produced runs of salmon. Specific actions that may be considered should either alone, or collectively, produce sufficiently large numbers of adult pink or sockeye salmon to accommodate a reasonable portion of the fishing fleet to provide a harvest that is separated in time or space from existing harvests. Actions that may fit these criteria include development of new hatchery runs (e.g., stock fry, presmolts or smolts) or habitat manipulation to increase production of selected stocks (e.g., lake fertilization, spawning channels, etc.). Actions that are designed to increase fish production by habitat manipulation are described in Appendix C.

Development of new runs would provide a benefit for commercial fishing by providing an alternate location and stock for commercial fishing activities. If the brood-stock selection for these new runs and the release site are carefully selected, there would be minimal interception of injured wild stocks. Good fishery management practices combined with a redistribution of the fishing fleet would enable an intensive commercial fishery to harvest these stocks (Appendix C).

ADF&G and PNP aquaculture organizations that have established a modern fisheries enhancement program in the area establish new runs of salmon for harvest by commercial fishers. Excellent success has been achieved with sockeye salmon (Ellison, 1993); however, results with pink salmon have been less consistent (Alaska Fish and Game Magazine). Some locations remain as opportunities for juvenile fish imprinting and adult fish terminal harvest areas that are readily accessible to the fishing fleets.

Every fisheries-enhancement program must be carefully planned and managed to avoid risks to wild stocks, and the fish-culture program must be carefully structured and controlled to avoid or minimize potential changes in the genetic makeup and health of the wild stocks that may be caused by the fish-culture program (Appendix C).

### Conclusions.

Short-term effects: Negligible. New runs probably cannot be established within one life cycle to support new commercial fisheries to replace opportunities lost because of fishing closures or reduced harvests.



Long-term effects: Moderate. These actions would assist the replacement of lost commercial fishing opportunities; however, some portions of the EVOS area would obtain greater benefits than others.

## **Sport Fishing**

Sport fishing was disrupted throughout most of the EVOS area because of the oil spill, and damage was sustained by several important sport fish species. Lost sport fishing opportunities may be replaced by creating new sport fisheries for salmon or trout. Alternative 3 would provide restoration actions to assist replacement of harvest opportunities that were lost because of fishing closures or harvest restrictions that occurred as a result of the EVOS. Actions that may be implemented as part of Alternative 3 include habitat protection and acquisition and creation of new hatchery-produced runs (EVOS Trustee Council, April, November 1993) (Appendix C).

Habitat protection may benefit sport fishing opportunities by providing long-term protection for natural production and stability of wild stocks of pink and sockeye salmon, Dolly Varden, and cutthroat trout. The criteria for these parcels that may benefit commercial fisheries depends on the values assigned for those species (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit replacement of lost opportunities for sport fishing would depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 62 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low to moderate value for sport fisheries. If only 62 parcels are purchased, the benefit is expected to provide low to moderate value (Appendix A).

Although the average value of forecasted habitat acquisition may not have a high overall rating for commercial fisheries, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat would continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

## **General Restoration**

Establishment of hatchery runs would provide some benefit for all fishers by providing new opportunities with new locations and stocks that anglers may utilize. Typically, a run of a few thousands of fish would provide tens of thousands of angler/days of recreation (Mills, 1993). Sport fisheries, however, will be successful only if they are located where they can be accessible to anglers. The ADF&G has already employed this strategy to improve sport fishing opportunities for trout and salmon in the EVOS area (Appendix C).

A small number of fish in a good, accessible location can provide angling to accommodate a substantial number of angler/days of recreation. Wherever large numbers of fishers concentrate to harvest a concentrated population of fish, some portions of the adjacent habitat may be affected; however, new sport fisheries would readily create new recreational opportunities, but these would likely be for different species in new locations.

## 4 Environmental Consequences

Every fisheries-enhancement program must be carefully planned and managed to avoid risks to wild stocks, and the fish-culture program must be carefully structured and controlled to avoid or minimize potential changes in the genetic makeup and health of the wild stocks that may be caused by the fish cultural program (Appendix C).

### Conclusions.

Short-term effects: Negligible. New sport fisheries probably cannot be established within one life cycle to replace lost sport fishing opportunities.

Long-term effects: High. After hatchery production is expanded newly established sport fisheries would provide substantial recreational benefits.

### Impact on the Economy

Qualitative analysis indicates that Alternative 3 would result in moderate economic benefits to commercial fisheries and recreation and moderate negative effects on forestry.

Quantitative analysis reflects effects resulting from habitat acquisition on forestry and other sectors but no effects on commercial fishing and recreation because data is not available to quantify these sectors. The quantitative analysis follows.

The largest impacts of Alternative 3 compared to 1990 (as described in Table 3-3 The Economy EVOS Area and Anchorage 1990, in Chapter 3) are in forestry. The acquisition of lands for habitat removes them from timber production. This results in a negative quantity in forestry for each of the six economic measures of final demand, industry output, employee compensation, property income, value added, and employment.

The negative effects on the economy first injected directly to the economy by purchasing habitat multiplies to positive and negative values in other sectors of the economy. Responding of money received from habitat acquisition has a direct effect on the construction sector as shown in Table 4-5 Alternative 3 in the amount of \$7.8 million in industry output but this is not enough to offset the negative effects in forestry. There is also spending, primarily from income received by timberland owners, in the service sector which results in \$5 million in final demand and 765 employees. The net effect is shown in the total line which has negative quantities for the four out of the six economic measures; only employee compensation and number of employees are positive.

Habitat acquisition and general restoration expenditures will have economic benefits for the commercial fisheries and recreation sectors of the economy. However, these benefits are not reflected in the IMPLAN projections presented in Table 4-5. Therefore, this table does not quantify important economic benefits in commercial fishing and recreation because these benefits are not quantified. Of the three most important economic sectors for this analysis, only forestry is quantified. The typical projects in various combinations, such as fish ladders, fish hatcheries, and preservation of habitat will economically enhance the commercial fisheries and recreation sectors of the economy. However, because studies and data are not available that quantify in terms of dollars or employment, it is not possible to quantify the economic effects for these two sectors of the economy. In Table 4-5 the quantities for the commercial fisheries and recreation sectors are reflections of the indirect effects of other sectors of the economy only; they are not reflections of the anticipated but unquantified effects on those sectors.

See the introduction to Chapter 4 on economics and Appendix D Economics Methodology for a more detailed discussion of methodology.

### **Conclusions.**

Qualitative analysis indicates that Alternative 3 will result in moderate economic benefits in commercial fisheries and recreation and moderate negative effects in forestry. Quantitative analysis reflects effects resulting from habitat acquisition on forestry and other sectors but not effects on commercial fishing and recreation. Quantitative analysis indicates that Alternative 3 results, in annual averages for a 10-year period, in a loss of approximately \$32 million in forestry industry output, an increase of \$8 million in construction industry output, and \$3 million in services. The corresponding changes in employment are a loss of 330 jobs in forestry, an increase of 70 in construction, and an increase of 766 in services.

Table 4-5. Alternative 3: 6% Administration, 7% Monitoring, 12% Restoration, 75% Habitat Protection  
Change from Base in 1990\$ Millions

| Economic Sector                 | Final Demand \$ | Industry Output \$ | Employee Comp. \$ | Property Income \$ | Value Added \$ | Employment # |
|---------------------------------|-----------------|--------------------|-------------------|--------------------|----------------|--------------|
| Forestry                        | -26.6009        | -32.6160           | -7.2206           | -4.1673            | -12.4092       | -329.5       |
| Commercial Fisheries            | 0.0003          | 0.0006             | 0.0000            | 0.0002             | 0.0003         | 0.01         |
| Mining                          | 0.058           | 0.0007             | 0.0001            | 0.0008             | 0.0005         | 0            |
| Construction                    | 8.4277          | 7.8589             | 2.9068            | 1.1774             | 4.1068         | 69.56        |
| Manufacturing                   | 0.0648          | -0.338             | -0.0522           | -0.0113            | -0.073         | -0.67        |
| Recreation Related              | 0.0461          | 0.0699             | 0.0249            | 0.0137             | 0.0409         | 1.41         |
| Communication & Utilities       | 0.0991          | 0.1912             | 0.0509            | 0.0825             | 0.1352         | 1.28         |
| Trade                           | 0.4721          | 0.8111             | 0.1675            | 0.0967             | 0.2287         | 9.9          |
| Finance, Insurance, Real Estate | 2.0637          | 1.8632             | 0.4635            | 0.132              | 0.6307         | 41.33        |
| Services                        | 5.1549          | 2.5028             | 3.7771            | -0.8467            | 2.9346         | 765.85       |
| Government                      | 1.5449          | 1.438              | 1.4781            | -0.0141            | 1.4637         | 27.58        |
| Miscellaneous                   | 0               | 0                  | 0                 | 0                  | 0              | 0            |
| Total                           | -8.5795         | -18.7276           | 1.5981            | -3.599             | -2.9408        | 586.55       |

Source: IMPLAN Economic Model. See text for methodology.

## Alternative 4: Moderate Restoration

### Introduction

This Alternative broadens the general restoration program to include all resources with documented injuries from the oil spill. It differs from Alternative 3 by addressing injured resources whose populations did not decline as a result of the spill. This alternative also allows for settlement funds to be used outside of the spill area, and allows for increasing opportunities for human uses of the area. This alternative also encourages using only the most effective restoration measures for general restoration actions.

A large part of this alternative is dedicated to habitat protection and acquisition which provides protective benefits to all resources and services injured by the oil spill as well as to other resources and human uses that are important to the greater EVOS ecosystem. Increasing the protection of habitat throughout the spill area will be beneficial to the entire ecosystem by reducing further habitat degradation that may compound the effects of the oil spill. The general restoration actions can help resources or services recover to their prespill conditions more rapidly than if the actions were not implemented. A third component of the restoration program is Monitoring and Research. These activities track the progress of recovery and provide valuable information that can be used to help the resources, and the overall ecosystem, recover from the oil spill and from other factors that may be delaying recovery.

### Impacts on Biological Resources

#### Impacts on Intertidal Resources

There are three actions that affect the intertidal zone that have been identified for this alternative, habitat protection, accelerating the recovery of *Fucus* in the upper intertidal zone, and cleaning oiled mussel beds. This alternative differs from Alternative 3 only in the more restrictive scenario of the habitat protection opportunity.

Habitat Protection. Although there are several types of actions that apply under this restoration category, this analysis only considers the types of benefits that may be gained from protecting the 81 upland parcels identified in the Comprehensive Habitat Protection Process: Large Parcel Evaluation & Ranking Volume I and II (EVOS Restoration Team, November 1993). Other aspects, such as the small parcels available for protection, of the habitat protection category are still being developed and cannot be analyzed in this DEIS.

The Habitat Protection process used to evaluate the 81 parcels for their potential benefits to injured resources and services combined intertidal and subtidal biota and used the following criteria for ranking the parcels:

- "High" for parcels adjacent to areas with a known high species abundance and diversity; high quality habitat for intertidal and subtidal biota;
- "Moderate" for parcels adjacent to extensive intertidal habitat with observed or probable moderate species diversity and abundance; and,



## 4 Environmental Consequences

- "Low" for parcels with little intertidal habitat with low species abundance (EVOS Restoration Team, November 1993).

In alternative 4, it is possible to protect all of the 81 parcels if it is assumed that the cost per acre is inexpensive. If a higher cost per acre is assumed for the protection of these parcels, fewer of the parcels that were ranked "Low" in the overall ranking for multiple resources and services are likely to be protected. Under this scenario, the potential benefit would change from 25 to 19 parcels ranked "High", from 33 to 10 parcels ranked "Moderate", and 19 to 4 parcels ranked "Low".

The benefits to intertidal and subtidal organisms through the protection of upland habitats comes in two forms. First, the protection can prevent the intertidal and subtidal areas from being altered by the actions that may occur on the parcels. Some actions can cause indirect adverse effects through siltation, or increased pollution, while other actions such as the construction of a dock or creating a new harbor, could directly alter the intertidal and subtidal habitats. The second type of protection reduces the disturbance caused by increased human activity (e.g. more people walking through the intertidal area; more pollution from littering or from bilge discharge). Obviously, the type of activity that may occur on a given parcel can substantially change the degree of benefit that is gained to the intertidal and subtidal zones.

The overall benefit from protecting most or all of the 81 parcels identified in the large parcel process is "Moderate" based on the evaluation criteria, but the actual benefit gained by the intertidal and subtidal organisms depends on the type and location of the activities that may occur. In areas where construction activities are anticipated in the intertidal zone, the protection would be especially effective. If the parcels correspond to areas of the intertidal zone that are still not recovering from the effects of the oil spill, the benefits could be even greater.

The other two actions that have been identified for this alternative can directly affect the intertidal zone. These actions affect specific organisms, *Fucus* and mussels, but are meant to provide broader benefits to the other organisms that live or feed in these communities.

Accelerate the recovery of the upper intertidal zone by re-establishing *Fucus*. The upper intertidal area, specifically the upper 1 meter vertical drop (1MVD), is probably the upper extent of suitable habitat for *Fucus* to grow. This means that the conditions are more extreme than in other habitats and would be more difficult to colonize. *Fucus* germlings that colonize in the upper intertidal area are subject longer periods of high temperatures and dryness during low tides. Without the shelter and moisture that is provided by adult *Fucus* plants the germlings can become desiccated and die. Studies conducted in Herring Bay, Prince William Sound, suggest that it may take 3 to 4 years for *Fucus* communities to expand 0.5m beyond their existing boundaries (Highsmith et al, October 1993).

Feasibility studies of techniques for accelerating the recovery of *Fucus* were begun in 1992. Attempts to transplant adult *Fucus* plants were generally unsuccessful (Stekoll pers comm. 4/8/94). Another technique which uses a biodegradable cloth to cover seeded areas is currently being tested (Stekoll, pers comm. 4/8/94). The results of this experiment will be known during the summer of 1994. In theory, the cloth will substitute for the adult *Fucus* by providing moisture and protection to the germlings during low tides. Because the technique is still being tested it is impossible to know how successful the action may be, or how easily it can be applied to the areas that could benefit from the action. If the technique is highly successful, the established germlings could become fully mature plants in 3-4 years and the

associated invertebrates will also recolonize in the upper intertidal zone. At this time, however, it is impossible to know the outcome of the research therefore any benefits from this action are unknown.

Cleaning oiled mussel beds has been considered as a possible method to reduce the hydrocarbon exposure for sea otters, harlequin ducks, and black oystercatchers. These animals depend on mussels for a large portion of their diet (Doroff and Bodkin, 1993). Mussels can be found in loose aggregations attached to intertidal rocks, or they can be found in dense aggregations (mussel beds) over pea gravel and silt sediments. Because mussels form a dense matt over the sediments and rocks, oil that was trapped beneath the mussels was not exposed to weathering and still remains toxic. It may be possible to clean mussels in mussel beds, but there are areas where it will be technically infeasible to remove the remaining oil.

One of the possible explanations of the continuing signs of injury to sea otters, river otters, harlequin ducks and black oystercatchers is that they are continuing to be exposed to hydrocarbon contamination by eating oiled mussels. Concern over this possible continuing source of contaminations led to feasibility studies to develop techniques to clean the sediments beneath the oiled mussel beds. One technique that will be tested in 1994, lifts sections of the mussel beds and replaces the contaminated sediments with clean sediments without serious damage to the mussel beds (Bodkin, pers comm.). Other techniques are likely to damage the existing mussels in order to remove the contaminated sediments. Approximately 60 locations with oiled mussel beds have been identified in Prince William Sound.

The extent and distribution of oiled mussel beds is still being determined and will be important in understanding the potential benefits that can be gained for other organisms by this action. There have been no studies to determine whether or not eating contaminated mussels is causing injury to other animals. The intent of cleaning oiled mussel beds is largely to eliminate a source of continuing contamination to other organisms. Studies which examined the effects of oil on the mussel beds noted a reduction in the number of large mussels and overall biomass of the mussel beds, but there did not appear to be a shortage of new recruits (smaller mussels) to the mussel beds (Highsmith et al, December 1993). It is unknown if the trapped oil beneath the mussel beds will ultimately cause further injury to the mussels; however, continued high levels of hydrocarbons have been found in mussel tissues which indicates that the mussels may be continuing to be contaminated.

If techniques are developed to clean the oiled sediments without destroying a large amount of the mussel beds then this action is unlikely to cause an adverse effect, and may provide tangible benefits to the mussels at the cleaned sites. It is reasonable to assume that the ability of this action to reduce the level of contamination beneath mussel beds is valid in all regions of the spill area. However, there is less information on the location of oiled mussel beds in areas outside of Prince William Sound.

## Conclusions.

Short-term benefits. Negligible.

## 4 Environmental Consequences

- Long term benefits. For direct restoration actions are unknown because both of these actions are still being tested. The long-term benefits of the Habitat Protection actions for reducing disturbance or preventing additional injury to intertidal organisms are moderate and will vary substantially between parcels.

### Marine Mammals

#### **Harbor Seals**

The restoration program for harbor seals under Alternative 4 is very similar to the program discussed in Alternative 3. This alternative differs in two manners, the Habitat Protection capabilities may differ if when the higher cost per acre is considered; and actions proposed that increase the number of people using an area can increase the potential for disturbance.

The greatest way to benefit the injured harbor seal populations is to determine what has caused the long-term decline of populations throughout the Gulf of Alaska. Such research activities cannot be analyzed in this DEIS because the environmental effects are dependent on the outcome of the research and how the results can be used for restoration. For this analysis we can only consider the effects of habitat protection and the two types of General Restoration Actions proposed in Chapter 2. Both of the proposed actions are information based programs that would be designed to change the impact of commercial fisheries or of subsistence harvest on the recovering seal populations.

Subsistence harvest is not believed to be the cause of the long-term decline of harbor seal populations in the Gulf of Alaska; however, any additional mortality may slow the recovery of injured populations. Subsistence harvest in Prince William Sound declined as a result of the oil spill and in 1991 harvest levels were probably less than 5 percent of the population. A healthy seal population would be able to easily sustain that level of harvest. Depending on the distribution, sex and age of the animals harvested, a 5 percent harvest could negatively affect an injured population.

One of the proposed actions would establish a cooperative program between subsistence users and research scientists or agency managers. The program would be designed to provide a two-way exchange of information that would provide benefits to all sides and could benefit the injured harbor seal populations. For example, recent studies indicated that harbor seals may have a high site fidelity to molting and pupping areas (e.g. the same individuals consistently use the same areas) (Pitcher 1990). If some of these areas show greater declines than other sites within Prince William Sound, then redirecting harvest towards the healthier, or the nonoiled areas could reduce any negative effects from the harvest without actually changing the number of animals harvested.

A similar cooperative program with commercial fishermen could also reduce pressure on the injured seal populations. This program would provide information on deterrent methods and regulations. Ideally it would provide information to the scientists on the extent of the interactions between the commercial fisheries and the seals, and would reduce the number of seal mortalities. The interactions with commercial fisheries probably result in fewer deaths than from the subsistence harvest and is unlikely to be the cause of the seal decline; however, the more that can be done to minimize the effects of human caused injury and mortality, the more likely it will be that the population will stabilize and recover.

Habitat Protection of upland parcels. Harbor seals use haulout sites that are either in the intertidal zone, or immediately adjacent to the intertidal zone; therefore, actions that occur on the upland are not likely to destroy the habitat. However, it is possible that habitat changes to the uplands may increase the amount of disturbance currently experienced at haulout sites on or near the parcel. Disturbance has been documented as adversely affecting harbor seals and other pinnipeds in other parts of their range (Allen, et al. 1984; Esipenko, 1986; Johnson, et al. 1989). These studies have shown that the greatest impacts from disturbances are at haulout sites during pupping and molting. During pupping, disturbance can result in higher pup mortality caused by abandonment, or from being crushed as the adults panic and return to the water (Johnson, 1977). The greatest disturbance is caused when people walk near or through haulout sites (Johnson, et al. 1989), but disturbance can also be caused by low flying aircraft and by boats that approach too close to the haulouts.

Habitat protection criteria for parcels that may benefit harbor seals include ratings of:

- "High" for parcels known to have a haulout of 10 or more seals on or immediately adjacent to the parcel;
- "Moderate" for parcels with known haulouts with sporadic use and less than 10 seals; or, probable haulouts in vicinity of the parcel; or probable feeding in nearshore waters; and,
- "Low" for possible feeding sites located in nearshore waters adjacent to the parcel (EVOS Restoration Team, November 1993).

Of the 81 parcels evaluated in the large parcel process, 25 of the parcels were ranked "High", 19 of the parcels were ranked "Moderate", 35 were ranked "Low" and 2 parcels were ranked as having no benefit to harbor seals. The overall value of these parcels, based on these rankings, is "moderate", although individual parcels may have exceptional value.

In alternative 4, it is possible to consider the value of all 81 parcels if it is assumed that the cost per acre is inexpensive, however, if the cost per acre is higher fewer acres of land are likely to be purchased. If a higher cost per acre is assumed for the protection of these parcels, fewer of the parcels that are ranked "Low" for multiple resources and services are likely to be protected. Under this scenario the potential benefit to harbor seals would change from 25 to 18 parcels ranked "High", from 19 to 6 parcels ranked "Moderate", and from 35 to 6 parcels ranked "Low".

The actual impact that development on these parcels will have on the harbor seals depends on, among other things, the type of disturbance caused, the length and duration of the disturbance, and whether or not the haulout area is used for pupping or molting. Within the EVOS area, there have been no studies to document the amount or effects of current activities that may cause disturbance to harbor seals so baseline data are unavailable. However, it is reasonable to assume that protection of upland habitats near haulout sites will reduce the risk of disturbance to the injured population.

Restoration actions for other resources/services. If actions are taken to increase recreation and commercial tourism activities, or construct large facilities such as hatcheries, in the oil spill area, careful site selection away from key haulout areas could avoid a long-term impact on harbor seals.

## 4 Environmental Consequences

### Conclusions.

- short-term benefits. Negligible. All of the proposed actions require some time after implementation before any changes could be expected.
- long-term benefits. Moderate. The proposed actions could reduce negative impacts on harbor seals, and may result in increased recovery rates in local areas.

### Sea Otters

The effects of actions under Alternative 4 are expected to be identical to those described in Alternative 3 with the exception of the amount of habitat that can be protected.

There are three types of actions aside from Research or Monitoring that are considered in this alternative: habitat acquisition, cleaning oiled mussel beds, and creating a cooperative program between subsistence users and sea otter scientists and managers.

Habitat protection. The benefit to sea otters of habitat protection actions on upland parcels is through reducing potential or actual disturbance. Sea otters appear to have a high tolerance to certain human activities, as evidenced by their abundance in highly travelled areas such as Orca Inlet near Cordova; however, their response to large-scale disturbances has not been studied. Large-scale disturbances, such as log-transfer sites, may force resident otters to leave the immediate area and may cause a long-term change in food availability as debris from the logs cover the substrate(). Disturbance is more likely to cause adverse effects to females with pups that concentrate in high quality habitats with abundant prey in the intertidal zones.

Habitat protection criteria for parcels that may benefit sea otters include ratings of:

- "High" for parcels adjacent to known pupping concentrations;
- "Moderate" for parcels adjacent to concentration areas for feeding and/or shelter; or, potential pupping areas; and,
- "Low" for feeding sites located in adjacent waters (EVOS Restoration Team, November 1993).

Of the 81 parcels evaluated in the large parcel process, 20 of the parcels were ranked "High", 16 of the parcels were ranked "Moderate", 42 were ranked "Low" and 3 parcels were ranked as having no benefit to sea otters. The overall value of these parcels, based on these rankings, is "low to moderate", although individual parcels may be near habitat of exceptional value.

In alternative 4, it is possible to consider the value of all 81 parcels if it is assumed that the cost per acre is inexpensive, however, if the cost per acre is higher fewer acres of land are likely to be purchased. If a higher cost per acre is assumed for the protection of these parcels, fewer of the parcels that are ranked "Low" for multiple resources and services are likely to be protected. Under this scenario the potential benefit to sea otters would change from 20 to 14 parcels ranked "High", from 16 to 8 parcels ranked "Moderate", and from 42 to 10 parcels ranked "Low".



Cleaning oiled mussel beds has been considered as a possible method to reduce the hydrocarbon exposure. Sea otters, especially juvenile otters and females with pups, depend on mussels for a large portion of their diet (Doroff and Bodkin, 1993). Mussels are found in shallower areas and are easier to obtain than other prey. Mussels can be found in loose aggregations attached to intertidal rocks, or they can be found in dense aggregations (mussel beds) over pea gravel and silt sediments. Because mussels form a dense matt over the sediments and rocks, oil that was trapped beneath the mussels was not exposed to weathering and still remains toxic. It may be possible to clean mussels in mussel beds, but there are areas where it will be technically infeasible to remove the remaining oil.

One of the possible explanations of the poor survival rate of post-weanling juveniles in the oiled areas is that they are continuing to be exposed to hydrocarbon contamination by eating oiled mussels. Concern over the possible continuing source of contaminations to otters and other higher order animals (e.g. black oystercatchers and harlequin ducks) led to feasibility studies to develop techniques to clean the sediments beneath the oiled mussel beds. One technique that will be tested in 1994, lifts sections of the mussel beds and replaces the contaminated sediments with clean sediments without serious damage to the mussel beds (Babcock, pers. comm.). Approximately 60 locations with oiled mussel beds have been identified in Prince William Sound.

The extent and distribution of oiled mussel beds is still being determined and will be important in understanding the potential benefit to sea otters that can be gained from cleaning. There have been no studies to determine whether or not eating contaminated mussels is causing injury to the sea otter population. However, it is possible to consider the potential benefit in terms of the level of risk to exposure. For example, the telemetry study by Monnett and Rotterman (1992) indicated that females and weanling otters did not range great distances between oiled and unoled areas. If a group of otters spends many months feeding in bays that have several oiled mussel beds, then they are at greater risk of exposure than otters that feed in areas with few or no oiled mussels. Of the oiled mussel beds identified so far, there are approximately 20 in Herring Bay off of Knight Island; cleaning half or all of these mussel beds would greatly reduce the risk to the local population. If only 1 or 2 beds in the area were cleaned, it may not reduce the risk of exposure at all. Similarly, if the only source of oil in an entire bay was from one mussel bed, removing that contamination could eliminate the majority of the risk to the local otters.

Cleaning oiled mussel beds is likely to be a labor intensive task that may last for several days at each location. Some short-term disturbance is likely to occur; however, it is not likely to permanently displace the local otters.

It is reasonable to assume that the ability of this action to reduce the risk of exposure is equally valid in other regions of the spill area. However, there is less information on the location of mussel beds and on the injury to the sea otter population.

Establishing a cooperative program between subsistence users and research scientists or agency managers is another action that is appropriate under this alternative. The program would be designed to provide a two-way exchange of information that would provide benefits to all sides and could benefit the injured sea otter population. Recent records of subsistence harvest of sea otters the oil spill area indicate that harvest levels are relatively low but increasing throughout the EVOS area. If subsistence levels increase in areas where the

## 4 Environmental Consequences

populations were affected by the spill, the additional harvest may slow or prevent localized recovery. For example, the densities of otters in some oiled areas is still very low (Bodkin and Ballachey, pers comm.) if these areas are consistently harvested, then redirecting harvest towards the healthier, or the nonoiled areas could reduce any negative effects without actually changing the number of animals harvested. Likewise, sea otters can sustain a greater harvest of males and juveniles than of breeding females.

Without any restoration actions, it may be reasonable to estimate that sea otters will recover to their prespill abundance in 7 to 35 years once the population begins to increase. If subsistence harvest rates rise substantially in the oiled areas, then the recovery estimates based on a 10 percent growth rate are unlikely and it is possible that the more conservative estimate of 35 years would be extended. If a cooperative program can be established, it may be possible to sustain a higher harvest rate, without changing the recovery rate of the injured population.

Actions implemented for other resources or services are not expected to impact the sea otter populations or their recovery.

### Conclusions.

- short-term effects. Negligible. All of the proposed actions will take time before any results could be expected.

- long-term effects. Moderate. The proposed actions improve the habitat quality through reducing the risk of exposure to oil, the potential for disturbance, and the impacts from subsistence harvest. These benefits could produce a change in abundance of otters in some areas, but are not likely to produce a notable increase on a regional scale.

### Birds

#### Harlequin Duck

Habitat Protection. Acquiring nesting habitat along streams on forested lands is the most effective means of preventing further injury to the harlequin duck population. Such acquisition would maximize protection of the harlequin ducks' reproductive potential, thus fostering recovery to pre EVOS levels. Thirteen of 18 high priority parcels being considered for acquisition have high potential value for nesting by harlequin ducks.

Cleaning Oiled Mussel Beds. Cleaning oiled mussel beds is considered to be a possible means of reducing hydrocarbon exposure to harlequin ducks via their food chain. Mussels, clams, and other bottom prey of harlequin ducks continue to be contaminated by oil still buried within the sediments. The harlequin ducks eat the contaminated prey, thus contaminating their body tissues. Although as yet unproven, this sub-lethal contamination is suspected of interfering with normal reproduction, resulting in few new broods being seen in the oiled area since the spill. Removal of the oil could thus eventually result in resumed production in the oiled area, followed by a population increase.

Conclusions. The short-term effects through 1996 of any land acquisition on harlequin duck recovery would be negligible, and populations likely will remain stable at 1990 - 1993 levels.



in oiled and non-oiled areas alike. Acquisition of the high priority package of land parcels would maximize the recovery potential of the injured harlequin duck population by guarding against loss of nesting habitat. Cleaning oiled mussel beds would eliminate the source of hydrocarbon contamination of body tissues that may be interfering with reproduction, and also enhance the food base of local populations. The long-term effects of this alternative would have a high benefit for maintaining, protecting, and increasing the reproductive potential of harlequin ducks in the EVOS area.

### Murres

**Habitat Protection.** Acquisition of habitat would have lower benefit to the injured murre population because there are no sizeable colonies, and very few smaller colonies, that are not already protected. A seabird colony on privately-owned Gull Island in Kachemak Bay has a colony of 10,000 common murres that is visited daily by commercial tour boats in summer. Acquisition of this colony would assure its long-term protection, although there are no imminent plans for development.

**Predator Control.** The reproductive behavior of murres has evolved to produce a sudden abundance of eggs and chicks; predators are able to eat a relatively few eggs and chicks, while the large majority of chicks grow too large for predators to handle. Mammalian predators are generally not a problem for murres because their island colonies are usually free of mammalian predators and murre nest sites are inaccessible. Bald eagles, ravens, northwestern crows, and especially glaucous-winged gulls, eat murre eggs and chicks in the EVOS area, although little is known about their impact on specific colonies. Recent work in Europe has shown that measures such as fiberglass poles placed on nesting colonies perpendicular to the cliff face reduces avian predation (D. Roseneau, oral comm., 1994). At least one year of study at injured colonies would be needed to determine the impact of avian predators and to design measures to deal with them.

Mammalian predators are not a pervasive problem for murres. A notable exception in the Bering Sea is on Otter Island, in the Pribilof Islands, where there was formerly a colony of about 10,000 murres. During a particularly cold winter in the late 1940's, Arctic foxes arrived on Otter Island via pack ice, and they and their progeny have since eliminated all murres there. Live trapping and translocating the few foxes that remain there would allow murres from the rest of the Pribilofs located a short distance away to re-colonize Otter Island, followed by a population increase. This would be an inexpensive project that could be accomplished within two weeks (V. Byrd, oral comm., 1994).

**Conclusions.** There would be negligible short-term benefit to the injured murre population from this action within the EVOS area. Acquisition of Gull Island with its colony of 10,000 common murres would assure protection of this popular tourist attraction, and thus would have a modest long-term benefit to murres. Outside the EVOS area, trapping and translocating Arctic foxes on Otter Island would allow natural re-colonization from the rest of the Pribilof Islands, with the potential of increasing the murre population within 10 years by approximately 10,000, the number that formerly nested there.

## 4 Environmental Consequences

### Pigeon Guillemot

**Habitat Protection.** In Prince William Sound, the large majority of pigeon guillemot colonies are on U. S. Forest Service (USFS) land (Sanger and Cody, written comm., 1994) that is not slated for logging (C. Frey, written comm., 1994). Two of the largest colonies in Prince William Sound are on private land at The Pleiades Islands and on Bligh Island, and guillemots there total about 3 percent of the 1993 breeding population (Sanger and Cody, written comm., 1994). In the 1970's, both of the latter colonies probably harbored larger numbers of nesting guillemots than at present. Two colonies adjacent to private land that is currently being logged on the eastern, nonoiled portion of Prince William Sound had very few guillemots in 1993, but it is unlikely that they were affected by the inland logging operations (Sanger and Cody, written comm., 1994). Outside of Prince William Sound, the Seal Bay area on Afognak Island has low numbers of pigeon guillemots and has already been acquired, and an EVOS predator control project at Kagamil Island in the Shumagin Islands will allow recolonization and modest population increase by pigeon guillemots (V. Byrd, oral comm., 1994). Little is known about the current status of guillemot colonies elsewhere in the EVOS area (USFWS, 1993).

**Predator Control.** Predator control has the potential to increase productivity of pigeon guillemots, but little is known about the nature of predation on guillemots throughout the EVOS area. Possible predator control methods might include live trapping and translocating predators, removing eggs from the nests of avian predators and replacing the live eggs with artificial ones so the adults do not lay a second clutch, installing predator exclosures, and deploying predator-proof nesting boxes. Studies are needed to determine the severity of predation at individual colonies, and if warranted, to design specific methods to reduce predation.

**Reduce Disturbance.** Human disturbance is not a pervasive problem at pigeon guillemot colonies. Most colonies are located in remote areas, in steep habitat that generally holds little appeal for recreational or other uses. However, because of the reduced size of the guillemot population throughout Prince William Sound, and the injury suffered by the population in the oiled area, it would be wise to take precautions to assure that there is no inadvertent disturbance. This could be done by educating land management entities about the locations of guillemot colonies on their land, and by posting colonies that are especially sensitive. Chief among the latter is the cluster of colonies at Jackpot Island, located on USFS land just offshore from Jackpot Bay in southwestern Prince William Sound. Jackpot Island has two beaches suitable for camping, and Jackpot Bay is a popular area for recreational boaters and fishermen, so there seems to be potential for inadvertent disturbance from recreationists.

**Conclusions.** This alternative would likely have negligible short-term effects for pigeon guillemots through 1996. On the long term, acquiring habitat where two of the largest colonies in Prince William Sound are located, one of which is included in the high priority acquisition package, would have a moderate effect on allowing population recovery, and in preventing further inroads to the injured population through habitat degradation.

### Marbled Murrelet

**Habitat Protection.** Details of habitat use by marbled murrelets are being clarified, and studies in Prince William Sound are showing that large, moss-covered limbs of old-growth conifers are the cornerstone of prime nesting habitat for marbled murrelets. Current and possible future logging of such habitat on private land is the single greatest threat to

population recovery of marbled murrelets, and it poses the additional threat of reducing the population more. Logging will ultimately occur on private lands and reduce murrelet habitat. Acquisition of prime nesting habitat would thus have a high benefit for allowing the injured marbled murrelet population to recover while preventing further injury to the population.

**Conclusions.** The short-term effects of land acquisition for the injured marbled murrelet population could have a high benefit if logging is imminent. On the long term, land acquisition is the highest possible benefit to the injured murrelet population.

## Fish

### Pink Salmon

Alternative 4 will provide moderate restoration actions to assist natural recovery of wild-stock pink salmon populations. Actions that may be implemented to restore wild-stock pink salmon populations as part of Alternative 4 include: habitat protection and acquisition and relocation of hatchery-produced runs (EVOS Trustee Council, April; November 1993) Appendix C).

Habitat protection criteria for parcels that may benefit pink salmon include ratings of "High" for parcels with a high density of pink salmon streams or streams known to have exceptional value; "Moderate" for parcels with an average density of pink salmon streams or streams with average production; and, "Low" for parcels with few or no pink salmon streams or streams with no production (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit wild-stock pink salmon populations according to Alternative 4 will depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 34 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide moderate value for the pink salmon resource (Appendix A). Of the 81 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 0, 38, 25, and 18 have been rated as no, low, moderate, and high value, respectively, for pink salmon. A total of 53% is rated as moderate or high value.

If only 34 parcels are purchased, the benefit is expected to provide moderate value for the pink salmon resource (Appendix A). Of the 34 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 0, 10, 12, and 12 have been rated as no, low, moderate, and high value, respectively, for pink salmon. A total of 70% is rated as moderate or high value.

Although the average value of forecasted habitat acquisition may not have a high overall rating for pink salmon, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).



## 4 Environmental Consequences

### Restoration Actions

Relocation of hatchery runs will provide a benefit for commercial fishing by providing an alternate location, timing or stock for commercial fishing activities. If the locations or timing to relocate these new runs are carefully selected, there will be little or no interception of injured wild stocks. Combined with good fishery management practices, and a redistribution of the commercial fishing fleet, fishing pressure can be diverted away from the wild stocks and refocused on the relocated hatchery runs which will allow the injured wild stocks to recover (Appendix C).

ADF&G and PNP aquaculture organizations have established a modern fisheries enhancement program that began in the mid-1970's that has included the establishment of new runs, however, some locations remain that provide ideal opportunities for juvenile fish imprinting and adult fish terminal harvest areas that are readily accessible to the fishing fleets.

### Conclusions.

|                     |  |
|---------------------|--|
| short-term effects. | Low. Although some benefits may be accrued, it is not reasonable to expect substantial results within one life-cycle.  |
| long-term effects.  | Moderate. It can be expected that these actions will assist the recovery of the injured wild stocks of pink salmon. Long-term benefits, however, may be accrued in only portions of the EVOS area. |

### Sockeye Salmon

Alternative 4 will provide moderate restoration actions to assist natural recovery of wild-stock sockeye salmon populations. Actions that may be implemented to restore wild-stock sockeye salmon populations as part of Alternative 4 include: habitat protection, lake fertilization, and actions that may improve survival rates of sockeye salmon eggs by using egg incubation boxes, net pen rearing or hatchery rearing (EVOS Trustee Council, April; November 1993).

Habitat protection criteria for parcels that may benefit sockeye salmon include ratings of "High" for parcels with sockeye salmon streams or systems known to have exceptional value; "Moderate" for parcels with sockeye salmon streams or systems with average production; and, "Low" for parcels with few or no sockeye salmon streams or systems with low production (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit wild-stock sockeye salmon populations according to Alternative 4 will depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 34 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low value for the pink salmon resource (Appendix A). Of the 81 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 16, 48, 8, and 9 have been rated as no, low, moderate, and high value, respectively, for pink salmon. A total of 17% is rated as moderate or high value.

If only 34 parcels are purchased, the benefit is expected to provide low to moderate value for the sockeye salmon resource (Appendix A). Of the 34 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 8, 13, 6, and 7 have been rated as no, low, moderate, and high value, respectively, for pink salmon. A total of 38% is rated as moderate or high value.

Although the average value of forecasted habitat acquisition may not have a high overall rating for pink salmon, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

## **Restoration Actions:**

Action 1: Migration corridor improvements entail mitigation of a barrier to fish migration that may prevent access to critical habitat for spawning or rearing and typically includes installation of a fishpass or removal of a migration barrier. The construction of a fishpass (i.e., fish ladder or steep pass) is a permanent form of habitat modification to enable fish to access spawning and rearing habitat above an impassable barrier such as a waterfall or cataract.

This technique has been widely applied throughout the EVOS area to increase populations of wild salmon stocks and to establish new populations by providing access to new or additional spawning habitat. It has not been widely applied for sockeye salmon, however, because juvenile sockeye salmon require lake rearing habitat.

Migration corridor improvements that create access to good quality spawning habitat is a proven technique to improve salmon populations, however, it will be effective for sockeye salmon only if the newly-produced fry have access to rearing habitat that is presently underutilized. The potential benefit will usually be limited by the amount of rearing habitat rather than the amount of new spawning habitat that is accessed. The installation is usually permanent, with a long lifespan. Within the EVOS area, potential benefits for sockeye salmon may be limited by the ability to identify new sites for application of this action where they will not interfere with management of other nearby wild stocks.

Action 2: Egg incubation boxes have been used highly successfully in the Copper River drainage to develop a small wild-stock population of sockeye salmon into an estimated annual total return of approximately 200,000 adult fish with an estimated annual commercial harvest of over 100,000 fish (Roberson and Holder, 1993). Other experiments to incubate sockeye and chum salmon eggs in egg incubation boxes in Prince William Sound were less successful (Jackson, 1974), however, when properly installed, these units control the water flow, substrate type, sedimentation, and predation to provide egg-to-fry survival rates as high as 90%. This compares quite favorably with an expected survival rate of 20% in redds of naturally-spawned sockeye salmon (Ref., ...).

The potential contribution of egg incubation boxes for the restoration of sockeye salmon stocks in the oil-spill area will be limited to drainages with: 1) limited successful

## 4 Environmental Consequences

reproduction; 2) spring areas with appropriate physical features and water quality and quantity; and, 3) underutilized rearing capacity for the sockeye salmon fry that are produced.

Although extensive surveys to locate potential sites to operate this technique have not been performed, if suitable locations can be identified within drainages that presently support small populations of sockeye salmon, this technique may be applied to help restore those populations without a major intrusion into the environment or the fish stock.

Action 3: Net-pen rearing is a practice that has been widely applied to increase the survival rate of all salmon species. This technique, however, has only recently been applied successfully for sockeye salmon because most previous attempts failed because sockeye salmon are particularly susceptible to the disease infectious hematopoietic necrosis virus (IHNV). (Mr. Terry Ellison, ADF&G, personal communication).

Although the net-pen rearing technique has been applied in both freshwater and in saltwater, most success has been achieved with freshwater rearing because the early lifestages from only a few stocks of sockeye salmon can survive in saltwater. Burke (1993), however, described a highly successful program for rearing juvenile sockeye salmon in saltwater net pens to the smolt stage, but only after they had been fed first in freshwater hatchery raceways. Consequently, although net-pen rearing of sockeye salmon in saltwater may have excellent potential for a hatchery-based application, it is of limited value for protection and restoration of wild stocks except where it may be used to create an alternate opportunity for commercial fishermen.

Juvenile sockeye salmon typically require rearing in freshwater for up to three years (Burgner, 1991). During this period, the mortality rate between the fry and smolt stages may range from 86 to 99% (Roberson and Holder, 1993), but fry held in net pens are largely protected from predators and food is provided, so the mortality rate is low while they are in the pens. Net-pen rearing of sockeye salmon fry in freshwater has not been widely applied; however, it appears to have been quite successful in English Bay lakes as a means to increase the freshwater survival rates (Schollenberger, 1993).

Net-pen rearing of sockeye salmon fry to increase their survival rate potentially may be employed in many systems throughout the EVOS area. Only two key ingredients are necessary: a source of fry and a suitable site to anchor and service the net pens. Fry may be captured from a spawning stream or transferred from a hatchery. Careful application of the net-pen rearing technique will increase the numbers of emigrating sockeye salmon smolts and returning adults with minimal undesirable effects on the population or the lake rearing system. The magnitude of the benefit will depend on the numbers of captive fry that can be accommodated.

Whenever any organisms are held captive in high density, they become more susceptible to disease or other catastrophic loss and there is a risk of disrupting natural genetic selection; however, these risks have been successfully minimized with good fish cultural practices (Schollenberger, 1993) and by following appropriate planning and permitting procedures (Appendix C).

Action 4: Hatchery rearing of sockeye salmon has had a long history in Alaska, however, during the last decade, this strategy has been improved and it has produced dramatic innovations and results (Ellison, 1993). In Alaska, cultured juvenile sockeye salmon have

been released as fed fry, presmolts and smolts. Each lifestage has its own particular logistical, biological and fish cultural constraints and advantages. Fry are less expensive to rear, transport and release, but they require at least one year of rearing in a lake before they smoltify and they will not survive to the adult stage as well as presmolts or smolts. Fry that are retained and fed in hatchery raceways may be released in late-fall as presmolts. These young fish require few resources from the lake system during the winter and emigrate as smolts in the spring. Smolts are expensive to rear and transport, but they will survive better to the adult stage; however, they can be released as migrants without reliance on freshwater rearing.

Injured wild stocks may be helped directly by a rearing and release program for that stock; or the wild stocks may be helped indirectly by creating an alternate opportunity for the commercial fishers to divert fishing pressure away from the injured wild stocks. For direct restoration, fry-rearing programs will be limited to those drainages where the forage is underutilized by the naturally-produced fry. Presmolt- and smolt-rearing programs, however, can provide direct restoration with little or no effect on plankton populations.

Whenever any organisms are held captive in high density, they become more susceptible to disease or other catastrophic loss and there is a risk of disrupting natural genetic selection; however, these risks have been successfully minimized with good fish cultural practices (Schollenberger, 1993) and by following appropriate planning and permitting procedures (Appendix C).

## Conclusions.

- short-term. Low; some benefits in some drainages may be accrued within one life cycle.
- long-term effects. High. It can be expected that these actions will assist the recovery of the injured wild stocks of sockeye salmon. Certain actions, however, may be useful in only portions of the EVOS area and all populations may not be totally restored.

## **Pacific Herring**

Alternative 4 includes only one restoration action to assist natural recovery of Pacific herring; habitat protection and acquisition (EVOS Trustee Council, April 1993).

Habitat protection criteria for parcels that may benefit Pacific herring include ratings of "High" for parcels with a documented consistent annual Pacific herring spawning along the parcel shoreline; "Moderate" for parcels with occasional spawning along the parcel shoreline; and, "Low" for parcels with no documented Pacific herring spawning along the parcel shoreline, but a possible feeding area (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit Pacific herring populations according to Alternative 4 will depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 34

## 4 Environmental Consequences

parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low to moderate value for the Pacific herring resource (Appendix A). Of the 81 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 7, 30, 29, and 15 have been rated as no, low, moderate, and high value, respectively, for Pacific herring. A total of 54% is rated as moderate or high value.

If only 34 parcels are purchased, the benefit is expected to provide moderate value for the Pacific herring resource (Appendix A). Of the 34 parcels that may be purchased from the estimated budget that is forecasted for this alternative, 2, 9, 14, and 9 have been rated as no, low, moderate, and high value, respectively, for Pacific herring. A total of 68% is rated as moderate or high value.

Although the average value of forecasted habitat acquisition may not have a high overall rating for Pacific herring, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

### Conclusions.

- short-term: Negligible. No benefits will be accrued within one life cycle.
- long-term: Moderate. Habitat protection and acquisition actions will have a long-term value to Pacific herring stocks in the EVOS area by helping to assure maintenance of production. Some habitat areas will recover sooner than others.

### Social and Economic Impacts

#### Cultural Resources

##### Habitat Acquisition

It is assumed here that 34 large parcels, a total of 478,500 acres, would be purchased. These parcels contain low (No known or suspected cultural resources/sites on parcel), moderate (No significant cultural resources/sites on or adjacent to parcel), or high (Documented concentration or significant cultural resources/sites on parcel) potential for benefiting cultural resources as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.2, or slightly higher than moderate. These estimates reflect known sites in the EVOS area, not all of the sites present. Not all sites have been found, so the actual benefit to cultural resources may be greater than reflected in these estimates. This analysis does not take into consideration small parcel acquisition, which is currently under evaluation. It is also possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels - possibly all 81 identified parcels (up to 863,100 acres).

Habitat acquisition and protection would have minor short-term benefits on site protection.. Moderate long-term benefits to archaeological site protection from habitat acquisition would accrue primarily through (1) placing private lands under public management and application of federal and state cultural resource protection laws, and (2) reducing the likelihood of damage to cultural resources resulting from extractive economic activities such as mining and logging.



## General Restoration

General restoration actions may include activities on individual sites (site stabilization, site salvage excavations, site monitoring and stewardship), or in local communities (archaeological repositories, acquiring replacement artifacts). Often, on-site work can be combined with community activities, as is envisioned in the site stewardship program. Each of the proposed actions considered here can be implemented independently or in combination with any of the others. The most effective approach is comprehensive, tailoring combinations of actions within each community whose cultural resources were injured by the spill. Actions considered applicable under Alternative 4 are discussed below.

### - Stabilize archaeological sites.

Archaeological sites affected through erosion begun or worsened by oil spill activities may be stabilized to slow or stop the erosion. Stabilization may entail re-contouring parts of the sites to cover up exposed cultural deposits. This would reduce the visibility of artifacts and so reduce chances of looting or vandalism. This is a relatively non-destructive alternative when compared to archaeologically excavating the sites or allowing damage to continue.

Stabilization is a site-specific activity that may be accomplished through several different methods. Some sites are located along high energy shorelines, or in high energy intertidal areas, and may not be suited to stabilization. Also, stabilization techniques that contrast with surrounding terrain may serve as magnets for visitation rather than protection against visitation. The benefit of stabilization is to preserve the integrity of the site, an effect that may be temporary (requiring periodic maintenance) or permanent. This would have an immediate benefit of moderate to high level in the short term, but has the potential to preserve sites and reduce damage at a high level over the long term.

### - Excavate Archaeological sites.

Not all sites can be stabilized, whether for physical or economic reasons. Ongoing vandalism, looting, and erosion of archaeological sites in the EVOS area can be mitigated through salvage excavation instead of stabilization. Excavation and stabilization can also be done on the same site. Scientific excavation of the sites most in danger of destruction can yield information important to understanding the history and prehistory of the EVOS area, a major element of Alaska's cultural heritage. Excavation can also remove human remains and funerary objects associated with the ancestors of contemporary people living in communities in the spill area. These remains could be moved to locations less likely to be disturbed by looters or vandals, or unearthed by ongoing erosion.

One benefit of excavation is permanent destruction of the excavated portions of the sites. This destruction, however, is controlled and exactly delimited, allowing for the appropriate care and analysis of removed items and associations. Without archaeological excavation, damage to, and eventual destruction of, several of the sites will continue with neither the public nor the resource benefiting. The short-term and long-term benefit of salvage excavation of highly endangered sites is therefore high. This action both protects the sites from further looting and vandalism and mitigates the spill-related damage already incurred. Some salvage excavation projects have already been funded by the Trustee Council.

### - Site monitoring and stewardship.

## 4 Environmental Consequences

Archaeological site stewardship programs active in Arizona, Arkansas, and Texas have demonstrated the utility of public education and increased oversight of sites for reducing continuing vandalism. A site stewardship program for the EVOS area would combine public education and site monitoring through recruitment, training, coordination, and maintenance of a corps of local interested citizens to watch over nearby archaeological sites. Sites to be monitored by local residents would be identified by land owners and managers on the basis of past and ongoing vandalism and erosion. Law enforcement officials may be involved as during investigations or called to sites to intercept active vandalism.

The benefits of site stewardship would be an increased knowledge and appreciation of archaeological methods of site monitoring and decreased site vandalism. These benefits would begin within the first year of implementation and continue for an indefinitely long term. The benefits of this action in the short term would be low, but are potentially high in the long term as site stewards become better trained and knowledge of the program is disseminated among people who are or may be inclined to damage sites. The action has additional importance in its involvement of local individuals and communities in protecting cultural resources.

### - Archaeology repositories.

Communities within the spill-affected area increasingly express a desire that archaeological materials remain in (or at least are regularly returned to) their area of origin for display and interpretation. Local preservation of artifacts and interpreting of Native heritage is proposed as a means to offset the increasing loss of artifacts and disturbance of Native graves in the spill area.

Placing artifacts in a local repository and using that repository as a base for interpreting cultural resources could help better educate residents and area visitors about practices of the past and the continuity of that past with the present and the future. These repositories may be established through modifying existing structures or by building new structures to accommodate collections. These would be located in communities within the oil spill area and could serve as local foci for heritage-oriented activities. The short-term benefits of this action would be to restore a feeling of involvement with and oversight of the cultural heritage of which local communities are part. This would be immediate but moderate. Long-term benefits are high in terms of enhanced community involvement. It is this involvement that will address spill related injury to the sense of cultural continuity and connectedness within the local communities.

### - Acquisition of replacement artifacts

Museums, agencies, and other repositories outside the spill area hold collections containing artifacts originally from the spill area. An action has been identified that would acquire some of these artifacts as a means of replacing a portion of the cultural heritage lost through the oil spill and subsequent cleanup activities. Many of these artifacts were removed from the spill area through ethnographic collecting and archaeological investigations in the 19th and early 20th centuries, and many reside outside of Alaska - in the lower 48 states, Europe, and Russia. Returning part of this diverse artifactual heritage to the spill area would have a low but immediate benefit in the communities within the spill area, allowing the people of the communities to more fully see the range of materials that represent a tangible part of their past. The long-term benefits of this approach are potentially high. By establishing a seed of improved cultural connectedness and fostering a sense of cultural continuity, this approach could grow into a major factor in producing a sense of recovery from the effects of the spill among the residents of those communities most affected.

This action could work through partnerships with existing museums or other regional repositories, or as combined with the establishment of local artifact repositories and interpretive centers. It is likely that communities would react differently from each other to this approach. Individual consultations with each community would be required to assess the importance and effectiveness in each.

**Conclusions.** Considered independently, habitat acquisition and protection, site monitoring and stewardship, and acquiring replacement artifacts would likely have low short-term benefits. Short-term benefits of artifact repositories would be immediate but moderate. Short-term benefits of salvage excavations and site stabilization would be immediate and high.

Long-term benefits are potentially moderate for each of the identified general restoration actions, but may vary between communities. The benefits would likely be high if actions were combined and village-based. Long-term benefits of habitat acquisition would be moderate.

On balance, this alternative would benefit cultural resources moderately in the short term, but moderate to high benefits in the long term.

## Subsistence

### **Habitat Protection**

It is assumed here that 34 parcels, a total of 478,500 acres, would be purchased. These parcels contain low (status as a subsistence use area unknown), moderate (known historic subsistence use area, which may be used again), or high (known current subsistence use area) potential for benefiting subsistence as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.4 (or between moderate and high).

Short-term benefits of habitat protection and acquisition on the recovery of subsistence species and subsistence use would be low, but the long-term benefits would be low to moderate. Protecting lands from the habitat degradation associated with extractive economic activities like mining and logging would help recovering subsistence resources recover more quickly.

This analysis does not take into consideration small parcel acquisition, which is currently under evaluation. It is also possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels - possibly all 81 identified parcels (863,100 acres).

### **General Restoration**

The additional 35 percent allotted for general restoration could fund projects that directly affect the subsistence resources and subsistence activities within the EVOS area. Those actions are summarized below. Please refer to the appropriate sections of this alternative for more detail on effects on individual species. These proposed actions could be conducted independently from each other or in combination.

## 4 Environmental Consequences

### - Harbor Seals

The decline in subsistence harvest of harbor seals may have helped stabilize the population. The proposed action to implement cooperative programs between subsistence users and agencies to assess the effects of subsistence harvest may help in sorting out which localities would be best utilized (or best left alone) for subsistence use in order to optimize natural recovery of the populations. This will be a moderate long-term benefit, taking as long as five to ten years to establish a measurably significant benefit. This action has the advantages of relatively low cost and spin-off value in improving communication between agency biologists and subsistence users. Cooperative programs proposed for reducing incidental take of harbor seals during fishing likewise would have low short-term benefits, but may have moderate long-term benefits in five to ten years. Reducing disturbance at haulout sites in the oil spill area would have a negligible benefit in the short term and a moderate benefit long term.

### - Sea Otters

One of the proposed actions would establish a cooperative program between subsistence users and research scientists or agency managers. While subsistence harvests are not a significant impact on sea otter populations, agency biologists and subsistence users would both benefit from the additional interaction and information sharing that would grow from such an action. Traditional knowledge of sea otter behavior and their relation to other parts of the ecosystem may be more extensive than is presently recognized by agency biologists. Similarly, the present range and concentration of sea otters may be better understood by agency biologists than is presently recognized by many subsistence users. This type of action would have little benefit immediately or in the short term on the recovery of sea otters, but the long-term benefit on management efforts - and so the sea otter populations - could be significant.

### - Intertidal Organisms

A project has been proposed to reduce hydrocarbon levels in oiled mussel beds by temporarily removing mussels, replacing oiled sediments, and returning the mussels. Part of this action would be to monitor treated and untreated mussel beds to document the differential rates of recovery. This action would have low short-term and moderate long-term benefits on subsistence users, and the benefits would be localized.

*Fucus*, one of the central elements in intertidal ecosystems, is important for subsistence users as food and as habitat for other subsistence resources. A pilot project has been proposed to transplant *Fucus* to increase its population in the high intertidal zone. Recovery of *Fucus* is estimated at a decade. This would have insignificant short-term benefits, but may have moderate long-term benefits to subsistence users.

The recruitment of intertidal clams on cleaned beaches will remain low until a substrate of appropriate grain size is re-established, either naturally or through restoration efforts. A project (94068) has been proposed to study the feasibility of depositing fine-grained sediments to enhance larval recruitment and population recovery. Should this prove feasible, it would be possible under this alternative to fund expansion of the technique within the spill area. The hypothesis is that population recovery could occur within one or two years. Should this hypothesis be substantiated, and if subsistence users could be assured of the safety of eating clams produced in the enhanced habitat, both long and short-term benefits on subsistence use would be high.

## - Pink Salmon

Relocation of hatchery runs has been identified as a means to divert the commercial fishing fleet away from wild stocks of pink salmon. The resultant recovery of stocks would benefit subsistence uses of pink salmon. The benefits of this action on subsistence mirror those of the pink salmon population: negligible in the short term, but high in the long term of five to ten years.

## - Sockeye Salmon

The use of egg incubation boxes has been proposed to restore or enhance sockeye salmon populations in the spill area. It is estimated that short-term benefits would be moderate, drainage-specific increases in populations. Long-term benefits would be low because of scarcity of appropriate siting locations. If appropriate siting locations are found near villages, this technique has the potential for working very well locally to increase the amount of sockeye salmon available (both long- and short-term) for subsistence use.

Net-pen rearing of sockeye salmon fry has been proposed to increase their survival rate. Since there are many appropriate locations for net pens in the EVOS, it is estimated that this technique would have strong short and long-term benefits on the sockeye salmon populations. The advantage to subsistence users would be a corollary benefit.

Hatchery rearing of sockeye salmon, with release possible as fed fry, presmolts, and smolts. A number of project types are applicable, using different combinations of biological, physical, logistical and technological factors. The short-term benefit of this type of action is likely to be low because it will take some time to establish the populations. The long-term benefit to pink salmon populations is estimated to be high, as several generations of improved survival rates to the smolt stage leading to the increased numbers of returning adults. The benefit to subsistence users will increase as populations of sockeye salmon increase. Benefit to subsistence users increases if wild stocks are separated from hatchery stocks. Concentration on hatchery stocks by commercial fisheries may reduce competition for wild stocks.

Fertilizing lakes to improve sockeye rearing success within the lake and increase sockeye population has also been proposed. Sockeye salmon populations have been successfully increased through lake fertilization, but there may be few candidate lake systems for this application. The short-term benefit of this action on subsistence users would be negligible, while the long-term outlook would be substantially increased numbers of sockeye in specific stream systems, a high long- term benefit for subsistence users in some locations..

Relocation of hatchery runs has been identified as a means to divert the commercial fishing fleet away from wild stocks of sockeye salmon. The resultant recovery of stocks would benefit subsistence uses of pink salmon. The benefits of this action on subsistence mirror those of the sockeye salmon population: negligible in the short term, but high in the long term of six to ten years.

## -Subsistence Food Testing

One of the main elements in the damage to subsistence uses in the spill area is the fear that once-safe subsistence foods are no longer safe to eat. An action has been proposed to conduct tests on subsistence foods to determine the amount of contamination, if any, in



## 4 Environmental Consequences

various types of subsistence foods. This action would provide immediate information to subsistence users, providing short- and long-term high level benefit to their sense of security.

**Conclusions.** Short-term benefits to populations of harvestable subsistence resources, and so to subsistence use, under this alternative on subsistence would be low. Long-term benefits of habitat acquisition to subsistence species and subsistence users would be low to moderate. General restoration actions would likely produce moderate to high benefits.

### Recreation and Tourism

#### **Habitat Protection**

It is assumed here that 34 parcels, a total of 478,500 acres, would be purchased under Alternative 4. These parcels contain low (low to no recreation use; access may be difficult), moderate (receives occasional public use; adjacent waters used for recreational boating; adjacent area receives high public use), or high (receives regular, high directed public use; highly visible to a large number of recreationists/tourists) potential for benefiting recreation and tourism as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.1 (or slightly higher than moderate).

The benefit to recreation and tourism of habitat protection and acquisition derive from protection of the scenic, wildlife, and undeveloped characteristics important for recreation values in the parcels being evaluated for acquisition. Extractive economic activities would reduce the recreational visual appeal of the landscape, shift or reduce wildlife viewing possibilities, and eliminate the relative lack of developed (logged or mined) character, thereby reducing the overall utility of those and surrounding areas for recreation purposes. These benefits would be low in the short term, but moderate to high in the long term. This analysis does not take into consideration small parcel acquisition, which is currently under evaluation. It is also possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels - possibly all identified parcels (up to 863,100 acres).

#### **General Restoration**

Restoration strategies for recreation and tourism are to preserve or improve the recreation and wilderness values of the spill area, remove or reduce residual oil if it is cost effective and less harmful than leaving it in place, and monitor recovery. Alternative 4 focuses on stabilizing and improving existing recreation opportunities. It does not allow for funding of projects that create new recreation opportunities or promote public land recreation use.

Specific actions identified under this alternative are discussed below. Where restoration actions are successful in increasing the number of recreationists/tourists, or causing a higher use level of mechanized transport, there is a concurrent change in the wilderness quality of the recreation experience, which some recreation users would consider a negative impact. Depending on the extent of development and the volume of visitors, this benefit could be widespread or localized.

## -Removing Residual Oil

Short-term benefits to populations of harvestable subsistence resources, and so to subsistence use, under this alternative on subsistence would be low. Long-term benefits of habitat acquisition would be low to moderate. General restoration actions would produce moderate to high benefits. Subsistence harvests at pre-spill levels, stabilization of subsistence activities, perception of subsistence species recovery and consumption safety, and reintegration of many of the cultural values associated with subsistence activities into the communities are likely to occur within five to ten years, especially if several actions are undertaken concurrently.

## -Easement Identification

Easement identification has been proposed as a means to reduce trespass and land-use conflicts between private landowners and the general public. This would improve recreation and tourism by letting people know where public land access exists. The short-term benefit would be low, since dissemination of the knowledge would accumulate impact over several years. Long-term benefit would be moderate to high, but may be very localized.

**Conclusions.** The short-term benefits of both habitat protection and acquisition and general restoration actions on recreation and tourism in terms of increased numbers of visitors, types of recreation opportunities available, and quality of experiences would be low. The long-term benefits of habitat protection and acquisition on recreation use levels and appreciation would be moderate. The long-term benefits of general restoration actions on numbers of visitors and recreation opportunity types would range from moderate to high, though these benefits may be offset somewhat by a changes in the wilderness quality of some types of recreational experiences as use increases.

## Wilderness

### Habitat Protection

It is assumed here that 34 parcels, a total of 478,500 acres, would be purchased. These parcels contain low (high/moderate evidence of human development and/or ongoing activities), moderate (area remote; evidence of human development and/or ongoing activities), or high (area remote; little or no evidence of human development) potential for benefiting wilderness as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.3 (or slightly higher than moderate). Short-term benefits on designated Wilderness would be low. Long-term benefits would be low, with benefits derived from protecting areas adjacent to or near Wilderness areas from extractive activities. This analysis does not take into consideration small parcel acquisition, which is currently under evaluation. It is also possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels - possibly all identified parcels (up to 863,100 acres).

### General Restoration

General restoration actions could include any that assist recovery of injured resources, or which prevent further injury. Any of these would have spin-off benefits that would improve wilderness values in the EVOS area. Recovery of designated Wilderness areas hinges on

## 4 Environmental Consequences

removal of traces of oil and clean-up activities and public perception that the areas are recovered. Public awareness projects or marketing projects that may affect public perception of the recovery of Wilderness areas could be undertaken under this alternative, as long as it is restricted to protecting and increasing existing use.

The concentration in this alternative would be on projects that remove residual oil and/or residual clean-up materials still existing in isolated pockets in Wilderness areas. These types of projects may only occur if they provide substantial improvement over natural recovery. Short-term benefits would be immediate but low. Long-term benefits to recovery of Wilderness values would be moderate.

**Conclusions.** Short-term benefits of habitat protection and acquisition, and those of proposed general restoration actions on designated Wilderness would be low. Long-term benefits of habitat protection and general restoration actions on restoration of the pristine environment of Wilderness areas and of Wilderness values would be moderate.

### Commercial Fishing

Alternative 4 will provide restoration actions to assist replacement of harvest opportunities that were lost because of fishing closures or harvest restrictions that occurred as a result of the EVOS. Actions that may be implemented as part of Alternative 4 include: habitat protection and acquisition and creation of new hatchery-produced runs (EVOS Trustee Council, April; November 1993) Appendix C).

Habitat protection may benefit commercial fishing opportunities by providing long-term protection for natural production and stability of wild stocks of pink and sockeye salmon and Pacific herring. The criteria for these parcels that may benefit commercial fisheries depends on the values assigned for those species (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit replacement of lost opportunities for commercial fishing according to Alternative 4 will depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 34 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low to moderate value for commercial fisheries. If only 34 parcels are purchased, the benefit is expected to provide moderate value (Appendix A).

Although the average value of forecasted habitat acquisition may not have a high overall rating for commercial fisheries, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

### **Restoration Actions.**

For commercial fishing resources, the primary action considered under Alternative 4 will replace lost opportunities by creating new hatchery-produced runs of salmon. Specific actions that may be considered should either alone, or collectively, produce sufficiently large numbers of adult pink or sockeye salmon to accommodate a reasonable portion of the fishing fleet to provide a harvest that is separated in time or space from existing harvests. Actions

that may potentially fit these criteria include: development of new hatchery runs (e.g., stock fry, presmolts or smolts) or habitat manipulation to increase production of selected stocks (e.g., lake fertilization, spawning channels, etc.). Actions that are designed to increase fish production by habitat manipulation are described in Appendix C.

Development of new runs will provide a benefit for commercial fishing by providing an alternate location and stock for commercial fishing activities. If the brood stock selection for these new runs and the release site is carefully selected, there will be minimal interception of injured wild stocks. Combined with good fishery management practices, and a redistribution of the fishing fleet, an intensive commercial fishery can harvest these stocks (Appendix C).

ADF&G and PNP aquaculture organizations that have established a modern fisheries enhancement program in the area establish new runs of salmon for harvest by commercial fishers. Excellent success has been achieved with sockeye salmon (Ellison, 1993); however, results with pink salmon have been less consistent (Alaska Fish and Game Magazine). Some locations remain as opportunities for juvenile fish imprinting and adult fish terminal harvest areas that are readily accessible to the fishing fleets.

Every fisheries enhancement program must be carefully planned and managed to avoid risks to wild stocks and the fish-culture program must be carefully structured and controlled to avoid or minimize potential changes in the genetics makeup and health of the wild stocks that may be caused by the fish cultural program (Appendix C.)

## Conclusions.

- short-term effect.: Negligible. New runs probably cannot be established within one lifecycle to support new commercial fisheries to replace opportunities lost because of fishing closures or reduced harvests.
- long-term effects. Moderate. These actions will assist the replacement of lost commercial fishing opportunities, however, some portions of the EVOS area will obtain greater benefits than in other portions.

## Sport Fishing

Sport fishing was disrupted throughout most of the EVOS area because of the oil spill and damage was sustained by several important sport fish species. Lost sport fishing opportunities may be replaced by creating new sport fisheries for salmon or trout. Alternative 4 will provide restoration actions to assist replacement of harvest opportunities that were lost because of fishing closures or harvest restrictions that occurred as a result of the EVOS. Actions that may be implemented to as part of Alternative 4 include: habitat protection and acquisition and creation of new hatchery-produced runs (EVOS Trustee Council, April; November 1993) Appendix C).

Habitat protection may benefit sport fishing opportunities by providing long-term protection for natural production and stability of wild stocks of pink and sockeye salmon, Dolly Varden



## 4 Environmental Consequences

and cutthroat trout. The criteria for these parcels that may benefit commercial fisheries depends on the values assigned for those species (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit replacement of lost opportunities for sport fishing according to Alternative 4 will depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 34 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low to moderate value for sport fisheries. If only 34 parcels are purchased, the benefit is expected to provide low to moderate value (Appendix A).

Although the average value of forecasted habitat acquisition may not have a high overall rating for commercial fisheries, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

### Restoration Actions.

Establishment of hatchery runs will provide some benefit for all fishers by providing new opportunities with new locations and stocks that anglers may utilize. Typically, a run of a few thousands of fish will provide tens of thousands of angler/days of recreation (Mills, 1993). Sport fisheries, however, will be successful only if they are located where they can be accessible by anglers. ADF&G has already employed this strategy to improve sport fishing opportunities for trout and salmon in the EVOS area (Appendix C.)

A small number of fish in a good, accessible location can provide angling to accommodate a substantial number of angler/days of recreation. Wherever large number of fishers concentrate to harvest a concentrated population of fish, some portions of the adjacent habitat may be affected, however, new sport fisheries will readily create new recreational opportunities, but these will likely be for different species in new locations.

Every fisheries enhancement program must be carefully planned and managed to avoid risks to wild stocks and the fish-culture program must be carefully structured and controlled to avoid or minimize potential changes in the genetics makeup and health of the wild stocks that may be caused by the fish cultural program (Appendix C.)

### Conclusions.

- short-term. Negligible. New sport fisheries probably cannot be established within one life cycle to replace lost sport fishing opportunities.
- long-term. High. After hatchery production is expanded and newly-established sport fisheries will provide substantial recreational benefits.

### Impact on the Economy

Qualitative analysis indicates that Alternative 4 will result in moderate economic benefits in commercial fisheries and recreation and moderate negative effects in forestry. Quantitative analysis reflects effects resulting from habitat acquisition on forestry and other sectors but not



effects on commercial fishing and recreation because data is not available to quantify in these sectors. The quantitative analysis follows.

The acquisition of lands for habitat removes them from timber production. This results in a negative quantity in forestry for each of the six economic measures of final demand, industry output, employee compensation, property income, value added, and employment. The negative effects on the economy first injected directly to the economy by purchasing habitat multiplies to positive and negative values in other sectors of the economy. Expenditure of funds on restoration has a direct effect on the construction sector as shown in Table 4-6 Alternative 4 in the amount of \$10.6 million in industry output but this is not enough to offset the negative effects in forestry. There is also spending, primarily in income received from timberland owners, in the service sector which results in \$2.6 million in final demand and 306 employees. The net effect is shown in the total line which has negative quantities for the three out of the six economic measures; employee compensation, value added, and employment are positive.

Habitat acquisition and general restoration expenditures will have economic benefits for the commercial fisheries and recreation sectors of the economy. However, these benefits are not reflected in the IMPLAN projections presented in Table 4-6. Therefore, this table does not quantify important economic benefits in commercial fishing and recreation because these benefits are not quantified. Of the three most important economic sectors for this analysis, only forestry is quantified. The typical projects in various combinations, such as fish ladders, fish hatcheries, and preservation of habitat will economically enhance the commercial fisheries and recreation sectors of the economy. However, because studies and data are not available that quantify in terms of dollars or employment, it is not possible to quantify the economic effects for these two sectors of the economy. In Table 4-6 the quantities for the commercial fisheries and recreation sectors are reflections of the indirect effects of other sectors of the economy only; they are not reflections of the anticipated but unquantified effects on those sectors.

See the introduction to Chapter 4 on economics and Appendix D Economics Methodology for a more detailed discussion of methodology.

**Conclusions.** Qualitative analysis indicates that Alternative 4 will result in moderate economic benefits in commercial fisheries and recreation and moderate negative effects in forestry. Quantitative analysis reflects effects resulting from habitat acquisition on forestry and other sectors but not effects on commercial fishing and recreation. Quantitative analysis indicates that Alternative 4 result, in annual averages for a 10-year period, in a loss of approximately \$23 million in forestry industry output, an increase of \$11 million in construction industry output, and \$2 million in government. The corresponding changes in employment are a loss of 143 jobs in forestry, an increase of 96 in construction, an increase of 306 in services and an increase of 45 in government.

Table 4-6. Alternative 4: 7% Administration, 8% Monitoring, 35% Restoration, 50% Habitat Protection  
Change from Base in 1990\$ Millions

| Economic Sector                 | Final Demand \$ | Industry Output \$ | Employee Comp. \$ | Property Income \$ | Value Added \$ | Employment # |
|---------------------------------|-----------------|--------------------|-------------------|--------------------|----------------|--------------|
| Forestry                        | -17.8153        | -22.9178           | -5.7724           | -2.3292            | -8.9597        | -142.6       |
| Commercial Fisheries            | 0               | 0                  | 0                 | 0                  | 0              | 0            |
| Mining                          | 0.0311          | 0.0664             | 0.0053            | 0.0305             | 0.0509         | 0.07         |
| Construction                    | 11.0338         | 10.6457            | 4.0013            | 1.6079             | 5.6373         | 95.74        |
| Manufacturing                   | 0.0293          | 0.1275             | 0.0242            | 0.0673             | 0.0433         | 0.32         |
| Recreation Related              | 0.0252          | 0.1271             | 0.0374            | 0.0325             | 0.0729         | 2.25         |
| Communication & Utilities       | 0.053           | 0.2072             | 0.0651            | 0.0716             | 0.1396         | 1.98         |
| Trade                           | 0.2535          | 0.3597             | 0.2105            | 0.0491             | 0.3038         | 8.77         |
| Finance, Insurance, Real Estate | 0.2437          | -0.1156            | -0.0831           | 0.0091             | -0.0567        | -2.5         |
| Services                        | 2.6824          | 0.8025             | 1.5116            | -0.499             | 1.0203         | 305.95       |
| Government                      | 2.4627          | 2.3916             | 2.1203            | -0.0098            | 2.4104         | 44.89        |
| Miscellaneous                   | 0               | 0                  | 0                 | 0                  | 0              | 0            |
| Total                           | -1.0006         | -8.3053            | 2.1202            | -1.0199            | 0.6623         | 314.88       |

Source: IMPLAN Economic Model. See text for methodology.

## The Proposed Action Alternative 5: Comprehensive Restoration

### Introduction

In this alternative, the general restoration program focuses on the status of recovery of injured resources rather than on the degree of injury caused by the oil spill. In this way, the components of the ecosystem that are having most difficulty recovering receive the greatest efforts - if there are general restoration actions that can realistically help. This alternative also increases the opportunity to conduct research into other aspects of the ecosystem that may be influencing the recovery of the resources and services injured by the oil spill. A Restoration Reserve fund would be established to provide funding for research, monitoring, and restoration activities to continue beyond the 10-year settlement period.

The habitat protection and acquisition program is a primary component of the overall restoration program, receiving the largest portion of the remaining settlement funds. Habitat protection and acquisition provides protective benefits to all resources and services injured by the oil spill as well as to other resources and human uses that are important to the greater EVOS ecosystem. Increasing the protection of habitat throughout the spill area will be beneficial to the entire ecosystem by reducing further habitat degradation that may compound the effects of the oil spill. The general restoration actions can help resources or services recover to their prespill conditions more rapidly than if the actions were not implemented. A third component of the restoration program is Monitoring and Research. These activities track the progress of recovery and provide valuable information that can be used to help the resources, and the overall ecosystem, recover from the oil spill and from other factors that may be delaying recovery.

### Impacts on Biological Resources Impact on Intertidal Resources

In Alternative 5 the restoration program for intertidal resources differs from the previous alternatives by adding an additional action, and by providing three possible scenarios for the Habitat Protection program. These changes are presented at the beginning of the discussion below, followed by the actions that are identical to those described in alternatives 3 and 4.

Habitat Protection. Although there are several types of actions that apply under this restoration category, this analysis only considers the types of benefits that may be gained from protecting the 81 upland parcels identified in the Comprehensive Habitat Protection Process: Large Parcel Evaluation & Ranking Volume I and II (EVOS Restoration Team, November 1993). Other aspects, such as the small parcels available for protection, of the habitat protection category are still being developed and cannot be analyzed in this DEIS.

The Habitat Protection process used to evaluate the 81 parcels for their potential benefits to injured resources and services combined intertidal and subtidal biota and used the following criteria for ranking the parcels:

## 4 Environmental Consequences

- "High" for parcels adjacent to areas with a known high species abundance and diversity; high quality habitat for intertidal and subtidal biota;
- "Moderate" for parcels adjacent to extensive intertidal habitat with observed or probable moderate species diversity and abundance; and,
- "Low" for parcels with little intertidal habitat with low species abundance (EVOS Restoration Team, November 1993).

In alternative 5, it is possible to consider the value of all 81 parcels if it is assumed that the cost per acre is inexpensive, however, if the cost per acre is higher fewer acres of land are likely to be purchased. In this alternative there is a range of funds available for Habitat Protection and Acquisition actions, so there are two more restrictive estimates that need to be assessed based on a higher cost per acre. For this analysis, when a higher cost per acre is assumed for the protection of these parcels, fewer of the parcels that are ranked "Low" for multiple resources and services are likely to be protected. Some of these parcels may still have "High" or "Moderate" value for intertidal and subtidal resources, even though their total ranking is "Low" when evaluated for all of the injured resources and services combined. Table 4-7 shows how the distribution of habitat evaluated as "high", "Moderate" or "low" changes for intertidal/subtidal benefits when all 81 parcels are considered or when the parcels are reduced from higher cost and/or less money is dedicated to habitat protection.

**Table 4-7**  
**Distribution of Habitat Evaluated**

|   | High Benefits | Moderate Benefits | Low Benefits |
|---|---------------|-------------------|--------------|
| All 81 parcels considered<br>(same in all alternatives) | 25 parcels    | 33 parcels        | 19 parcels   |
| Higher parcel cost with 50%<br>remaining funds          | 19 parcels    | 10 parcels        | 4 parcels    |
| Higher parcel cost with 45%<br>remaining funds          | 18 parcels    | 9 parcels         | 3 parcels    |

Under the most restrictive scenario, out of the 81 parcels evaluated 72 percent of the parcels ranked "High" for their intertidal/subtidal habitat would still be protected. The benefits to intertidal and subtidal organisms through the protection of upland habitats comes in two forms. First, the protection can prevent the intertidal and subtidal areas from being altered by the actions that may occur on the parcels. Some actions can cause indirect adverse effects through siltation, or increased pollution, while other actions such as the construction of a dock or creating a new harbor, could directly alter the intertidal and subtidal habitats. The second type of protection reduces the disturbance caused by increased human activity (e.g. more people walking through the intertidal area; more pollution from littering or from bilge discharge). Obviously, the type of activity that may occur on a given parcel can substantially change the degree of benefit that is gained to the intertidal and subtidal zones.

The actual benefit gained by the intertidal and subtidal organisms depends on the type and location of the activities that may occur. In areas where construction activities are anticipated in the intertidal zone, the protection would be especially effective. If the parcels correspond to areas of the intertidal zone that are still not recovering from the effects of the oil spill, the benefits could be even greater.

This alternative includes establishing a clam mariculture program to help the recovery of subsistence uses in the spill area (also see the discussion on impacts to subsistence users in this alternative). This program would create a bivalve hatchery that would provide seed sources for creating new clam beds or re-establishing clam beds injured by the oil spill. Because this action is targeted towards subsistence activities, the areas that would benefit from this action would probably be close to villages within the spill area. Eyak, Tatitlek, Chenega Bay, Nanwalek and Port Graham are some of the villages that have been discussed as benefiting from this action (EVOS Trustee Council, October 1992). The spill-wide distribution of clam beds that were injured from the oil spill and clean up activities is unknown. To the extent that this action re-establishes clam beds that are still exhibiting lower abundance of clams than unoiled areas, this action can substantially accelerate the recovery of the clam beds. If the mariculture program targets new areas to create clam beds, other intertidal habitats could be lost. Mariculture facilities that are designed like a commercial operation should have negligible effects on the intertidal communities.

The other two actions that have been identified for this alternative can directly affect the intertidal zone. These actions affect specific organisms, *Fucus* and mussels, but are meant to provide broader benefits to the other organisms that live or feed in these communities.

Accelerate the recovery of the upper intertidal zone by re-establishing *Fucus*. The upper intertidal area, specifically the upper 1 meter vertical drop (1MVD), is probably the upper extent of suitable habitat for *Fucus* to grow. This means that the conditions are more extreme than in other habitats and would be more difficult to colonize. *Fucus* germlings that colonize in the upper intertidal area are subject longer periods of high temperatures and dryness during low tides. Without the shelter and moisture that is provided by adult *Fucus* plants the germlings can become desiccated and die. Studies conducted in Herring Bay, Prince William Sound, suggest that it may take 3 to 4 years for *Fucus* communities to expand 0.5m beyond their existing boundaries (Highsmith et al, October 1993).

Feasibility studies of techniques for accelerating the recovery of *Fucus* were begun in 1992. Attempts to transplant adult *Fucus* plants were generally unsuccessful (Stekoll pers comm. 4/8/94). Another technique which uses a biodegradable cloth to cover seeded areas is currently being tested (Stekoll, pers comm. 4/8/94). The results of this experiment will be known during the summer of 1994. In theory, the cloth will substitute for the adult *Fucus* by providing moisture and protection to the germlings during low tides. Because the technique is still being tested it is impossible to know how successful the action may be, or how easily it can be applied to the areas that could benefit from the action. If the technique is highly successful, the established germlings could become fully mature plants in 3-4 years and the associated invertebrates will also recolonize in the upper intertidal zone. At this time, however, it is impossible to know the outcome of the research therefore any benefits from this action are unknown.



## 4 Environmental Consequences

Cleaning oiled mussel beds has been considered as a possible method to reduce the hydrocarbon exposure for sea otters, harlequin ducks, and black oystercatchers. These animals depend on mussels for a large portion of their diet (Doroff and Bodkin, 1993). Mussels can be found in loose aggregations attached to intertidal rocks, or they can be found in dense aggregations (mussel beds) over pea gravel and silt sediments. Because mussels form a dense matt over the sediments and rocks, oil that was trapped beneath the mussels was not exposed to weathering and still remains toxic. It may be possible to clean mussels in mussel beds, but there are areas where it will be technically infeasible to remove the remaining oil.

One of the possible explanations of the continuing signs of injury to sea otters, river otters, harlequin ducks and black oystercatchers is that they are continuing to be exposed to hydrocarbon contamination by eating oiled mussels. Concern over this possible continuing source of contaminations led to feasibility studies to develop techniques to clean the sediments beneath the oiled mussel beds. One technique that will be tested in 1994, lifts sections of the mussel beds and replaces the contaminated sediments with clean sediments without serious damage to the mussel beds (Bodkin, pers comm.). Other techniques are likely to damage the existing mussels in order to remove the contaminated sediments. Approximately 60 locations with oiled mussel beds have been identified in Prince William Sound.

The extent and distribution of oiled mussel beds is still being determined and will be important in understanding the potential benefits that can be gained for other organisms by this action. There have been no studies to determine whether or not eating contaminated mussels is causing injury to other animals. The intent of cleaning oiled mussel beds is largely to eliminate a source of continuing contamination to other organisms. Studies which examined the effects of oil on the mussel beds noted a reduction in the number of large mussels and overall biomass of the mussel beds, but there did not appear to be a shortage of new recruits (smaller mussels) to the mussel beds (Highsmith et al, December 1993). It is unknown if the trapped oil beneath the mussel beds will ultimately cause further injury to the mussels; however, continued high levels of hydrocarbons have been found in mussel tissues which indicates that the mussels may be continuing to be contaminated.

If techniques are developed to clean the oiled sediments without destroying a large amount of the mussel beds then this action is unlikely to cause an adverse effect, and may provide tangible benefits to the mussels at the cleaned sites. It is reasonable to assume that the ability of this action to reduce the level of contamination beneath mussel beds is valid in all regions of the spill area. However, there is less information on the location of oiled mussel beds in areas outside of Prince William Sound.

### Conclusions.

- short-term benefits. Negligible.
- long-term benefits. For direct restoration actions are unknown because both of these actions are still being tested. The long-term benefits of the Habitat Protection actions for reducing disturbance or preventing additional injury to intertidal organisms are moderate and will vary substantially between parcels.

## Marine Mammals

### **Harbor Seals**

The restoration program for harbor seals that is possible under Alternative 5 differs from the previous alternatives by adding an additional action. The Habitat Protection capabilities may also differ from those described in Alternatives 2 and 4 because our estimated range of potential funding reduces the amount of upland that could be protected slightly more than the more restrictive scenario presented in Alternative 4. It is also possible that efforts made to increase, or create new, recreation and commercial tourism use of the oil spill area, could increase the level of disturbance on the harbor seal populations. These changes are presented at the beginning of the discussion below, and are followed by a repeat of the discussions that are applicable here from other alternatives.

The only new action proposed for harbor seals in this alternative is to reduce disturbance at haulout sites in the oil spill area. Several studies have documented the effects of disturbances on harbor seals and other pinnipeds (Allen, et al. 1984; Esipenko, 1986; Johnson, et al. 1989). These studies have shown that the greatest impacts from disturbance are during pupping and molting seasons. During pupping, disturbance can result in higher pup mortality caused by abandonment, or from being crushed as the adults panic and return to the water (Johnson, 1977). During molting, seals are under physiological stress and may be more susceptible to disease and injury. The greatest disturbance is caused when people walk near or through haulout sites (Johnson, et al. 1989), seals are less disturbed by boats or planes as long as the distance is reasonable. Within the EVOS area, there have been no studies to document the amount or effects of disturbance. Without these data, it is impossible to determine if this action will reduce seal mortality and aid recovery, however, it may become increasingly important as recreational use and commercial tourism of the EVOS area expands.

Restoration actions for other resources/services. If actions are taken to increase, or create new, recreation and commercial tourism activities in the oil spill area, there could be a negative, long-term impact on harbor seals. These impacts could be avoided or minimized by implementing education programs to minimize the level of human-caused disturbance. Aside from monitoring and research activities, and assuming that the actions previously described are implemented, none of the other actions proposed under this alternative for other resources or services are likely to impact harbor seals.

Habitat Protection of upland parcels. Harbor seals use haulout sites that are either in the intertidal zone, or immediately adjacent to the intertidal zone; therefore, actions that occur on the upland are not likely to destroy the habitat. However, it is possible that habitat changes to the uplands may increase the amount of disturbance currently experienced at haulout sites on or near the parcel. Disturbance has been documented as adversely affecting harbor seals and other pinnipeds in other parts of their range (Allen, et al. 1984; Esipenko, 1986; Johnson, et al. 1989). These studies have shown that the greatest impacts from disturbances are at haulout sites during pupping and molting. During pupping, disturbance can result in higher pup mortality caused by abandonment, or from being crushed as the adults panic and return to the water (Johnson, 1977). The greatest disturbance is caused when people walk near or through haulout sites (Johnson, et al. 1989), but disturbance can also be caused by low flying aircraft and by boats that approach too close to the haulouts.

## 4 Environmental Consequences

Habitat protection criteria for parcels that may benefit harbor seals include ratings of:

- "High" for parcels known to have a haulout of 10 or more seals on or immediately adjacent to the parcel;
- "Moderate" for parcels with known haulouts with sporadic use and less than 10 seals; or, probable haulouts in vicinity of the parcel; or probable feeding in nearshore waters; and,
- "Low" for possible feeding sites located in nearshore waters adjacent to the parcel (EVOS Restoration Team, November 1993).

Of the 81 parcels evaluated in the large parcel process, 25 of the parcels were ranked "High", 19 of the parcels were ranked "Moderate", 35 were ranked "Low" and 2 parcels were ranked as having no benefit to harbor seals. The overall value of these parcels, based on these rankings, is "moderate", although individual parcels may have exceptional value.

In alternative 5, it is possible to consider the value of all 81 parcels if it is assumed that the cost per acre is inexpensive, however, if the cost per acre is higher fewer acres of land are likely to be purchased. In this alternative there is a range of funds available for Habitat Protection and Acquisition actions, so there are two more restrictive estimates that need to be assessed based on a higher cost per acre. For this analysis, when a higher cost per acre is assumed for the protection of these parcels, fewer of the parcels that are ranked "Low" for multiple resources and services are likely to be protected. Under the scenario where 50 percent of the remaining settlement funds are available for habitat protection actions, the potential benefit to harbor seals is identical to the changes described in Alternative 4. Table 4-8 shows how the distribution of habitat evaluated as "high", "Moderate" or "low" change when all 81 parcels are considered or when the parcels are reduced from higher cost and/or less money dedicated to habitat protection.

**Table 4-8**  
**Distribution of Habitat Evaluated**

|  | High Benefits | Moderate Benefits | Low Benefits |
|--|---------------|-------------------|--------------|
| All 81 parcels considered (same in all alternatives) | 25 parcels    | 19 parcels        | 15 parcels   |
| Higher parcel cost with 50% remaining funds          | 18 parcels    | 6 parcels         | 7 parcels    |
| Higher parcel cost with 45% remaining funds          | 17 parcels    | 5 parcels         | 6 parcels    |

Under the most restrictive scenario, out of the 81 parcels evaluated 68 percent of the parcels ranked "High" for harbor seals would still be protected. Because the actual impact that development on these parcels will have on the harbor seals depends on, among other things, the type of disturbance caused, the length and duration of the disturbance, and whether or not the haulout area is used for pupping or molting, it is impossible to know what change in the protection to sites with haulouts will have on the recovering harbor seal population. Within the EVOS area, there have been no studies to document the amount or effects of current

activities that may cause disturbance to harbor seals so baseline data are unavailable. However, it is reasonable to assume that protection of upland habitats near haulout sites will reduce the risk of disturbance to the injured population.

The remaining actions were described in Alternatives 3 and 4, they are repeated here. Both of the proposed actions are information based programs that would be designed to change the impact of commercial fisheries or of subsistence harvest on the recovering seal populations.

Subsistence harvest is not believed to be the cause of the long-term decline of harbor seal populations in the Gulf of Alaska; however, any additional mortality may slow the recovery of injured populations. Subsistence harvest in Prince William Sound declined as a result of the oil spill and in 1991 harvest levels were probably less than 5 percent of the population. A healthy seal population would be able to easily sustain that level of harvest. Depending on the distribution, sex and age of the animals harvested, a 5 percent harvest could negatively affect an injured population.

One of the proposed actions would establish a cooperative program between subsistence users and research scientists or agency managers. The program would be designed to provide a two-way exchange of information that would provide benefits to all sides and could benefit the injured harbor seal populations. For example, recent studies indicated that harbor seals may have a high site fidelity to molting and pupping areas (e.g. the same individuals consistently use the same areas) (Pitcher 1990). If some of these areas show greater declines than other sites within Prince William Sound, then redirecting harvest towards the healthier, or the nonoiled areas could reduce any negative effects from the harvest without actually changing the number of animals harvested.

A similar cooperative program with commercial fishermen could also reduce pressure on the injured seal populations. This program would provide information on deterrent methods and regulations. Ideally it would provide information to the scientists on the extent of the interactions between the commercial fisheries and the seals, and would reduce the number of seal mortalities. The interactions with commercial fisheries probably result in fewer deaths than from the subsistence harvest and is unlikely to be the cause of the seal decline; however, the more that can be done to minimize the effects of human caused injury and mortality, the more likely it will be that the population will stabilize and recover.

## Conclusions.

- short-term benefits. Negligible. All of the proposed actions require some time after implementation before any changes could be expected.
- long-term benefits. Moderate. The proposed actions could reduce negative impacts on harbor seals, and may result in increased recovery rates in local areas.

## Sea Otters

The effects of actions under Alternative 5 are expected to be identical to those described in Alternatives 3 and 4 with the exception of the amount of habitat that can be protected.

## 4 Environmental Consequences

There are three types of actions aside from Research or Monitoring that are considered in this alternative: habitat acquisition, cleaning oiled mussel beds, and creating a cooperative program between subsistence users and sea otter scientists and managers.

Habitat protection. The benefit to sea otters of habitat protection actions on upland parcels is through reducing potential or actual disturbance. Sea otters appear to have a high tolerance to certain human activities, as evidenced by their abundance in highly travelled areas such as Orca Inlet near Cordova; however, their response to large-scale disturbances has not been studied. Large-scale disturbances, such as log-transfer sites, may force resident otters to leave the immediate area and may cause a long-term change in food availability as debris from the logs cover the substrate(). Disturbance is more likely to cause adverse effects to females with pups that concentrate in high quality habitats with abundant prey in the intertidal zones.

Habitat protection criteria for parcels that may benefit sea otters include ratings of:

- "High" for parcels adjacent to known pupping concentrations;
- "Moderate" for parcels adjacent to concentration areas for feeding and/or shelter; or, potential pupping areas; and,
- "Low" for feeding sites located in adjacent waters (EVOS Restoration Team, November 1993).

In this alternative there is a range of funds (45 to 50 percent) available for Habitat Protection and Acquisition actions, so there are two more restrictive estimates that need to be assessed based on a higher cost per acre. The differences are shown in Table 4.XXX. Under the first scenario, all of the 81 large parcels described in the Comprehensive Habitat Protection Process: Large Parcel Evaluation & Ranking Volume I and Volume II (EVOS Restoration Team, November 1993) are considered in the analysis (this scenario is possible under all alternatives if a low cost per acre is assumed). When a higher cost per acre is assumed for the protection of these parcels, fewer of the parcels that are ranked "Low" for multiple resources and services are likely to be protected. Under the scenario where 50 percent of the remaining settlement funds are available for habitat protection actions, the potential benefit to sea otters is identical to the changes described in Alternative 4. Table 4-9 shows how the distribution of habitat evaluated as "High", "Moderate" or "Low" change when all 81 parcels are considered or when the parcels are reduced from higher cost and/or less money dedicated to habitat protection.



**Table 4-9**  
**Distribution of Habitat Evaluated**

|  | High Benefits | Moderate Benefits | Low Benefits |
|--|---------------|-------------------|--------------|
| All 81 parcels considered (same in all alternatives) | 20 parcels    | 16 parcels        | 42 parcels   |
| Higher parcel cost with 50% remaining funds          | 14 parcels    | 10 parcels        | 10 parcels   |
| Higher parcel cost with 45% remaining funds          | 14 parcels    | 8 parcels         | 9 parcels    |

Under the most restrictive scenario, out of the 81 parcels evaluated 70 percent of the parcels ranked "High" for sea otters would still be protected. These areas are associated with pupping concentrations which are most likely to be sensitive to disturbance from human activities.

The following discussion of restoration actions and their potential benefits are identical to Alternatives 3 and 4.

Cleaning oiled mussel beds has been considered as a possible method to reduce the hydrocarbon exposure. Sea otters, especially juvenile otters and females with pups, depend on mussels for a large portion of their diet (Doroff and Bodkin, 1993). Mussels are found in shallower areas and are easier to obtain than other prey. Mussels can be found in loose aggregations attached to intertidal rocks, or they can be found in dense aggregations (mussel beds) over pea gravel and silt sediments. Because mussels form a dense matt over the sediments and rocks, oil that was trapped beneath the mussels was not exposed to weathering and still remains toxic. It may be possible to clean mussels in mussel beds, but there are areas where it will be technically infeasible to remove the remaining oil.

One of the possible explanations of the poor survival rate of post-weanling juveniles in the oiled areas is that they are continuing to be exposed to hydrocarbon contamination by eating oiled mussels. Concern over the possible continuing source of contaminations to otters and other higher order animals (e.g. black oystercatchers and harlequin ducks) led to feasibility studies to develop techniques to clean the sediments beneath the oiled mussel beds. One technique that will be tested in 1994, lifts sections of the mussel beds and replaces the contaminated sediments with clean sediments without serious damage to the mussel beds (Babcock pers. comm.). Approximately 60 locations with oiled mussel beds have been identified in Prince William Sound.

The extent and distribution of oiled mussel beds is still being determined and will be important in understanding the potential benefit to sea otters that can be gained from cleaning. There have been no studies to determine whether or not eating contaminated mussels is causing injury to the sea otter population. However, it is possible to consider the

## 4 Environmental Consequences

potential benefit in terms of the level of risk to exposure. For example, the telemetry study by Monnett and Rotterman (1992) indicated that females and weanling otters did not range great distances between oiled and unoiled areas. If a group of otters spends many months feeding in bays that have several oiled mussel beds, then they are at greater risk of exposure than otters that feed in areas with few or no oiled mussels. Of the oiled mussel beds identified so far, there are approximately 20 in Herring Bay off of Knight Island; cleaning half or all of these mussel beds would greatly reduce the risk to the local population. If only 1 or 2 beds in the area were cleaned, it may not reduce the risk of exposure at all. Similarly, if the only source of oil in an entire bay was from one mussel bed, removing that contamination could eliminate the majority of the risk to the local otters.

Cleaning oiled mussel beds is likely to be a labor intensive task that may last for several days at each location. Some short-term disturbance is likely to occur; however, it is not likely to permanently displace the local otters.

It is reasonable to assume that the ability of this action to reduce the risk of exposure is equally valid in other regions of the spill area. However, there is less information on the location of mussel beds and on the injury to the sea otter population.

Establishing a cooperative program between subsistence users and research scientists or agency managers is another action that is appropriate under this alternative. The program would be designed to provide a two-way exchange of information that would provide benefits to all sides and could benefit the injured sea otter population. Recent records of subsistence harvest of sea otters the oil spill area indicate that harvest levels are relatively low but increasing throughout the EVOS area. If subsistence levels increase in areas where the populations were affected by the spill, the additional harvest may slow or prevent localized recovery. For example, the densities of otters in some oiled areas is still very low (Bodkin and Ballachey, pers comm) if these areas are consistently harvested, then redirecting harvest towards the healthier, or the nonoiled areas could reduce any negative effects without actually changing the number of animals harvested. Likewise, sea otters can sustain a greater harvest of males and juveniles than of breeding females.

Without any restoration actions, it may be reasonable to estimate that sea otters in Prince William Sound will recover to their prespill abundance in 7 to 35 years once the population begins to increase. If subsistence harvest rates rise substantially in the oiled areas, then the recovery estimates based on a 10 percent growth rate are unlikely and it is possible that the more conservative estimate of 35 years would be extended. If a cooperative program can be established, it may be possible to sustain a higher harvest rate, without changing the recovery rate of the injured population.

Actions implemented for other resources or services are not expected to impact the sea otter populations or their recovery.

### Conclusions.

- short-term effects. Negligible. All of the proposed actions will take time before any results could be expected.
- long-term effects. Moderate. The proposed actions improve the habitat quality through reducing the risk of exposure to oil, the potential for disturbance, and the impacts from subsistence harvest. These

benefits could produce a change in abundance of otters in some areas, but are not likely to produce a notable increase on a regional scale.

## **Birds**

### **Harlequin Duck**

**Habitat Protection.** Acquiring nesting habitat along streams on forested lands would have the highest benefit for preventing further injury to the harlequin duck population. Such acquisition would maximize protection of the harlequin ducks' reproductive potential, thus fostering recovery to pre EVOS levels. Thirteen of 18 high priority parcels being considered for acquisition have high potential value for nesting by harlequin ducks.

**Cleaning Oiled Mussel Beds.** Cleaning oiled mussel beds is considered to be a possible means of reducing hydrocarbon exposure to harlequin ducks via their food chain. Mussels, clams, and other bottom prey of harlequin ducks continue to be contaminated by oil still buried within the sediments. The harlequin ducks eat the contaminated prey, thus contaminating their body tissues. Although as yet unproven, this sub-lethal contamination is suspected of interfering with normal reproduction, resulting in few new broods being seen in the oiled area since the spill. Removal of the oil could thus result in resumed production in the oiled area, followed by a population increase.

**Conclusions.** The short-term effects through 1996 of the proposal on harlequin duck recovery would be negligible, and populations likely will remain stable at 1990 - 1993 levels in oiled and non-oiled areas alike. Acquisition of the high priority package of land parcels would maximize the recovery potential of the injured harlequin duck population by guarding against loss of nesting habitat. Cleaning oiled mussel beds would eliminate the source of hydrocarbon contamination of body tissues that may be interfering with reproduction, and also enhance the food base of local populations. The long-term effects of this alternative would have a high benefit to help maintain, protect, and increase the reproductive potential of harlequin ducks in the EVOS area.

### **Murres**

**Habitat Protection.** Acquisition of habitat would have only moderate benefit to the injured murre population because there are no sizeable colonies, and very few smaller colonies, that are not already protected. A seabird colony on privately-owned Gull Island in Kachemak Bay has a colony of 10,000 common murres that is visited daily by commercial tour boats in summer. Acquisition of this colony would assure its long-term protection, although there are no imminent plans for development.

**Predator Control.** The reproductive behavior of murres has evolved to produce a sudden abundance of eggs and chicks. The result is that predators are able to eat only a relatively few eggs and chicks, while the large majority of chicks grow too large for predators to handle. Mammalian predators are generally not a problem for murres because their island colonies are usually free of mammalian predators and murre nest sites are inaccessible. Bald eagles, ravens, northwestern crows, and especially glaucous-winged gulls, eat murre eggs and chicks in the EVOS area, although little is known about their impact on specific colonies.

## 4 Environmental Consequences

Recent work in Europe has shown that measures such as fiberglass poles placed perpendicular to the cliff face on nesting colonies reduces avian predation (D. Roseneau, oral comm., 1994). At least one year of study at injured colonies would be needed to determine the impact of avian predators and to design measures to deal with them.

Mammalian predators are not a pervasive problem for murre. A notable exception in the Bering Sea is on Otter Island, in the Pribilof Islands, where there was formerly a colony of about 10,000 murre. During a particularly cold winter in the late 1940's, Arctic foxes arrived on Otter Island via pack ice, and they and their progeny have since eliminated all murre there. Live trapping and translocating the few foxes that remain there would allow murre from the rest of the Pribilofs to re-colonize Otter Island, followed by a population increase. This would be an inexpensive project that could be accomplished within two weeks (V. Byrd, oral comm., 1994).

**Reduce Disturbance.** Murre are sensitive to disturbance during the nesting period, especially loud noise. Sudden loud noises like gunshots will scare murre off their nests, which has two deleterious effects - eggs and chicks are knocked off the cliffs as the panicked adults leave *en masse*, and the remaining exposed eggs and chicks fall easy prey to avian predators. Gunfire appears to be a potential problem near the Barren Islands during the nesting season, when halibut fishermen routinely shoot the fish before landing them. This appears to occur fairly frequently. While such disturbance may not be a problem for a healthy population, it could delay recovery of an affected colony, such as that at the Barren Islands.

This action would first fund a program to educate fisherman and charter boat captains, and seek their voluntary reduction of disturbance. If voluntary actions were not effective, the next step would be to develop regulations that prohibited disturbance at the Barren Islands. With mandatory regulations, enforcement may also be necessary, which could require additional funding. If gunshot noise near the Barren Island murre colonies were eliminated there is good chance for a low to moderate benefit to the recovering murre populations at the Barren Islands. If disturbance proves to be an important problem, there are methods for preventing these disturbances.

This action could have a moderately beneficial effect on reducing the recovery time at colonies where human activities disturb the birds during nesting. This action would most likely have the greatest benefit at the Barren Islands. Murre at the Chiswell Islands colonies appear to have habituated to tour boats, so protective measures there, where gunshots are infrequent, would have limited effect.

**Conclusions.** There would be low short-term benefit to the injured murre population from this action within the EVOS area. On the longer term, within 10 years, the entire package would have the positive benefit of increasing or protecting the murre population by at least 20,000 birds. Reducing disturbance that causes additional mortality at the Barren Islands would allow population recovery to proceed at a faster rate than otherwise possible. Outside the EVOS area, trapping Arctic foxes on Otter Island would allow natural re-colonization from the rest of the Pribilof Islands, with the potential of increasing the murre population within 10 years by approximately 10,000, the number that formerly nested there.



## Pigeon Guillemot

**Habitat Protection.** In Prince William Sound, the large majority of pigeon guillemot colonies are on U. S. Forest Service (USFS) land (Sanger and Cody, written comm., 1994) that is not slated for logging (C. Frey, written comm., 1994). Two of the largest colonies in Prince William Sound are on private land at The Pleiades Islands and on Bligh Island, and guillemots there total about 3 percent of the 1993 breeding population (Sanger and Cody, written comm., 1994). In the 1970's, both of the latter colonies probably harbored larger numbers of nesting guillemots than at present. Two colonies adjacent to private land that is currently being logged on the eastern, nonoiled portion of Prince William Sound had very few guillemots in 1993, but it is unlikely that they were affected by the inland logging operations (Sanger and Cody, written comm., 1994). Outside of Prince William Sound, the Seal Bay area on Afognak Island has low numbers of pigeon guillemots and has already been acquired, and an EVOS predator control project at Kagamil Island in the Shumagin Islands will allow recolonization and modest population increase by pigeon guillemots. Little is known about the current status of guillemot colonies elsewhere in the EVOS area (USFWS, 1993).

**Predator Control.** Predator control has the potential to increase productivity of pigeon guillemots, but little is known about the nature of predation on guillemots throughout the EVOS area. Possible predator control methods might include live trapping and translocating predators, removing eggs from the nests of avian predators and replacing the live eggs with artificial ones so the adults do not lay a second clutch, installing predator exclosures at key colonies, and deploying predator-proof nesting boxes. Studies are needed to determine the severity of predation at individual colonies, and if warranted, to design specific methods to reduce predation.

**Reduce Disturbance.** Human disturbance is not a pervasive problem at pigeon guillemot colonies. Most colonies are located in remote areas, in steep habitat that generally holds little appeal for recreational or other uses. However, because of the reduced size of the guillemot population throughout Prince William Sound, and the injury suffered by the segment of the population in the oiled area, it would be wise to take precautions to assure that there is no inadvertent disturbance. This could be done by educating land management entities about the locations of guillemot colonies on their land, and by posting colonies that are especially sensitive. Chief among the latter are the 3 colonies at Jackpot Island, located on USFS land just offshore from Jackpot Bay in southwestern Prince William Sound. Jackpot Island has two beaches that are suitable for camping, and Jackpot Bay is a popular area for recreational boaters and fishermen, so there seems to be potential for inadvertent disturbance from recreationists.

**Conclusions.** This alternative would likely have negligible short-term effects for pigeon guillemots through 1996. On the long term, acquiring habitat where two of the largest colonies in Prince William Sound are located, one of which is included in the high priority acquisition package, would have a moderate effect on population recovery, and in preventing further inroads to the injured population through habitat degradation.



## 4 Environmental Consequences

### Marbled Murrelet

**Habitat Protection.** Details of habitat use by marbled murrelets are being clarified, and studies in Prince William Sound are showing that large, moss-covered limbs of old-growth conifers are the cornerstone prime nesting habitat for marbled murrelets. Current and possible future logging of such habitat on private land is the single greatest threat to population recovery of marbled murrelets, and it poses the additional threat of reducing the population more. Acquisition of prime nesting habitat would thus maximize the potential for the injured marbled murrelet population to recover while preventing further injury to the population.

**Conclusions.** The short-term effects of land acquisition for the injured marbled murrelet population could have a high benefit if logging is imminent. On the long term, land acquisition is the highest possible benefit to the injured murrelet population.

### Fish

#### Pink Salmon

Alternative 5 will provide comprehensive restoration actions to assist natural recovery of wild-stock pink salmon populations. Actions that may be implemented to restore wild-stock pink salmon populations as part of Alternative 5 include: habitat protection and acquisition, migration corridor improvements, egg incubation boxes, net pen rearing, hatchery rearing, habitat improvement, and relocation of hatchery-produced runs and other methods (EVOS Trustee Council, April; November 1993) Appendix C).

Habitat protection criteria for parcels that may benefit pink salmon include ratings of "High" for parcels with a high density of pink salmon streams or streams known to have exceptional value; "Moderate" for parcels with an average density of pink salmon streams or streams with average production; and, "Low" for parcels with few or no pink salmon streams or streams with no production (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit wild-stock pink salmon populations according to Alternative 5 will depend on the average cost per acre and the final budget allocation. Therefore, the maximal number of parcels that may be purchased includes all that are available and the minimal number of parcels that may be purchased ranges between 31 and 34 parcels. If all habitat parcels are protected, it is expected to provide approximately a moderate benefit for the pink salmon resource (Appendix A), as described in Alternative 2.

If between 31 and 34 parcels can be purchased according to Alternative 5, the expected protective value will be rated as moderate (Appendix A.). Of the parcels that may be purchased, 70% or more are rated as moderate or high value.

**Table 4-10**  
**Parcel Ratings**

| Total number of<br>parcels | Number of parcels with benefit values rated |          |     |      |
|----------------------------|---|----------|-----|------|
|                            | High  | Moderate | Low | None |
| 34                         | 12  | 12       | 10  | 0    |
| 31                         | 12  | 10       | 9   | 0    |

Although the average value of forecasted habitat acquisition may not have a high overall rating for pink salmon, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

**Comprehensive Restoration Actions:**

Action 1. Migration corridor improvements entail mitigation of a barrier to fish migration that may prevent access to critical habitat for spawning or rearing. This typically involves installation of a fishpass or removal of a migration barrier. The construction of a fishpass (i.e., fish ladder or steep pass) is a permanent form of habitat modification to enable fish to access spawning and rearing habitat above an impassable barrier such as a steep waterfall or cataract (Appendix C).

This technique has been widely applied throughout the EVOS area, especially in Prince William Sound, to increase populations of wild stock pink salmon and to establish new populations by providing access to new or additional spawning habitat (Kohler,---). (Blackett,---) Pink salmon migrate directly to saltwater after they emerge from the spawning gravel so they do not require freshwater rearing habitat; consequently, population benefits will be accrued for pink salmon wherever access can be provided to new or underutilized spawning habitat. Because this technique has been so widely applied, however, the most valuable locations in most of the EVOS area have already been utilized.

The potential benefit from migration corridor improvements is in direct proportion to the amount of new spawning habitat that is accessed. Within the EVOS area, potential benefits from this action may be limited by the ability to identify new sites for application of this action. Willette, *et al.* (1993) recently attempted to survey

Action 2: Egg incubation boxes have been used highly successfully in the Copper River drainage to develop a small wild-stock population of sockeye salmon into an estimated annual total return of approximately 200,000 adult fish with an estimated annual commercial harvest of over 100,000 fish (Roberson and Holder, 1993). Other experiments to incubate sockeye and chum salmon eggs in egg incubation boxes in Prince William Sound were less successful (Jackson, 1974), however, Mr. Terry Ellison (ADF&G, 1994, oral comm.)

## 4 Environmental Consequences

reports that egg incubation boxes were used effectively for several years to increase the numbers of pink salmon returning Cannery Creek in Prince William Sound. These and other results demonstrate the importance of proper site selection, installation, and operational techniques.

In-stream egg incubation boxes provide a low-cost restoration or enhancement technique that is ideally suited for small-scale, low-technology operations at remote sites that meet the selection criteria. When they are used for enhancement of indigenous stocks, these units can minimize the fish genetic and pathology concerns associated with transport of eggs or fry.

The potential contribution of egg incubation boxes for the restoration or improvement of wild pink salmon stocks in the EVOS area may be very good in drainages which have reasonably accessible spring areas or year-round free-flowing water. Although extensive surveys to locate potential sites to operate this technique have not been performed, some potential sites may exist, however, for application of this action in some drainages.

Where an optimal location can be utilized, dramatic results can be attained (Roberson and Holder, 1993). Where suitable locations can be identified, this action may be applied to help restore or improve pink salmon populations without a major intrusion into the environment or the wild fish stocks. Within individual drainages, it can be used to benefit individual stocks, however logistical costs may constrain widespread small-scale development.

Action 3. Net-pen rearing is a practice that has been widely applied to increase the survival rate of all salmon species. This is a common technique that has been widely used in ADF&G and PNP programs in the EVOS area and throughout the State of Alaska to improve the survival rate of juvenile pink salmon (Appendix C). It has not been commonly applied, however, for wild stocks of pink salmon.

Net-pen rearing of wild-stock pink salmon fry to increase their survival rate potentially may be employed in many systems throughout the EVOS area where there is a source of fry and a suitable site to anchor and service the net pens. The wild-stock fry may be captured as they emigrate from a spawning stream.

Careful application of the net-pen rearing technique can be expected to increase the survival rate of juvenile pink salmon and, consequently, returning adults (reference,---). The magnitude of the benefit will depend on the numbers of captive fry that can be accommodated. Whenever any organisms are held captive in high density, however, they become more susceptible to disease or other catastrophic loss and there is a risk of disrupting natural genetic selection; however, these risks have been successfully minimized with good fish cultural practices (Schollenberger, 1993) and by following appropriate planning and permitting procedures (Appendix C).

Action 4: Hatchery rearing of pink salmon fry to increase the survival rate to the adult stage has had a long history in Alaska. Typically, these operations have been based on a large, established hatchery brood stock that was derived from a donor wild stock, however, individual wild stocks may be used annually to supply the eggs. As the fry emerge, they must be transported to the estuarine rearing site at the stream mouth.

Hatchery rearing for pink salmon fry may be a useful technique to restore pink salmon populations in many drainages in the EVOS area, however, the wild stocks must be selected for egg takes and the fry rearing pens must be operated at the mouth of the systems that are

selected. Candidate locations must have enough spawners to supply the eggs and the physical features of the stream mouths must accommodate the net pens.

Injured wild stocks may be helped directly by a rearing and release program for that stock; or the wild stocks may be helped indirectly by creating an alternate opportunity for the commercial fishers to divert fishing pressure away from the injured wild stocks. For direct restoration, fry-rearing programs will be limited to those drainages which can provide brood stock and accommodate a rearing program. The magnitude of the increase will depend on the physical and biological constraints of that drainage system and the magnitude of the restoration effort. Whenever any organisms are held captive in high density, however, they become more susceptible to disease or other catastrophic loss and there is a risk of disrupting natural genetic selection; however, these risks have been successfully minimized with good fish cultural practices (Schollenberger, 1993; and appropriate planning (Appendix C).

Action 5. Habitat improvement techniques are employed to overcome a factor in the fishes environment that may limit the full potential production from that system. Habitat improvement to achieve increased production usually entails one of the fishes life history needs that may limit production within that drainage. Consequently, it is important to determine what aspect of the life history is the limiting factor and what must be done to improve conditions for increased production. Because pink salmon utilize the freshwater environment only for spawning, habitat improvement opportunities are limited primarily to improving migration corridors and creating new spawning habitat.

Fishpasses and migration habitat improvement applications are discussed in Action 1. Surveys have been performed to identify potential locations for habitat improvement projects in the EVOS area and no potential sites have been discovered for large-scale projects (Willette, *et al.*, 1993). Potential sites may exist, however, for limited application for some wild stocks of pink salmon in some drainages.

Pink salmon will benefit from access or development of any new spawning habitat, however, because of the cost of installation and the value of pink salmon, opportunities and benefits are probably limited.

Wherever fish stocks are created or increased, however, there may be an interference with other stocks that are already present. There may be a risk of overharvesting the existing stocks. Returning adult fish may stray into adjacent drainages, interbreed with naturally-reproducing populations, and disturb the genetic makeup of those populations.

Action 6. Relocation of hatchery runs will provide a benefit for wild-stock pink salmon by providing an alternate location, timing, or stock for commercial fishing activities. If the locations or timing to establish these new runs are carefully selected, there will be little or no interception of the wild stocks. Combined with good fishery management practices and a redistribution of the commercial fishing fleet, fishing pressure can be diverted away from the wild stocks that need additional protection and refocused on the relocated hatchery runs which will allow the wild stocks to recover. This action will be described as an action that may affect commercial fishing, however, this action may have limited potential application in the EVOS area, because a commercial fisheries enhancement program has already been

## 4 Environmental Consequences

operating here for a number of years and locations to establish new runs may be limited (Ref...).

### Conclusions.

- short-term effects. Low. Although some benefits may be accrued, it is not reasonable to expect substantial results within one life-cycle.
- long-term effects. High. It can be expected that these actions will assist the recovery of the injured wild stocks of pink salmon. Long-term effects of some or all of these actions may be realized in six to ten years (three to five generations of pink salmon). Certain actions, however, may be useful in only portions of the EVOS area and all populations may not be totally restored.

### **Sockeye Salmon**

Alternative 5 will provide comprehensive restoration actions to assist natural recovery of wild-stock sockeye salmon populations. Actions that may be implemented to restore wild-stock sockeye salmon populations as part of Alternative 5 include: habitat protection, lake fertilization, migration corridor improvements, actions that may improve survival rates of sockeye salmon eggs by using egg incubation boxes, net pen rearing or hatchery rearing, and other methods (EVOS Trustee Council, April; November 1993).

Habitat protection criteria for parcels that may benefit sockeye salmon include ratings of "High" for parcels with sockeye salmon streams or systems known to have exceptional value; "Moderate" for parcels with sockeye salmon streams or systems with average production; and, "Low" for parcels with few or no sockeye salmon streams or systems with low production (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit wild-stock sockeye salmon populations according to Alternative 5 will depend on the average cost per acre and the final budget allocation. Therefore, the maximal number of parcels that may be purchased includes all available parcels and the minimal number of parcels that may be purchased ranges between 31 and 34 parcels. If all habitat parcels are protected, it is expected to provide approximately a low benefit for the sockeye salmon resource (Appendix A), as described in Alternative 2.

If between 31 and 34 parcels can be purchased according to Alternative 5, the expected protective value will be rated as low to moderate (Appendix A.). Of the parcels that may be purchased, 38 to 42% are rated as moderate or high value.



**Table 4-11**  
**Parcel Ratings**

| Total number of<br>parcels | Number of parcels with benefit value rated |          |     |      |
|----------------------------|--|----------|-----|------|
|                            | High                                       | Moderate | Low | None |
| 34                         | 7  | 6        | 13  | 8    |
| 31                         | 7  | 6        | 12  | 6    |

Although the average value of forecasted habitat acquisition may not have a high overall rating for sockeye salmon, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

#### **Comprehensive Restoration Actions:**

Action 1. Lake fertilization is a potential action that may be taken to improve the rearing success of juvenile sockeye salmon during their one to three years in the lake environment and increase their survival to the smolt stage. ADF&G began a lake limnology and lake fertilization program in the late 1970's and a number of lake systems in the area have been treated to improve sockeye salmon production (Kyle, 1994) (Table IV- )

Within the EVOS area, new opportunities for lake enrichment projects may be limited because of the successes that have already been achieved in the present program. Where new opportunities exist, however, this action can be expected to improve the rearing habitat and produce additional sockeye salmon.

Lake nutrient enrichment has been used successfully to improve the freshwater survival rates of juvenile sockeye salmon and to produce more adult fish in Canada and the United States (Canada, --; Koenings and Kyle,---). Within the EVOS area, benefits from this action will depend primarily on the ability to identify new candidate lake systems in areas where returning adult fish may be harvested without risk of overharvesting existing wild stocks.

Wherever fish stocks are created or increased, however, there may be an interference with stocks that are already present. There may be a risk of overharvesting the existing stocks. Returning adult fish may stray into adjacent drainages, interbreed with naturally-reproducing populations, and disturb the genetic makeup of those populations.

Action 2: Migration corridor improvements entail mitigation of a barrier to fish migration that may prevent access to critical habitat for spawning or rearing and typically includes installation of a fishpass or removal of a migration barrier. The construction of a fishpass (i.e., fish ladder or steep pass) is a permanent form of habitat modification to enable fish to

## 4 Environmental Consequences

access spawning and rearing habitat above an impassable barrier such as a waterfall or cataract.

This technique has been widely applied throughout the EVOS area to increase populations of wild salmon stocks and to establish new populations by providing access to new or additional spawning habitat. It has not been widely applied for sockeye salmon, however, because juvenile sockeye salmon require lake rearing habitat.

Migration corridor improvements that create access to good quality spawning habitat is a proven technique to improve salmon populations, however, it will be effective for sockeye salmon only if the newly-produced fry have access to rearing habitat that is presently underutilized. The potential benefit will usually be limited by the amount of rearing habitat rather than the amount of new spawning habitat that is accessed. The installation is usually permanent, with a long lifespan. Within the EVOS area, potential benefits for sockeye salmon may be limited by the ability to identify new sites for application of this action where they will not interfere with management of other nearby wild stocks.

Action 3: Egg incubation boxes have been used highly successfully in the Copper River drainage to develop a small wild-stock population of sockeye salmon into an estimated annual total return of approximately 200,000 adult fish with an estimated annual commercial harvest of over 100,000 fish (Roberson and Holder, 1993). Other experiments to incubate sockeye and chum salmon eggs in egg incubation boxes in Prince William Sound were less successful (Jackson, 1974), however, when properly installed, these units control the water flow, substrate type, sedimentation, and predation to provide egg-to-fry survival rates as high as 90%. This compares quite favorably with an expected survival rate of 20% in redds of naturally-spawned sockeye salmon (Ref., ...).

The potential contribution of egg incubation boxes for the restoration of sockeye salmon stocks in the oil-spill area will be limited to drainages with: 1) limited successful reproduction; 2) spring areas with appropriate physical features and water quality and quantity; and, 3) underutilized rearing capacity for the sockeye salmon fry that are produced.

Although extensive surveys to locate potential sites to operate this technique have not been performed, if suitable locations can be identified within drainages that presently support small populations of sockeye salmon, this technique may be applied to help restore those populations without a major intrusion into the environment or the fish stock.

Action 4: Net-pen rearing is a practice that has been widely applied to increase the survival rate of all salmon species. This technique, however, has only recently been applied successfully for sockeye salmon because most previous attempts failed because sockeye salmon are particularly susceptible to the disease infectious hematopoietic necrosis virus (IHNV). (Mr. Terry Ellison, ADF&G, personal communication).

Although the net-pen rearing technique has been applied in both freshwater and in saltwater, most success has been achieved with freshwater rearing because the early lifestages from only a few stocks of sockeye salmon can survive in saltwater. Burke (1993), however, described a highly successful program for rearing juvenile sockeye salmon in saltwater net pens to the smolt stage, but only after they had been fed first in freshwater hatchery raceways. Consequently, although net-pen rearing of sockeye salmon in saltwater may have excellent

potential for a hatchery-based application, it is of limited value for protection and restoration of wild stocks except where it may be used to create an alternate opportunity for commercial fishermen.

Juvenile sockeye salmon typically require rearing in freshwater for up to three years (Burgner, 1991). During this period, the mortality rate between the fry and smolt stages may range from 86 to 99% (Roberson and Holder, 1993), but fry held in net pens are largely protected from predators and food is provided, so the mortality rate is low while they are in the pens. Net-pen rearing of sockeye salmon fry in freshwater has not been widely applied; however, it appears to have been quite successful in English Bay lakes as a means to increase the freshwater survival rates (Schollenberger, 1993).

Net-pen rearing of sockeye salmon fry to increase their survival rate potentially may be employed in many systems throughout the EVOS area. Only two key ingredients are necessary: a source of fry and a suitable site to anchor and service the net pens. Fry may be captured from a spawning stream or transferred from a hatchery. Careful application of the net-pen rearing technique will increase the numbers of emigrating sockeye salmon smolts and returning adults with minimal undesirable effects on the population or the lake rearing system. The magnitude of the benefit will depend on the numbers of captive fry that can be accommodated.

Whenever any organisms are held captive in high density, they become more susceptible to disease or other catastrophic loss and there is a risk of disrupting natural genetic selection; however, these risks have been successfully minimized with good fish cultural practices (Schollenberger, 1993) and by following appropriate planning and permitting procedures (Appendix C).

Action 5: Hatchery rearing of sockeye salmon has had a long history in Alaska, however, during the last decade, this strategy has been improved and it has produced dramatic innovations and results (Ellison, 1993). In Alaska, cultured juvenile sockeye salmon have been released as fed fry, presmolts and smolts. Each lifestage has its own particular logistical, biological and fish cultural constraints and advantages. Fry are less expensive to rear, transport and release, but they require at least one year of rearing in a lake before they smoltify and they will not survive to the adult stage as well as presmolts or smolts. Fry that are retained and fed in hatchery raceways may be released in late-fall as presmolts. These young fish require few resources from the lake system during the winter and emigrate as smolts in the spring. Smolts are expensive to rear and transport, but they will survive better to the adult stage; however, they can be released as migrants without reliance on freshwater rearing.

Injured wild stocks may be helped directly by a rearing and release program for that stock; or the wild stocks may be helped indirectly by creating an alternate opportunity for the commercial fishers to divert fishing pressure away from the injured wild stocks. For direct restoration, fry-rearing programs will be limited to those drainages where the forage is underutilized by the naturally-produced fry. Presmolt- and smolt-rearing programs, however, can provide direct restoration with little or no effect on plankton populations.

Whenever any organisms are held captive in high density, they become more susceptible to disease or other catastrophic loss and there is a risk of disrupting natural genetic selection;

## 4 Environmental Consequences

however, these risks have been successfully minimized with good fish cultural practices (Schollenberger, 1993) and by following appropriate planning and permitting procedures (Appendix C).

### **Conclusions. (for the sockeye salmon resource)**

- short-term. Low; some benefits in some drainages may be accrued within one life cycle.
- long-term effects. High. It can be expected that these actions will assist the recovery of the injured wild stocks of sockeye salmon. Long-term effects of some or all of these actions may be realized in ten to fifty years (two to ten generations of sockeye salmon). Certain actions, however, may be useful in only portions of the EVOS area and all populations may not be totally restored.

### **Pacific Herring**

Alternative 5 includes only one restoration action to assist natural recovery of Pacific herring; habitat protection and acquisition (EVOS Trustee Council, April 1993).

Habitat protection criteria for parcels that may benefit Pacific herring include ratings of "High" for parcels with a documented consistent annual Pacific herring spawning along the parcel shoreline; "Moderate" for parcels with occasional spawning along the parcel shoreline; and, "Low" for parcels with no documented Pacific herring spawning along the parcel shoreline, but a possible feeding area (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit Pacific herring populations according to Alternative 5 will depend on the average cost per acre and the final budget allocation. Therefore, the maximal number of parcels that may be purchased includes all that are available and the minimal number of parcels that may be purchased ranges between 31 and 34 parcels. If all habitat parcels are protected, it is expected to provide approximately a low to moderate benefit for the Pacific herring resource (Appendix A), as described in Alternative 2.

If between 31 and 34 parcels can be purchased according to Alternative 5, the expected protective value will be rated as moderate (Appendix A.). Of the parcels that may be purchased, 68% are rated as moderate or high value.

**Table 4-12**  
**Parcel Ratings**

| Total number of parcels | Number of parcels with benefit values rated |          |     |      |
|-------------------------|---|----------|-----|------|
|                         | High  | Moderate | Low | None |
| 34                      | 9   | 14       | 9   | 2    |
| 31                      | 8   | 13       | 8   | 2    |

Although the average value of forecasted habitat acquisition may not have a high overall rating for Pacific herring, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

**Conclusions.** (for the Pacific herring resource)

- short-term. Negligible. No benefits will be accrued within one life cycle.
- long-term. Moderate. Habitat protection and acquisition actions will have a long-term value to Pacific herring stocks in the EVOS area by helping to assure maintenance of production. Over half of the parcels that may be purchased have moderate or high value for Pacific herring.

**Social and Economic  
Impacts**

**Cultural Resources**

**Habitat Acquisition**

It is assumed here that between 31 and 34 large parcels, a total of 421,500 to 478,500 acres, would be purchased. These parcels contain low (No known or suspected cultural sites on parcel), moderate (No significant cultural sites on or adjacent to parcel), or high (Documented concentration or significant cultural sites on parcel) potential for benefiting cultural resources as analyzed by the Habitat Protection Work Group (November 30, 1993). For the purpose of this analysis, benefit consists of protection of sites from further damage. If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.2 to 2.3 (or slightly higher than moderate). These estimates reflect known sites in the EVOS area, not all of the sites present. Not all sites have been found, so the actual protection for cultural resources may be greater than reflected in these estimates. This analysis also does not take into consideration small parcel acquisition, which is currently under evaluation.



## 4 Environmental Consequences

It is possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels - possibly all 81 identified parcels, which would result in some benefit in terms of archaeological site protection for 863,100 acres.

Benefits from habitat acquisition would accrue primarily through (1) placing private lands under public management and application of federal and state cultural resource protection laws, and (2) reducing the likelihood of damage to cultural resources resulting from extractive economic activities such as mining and logging. Benefits would accrue slowly, with no immediate or short-term benefits. Considered without the impacts discussed below for general restoration, the long-term benefits of habitat protection and acquisition would be moderate for cultural resources.

### General Restoration

General restoration actions may include activities on individual sites (site stabilization, site salvage excavations, site monitoring and stewardship), or in local communities (archaeological repositories, acquiring replacement artifacts). Often, on-site work can be combined with community activities, as is envisioned in the site stewardship program. Each of the proposed actions considered here can be implemented independently or in combination with any of the others. The most effective approach is comprehensive, tailoring combinations of actions within each community whose cultural resources were injured by the spill. Actions considered applicable for Alternative 5 are discussed below.

#### - Stabilize archaeological sites.

Archaeological sites affected through erosion begun or worsened by oil spill activities may be stabilized to slow or stop the erosion. Stabilization may entail re-contouring parts of the sites to cover up exposed archaeological deposits. This would reduce the visibility of artifacts and so reduce chances of looting or vandalism. This is a relatively non-destructive alternative when compared to archaeologically excavating the sites or allowing damage to continue.

Stabilization is a site-specific activity that may be accomplished through several different methods. Some sites are located along high energy shorelines, or in high energy intertidal areas, and may not be suited to stabilization. Also, stabilization techniques that contrast with surrounding terrain may serve as magnets for visitation rather than protection against visitation. The benefit of stabilization is to preserve the integrity of the site, a benefit that may be temporary (requiring periodic maintenance) or permanent. This would have an immediate and short-term high level of benefit by reducing or stopping site degradation at specific sites. It also has the potential to preserve sites and reduce damage at a high level over the long term.

#### - Excavate Archaeological sites.

Not all sites can be stabilized, whether for physical or economic reasons. Ongoing vandalism, looting, and erosion of archaeological sites in the EVOS area can be mitigated through salvage excavation instead of stabilization. Excavation and stabilization can also be done on the same site. Scientific excavation of the sites most in danger of destruction can yield information important to understanding the history and prehistory of the EVOS area, a major element of Alaska's cultural heritage. Excavation can also remove human remains and funerary objects associated with the ancestors of contemporary people living in communities in the spill area. These remains could be moved to locations less likely to be disturbed by looters or vandals, or unearthed by ongoing erosion.

One effect of excavation is permanent destruction of the excavated portions of the sites. This destruction, however, is controlled and exactly delimited, allowing for the appropriate care and analysis of removed items and associations. Without archaeological excavation, damage to, and eventual destruction of, several of the sites will continue with neither the public nor the resource benefiting. The short-term and long-term benefit of salvage excavation of highly endangered sites is therefore high. This action both protects the sites from further looting and vandalism and mitigates the spill-related damage already incurred.

- Site monitoring and stewardship.

Archaeological site stewardship programs active in Arizona, Arkansas, and Texas have demonstrated the utility of public education and increased oversight of sites for reducing continuing vandalism. A site stewardship program for the EVOS area would combine public education and site monitoring through recruitment, training, coordination, and maintenance of a corps of local interested citizens to watch over nearby archaeological sites. Sites to be monitored by local residents would be identified by land owners and managers on the basis of past and ongoing vandalism and erosion. Law enforcement officials may be involved as during investigations or called to sites to intercept active vandalism.

The benefits of site stewardship would be an increased knowledge and appreciation of archaeological methods of site monitoring and decreased site vandalism. These benefits would begin within the first year of implementation and continue for an indefinitely long term. The benefits of this action in the short term would be low, but are potentially high in the long term as site stewards become better trained and knowledge of the program is disseminated as a disincentive among people who do, or may be inclined to, damage sites. The action has additional importance by involving local individuals and communities in cultural resources protection.

- Archaeology repositories.

Communities within the spill-affected area increasingly express a desire that archaeological materials remain in (or at least are regularly returned to) their area of origin for display and interpretation. Local preservation of artifacts and interpreting of Native heritage is proposed as a means to offset the increasing loss of artifacts and disturbance of Native graves in the spill area.

Placing artifacts in a local repository and using that repository as a base for interpreting cultural resources could help better educate residents and area visitors about practices of the past and the continuity of that past with the present and the future. These repositories may be established through modifying existing structures or by building new structures to accommodate collections. These would be located in communities within the oil spill area and could serve as local foci for heritage-oriented activities. The short-term benefits of this action would be to restore a feeling of involvement with and oversight of the cultural heritage of which local communities are part. This would be immediate but moderate. Long-term benefits are high in terms of enhanced community involvement. It is this involvement that will address spill related injury to the sense of cultural continuity and connectedness within the local communities.

- Acquisition of replacement artifacts

Museums, agencies, and other repositories outside the spill area hold collections containing artifacts originally from the spill area. An action has been identified that would acquire some

## 4 Environmental Consequences

of these artifacts as a means of replacing a portion of the cultural heritage lost through the oil spill and subsequent cleanup activities. Many of these artifacts were removed from the spill area through ethnographic collecting and archaeological investigations in the 19th and early 20th centuries, and many reside outside of Alaska - in the lower 48 states, Europe, and Russia. Returning part of this diverse artifactual heritage to the spill area would have a low but immediate benefit in the communities within the spill area, allowing the people of the communities to more fully see the range of materials that represent a tangible part of their past. The long-term benefits of this approach are potentially high. By establishing a seed of improved cultural connectedness and fostering a sense of cultural continuity, this approach could grow into a major factor in producing a sense of recovery from the effects of the spill among the residents of those communities most affected.

This action could work through partnerships with existing museums or other regional repositories, or as combined with the establishment of local artifact repositories and interpretive centers. It is likely that communities would react differently from each other to this approach. Individual consultations with each community would be required to assess the importance and effectiveness in each.

**Conclusions.** Considered independently, habitat acquisition and protection, site monitoring and stewardship, and acquiring replacement artifacts would likely have low short-term benefits. Short-term benefits of artifact repositories would be immediate but moderate. Short-term benefits of salvage excavations and site stabilization would be immediate and high.

Long-term benefits are potentially moderate for each of the identified general restoration actions, but may vary between communities. The benefits would likely be higher if actions were combined and village-based. Long-term benefits of habitat acquisition would be moderate.

On balance, this alternative would benefit cultural resources moderately in the short term, but moderate to high benefits to site protection, understanding and appreciation of cultural resources.

### Subsistence

#### **Habitat Protection**

It is assumed here that between 31 and 34 large parcels, a total of 421,500 to 478,500 acres, would be purchased. These parcels contain low (status as a subsistence use area unknown), moderate (known historic subsistence use area, which may be used again), or high (known current subsistence use area) potential for benefiting subsistence as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average between 2.3 and 2.4 (or between moderate and high).

Protecting lands from the habitat degradation associated with extractive economic activities like mining and logging would help recovering subsistence resources recover more quickly. This is the main benefit to subsistence that may be achieved by the habitat protection and acquisition portion of Alternative 5. Short-term benefits of habitat protection and acquisition would be negligible, but the long-term benefits would likely be low to moderate.

This analysis does not take into consideration small parcel acquisition, which is currently under evaluation. It is also possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels - possibly all identified parcels (863,100 acres).

## General Restoration

General restoration projects may be funded that directly affect the subsistence resources and subsistence users within the EVOS area. These proposed actions could be conducted independently from each other or in combination.

### - Harbor Seals

The decline in subsistence harvest of harbor seals may have helped stabilize the harbor seal population. The proposed action to implement cooperative programs between subsistence users and agencies to assess the effects of subsistence harvest may help in sorting out which localities would be best utilized (or best left alone) for subsistence use in order to optimize natural recovery of the populations. This will be a moderate long-term benefit, taking as long as five to ten years to establish a measurably significant effect. This action has the advantages of relatively low cost and spin-off value in improving communication between agency biologists and subsistence users. Cooperative programs proposed for reducing incidental take of harbor seals during fishing likewise would have low short-term benefits to harbor seal populations, but may have moderate long-term benefits in five to ten years. Reducing disturbance at haulout sites in the oil spill area would have a negligible benefit in the short term and a moderate benefit long term.

### - Sea Otters

One of the proposed actions would establish a cooperative program between subsistence users and research scientists or agency managers. While subsistence harvests are not a significant impact on sea otter populations, agency biologists and subsistence users would both benefit from the additional interaction and information sharing that would grow from such an action. Traditional knowledge of sea otter behavior and their relation to other parts of the ecosystem may be more extensive than is presently recognized by agency biologists. Similarly, the present range and concentration of sea otters may be better understood by agency biologists than is presently recognized by many subsistence users. This type of action would have little benefit immediately or in the short term on the recovery of sea otters, but the long-term benefit on management efforts - and so the sea otter populations and subsistence users - could be significant.

### - Intertidal Organisms

A project has been proposed to reduce hydrocarbon levels in oiled mussel beds by temporarily removing mussels, replacing oiled sediments, and returning the mussels. Part of this action would be to monitor treated and untreated mussel beds to document the differential rates of recovery. This action would have low short term and moderate long-term benefits on subsistence users through increasing the abundance of edible mussels. This benefits would likely be localized.

*Fucus*, one of the central elements in intertidal ecosystems, is important for subsistence users as food and as habitat for other subsistence resources. A pilot project has been proposed to transplant *Fucus* to increase its population in the high intertidal zone. Recovery of *Fucus* is

## 4 Environmental Consequences

estimated at a decade. This would have insignificant short-term benefits, but may have moderate long-term benefits to subsistence users.

The recruitment of intertidal clams on cleaned beaches will remain low until a substrate of appropriate grain size is re-established, either naturally or through restoration efforts. A project has been proposed to study the feasibility of depositing fine-grained sediments to enhance larval recruitment and population recovery. Should this prove feasible, it would be possible under this alternative to fund expansion of the technique within the spill area. The hypothesis is that population recovery could occur within one or two years. Should this hypothesis be substantiated, and if subsistence users could be assured of the safety of eating clams produced in the enhanced habitat, both long and short-term benefit of increased availability of clams for subsistence use would be high.

### - Pink Salmon

Relocation of hatchery runs has been identified as a means to divert the commercial fishing fleet away from wild stocks of pink salmon. The resultant recovery of stocks would benefit subsistence uses of pink salmon. The benefits of this action on subsistence mirror those of the pink salmon population: negligible in the short term, but high in the long term of five to ten years.

### - Sockeye Salmon

The use of egg incubation boxes has been proposed to restore or enhance sockeye salmon populations in the spill area. It is estimated that short-term benefits would be moderate, drainage-specific increases in populations. Long-term benefits would be low because of scarcity of appropriate siting locations. If appropriate siting locations are found near villages, this technique has the potential for working very well locally to increase the amount of sockeye salmon available (both long- and short-term) for subsistence use.

Net-pen rearing of sockeye salmon fry has been proposed to increase their survival rate. Since there are many appropriate locations for net pens in the EVOS, it is estimated that this technique would have strong short and long-term benefits on the sockeye salmon populations. The advantage to subsistence users would be a corollary benefit.

Hatchery rearing of sockeye salmon, with release possible as fed fry, presmolts, and smolts has been proposed as another method to increase their population. A number of project types are applicable, using different combinations of biological, physical, logistical and technological factors. The short-term benefit of this type of action is likely to be low because it will take some time to establish the populations. The long-term benefit to pink salmon populations is estimated to be high, as several generations of improved survival rates to the smolt stage leading to the increased numbers of returning adults. The benefit to subsistence users will increase as populations of sockeye salmon increase. Benefit to subsistence users increases if wild stocks are separated from hatchery stocks. Concentration on hatchery stocks by commercial fisheries may reduce competition for wild stocks.

Fertilizing lakes to improve sockeye rearing success within the lake and increase sockeye population has also been proposed. Sockeye salmon populations have been successfully increased through lake fertilization, but there may be few candidate lake systems for this application. The short-term benefit of this action on subsistence users would be negligible, while the long-term outlook would be substantially increased numbers of sockeye in specific stream systems, a high long-term benefit for subsistence users in some locations.



Relocation of hatchery runs has been identified as a means to divert the commercial fishing fleet away from wild stocks of sockeye salmon. The resultant recovery of stocks would benefit subsistence uses of sockeye salmon. The benefits of this action on subsistence mirror those of the sockeye salmon population: negligible in the short term, but high in the long term of six to ten years.

#### -Subsistence Food Testing

One of the main elements in the damage to subsistence uses in the spill area is the fear that once-safe subsistence foods are no longer safe to eat. An action has been proposed to conduct tests on subsistence foods to determine the amount of contamination, if any, in various types of subsistence foods. This action would provide immediate information to subsistence users, providing short- and long-term high level benefit to their sense of security.

**Conclusions.** Short-term benefits to populations of harvestable subsistence resources, and so to subsistence use, under this alternative on subsistence would be low. Long-term benefits of habitat acquisition would be low to moderate. General restoration actions would produce moderate to high benefits.

#### Recreation and Tourism

##### **Habitat Protection**

It is assumed here that between 31 and 34 large parcels, a total of 421,500 to 478,500 acres, would be purchased. These parcels contain low (low to no recreation use; access may be difficult), moderate (receives occasional public use; adjacent waters used for recreational boating; adjacent area receives high public use), or high (receives regular, high directed public use; highly visible to a large number of recreationists/tourists) potential for benefiting recreation and tourism as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.1 (or slightly higher than moderate).

The benefit to recreation and tourism of habitat protection and acquisition derive from protection of the scenic, wildlife, and undeveloped characteristics important for recreation values in the parcels being evaluated for acquisition. Extractive economic activities would reduce the recreational visual appeal of the landscape, shift or reduce wildlife viewing possibilities, and eliminate the relative lack of developed (logged or mined) character, thereby reducing the overall utility of those and surrounding areas for recreation purposes. These benefits would be low in the short term, but moderate to high in the long term.

This analysis does not take into consideration small parcel acquisition, which is currently under evaluation. It is also possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels - possibly all identified parcels (863,100 acres).

##### **General Restoration**

Restoration strategies for recreation and tourism are to preserve or improve the recreation and wilderness values of the spill area, remove or reduce residual oil if it is cost effective and

## 4 Environmental Consequences

less harmful than leaving it in place, and monitor recovery. Alternative 5 focuses on stabilizing and improving existing recreation opportunities. It allows for funding of projects that create new recreation opportunities or promote public land recreation use as long as the projects benefit the same user group that was injured.

### -Removing Residual Oil

Removing residual oil on beaches important for recreation use would restore these beaches to useable condition, which would have a moderate short-term benefit. The long-term benefits of this action would locally be high, but are estimated to be moderate overall.

### -Easement Identification

Easement identification has been proposed as a means to reduce trespass and land-use conflicts between private landowners and the general public. This would improve recreation and tourism by letting people know where public land exists. The short-term benefit would be low, since dissemination of the knowledge would accumulate impact over several years. Long-term benefit would be moderate to high, but may be very localized.

### - New Recreation Opportunities

New recreation opportunities may include new facilities, trails, recreation sites, or support for activities in new areas (like new access or supply means). This would benefit recreation and tourism through expanding the numbers of available places to take part in activities already present in the spill area, or by expanding the range of available types of activities beyond those now present. These actions may produce immediate impacts that are minimal in the short term, but which could be major in the long term.

### -Promoting Recreation Use

Promoting recreation use on public lands could take a variety of forms, from creating new visitor centers or building a marine environmental institute, to distribution of educational or interpretive information through existing marketing sources. Various education and public information projects have been proposed, including, for example, a Leave No Trace education program and a recreation information center at Portage. These actions would have low benefits on numbers or categories of recreationists or tourists in the short term, but may potentially greatly increase visitation in the long term, especially if they are used to inform and educate the public concerning other spill-related restoration actions that affect recreation and tourism. The benefits of new recreation alternatives and recreation marketing have potential to greatly increase recreation use and tourism in the spill area in both the short term and long term. This includes increased visitors to population centers and remote locations throughout the spill area. However, increasing the level of recreation and tourism use creates negative effects for ecosystems, especially if increased pressures occur to species and landscapes not recovered or recovering from the spill. Increased numbers of people and technology (boats, planes, generators, etc.) may also change the wilderness quality of the recreation experience.

**Conclusions.** The short-term benefits of both habitat protection and acquisition and general restoration actions on recreation and tourism in terms of increased numbers of visitors, types of recreation opportunities available, and quality of experiences would be low. The long-term benefits of habitat protection and acquisition on recreation use levels and appreciation would be moderate. The long-term benefits of general restoration actions on numbers of visitors and recreation opportunity types would range from moderate to high, though these benefits may be offset somewhat by a change in the wilderness quality of recreational activities as use increases.

## Wilderness

### **Habitat Protection**

It is assumed here that between 31 and 34 large parcels, a total of 421,500 to 478,500 acres, would be purchased. These parcels contain low (high/moderate evidence of human development and/or ongoing activities), moderate (area remote; evidence of human development and/or ongoing activities), or high (area remote; little or no evidence of human development) potential for benefiting wilderness as analyzed by the Habitat Protection Work Group (November 30, 1993). If low potential benefit on a parcel is assigned a value of 1, moderate potential benefit a value of 2, and high potential benefit a value of 3, these parcels average 2.3 to 2.4 (or between moderate and high). There would be negligible short-term benefits on designated Wilderness. Long-term benefits would likely be low, with benefits achieved by extending protection from extractive activities to areas adjacent to or near Wilderness areas, thereby increasing the viability of undisturbed ecological relationships that may exist between species in those lands. This analysis does not take into consideration small parcel acquisition, which is currently under evaluation. It is also possible that land prices will be lower than those assumed here. That would result in the purchase of more parcels - possibly all identified parcels, which would result in extending the range of possible benefit to Wilderness areas from 863,100 acres.

### **General Restoration**

General restoration actions could include any that assist recovery of injured resources, or which prevent further injury. Any of these would have spin-off benefits that would improve wilderness values in the EVOS area. Recovery of designated Wilderness areas hinges on removal of traces of oil and remaining materials from clean-up activities, and public perception that the areas are recovered.

Projects that remove residual oil and/or residual clean-up materials still existing in isolated pockets in Wilderness areas may occur under this alternative. Short-term benefits to Wilderness recovery would be immediate, but if the public perception aspect of recovery is not addressed this benefit would be low to moderate. In the long term, benefits would be moderate if the public perception aspect of recovery are not addressed, even if all oil and residual clean-up materials were removed. However, if actions are taken to make the public aware of continued clean-up activities and the continued pristine nature of Wilderness areas in the spill area, the benefits of clean-up activities would be magnified, creating a high level of recovery in the long term.

**Conclusions.** Short-term benefits of habitat protection and acquisition on designated Wilderness would be negligible. Those of proposed general restoration actions would be low. Long-term benefits on designated Wilderness of habitat protection and acquisition would be low, while the benefits of general restoration actions - if done in combination - would be high.

### Commercial Fishing

Alternative 5 will provide restoration actions to assist replacement of harvest opportunities that were lost because of fishing closures or harvest restrictions that occurred as a result of

## 4 Environmental Consequences

the EVOS. Actions that may be implemented as part of Alternative 5 include: habitat protection and acquisition and creation of new hatchery-produced runs (EVOS Trustee Council, April; November 1993) Appendix C).

Habitat protection may benefit commercial fishing opportunities by providing long-term protection for natural production and stability of wild stocks of pink and sockeye salmon and Pacific herring. The criteria for these parcels that may benefit commercial fisheries depends on the values assigned for those species (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit replacement of lost opportunities for commercial fishing according to Alternative 5 will depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 31 or 34 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low to moderate value for commercial fisheries. If between 31 and 34 parcels are purchased, the benefit is expected to provide moderate value (Appendix A).

Although the average value of forecasted habitat acquisition may not have a high overall rating for commercial fisheries, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

### Restoration Actions.

For commercial fishing resources, the primary action considered under Alternative 5 will replace lost opportunities by creating new hatchery-produced runs of salmon. Specific actions that may be considered should either alone, or collectively, produce sufficiently large numbers of adult pink or sockeye salmon to accommodate a reasonable portion of the fishing fleet to provide a harvest that is separated in time or space from existing harvests. Actions that may potentially fit these criteria include: development of new hatchery runs (e.g., stock fry, presmolts or smolts) or habitat manipulation to increase production of selected stocks (e.g., lake fertilization, spawning channels, etc.). Actions that are designed to increase fish production by habitat manipulation are described in Appendix C.

Development of new runs will provide a benefit for commercial fishing by providing an alternate location and stock for commercial fishing activities. If the brood stock selection for these new runs and the release site is carefully selected, there will be minimal interception of injured wild stocks. Combined with good fishery management practices, and a redistribution of the fishing fleet, an intensive commercial fishery can harvest these stocks (Appendix C).

ADF&G and PNP aquaculture organizations that have established a modern fisheries enhancement program in the area establish new runs of salmon for harvest by commercial fishers. Excellent success has been achieved with sockeye salmon (Ellison, 1993); however, results with pink salmon have been less consistent (Alaska Fish and Game Magazine). Some locations remain as opportunities for juvenile fish imprinting and adult fish terminal harvest areas that are readily accessible to the fishing fleets.

Every fisheries enhancement program must be carefully planned and managed to avoid risks to wild stocks and the fish-culture program must be carefully structured and controlled to



avoid or minimize potential changes in the genetics makeup and health of the wild stocks that may be caused by the fish cultural program (Appendix C.)

## Conclusions.

- short-term effects. Negligible. New runs probably cannot be established within one lifecycle to support new commercial fisheries to replace opportunities lost because of fishing closures or reduced harvests.
- long-term effects. Moderate. These actions will assist the replacement of lost commercial fishing opportunities, however, some portions of the EVOS area will obtain greater benefits than in other portions.

## Sport Fishing

Sport fishing was disrupted throughout most of the EVOS area because of the oil spill and damage was sustained by several important sport fish species. Lost sport fishing opportunities may be replaced by creating new sport fisheries for salmon or trout. Alternative 5 will provide restoration actions to assist replacement of harvest opportunities that were lost because of fishing closures or harvest restrictions that occurred as a result of the EVOS. Actions that may be implemented to as part of Alternative 5 include: habitat protection and acquisition and creation of new hatchery-produced runs (EVOS Trustee Council, April; November 1993) Appendix C).

Habitat protection may benefit sport fishing opportunities by providing long-term protection for natural production and stability of wild stocks of pink and sockeye salmon, Dolly Varden and cutthroat trout. The criteria for these parcels that may benefit commercial fisheries depends on the values assigned for those species (EVOS Restoration Team, 1993).

Forecasted habitat protection that may benefit replacement of lost opportunities for sport fishing according to Alternative 5 will depend on the average cost per acre and the final budget allocation. Therefore, the number of parcels that may be purchased is expected to range between 31 and 34 parcels and all parcels that are available. If all available parcels are purchased, the benefit is expected to provide low to moderate value for sport fisheries. If between 31 and 34 parcels are purchased, the benefit is expected to provide low to moderate value (Appendix A).

Although the average value of forecasted habitat acquisition may not have a high overall rating for commercial fisheries, individual parcels may have exceptional value. In the event that some of these parcels may not be protected through acquisition, the habitat will continue to have some measure of protection through the protective actions of normal resource agency planning and permitting requirements (Appendix C).

## Restoration Actions.

Establishment of hatchery runs will provide some benefit for all fishers by providing new opportunities with new locations and stocks that anglers may utilize. Typically, a run of a few thousands of fish will provide tens of thousands of angler/days of recreation (Mills, 1993). Sport fisheries, however, will be successful only if they are located where they can be



## 4 Environmental Consequences

accessible by anglers. ADF&G has already employed this strategy to improve sport fishing opportunities for trout and salmon in the EVOS area (Appendix C.)

A small number of fish in a good, accessible location can provide angling to accommodate a substantial number of angler/days of recreation. Wherever large number of fishers concentrate to harvest a concentrated population of fish, some portions of the adjacent habitat may be affected, however, new sport fisheries will readily create new recreational opportunities, but these will likely be for different species in new locations.

Every fisheries enhancement program must be carefully planned and managed to avoid risks to wild stocks and the fish-culture program must be carefully structured and controlled to avoid or minimize potential changes in the genetics makeup and health of the wild stocks that may be caused by the fish cultural program (Appendix C.)

### Conclusions.

- short-term. Negligible. New sport fisheries probably cannot be established within one life cycle to replace lost sport fishing opportunities.
- long-term. High. After hatchery production is expanded and newly-established sport fisheries will provide substantial recreational benefits.

### Economy

Qualitative analysis indicates that Alternative 5 will result in moderate economic benefits in commercial fisheries and recreation and moderate negative effects in forestry. Quantitative analysis reflects effects resulting from habitat acquisition on forestry and other sectors but not effects on commercial fishing and recreation because data is not available to quantify in these sectors. The quantitative analysis follows.

The acquisition of lands for habitat removes them from timber production. This results in a negative quantity for each of the six economic measures of final demand, industry output, employee compensation, property income, value added, and employment.

The negative effects on the economy first injected directly to the economy by purchasing habitat multiplies to negative values in other sectors of the economy. Expenditure of funds on restoration has a direct effect on the construction sector as shown in Table 4-13 Alternative 5 in the amount of \$6.2 million in industry output but this is not enough to offset the negative effects in forestry. The net effect is shown in the total line which has negative quantities for the five out of the six economic measures; only employment is positive.

Alternative 5 assumes ranges of expenditures for the expenditure categories. In the quantitative economic analysis specific points within the ranges are assumed for the purpose of simplifying the analysis.

Habitat acquisition and general restoration expenditures will have economic benefits for the commercial fisheries and recreation sectors of the economy. However, these benefits are not reflected in the IMPLAN projections presented in Table 4-13. Therefore, this table does not quantify important economic benefits in commercial fishing and recreation because these benefits are not quantified. Of the three most important economic sectors for this analysis, only forestry is quantified. The typical projects in various combinations, such as fish ladders,

fish hatcheries, and preservation of habitat will economically enhance the commercial fisheries and recreation sectors of the economy. However, because studies and data are not available that quantify in terms of dollars or employment, it is not possible to quantify the economic effects for these two sectors of the economy. In Table 4-13 the quantities for the commercial fisheries and recreation sectors are reflections of the indirect effects of other sectors of the economy only; they are not reflections of the anticipated but unquantified effects on those sectors.

See the introduction to Chapter 4 on economics and Appendix D Economics Methodology for a more detailed discussion of methodology.

## Conclusion

Qualitative analysis indicates that Alternative 5 will result in moderate economic benefits in commercial fisheries and recreation and moderate negative effects in forestry. Quantitative analysis reflects effects resulting from habitat acquisition on forestry and other sectors but not effects on commercial fishing and recreation. Quantitative analysis indicates that Alternative 5 results, in annual averages for a 10-year period, in a loss of approximately \$28 million in forestry industry output, an increase of \$6 million in construction industry output, and \$2 million in services. The corresponding changes in employment are a loss of 278 jobs in forestry, an increase of 55 in construction, and an increase of 320 in services.

Table 4-13. Alternative 5  
Change from Base in 1990\$ Millions

| Economic Sector                 | Final Demand \$ | Industry Output \$ | Employee Comp. \$ | Property Income \$ | Value Added \$ | Employment # |
|---------------------------------|-----------------|--------------------|-------------------|--------------------|----------------|--------------|
| Forestry                        | -22.424         | -27.599            | -6.11             | -3.526             | -10.5          | -279         |
| Commercial Fisheries            | 0               | 0                  | 0                 | 0                  | 0              | 0            |
| Mining                          | 0.013           | -0.0451            | -0.003            | -0.02              | -0.034         | 0            |
| Construction                    | 6.761           | 6.261              | 2.21              | 0.936              | 3.262          | 55           |
| Manufacturing                   | 0.012           | -0.334             | -0.054            | -0.017             | -0.08          | 1            |
| Recreation Related              | 0.011           | 0.023              | 0.006             | 0.0072             | 0.013          | 0            |
| Communication & Utilities       | 0.022           | 0.03               | 0.006             | 0.019              | 0.026          | 0            |
| Trade                           | 0.0103          | -0.044             | -0.036            | -0.008             | -0.058         | 0            |
| Finance, Insurance, Real Estate | 0.4             | -0.026             | -0.032            | 0.048              | 0.01           | -1           |
| Services                        | 3.953           | 1.597              | 1.803             | -0.241             | 1.578          | 321          |
| Government                      | 2.119           | 2.024              | 2.08              | -0.019             | 2.06           | 38           |
| Miscellaneous                   | 0               | 0                  | 0                 | 0                  | 0              | 0            |
| Total                           | -9.021          | -18.112            | -0.028            | -2.83              | -3.722         | 135          |

Source: IMPLAN Economic Model. See text for methodology.

## Cumulative Effects

### Introduction

Actions that may affect EVOS restoration include the Whittier road access project, Whittier harbor expansion, Cordova road access, harbor dredging at Shepard Point near Cordova, tourism and recreation development at Child's Glacier on the Copper River Delta, the Trans-Alaska Gas Pipeline terminal in Port Valdez, Lower Cook Inlet oil development, and the effects of EVOS projects for Fiscal Years 1992 through 1994 (FY's 1992-94). This section discusses these actions, evaluates their effects on each injured resource, and summarizes the cumulative effects on each resource.

#### Whittier Road Access and Whittier Harbor Expansion

These two actions are considered together because their effects on resources would be similar. Road access to Whittier and expansion of Whittier harbor both would dramatically increase the number of people in Prince William Sound. Numbers of recreational boaters of all kinds, tourists aboard charter and tour boats, and seasonal and year-round residents of Whittier would all increase. The increase in boat traffic would be especially pronounced within 30 to 40 miles of Whittier, the normal range of weekend boaters. Even without these actions, recreational and tour boat use has steadily increased the past few years in this part of Prince William Sound, particularly in Blackstone Bay, around Esther and Culross Islands, in Port Wells, and in Harriman and College Fjords. These two actions would create even more pressure on these areas and their resources. Boat traffic between Whittier and Valdez and throughout Prince William Sound would also increase.

#### Cordova Road Access

Road access to Cordova would increase the number of people who use southeastern Prince William Sound. Numbers of recreational boaters and tourists aboard charter and tour boats will all increase markedly, especially within 30 to 40 miles of Cordova, the normal maximum range of weekend boaters. Boat traffic throughout eastern Prince William Sound also would increase.

#### Shepard Point (Nelson Bay) Dredging

Dredging near Cordova at Shepard Point in Nelson Bay is proposed to accommodate berthing of cruise ships and tour boats to enhance tourism in the Cordova area. This action would alter the natural character of the local nearshore environment and temporarily create dredge spoils and noise.

#### Child's Glacier Tourism Development

A lodge and related tourism and recreation facilities are planned for construction near Child's Glacier and the "Million Dollar Bridge."

## 4 Environmental Consequences

### Trans-Alaska Gas Pipeline Terminal

Construction of the terminal for the Trans-Alaska Gas Pipeline is planned for Anderson Bay, near the mouth of Port Valdez.

### Lower Cook Inlet Oil Development

Minerals Management Service (MMS) Lease Sale 149 is proposed to be held in 1996 for the Outer Continental Shelf in Cook Inlet from the north end of Kodiak Island to the north end of the Kenai Peninsula.

The base case in a scenario formulated by MMS projects the following activity over a 30-year period:

- 3 exploration wells
- 5 delineation wells
- 3 production platforms
- 48 production/service wells
- 1 shorebase
- 125 miles of 12-inch pipeline offshore to the Nikiski industrial complex, which would self-bury because of turbid conditions
- 200 million barrels of oil produced

Additional MMS projections are that development of infrastructure and production of oil would include considerable aerial and marine support from a shorebase; oil would be used locally or sent via tanker to the West Coast of the U.S.; and an oil spill of 50,000 barrels is estimated to have a 27-percent chance of occurring at some time over the 19-year period of production.

### FY's 1992 - 94 EVOS Projects

The EVOS projects funded in FY's 1992 - 94, are shown in Appendix E of this EIS. These projects were reviewed for inclusion of their potential impacts in this analysis.

## Biological Resources Intertidal Resources

Several of the actions are unlikely to impact the intertidal zone. This discussion focuses on those actions that could affect the recovery of intertidal organisms. The harbor expansion projects at Whittier and Cordova (Shepard Point) would cause a localized loss of the existing intertidal habitats. Because neither of these specific areas were directly impacted by the EVOS, these localized losses should not have a negative effect on the recovery of the injured intertidal areas.

Lower Cook Inlet oil development would increase the risk by 27 percent of another oil spill occurring in the EVOS area. Likewise, the increased tanker traffic caused by the Trans-Alaska Gas Pipeline would increase the risk of another oil spill, indirectly, through an increased potential for oil tanker collisions. Any oil spill within the EVOS area could have an enormous impact on the intertidal zone. The EIS's associated with these two actions would have to consider the potential impacts on the intertidal organisms in the event of an oil



spill. If no oil spills occurred, and steps were taken to reduce disturbance, there should be little or no impacts.

Restoration actions undertaken in response to the EVOS from 1992 to 1994 include feasibility studies to develop effective techniques to clean oiled mussel beds and to accelerate the recovery of *Fucus* in the upper intertidal zone. The results of these actions, if positive, would enable the implementation of restoration projects to occur more quickly.

**Conclusions.** The cumulative actions that may affect EVOS restoration, combined with the proposed action, should not change the expected benefits, assuming that another oil spill does not occur.

### **Marine Mammals**

#### **Harbor Seals and Sea Otters**

Increased potential for disturbance to harbor seals and sea otters would be the primary impact caused by most of the cumulative actions being considered. The Whittier road access, the Whittier harbor expansion, the Cordova road access, the Shepard Point dredging, and the Trans-Alaska Gas Pipeline would result in increased boat traffic, from tankers to pleasure boats and kayaks, in Prince William Sound. This increase probably would have a negligible impact on sea otters, but it could harm harbor seals. The proposed action includes an information-based program that would minimize the impacts of human-caused disturbance to harbor seals. If this program were implemented in proportion to the increase in human use, the overall effects should be negligible. A lodge at Child's Glacier should have no impact on harbor seals and/or sea otters.

The Lower Cook Inlet Oil development has the potential to create disturbance near haulout sites, but the greatest negative impact would be caused if there were another oil spill. The increased tanker traffic caused by the Trans-Alaska Gas Pipeline also might increase the risk of another oil spill, indirectly, through an increased potential for oil-tanker collisions. Any oil spill within the EVOS area could have an enormous impact on the recovery of sea otters and harbor seals. The MMS has estimated that there is a 27-percent chance of an oil spill occurring from Lower Cook Inlet oil development during the 19-year production period. The EIS's with these two actions should consider the impacts on marine mammals in the event of an oil spill. If no oil spills occur, and steps are taken to reduce disturbance, there should be little or no impact on sea otters and harbor seals.

Restoration actions undertaken in response to the EVOS in FY's 1992 through 1994 include feasibility studies to develop effective techniques for cleaning oiled mussel beds. The results of these studies, if positive, would enable the implementation of restoration projects to occur more quickly. This will reduce the risk of continuing exposure to hydrocarbons for sea otters.

Initiation of a cooperative program with subsistence users also is scheduled to begin in 1994. This would have no effect on the results of the analysis of this action; however, it would accelerate the timing of the benefits by at least 1 year.

## 4 Environmental Consequences

The EVOS program also has protected uplands in Kachemak Bay and Seal Bay. These areas are adjacent to valuable habitat for sea otters and harbor seals, and this protection would help maintain these high-quality habitats.

### **Conclusions.** (Cumulative effects on harbor seals and sea otters)

The cumulative actions that may affect EVOS restoration, combined with the proposed action, should not change the expected benefits, assuming that another oil spill does not occur.

### **Harlequin Ducks**

Increased boat traffic in Prince William Sound, especially from smaller motorboats that generally travel close to shore, would have an increasing disturbance effect on harlequin ducks, especially during late summer when molting takes place and new broods are first acclimatizing to the marine environment. Occasional hikers in riparian habitat should have a negligible disturbance effect on nesting harlequin ducks. Increased hunting pressure may affect populations, but hunting regulations could be adjusted where necessary to negate this effect. New oil development in Cook Inlet would increase the risk of a spill that might repeat the injury suffered by the Prince William Sound population. Cleaning oiled mussel beds would have a moderate to high benefit for local populations of harlequin ducks but would have little influence on their overall recovery. Other proposed actions in this alternative appear to have a negligible lasting effect on harlequin ducks.

### **Conclusions.** (Cumulative effects on harlequin ducks)

The combined effects of proposed Alternative 5 and the cumulative actions described above would be moderately beneficial to harlequin duck populations in the EVOS zone.

### **Common Murres**

Murre populations generally are quite low in Prince William Sound, but important seabird colonies lie within the lower Cook Inlet oil-sale area, including the injured breeding population of common murres in the Barren Islands. There also are several smaller colonies in the sale area, including Gull Island in Kachemak Bay and Chisik Island at the mouth of Tuxedni Bay. An oil spill near these colonies would have a major, highly negative effect on the injured population of common murres, especially at the Barren Islands, where the population is just beginning to recover.

### **Conclusions.** (Cumulative effects on common murres)

The combined effects of the proposed alternative and the actions described above would be moderately beneficial for common murres in much of the EVOS area. However, proposed oil development in lower Cook Inlet would have an extremely high negative impact on the recovering common murre population at the Barren Islands, should a spill reach those islands during the nesting season.

### **Pigeon Guillemots**

Increased boat traffic in Prince William Sound would create the threat of disturbance to a few colonies of pigeon guillemots. Guillemots are most susceptible to disturbance during the

early stages of the breeding season, when they are highly social at their colonies. However, this social behavior mostly takes place in the early morning when most boaters are inactive, so actual disturbance is likely to be low. Predator control slated for the Shumagin Islands, downstream from the EVOS area, would allow a local increase in pigeon guillemot numbers.

**Conclusions.** Cumulative effects on pigeon guillemots)

The combined effects of proposed Alternative 5 and the actions described above would be highly beneficial for the pigeon guillemot populations at the colonies slated for predator removal. Benefits for the overall EVOS area would be moderate.

**Marbled Murrelets**

The effects of this alternative on marbled murrelets likely would result in a negligible increase in the prey base of marbled murrelets.

**Conclusions.** (Cumulative effects on marbled murrelets)

The combined effects of proposed Alternative 5 and the cumulative actions described above would produce a high overall benefit for marbled murrelet populations.

**Fish**

**Pink Salmon, Sockeye Salmon, Pacific Herring, and Commercial Fishing**

**Proposed Actions and Expected Effects.** Increased road access to Whittier and Cordova and an expansion of the capacity of the Whittier boat harbor may cause an increased number of commercial fishers or increase the ease of access to commercial fisheries, so pressure on the commercial-fisheries resource could be expected to increase. However, increased effort can be expected to be offset by an increased effort to manage or to enhance the fisheries. These actions also could increase the volume of recreational users and tourism, which could have a disruptive effect on the execution of the fisheries and potentially lead to a degradation of important fish spawning and rearing habitat.

Development of a Lower Cook Inlet oil field may have a disruptive effect on fish migrations and the execution of the fishery; however, before the oil field is developed, the potential impacts should be discussed and, presumably, resolved; e.g., by seasonal operational plans or well-defined shipping lanes.

Dredging operations to expand cruise ship traffic near Cordova could have a disruptive effect on other vessel movements during both the construction and operational phases. Potential direct disruptive effects on the fish resources may be minimized by controlling activities during critical periods of fish production and migration.

Trans-Alaska Gas Pipeline construction and operation may have a similar, but lesser, effect on fish or fisheries in the EVOS area as would the Trans-Alaska Oil Pipeline. Some local effects may occur, and shipping may increase the number of tankers in the same shipping lanes, but accidental leakage of gas is not expected to harm the aquatic environment.

## 4 Environmental Consequences

Increased tanker traffic in the shipping lanes would increase the likelihood of a tanker collision and potentially resultant oil spill.

Recreational development near Child's Glacier would increase the number of visitors and recreational fishers, but it is unlikely to have an important effect on commercial fishing or fishes.

Fisheries restoration projects that have already been funded would contribute to the recovery of commercial fish and fisheries, but these projects alone would not have a substantial effect. Fish hatchery operations in FY 1994 are a continuation of established programs that help provide stability to the operation of the fishery and habitat-restoration programs to improve protection and production of wild stocks of fish.

**Discussion.** Several of these potential actions might have an individual or cumulative negative impact on commercial fish and fisheries; one would be beneficial. Each, however, must be evaluated with its own environmental review and designed to minimize or avoid potential damage during both the construction and operational phases.

**Conclusions.** (Cumulative effects on pink salmon, sockeye salmon, Pacific herring, and commercial fishing)

- short-term effects: No development is likely within one lifecycle.
- long-term effects: With proper planning and environmental safeguards, there should be minimal negative effects to reduce the benefits expected from implementation of Alternative 5. Some combined actions, however, could be expected to have collective or localized negative effects.

### Sport Fishing, Pink Salmon, Sockeye Salmon, Cutthroat Trout, and Dolly Varden

**Proposed Actions and Expected Effects.** Increased road access to Whittier and Cordova and an expansion of the capacity of the Whittier boat harbor may cause an increase number of visitors, tourists, and fishers or increase the ease of access to recreational fisheries, so pressure on the fisheries resources could be expected to increase. Increased demand for the available resources could be expected to be offset by an increased effort to enhance the fisheries or manage them more conservatively. These actions also could increase the volume of other recreational and tourist activities, which could have a disruptive effect on the execution of the fisheries and potentially could lead to a degradation of important fish spawning and rearing habitat.

Development of a Lower Cook Inlet oil field may have a disruptive effect on fish migrations. However, before the oil field is developed, the potential impacts should be discussed and, presumably, resolved. (e.g., by seasonal operational plans or well-defined shipping lanes).

Dredging operations to expand cruise ship traffic near Cordova may have a disruptive effect on other vessel movements during both the construction and operational phases. Potential direct disruptive effects on the fish resource could be minimized by controlling activities during critical periods of fish production and migration.

The Trans-Alaska Gas Pipeline construction and operation may have a similar, but lesser, effect on fish or fisheries in the EVOS area than the Trans-Alaska Gas Pipeline. Some local effects may occur and shipping may increase the number of tankers in the same shipping lanes, but accidental leakage of gas is not expected to harm the aquatic environment. Increased tanker traffic in the shipping lanes would increase the likelihood of a tanker collision and potentially resultant oil spill.

Recreational development near Child's Glacier would increase the number of visitors and recreational fishers. Increased demand for the available resource could be expected to be offset by an increased effort to enhance the fisheries or manage them more conservatively. This action also could increase the volume of other recreational and tourist activities, which could have a disruptive effect on the fisheries and potentially lead to a degradation of important fish spawning and rearing habitat.

Fisheries restoration projects that already have been funded would contribute to the recovery of sport and commercial fish and fisheries, but these projects alone would not have a substantial effect. Fish-hatchery operations in FY 1994 are a continuation of established programs that help provide stability to the operation of fisheries, and habitat-restoration programs improve protection and production of wild stocks of fish.

**Discussion.** Several of these potential actions may have an individual or cumulative negative impact on sport fish and fisheries; one will be beneficial. Each, however, must be evaluated with its own environmental review and designed to minimize or avoid potential damage during both the construction and operational phases.

**Conclusions.** (Cumulative effects on sport fishing, pink salmon, sockeye salmon, cutthroat trout, and Dolly Varden)

- short-term effects: No development is likely within one lifecycle.
- long-term effects: With proper planning and environmental safeguards, there should be minimal negative effects to reduce the benefits expected from implementation of the preferred alternative. Some combined actions, however, could be expected to have collective or localized negative effects.

## Social and Economic Resources Cultural Resources

Factors that might impact cultural resources are: (1) construction that may damage archaeological or historic sites; (2) increased access to or numbers of visitors to sites, thus allowing for activities that could damage archaeological or historic sites; or (3) changes in the levels of site monitoring and/or interpretation.

The Whittier road access would increase ease of access to Whittier, which would produce an increase in the population of visitors to Prince William Sound. This would result in increased numbers of people using small motorboats, the Alaska State Ferry, and boat charters out of Whittier. The proposed expansion of the Whittier harbor would allow more



## 4 Environmental Consequences

and larger pleasure boats to use the area. The increase in small- motorboat use would allow greater numbers of people to visit culturally sensitive areas, especially within the 30- to 40-mile normal maximum range for weekend boaters. Without sufficient monitoring and/or interpretation, this would increase the possibility of damage to archaeological and historic sites in the region. However, if interpretation and monitoring are increased in proportion to the visitor population, there is the potential for greatly expanded public knowledge and appreciation of the cultural resources of the region.

Cordova Road access similarly would increase the population of visitors to Prince William Sound. In addition to exposing archaeological and historical sites to increased use through boat access, the Cordova Road would allow easier access to areas alongside or near the road. Similar effects could be expected as a result of the Childs Glacier lodge/motel development proposed by Chugach Alaska Corporation and Princess Lodge. Again, site monitoring and public education/interpretation could reduce the levels of impact.

Lower Cook Inlet oil development may increase populations and coastal activities in and around Cook Inlet communities. Depending on the location and extent of these increases, archaeological and historical sites could be adversely affected. If site excavations, monitoring, and interpretation are undertaken as discussed in the proposed alternative, the negative effects of these projects may be reduced.

The proposed harbor at Shepard Point near Cordova would have no substantial impacts that would produce cumulative effects that need to be considered in this EIS. The Trans-Alaska Gas Pipeline terminal likewise would produce site-specific impacts that would not substantially impact the cultural resources of the spill area.

The projects funded by the Trustee Council between FY's 1992 - 94 are producing local benefits to archaeological and historical sites and also should produce some benefit to the understanding and appreciation of cultural resources in EVOS communities.

### Conclusions. (Cumulative impacts on cultural resources)

Taken into consideration in conjunction with other ongoing or planned projects in the spill area, the benefits of Alternative 5 would be somewhat reduced. The benefits of this proposed alternative would help offset the negative impacts of the cumulative actions.

### Subsistence

Cumulative impacts on subsistence are those that affect the populations and distributions of species that subsistence users harvest as well as those that affect the attitude subsistence users have toward harvesting those species. This includes impacts of the proposed action and other ongoing planned projects in the EVOS area.

The main impact on subsistence from other ongoing or planned projects in the spill area would be from increased competition for resources that are both subsistence and recreation species. It is anticipated that these cumulative effects would be restricted to Prince William Sound. The road projects to Whittier and Cordova, the Whittier harbor expansion, and the lodge development at Childs Glacier each may add increments of additional numbers of recreational boaters in Prince William Sound. While it is unlikely that increased numbers of recreational boaters would affect the numbers of sea mammals, it is possible that increased boat traffic could cause some disturbance of harbor seals or sea otters in localized areas.

There also may be increased competition for salmon or other fish used by sport anglers. However, the primary impact may be competition for deer in Prince William Sound, especially at locations like Montague Island.

Projects funded by the Trustee Council from FY's 1992 - 94 (Subsistence Food Testing, Subsistence Planning, and efforts to increase populations of subsistence harvest species) have produced some benefits to the confidence levels of subsistence users toward the safety of consuming traditional foods.

## **Conclusions.** (Cumulative impacts on subsistence)

Increased competition for subsistence resources may result from ongoing or planned projects in the Prince William Sound region. The benefits expected from the proposed alternative, Alternative 5, will not substantially offset the impact of that competition.

## **Recreation and Tourism**

The factors that may come into play in the cumulative effects on recreation and tourism include the numbers and types of visitors, their distribution, and the availability of suitable facilities or sites. This analysis is concerned with recreation and tourism in the entire EVOS area.

Whittier road access and Cordova road access would increase the numbers of visitors to Prince William Sound and the Copper River Delta. They also would increase the use of vehicle access to tourist facilities and businesses in Whittier as well as to recreation sites in Prince William Sound. This would allow more people to use existing campgrounds, interpretive sites, picnic areas, and so on, especially in the Cordova area. The proximity of Whittier to Anchorage would allow potentially large increases in numbers of visitors, which would allow for new tourism-based businesses. The increased access to both Cordova and Whittier also would likely increase the number of small motorboats using Prince William Sound. This would put additional stress on recreation sites, which could have damaging effects to local ecosystems and cause shifting in recreation use patterns. Recovery of recreation as discussed for the proposed alternative, Alternative 5, would help balance the shift in recreation use patterns and provide new recreational use opportunities. Habitat protection and acquisition would allow additional public access to lands that were previously privately owned, thereby providing new recreation site opportunities. Recreation projects developed for general restoration may provide additional facilities or enhance existing facilities or sites in a way that would reduce the impact of increased numbers of visitors.

The proposed lodge/motel at Childs Glacier also would increase the numbers of visitors along the Cordova road system, and there is additional potential for airplane and boat charter operations in connection with this development. Again, the recovery of recreation as discussed for Alternative 5 would help balance the shift in recreation use patterns and provide new recreational use opportunities.

Should a deep-water harbor be constructed at Shepard Point, Cordova could become a focus for cruise ship-based tourism. A harbor of that type potentially would be a major positive impact to tourism in Cordova, primarily affecting retail sales. Some additional charter

## 4 Environmental Consequences

business (bus, small boat, and airplane) is expected as a result of this development; however, little effect is expected on dispersed or remote recreation in the area.

The proposed Lower Cook Inlet oil development would result in the development of infrastructure, which would entail both short-term and long-term population increases in some communities. It also would entail considerable aerial and marine support from a shore base. This could have a substantial local impact on demand for recreation opportunities in the Lower Cook Inlet region. During the construction phase, the additional air and marine traffic could disrupt the recreation quality in the area and along the transportation routes. Acquisition of lands through the EVOS restoration process may make more lands available for public recreation, and public education/ information availability may help distribute recreational activities to decrease impact from overuse of a few areas. The presence of 48 production/service wells and 3 production platforms would impact the visual character of the landscape, which would change the recreational experience in the region.

The Trans-Alaska Gas Pipeline is anticipated to have little impact on recreation and tourism in the EVOS area.

Projects funded for recreation and tourism by the Trustee Council for FY's 1992-94 have been directed toward gaining information on the quantity and types of impacts to those services. While this information is expected to have considerable benefits to the Trustee Council's ability to appropriately plan restoration activities, no projects have yet been funded that would directly benefit these services.

### Conclusions. (Cumulative effects on recreation and tourism)

In combination with the effects of the proposed alternative, the cumulative effects of these projects would be increased pressure on facilities and undeveloped sites and a change in recreation experience for visitors to Prince William Sound.

### Wilderness

### Conclusions.

None of the developments considered would, in combination with actions under the proposed alternative, have a cumulative effect on Wilderness.

### Economy

The actions described in the cumulative case would have an economic impact of increasing employment and output by 1 percent per year over a 10-year period. An increase in employment of 1 percent per year is projected in a report by the Institute for Social and Economic Research (ISER) (1992). These employment projections in the ISER report assume approximately the same range of projects and factors affecting the economy as described in this cumulative case. The 1-percent annual increase in employment and output as a result of cumulative-case activity plus the economic impact from Alternative 5 would result in moderate economic effects.

To: EIS Team.

I have read and reread the comment by John F. on page 10, chapter 4, attached. I am still not certain what it means, but my translation is Para 1, below. Para 2 provides an expansion and Para 3 may also be useful. I think that we need to talk about this and I am not comfortable with John's replacement statement.

TO D  
INCORPORATE

The No Action Alternative is required by NEPA to provide an understanding of what may occur if no actions are implemented to restore the injured resources to pre-spill conditions.

(It is intended to be a forecast or projection of conditions from the present status of the injured resources [i.e., Draft Restoration Plan] to a future status if no actions are taken.)

It will provide additional background for analysis and comparison to forecast impacts from actions of other alternatives.

Sorry... I didn't intend to remain so

Anonymous -

Bill Hauser

## Environmental Consequences

### Alternative 1 - No Action

or projected

provide understanding of  
what may occur if the  
proposal is not adopted.  
It is a forward impact  
projection of the existing  
levels of action/no-action  
in being at the time of  
the proposal.

#### Introduction

The No Action Alternative is required by NEPA to ~~provide a basis for comparing the impacts of the other proposed alternatives~~. In this DEIS, the No Action Alternative describes what would happen to the resources and services injured by EVOS if no restoration actions were implemented. Because none of the civil settlement funds would be spent to aid recovery, the only actions undertaken within the spill area would be the result of normal agency management or private enterprise. For biological resources, recovery from oil spill injuries would be unaided (natural recovery) and could be complicated by other human activities that could cause further injuries or habitat loss. The recovery of other resources or services also may be influenced by other nonoil spill-related actions.

#### Biological Resources Impact on Intertidal Resources

The intertidal zone was especially vulnerable to injury from the EVOS and from the subsequent cleanup operations. The oil spill caused population declines and sublethal injuries to the plants and animals of the intertidal zone. Portions of 1,500 miles of coastline were oiled (350 miles were heavily oiled), resulting in significant impacts to intertidal habitats, particularly in the upper intertidal zone. Direct oiling killed many organisms, but beach cleaning, particularly high-pressure, hot-water washing, had a devastating effect on intertidal life (Houghton, Lees, and Driskall, 1993).

Coastal habitat studies documented changes in many species of algae, invertebrates, and fish; the injuries were highly variable between species, regions, and habitats (Highsmith et al., December 1993). For most of the intertidal zone, the effects of the oil spill were probably short term. Studies in 1992 and 1993 showed that many of the differences in habitats and organisms that were documented in 1989 and 1990 were recovered (Houghton, Lees, and Driskall, 1993; Highsmith et al., December 1993). However, some areas had not yet begun to recover or were recovering very slowly. This was especially evident in the upper 1 meter vertical drop (MVD) of sheltered rocky habitats where the algae *Fucus gardneri* is the dominant plant species (Highsmith et al., December 1993; Highsmith et al., October 1993; Houghton, Lees, and Driskall, 1993). This discussion focuses on the organisms and habitats that are the least likely to have recovered.

#### ***Fucus***

This algae, or rockweed, is an important component of the upper intertidal zone because it provides food for many invertebrates, as well as shelter from predation and desiccation for many plants and animals (Highsmith et al., October 1993). The oil spill and subsequent cleanup destroyed many of the plants in the upper meter and reduced the reproductive capacity of the adult plants that survived (Highsmith et al., October 1993). These injuries were documented in all regions of the spill area but were highly variable between tidal elevations (MVD) and habitats (Highsmith et al., December 1993).

The Herring Bay Experimental and Monitoring study (Highsmith et al., October 1993) provided information on the recovery of plants and invertebrates in the intertidal zone.



## Chapter 4

### Introduction

This chapter contains the analysis of the environmental consequences that could result from implementing the five alternatives described. In many environmental impact statements (EIS's) the analysis focuses on the numbers or degree of loss to various resources. It is an important distinction of this EIS that with few exceptions, the impacts estimated to occur under the various alternatives are increases in populations or services from some existing injured level.

The analysis of impacts is based in large part upon what has been learned from studies carried on since the *Exxon Valdez* Oil Spill (EVOS). Much of this research has focused on the area of Prince William Sound. As a result, most of the estimated impacts from actions in the alternatives are based on what we have learned from the Prince William Sound studies and extrapolated for analysis in the other areas of the EVOS.

The current situation provides the basis for comparing the effects of the action alternatives. In this programmatic document, it should be noted that the No Action Alternative consists of normal agency management activities and the assumptions that (1) natural recovery will be the only restoring agent at work and (2) private land owners will harvest their commercial timber lands in the long term.

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If the No Action Alternative were implemented, current management would continue, no new activities or programs would be instituted as a result of the oil spill, and the scope of present activities and programs would not change. Agency monitoring of natural recovery would remain at present levels, and their responsibilities would remain unchanged. None of the remaining funds from the civil settlement would be spent at this time on restoration activities if this alternative were implemented.

Monitoring and research, as actions, generally do not impact resources and services and therefore are analyzed only for their economic impacts. It is recognized that the general restoration category also includes such actions as data gathering, surveys, and analysis that would not impact the resources--thus these activities would not be included in the EIS analysis except for the impacts on the economy.

but without m & r that is focused on ~~injured~~ resources that were injured because of the EVOS, it ~~will~~<sup>may</sup> be unclear when or if those resources have recovered. Therefore, management agencies will assume the "worst case" and manage those resources most conservatively.

W.J. H.

## Unavoidable Adverse Impacts

### Impact on Biological Resources

No unavoidable adverse impacts on biological resources are expected from the proposed action (Alternative 5). In fact, the opposite is estimated to be true. The proposed action should result in benefit to varying degrees for all biological resources analyzed.

### Impact on Social and Cultural Resources

There are no projected unavoidable adverse impacts on the social and cultural resources by the proposed action.

### Impact on the Economy

The proposed action (Alternative 5) will have a moderate adverse impact on the forestry sector of the economy because a certain amount of timberlands will not be available for harvesting. Forestry output and employment will be less to a moderate degree.

## **4 Environmental Consequences**

### **Relationship Between Local Short-Term Uses and Enhancement of Long-Term Productivity**

In this section, the short-term impacts and uses of various components of the environment are related to long-term impacts and the maintenance and enhancement of long-term productivity.

#### **Impact on Biological Resources**

The nature of the proposed action (Alternative 5) is, like that of the other action alternatives in this EIS, it does not adversely impact the biological resources. Details of the short and long-term impacts are discussed in the description of the environmental consequences of each alternative earlier in this chapter. The short-term impacts are beneficial to all the resources although usually to a negligible degree. The long-term aim of all the alternatives including the Proposed Action is recovery from the EVOS injury. Long-term productivity is benefited or enhanced by the action pattern contained in the Proposed Action.

#### **Impact on Social and Cultural Resources**

Similarly to the biological resources, the social and cultural resources are benefited by the Proposed Action. The actions proposed will restore the resources and services injured by the EVOS and thus benefit the lives of those who use them.

#### **Impact on the Economy**

The protection of habitat will necessarily adversely impact the timber related economy of the EVOS area. This is in the form of reducing or eliminating the potential for commercial timber operations on private lands into the future. This will also have a long-term beneficial effect on biological resources such as commercial fish species, that may offset this adverse impact. The impacts associated with the proposed action are discussed in detail earlier in this chapter.

U.S. Fish and Wildlife Service

Subsistence Management

Region 7 - Alaska

JOHN FARRELL

5/5/94

~~XXXXXXXXXX~~

1. PURPOSE OF PROT.
2. DEFINITION ON NO ACTION
  - NO A REQUIRED BY NEPA TO
  - 1) PROVIDE UNDERSTANDING OF WHAT MAY OCCUR IN P.A. IS NOT
  - 2) PROJECT WHAT IMPACTS OCCUR
- ③ FISH IS STILL TOO EXPANSIVE
- ④ UNAVOIDABLE COULD BE DELETED.
- ⑤ IRREV. - TIMBER
  - IF TIMBER IS SET ASIDE
  - THERE IS A LOSS. TO TIMBER ECONOMY.
- ⑥ DEFINITIONS: WILDERNESS SPECIFICALLY  
ALL NEED TIGHTENING IN GENERAL.



## **Irreversible and Irretrievable Impacts**

### **Impact on Biological Resources**

There are no irreversible or irretrievable impacts on the biological resources. The Proposed action results in benefits to the biological resources through actions proposed to restore the injured resources from the EVOS.

### **Impact on Social and Cultural Resources**

There are no irreversible or irretrievable impacts on the social and cultural resources.

### **Impact on the Economy**

There are no irreversible or irretrievable impacts on the economy.



## **4 Environmental Consequences**

### **ANILCA Section 810(a) Evaluation and Finding**

#### **Introduction**

Section 810 of the Alaska National Interest Lands Conservation Act (ANILCA) requires Federal agencies having jurisdiction over lands in Alaska to evaluate the potential impacts of proposed actions on subsistence uses and needs. Section 810 of ANILCA states:

In determining whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands under any provision of law authorizing such actions, the head of the Federal agency having primary jurisdiction over such lands or his designee shall evaluate the effect of such use, occupancy, or disposition on subsistence uses and needs, the availability of other lands for the purposes sought to be achieved, and other alternatives which would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes. No such withdrawal, reservation, lease, permit, or other use, occupancy or disposition of such lands which would significantly restrict subsistence uses shall be effected until the head of such Federal agency—

- (1) gives notice to the appropriate State agency and the appropriate local committees and regional councils established pursuant to section 805;
- (2) gives notice of, and holds, a hearing in the vicinity of the area involved; and
- (3) determines that (A) such a significant restriction of subsistence uses is necessary, consistent with sound management principles for the utilization of the public lands, (B) the proposed activity will involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other disposition, and (C) reasonable steps will be taken to minimize adverse impacts upon subsistence uses and resources resulting from such actions.

In 1984, the Alaska Land Use Council adopted guidelines for complying with the requirements of Section 810. These guidelines provide the framework for this ANILCA Section 810(a) evaluation and finding.

The Section 810 evaluation consists of three components: 1) the impacts of the program on subsistence uses and needs; 2) the availability of other lands to fulfill the purposes of the program; and 3) alternatives to reduce or eliminate the proposed program from lands needed for subsistence purposes.

#### **Impacts on Subsistence Uses and Needs**

In accordance with the guidelines adopted by the Alaska Land Use Council, three criteria were used to evaluate the impact of the alternatives on subsistence uses and needs: 1) a reduction in subsistence uses due to factors such as direct impacts on the resource, adverse impacts on habitat, or increased competition for the resources; 2) a reduction in subsistence uses due to changes in availability of subsistence resources caused by an alteration in their distribution, migration, or location; and 3) a limitation on the access of subsistence users to harvestable resources.

#### **Impacts on Biological Resources**

This assessment examines the reduction in subsistence uses due to factors such as direct impacts on the resource, adverse impacts on habitat, or increased competition for the resources. All alternatives will consider all of the shoreline oiled by the spill, severely affected communities, and adjacent uplands to the watershed divide. None of the alternatives will change subsistence laws or regulations.

#### **Impacts On The Availability Of Subsistence Resources**

This assessment examines the reduction in subsistence uses due to changes in the availability of subsistence resources caused by an alteration in their distribution, migration, or location. None of the alternatives contain provisions that will modify habitat or otherwise alter the distribution, migration, or location of wildlife populations in a way that would produce negative impacts on the availability of subsistence resources..

#### **Impacts On The Access To Subsistence Resources**

This assessment examines the limitation on the access of subsistence users to harvestable resources. None of the alternatives contain provisions that will alter subsistence user access to harvestable resources. Decisions and regulations concerning access generally will continue to be the responsibility of the respective land manager.

#### **Availability of Other Lands to Fulfill the Purpose of the Program**

All alternatives will consider all of the shoreline oiled by the spill, severely affected communities, and adjacent uplands to the watershed divide. In addition, alternatives IV would allow restoration actions to occur anywhere there is a link to injured resources or services. Alternative V would allow restoration actions outside the spill area under certain conditions, but these must be within Alaska.

#### **Other Alternatives That Would Reduce or Eliminate the Proposed Action from Lands Needed for Subsistence Purposes**

No other alternatives have been identified that would reduce or eliminate the proposed action from lands needed for subsistence purposes.

#### **Finding**

The intent of the above evaluation is to find if implementation of any of the proposed alternatives may present a significant restriction of subsistence uses on public lands. In accordance with the Alaska Land Use Council guidelines, a potential restriction to subsistence is considered significant if, after any modification warranted by consideration of alternatives, conditions, or stipulations, it can be expected to result in a substantial reduction

## 4 Environmental Consequences

in the opportunity to continue subsistence uses of renewable resources. Reductions in the opportunity to continue subsistence uses generally are caused by reductions in the abundance, or major redistributions, of harvestable resources; substantial interference with access; or major increases in the use of those resources.

### Alternative 1 Finding

This evaluation concludes that this alternative would have no impacts on harvestable resources or on subsistence use.

### Alternative 2 Finding

Under Alternative 2 there would be better long-term protection of harvestable resources than under Alternative 1. Any effects on harvestable resource populations should be positive. There are no effects anticipated on subsistence uses, availability of subsistence resources caused by an alteration in their distribution, or substantial interference with access of subsistence users to harvestable resources.

### Alternative 3 Finding

Under Alternative 3 there would be better long-term protection of harvestable resources than under Alternative 1 and protection at a comparable level to that under Alternative 2, so any effects on harvestable resource populations should be positive. There would be no substantial effect on redistributions, though some proposed actions may cause some beneficial redistribution of some harvestable resources. There would be no substantial interference with access or major increases in the use of harvestable resources.

### Alternative 4 Finding

Under Alternative 4 there would be better long-term protection of harvestable resources than under Alternative 1 but at a somewhat reduced level than under Alternatives 2 and 3. Any effects on harvestable resource populations should be positive. There would be no substantial effect on redistributions, though some proposed actions may cause some beneficial redistribution of some harvestable resources. There would be no substantial interference with access or major increases in the use of harvestable resources.

### Alternative 5 Finding

Under Alternative 5 there would be better long-term protection of harvestable resources than under Alternative 1, at a somewhat reduced level than under Alternatives 2 and 3, and at a level comparable to that under Alternative 4. Any effects on harvestable resource populations should be positive. There would be no substantial effect on redistributions, though some proposed actions may cause some beneficial redistribution of some harvestable resources. There would be no substantial interference with access or major increases in the use of harvestable resources.

## Notice and Hearings

The public notice and hearing requirements contained in Section 810(a)(1-3) must be met if it is found that the proposed action may present a significant restriction on subsistence uses.

**Preliminary  
Determination**

Because of the lack of potential for impacts resulting from implementation of the alternatives considered for adoption, no public notice and hearings were required or took place.

Determinations whether: (1) such a significant restriction of subsistence uses is necessary, consistent with sound management principles for the utilization of the public lands; (2) the proposed activity will involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other disposition; and (3) reasonable steps will be taken to minimize adverse impacts on subsistence uses and resources resulting from such actions have been made in accordance with Section 810(a)(3).

**Necessity and Consistent with Sound Management of Public Lands**

The alternatives proposed have been examined to determine whether they are necessary, consistent with sound management of public lands to maintain subsistence resources and lifestyles. The Federal Water Pollution Control Act, 33 USC 1321 (f)(5) provides the authority for the civil settlement. The civil settlement includes two documents. The first is a Consent Decree between Exxon and the State of Alaska and the United States that requires Exxon to pay the United States and the State of Alaska \$900 million over a period of ten years. The second is the Memorandum of Agreement between the State of Alaska and the United States. Both were approved by the U.S. District Court.

Based on the analysis of the information presented in this document, Alternatives II, III, IV and V may have significant positive impact on subsistence uses. Under these alternatives, significant amounts of habitat important for harvestable resources will be better protected from potential degradation than in the existing condition or Alternative I. Additionally, Alternatives III, IV and V would provide for a variety of general restoration actions that are designed to stabilize or enhance harvestable resources. This would result increased local subsistence resource harvest potential in ways that are consistent with sound management of public lands.

**Amount of Public Land Necessary to Accomplish the Proposed Action**

All alternatives will consider all of the shoreline oiled by the spill, severely affected communities, and adjacent uplands to the watershed divide. None of the alternatives will change subsistence laws or regulations.

**Reasonable Measures to Minimize Adverse Impacts upon Subsistence Uses and Resources**

None of the alternatives will have adverse impacts on subsistence uses and resources. Therefore, no measures are required to minimize adverse impacts on subsistence uses and resources.

## **4 Environmental Consequences**

**Final Determination** The Record of Decision for the final EIS will include a final determination about whether the selected alternative may present a significant restriction on subsistence uses. The final determination will re-list the above criteria and make final determination on each of the categories considering further information obtained from hearings, public comments and other sources incorporated in the preparation of the final EIS. The summary evaluation, findings, and determinations will be contained in the Record of Decision.

# **Chapter 5**

## **Response to Comments**



THIS CHAPTER WILL BE COMPLETED FOR THE FINAL ENVIRONMENTAL  
IMPACT STATEMENT.

# **Chapter 6**

## **Consultation and Coordination**

# Chapter 6

## Consultation and Coordination

### Development of the Proposed Action

As a direct result of the litigation and settlement discussed below, the Federal and State governments, acting as members of the Trustee Council are responsible for taking actions necessary for the restoration of injured resources and services from the EVOS. The Federal Water Pollution Control Act (Clean Water Act) ( 33 U.S.C. § 1321[f] ) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 U.S.C. § 9607[f]) provide the legal basis for these responsibilities.

The EVOS contaminated thousands of miles of Alaska's coastline. It killed birds, mammals, and fish, and disrupted the ecosystem in the path of the oil. In 1991, Exxon agreed to pay the United States and the State of Alaska \$900 million over ten years to restore the resources injured by the spill, and the reduced or lost services (human uses) they provide. Of that amount, approximately \$620 million remains available to fund restoration activities.

The *Exxon Valdez* Restoration Plan will provide long-term guidance to the Trustee Council for using these funds in restoring the resources and services injured by the oil spill.

The Trustees began developing a restoration plan in 1990. Most of the effort at that time was focused on identifying and developing possible restoration techniques. Following the settlement between the Exxon companies and the United States and the State of Alaska on October 9, 1991, the Trustees decided to continue development of a restoration plan and to allow for meaningful public participation. Following public review and comment on the brochure in April 1993, the Trustees developed the draft Restoration Plan in November 1993 as the proposed action for this EIS. The final Restoration Plan will assist the decisionmaking process by establishing management direction for identifying and selecting of activities to restore injured resources and services. Program-level guidelines will assist in evaluating and

## 6 Consultation and Coordination

implementing future proposed restoration activities. These activities will be developed as part of the Trustees' Annual Work Program and will be evaluated by the policies set forth in the Restoration Plan. Each Annual Work Program will contain descriptions of the restoration activities to be funded that year, based on the policies and spending guidelines of the Restoration Plan, public comments, and changing restoration needs.

The brochure described five alternative courses of action, including the no action alternative; explained the evaluation criteria used; and outlined the differences among each of the alternatives. It also discussed an approach to implementing the alternatives; and it covered administration, funding allocation guidelines and mechanisms, monitoring, and public participation.

Based on public comment on the alternatives presented in the brochure, the Trustees have modified and designated Alternative 5 as the proposed action for this EIS and have published this modified alternative as the draft Restoration Plan. This EIS is intended to assist decisionmakers and the public in assessing the merits of the various alternatives and determining which of the possible alternatives should be selected as the final Restoration Plan.

The MOA between the Federal and State governments requires meaningful public involvement. Toward that end, all decisions made by the Trustees have been made in an open public forum with opportunity for public comment. Public comments received on the Restoration Framework document also were used to identify significant issues related to implementing a restoration program. A Summary of Alternatives for Public Comment on the Draft Restoration Plan was released in April 1993. Public comments on the Summary of Alternatives, the draft Restoration Plan, and the DEIS will be used to refine the final Restoration Plan.

To ensure that the public had the opportunity to identify issues related to the proposed action to be addressed, the Trustees had five periods for public comment. The first was in January and February 1992, to solicit input for the formation of a Public Advisory Group. In May 1992, the public was invited to comment on the Restoration Framework at meetings in Seldovia (teleconferenced to Port Graham), Homer, Kodiak, Juneau, Tatitlek, Valdez, Seward, Whittier, Chenega Bay, Anchorage, Cordova, and Fairbanks. These comments were used to identify issues related to implementing a restoration program. In November 1992, agencies and individuals were invited to an "open house" held in Anchorage to discuss input for the DEIS. A fourth round of meetings was held in April 1993 to collect public comments on the Summary of Alternatives for Public Comment, released in April 1993. These meetings were held in Chignik Lagoon, Chignik Lake, Chenega Bay, Kodiak, Port Graham, Ouzinkie, Port Lions, Seldovia, Larsen Bay, Homer, Akhiok, Old Harbor, Nanwalek (English Bay), Anchorage, Valdez, Seward, Tatitlek, Juneau, Cordova, Fairbanks, and Whittier. A fifth period for public comment was held in late January and early February 1994 after the publication of the draft Restoration Plan and the Revised Notice of Intent to prepare an EIS. A public meeting was held in Anchorage at that time.

The DEIS and the draft Restoration Plan will be available for public comment for 45 days. The comments received from the public will be used to create the final EIS.

In addition, a Public Advisory Group, formed in October 1992, was established to provide input to the Trustees on all matters relating to planning, evaluating, and allocating funds, as well as planning, evaluating, and conducting injury assessments and restoration activities.

This group is made up of 15 members who represent a cross-section of the interest groups and the public affected by and concerned about the spill. Additionally there are two ex officio members representing the Alaska Legislature.

## Development of the EIS

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## 6 Consultation and Coordination

The Trustees have sought public input on the following questions in regard to the draft Restoration Plan:

- Which resources and services should be targeted for restoration efforts?  
  
Should restoration actions address all injured resources and services, or should they address only those biological resources whose populations declined measurably as a result of the spill?
- How long should restoration actions last?  
  
Should they be undertaken until a resource or service has recovered, then stopped? Or should they continue beyond the point of restoration to prespill levels?
- Which restoration actions should be undertaken?  
  
Should the plan include only those actions that are expected to produce substantial improvement over the rate of natural (unaided) recovery? Or should actions believed to produce at least some improvement over the rate of unaided recovery be included as well?
- In what geographic area should restoration actions be taken?  
  
Should actions be limited to the spill area, or should they be taken in any area where there is a link to injured resources or services?
- To what extent, if any, should restoration actions create opportunities for human use?  
  
Should human use of, and access to, the spill area be decreased? Protected? Increased? Or should new opportunities for human use be considered?

### Issues

The interdisciplinary team (IDT) of federal and state scientists assigned to write the EIS reviewed and analyzed the concerns and ideas expressed in the public involvement and interagency scoping. The following issue statements describe those concerns and ideas in general terms. The issue statements were evaluated to decide which issues were significant and should be addressed in the EIS.

The public, agencies, community leaders, and other knowledgeable individuals and organizations raised many issues during the scoping process. The agencies identified the significant issues based on "reviews of similar actions, knowledge of the area or areas involved, discussions with community leaders, and/or consultations with experts and other agencies familiar with such actions and their effects" (Forest Service Handbook 1909.15 [11.5]). These issues are addressed in this document.

Public meetings were held in the following communities during one or more of the public comment periods held in the development and preparation of this EIS. A Summary of Public Comment on Alternatives (EVOS Trustee Council, September 1993) was published summarizing the results of the most extensive public involvement effort during the



preparation of the proposed action and alternatives for this EIS. Approximately 2,000 people gave written or oral comments at that time.

|                |            |             |
|----------------|------------|-------------|
| Akhiok         | Juneau     | Port Graham |
| Anchorage      | Karluk     | Port Lions  |
| Chenega Bay    | Kodiak     | Seldovia    |
| Chignik Lake   | Larsen Bay | Seward      |
| Chignik Lagoon | Nanwalek   | Tatitlek    |
| Cordova        | Old Harbor | Valdez      |
| Fairbanks      | Ouzinkie   | Whittier    |
| Homer          |            |             |

The comments recieved addressed the planning alternatives which were included in the brochure, Draft *Exxon Valdez* Oil Spill Restoration Plan Summary of Alternatives for Public Comment (EVOS Trustee Council, April 1993) and the issues and injured resources and services.

The EIS was developed by considering the No Action Alternative, the proposed action and the planning alternatives 2 through 4 as presented in the brochure. The reasonably foreseeable actions that were consistent with the policies contained in each alternative were then estimated and evaluated in Chapter 4 of this EIS.

## List of Contacts for Preparation and Review of the EIS

Federal, State, and local government agencies, academic institutions, special-interest groups, Native groups, and private citizens consulted prior to and during the preparation of this EIS are listed below.

## **6** Consultation and Coordination

### **Federal Agencies**

The following lists are  
being compiled.

### **State of Alaska**

### **Local and Regional Government Organizations**

### **Native Organizations /Groups**

### **Others**

## **Contributing Authors and Support Staff**

### **Contributing Authors**

### **Supporting Staff**

### **Trustee Council**

### **Restoration Planning Work Group**

# **Appendix A**

## **Habitat Protection**

DRAFT - April 26, 1994

DRAFT - April 26, 1994

DRAFT - April 26, 1994

Table A-1.

## Summary of Data from Large Parcel Evaluation and Ranking

| Potential for Benefit → |        | Pink Smn. | Sockeye Salmon | Cutthroat Trout | Dolly Varden | Pacific Herring | Bald Eagle | Black Oystercatcher | Common Murre | Harbor Seal | Harlequin Duck | Intertidal/Subtidal Biota | Marbled Murrelet | Pigeon Guillemot | River Otter | Sea Otter | Recreation/Tourism | Wilderness | Cultural Resources | Subsistence |
|-------------------------|--------|-----------|----------------|-----------------|--------------|-----------------|------------|---------------------|--------------|-------------|----------------|---------------------------|------------------|------------------|-------------|-----------|--------------------|------------|--------------------|-------------|
| Parcel #                | Acres  |           |                |                 |              |                 |            |                     |              |             |                |                           |                  |                  |             |           |                    |            |                    |             |
| AJV 03                  | 13,400 | H         | M              | -               | L            | M               | H          | H                   | L            | H           | H              | H                         | H                | H                | M           | H         | M                  | H          | H                  | L           |
| EYA 02                  | 9,100  | H         | L              | L               | M            | M               | H          | H                   | L            | H           | H              | H                         | M                | L                | M           | H         | H                  | M          | H                  | H           |
| CHE 02                  | 12,100 | H         | H              | M               | H            | L               | M          | L                   | L            | M           | H              | M                         | M                | H                | M           | M         | H                  | H          | M                  | H           |
| TAT 01                  | 8,800  | L         | L              | L               | L            | H               | H          | H                   | L            | M           | H              | H                         | M                | H                | H           | M         | M                  | M          | H                  | H           |
| AKI 06                  | 16,900 | H         | H              | -               | H            | H               | H          | L                   | L            | H           | H              | H                         | M                | H                | H           | L         | H                  | M          | M                  | H           |
| CHE 01                  | 7,900  | M         | H              | H               | H            | L               | H          | M                   | L            | M           | M              | M                         | M                | L                | H           | M         | H                  | M          | L                  | H           |
| AJV 01                  | 27,100 | H         | L              | -               | H            | H               | M          | H                   | L            | H           | H              | H                         | H                | H                | M           | H         | L                  | H          | H                  | L           |
| AKI 04                  | 34,300 | H         | -              | -               | H            | M               | M          | H                   | H            | H           | H              | H                         | H                | H                | H           | L         | L                  | H          | M                  | M           |
| EYA 03                  | 7,100  | H         | L              | H               | M            | M               | H          | M                   | L            | M           | L              | M                         | M                | L                | M           | H         | H                  | H          | L                  | H           |

## DRAFT - April 26, 1994

## DRAFT - April 26, 1994

## DRAFT - April 26, 1994

| Potential for Benefit → |        | Pink Smn. | Sockeye Salmon | Cutthroat Trout | Dolly Varden | Pacific Herring | Bald Eagle | Black Oystercatcher | Common Murre | Harbor Seal | Harlequin Duck | Intertidal/Subtidal Biota | Marbled Murrelet | Pigeon Guillemot | River Otter | Sea Otter | Recreation/Tourism | Wilderness | Cultural Resources | Subsistence |
|-------------------------|--------|-----------|----------------|-----------------|--------------|-----------------|------------|---------------------|--------------|-------------|----------------|---------------------------|------------------|------------------|-------------|-----------|--------------------|------------|--------------------|-------------|
| Parcel #                | Acres  |           |                |                 |              |                 |            |                     |              |             |                |                           |                  |                  |             |           |                    |            |                    |             |
| KIB 01                  | 27,900 | M         | L              | -               | H            | M               | L          | M                   | L            | M           | M              | H                         | M                | H                | H           | H         | M                  | H          | H                  | L           |
| AKI 08                  | 15,600 | L         | H              | -               | H            | H               | H          | M                   | L            | H           | M              | L                         | L                | L                | H           | L         | M                  | M          | H                  | H           |
| KON 01                  | 9,900  | H         | -              | -               | L            | H               | H          | H                   | M            | H           | H              | H                         | H                | H                | H           | H         | H                  | L          | H                  | H           |
| KON 04                  | 28,200 | H         | H              | -               | H            | -               | H          | -                   | -            | -           | H              | -                         | L                | -                | H           | -         | H                  | M          | H                  | H           |
| ENB 06                  | 3,800  | H         | L              | L               | M            | L               | H          | H                   | L            | L           | H              | H                         | H                | H                | H           | H         | M                  | H          | L                  | L           |
| EYA 01                  | 3,400  | M         | L              | L               | L            | M               | H          | L                   | L            | M           | H              | M                         | M                | L                | H           | M         | M                  | H          | M                  | H           |
| KON 02                  | 7,000  | L         | -              | -               | L            | M               | H          | M                   | M            | H           | H              | H                         | H                | H                | H           | H         | H                  | H          | H                  | H           |
| PTG 05                  | 11,500 | H         | H              | -               | M            | M               | L          | H                   | L            | L           | H              | H                         | H                | M                | H           | H         | M                  | M          | L                  | L           |

Total Acres Ranked as "High" in the Large Parcel Evaluation Process = 244,000

|        |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|--------|-------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AKI 05 | 8,200 | M | - | - | L | H | M | M | L | H | H | H | H | H | H | L | L | H | M | L |
|--------|-------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

DRAFT - April 26, 1994

DRAFT - April 26, 1994

DRAFT - April 26, 1994

| Potential for Benefit → |        | Pink Smn. | Sockeye Salmon | Cutthroat Trout | Dolly Varden | Pacific Herring | Bald Eagle | Black Oystercatcher | Common Murre | Harbor Seal | Harlequin Duck | Intertidal/Subtidal Biota | Marbled Murrelet | Pigeon Guillemot | River Otter | Sea Otter | Recreation/Tourism | Wilderness | Cultural Resources | Subsistence |
|-------------------------|--------|-----------|----------------|-----------------|--------------|-----------------|------------|---------------------|--------------|-------------|----------------|---------------------------|------------------|------------------|-------------|-----------|--------------------|------------|--------------------|-------------|
| Parcel #                | Acres  |           |                |                 |              |                 |            |                     |              |             |                |                           |                  |                  |             |           |                    |            |                    |             |
| ATV 04                  | 56,700 | M         | M              | -               | M            | H               | M          | M                   | L            | H           | H              | M                         | M                | H                | M           | H         | M                  | H          | M                  | H           |
| END 02                  | 6,200  | L         | L              | -               | L            | M               | L          | M                   | L            | L           | M              | M                         | H                | M                | H           | M         | H                  | H          | H                  | L           |
| PTG 01                  | 4,300  | M         | M              | L               | M            | M               | M          | H                   | L            | M           | M              | M                         | M                | M                | H           | M         | H                  | M          | M                  | L           |
| ATV 06                  | 27,300 | M         | M              | -               | L            | H               | M          | M                   | L            | L           | H              | L                         | M                | H                | M           | H         | M                  | M          | L                  | H           |
| AXI 01                  | 4,900  | M         | -              | -               | M            | M               | M          | L                   | L            | H           | H              | H                         | H                | H                | M           | L         | L                  | H          | M                  | L           |
| CHZ 02                  | 6,200  | M         | L              | L               | L            | L               | H          | M                   | L            | H           | M              | M                         | H                | L                | M           | H         | L                  | H          | M                  | H           |
| END 08                  | 15,700 | H         | M              | -               | L            | M               | H          | M                   | M            | M           | M              | H                         | M                | M                | L           | M         | M                  | L          | H                  | H           |
| PTO 01                  | 3,500  | L         | L              | L               | L            | M               | M          | H                   | L            | L           | M              | H                         | H                | H                | M           | H         | M                  | H          | M                  | L           |
| PTO 11                  | 3,500  | L         | L              | L               | L            | L               | H          | H                   | L            | H           | L              | H                         | M                | L                | L           | M         | L                  | H          | M                  | H           |
| AXI 09                  | 15,900 | L         | -              | -               | L            | L               | M          | M                   | L            | H           | H              | H                         | H                | M                | H           | H         | L                  | L          | H                  | H           |



DRAFT - April 26, 1994

DRAFT - April 26, 1994

DRAFT - April 26, 1994

| Potential for Benefit → |        | Pink Smn. | Sockeye Salmon | Cutthroat Trout | Dolly Varden | Pacific Herring | Bald Eagle | Black Oystercatcher | Common Murre | Harbor Seal | Harlequin Duck | Intertidal/Subtidal Biota | Marbled Murrelet | Pigeon Guillemot | River Otter | Sea Otter | Recreation/Tourism | Wilderness | Cultural Resources | Subsistence |
|-------------------------|--------|-----------|----------------|-----------------|--------------|-----------------|------------|---------------------|--------------|-------------|----------------|---------------------------|------------------|------------------|-------------|-----------|--------------------|------------|--------------------|-------------|
| Parcel #                | Acres  |           |                |                 |              |                 |            |                     |              |             |                |                           |                  |                  |             |           |                    |            |                    |             |
| CAC 02                  | 10,000 | L         | M              | M               | L            | L               | M          | L                   | L            | H           | M              | M                         | M                | M                | L           | L         | L                  | M          | H                  | H           |
| CAC 05                  | 800    | M         | L              | L               | L            | L               | M          | H                   | L            | H           | L              | H                         | L                | L                | L           | H         | L                  | L          | H                  | H           |
| EVA 01                  | 13,000 | L         | H              | H               | H            | -               | H          | -                   | L            | L           | L              | L                         | L                | -                | H           | L         | H                  | L          | L                  | H           |
| KON 03                  | 22,400 | L         | -              | -               | L            | M               | M          | H                   | M            | M           | H              | H                         | H                | H                | H           | M         | H                  | L          | L                  | H           |
| KON 05                  | 21,500 | M         | -              | -               | M            | L               | M          | M                   | L            | H           | M              | L                         | L                | L                | H           | L         | L                  | H          | M                  | H           |
| APV 05                  | 12,700 | M         | L              | -               | M            | H               | H          | M                   | L            | L           | L              | M                         | M                | M                | M           | M         | M                  | M          | L                  | H           |
| FTO 07                  | 10,500 | L         | H              | L               | L            | M               | M          | H                   | L            | L           | L              | M                         | H                | M                | M           | L         | L                  | M          | H                  | L           |
| CHI 04                  | 7,300  | L         | L              | L               | L            | L               | H          | H                   | L            | H           | H              | M                         | M                | L                | M           | H         | L                  | H          | H                  | H           |
| GCD 05                  | 5,300  | L         | -              | -               | L            | L               | H          | M                   | M            | M           | M              | M                         | M                | M                | M           | L         | M                  | M          | M                  | H           |
| KON 06                  | 22,400 | M         | L              | -               | M            | -               | M          | -                   | -            | L           | H              | -                         | L                | -                | H           | -         | L                  | H          | M                  | H           |

DRAFT - April 26, 1994

DRAFT - April 26, 1994

DRAFT - April 26, 1994

| Potential for Benefit → | Pink Smn. | Sockeye Salmon | Cutthroat Trout | Dolly Varden | Pacific Herring | Bald Eagle | Black Oystercatcher | Common Murre | Harbor Seal | Harlequin Duck | Intertidal/Subtidal Biota | Marbled Murrelet | Pigeon Guillemot | River Otter | Sea Otter | Recreation/Tourism | Wilderness | Cultural Resources | Subsistence |
|-------------------------|-----------|----------------|-----------------|--------------|-----------------|------------|---------------------|--------------|-------------|----------------|---------------------------|------------------|------------------|-------------|-----------|--------------------|------------|--------------------|-------------|
| Parcel #                | Acres     |                |                 |              |                 |            |                     |              |             |                |                           |                  |                  |             |           |                    |            |                    |             |

|        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|--------|--------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OLD 04 | 4,600  | H | - | - | L | H | M | L | M | L | M | M | L | L | M | L | M | M | M | H |
| CHE 03 | 14,000 | H | L | M | L | L | H | M | L | L | L | M | M | L | M | H | M | H | M | H |
| OLD 01 | 9,500  | H | - | - | L | H | H | L | M | M | M | H | L | M | M | L | M | M | H | H |

Total Acres Ranked as "Moderate" in the Large Parcel Evaluation Process = 309,100

|        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|--------|--------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EYA 04 | 3,700  | H | L | M | M | M | H | M | L | H | L | M | M | L | M | M | H | M | M | H |
| PTG 08 | 16,200 | H | L | L | M | H | H | M | L | H | L | H | M | L | M | M | L | L | M | H |
| AKI 02 | 4,200  | L | - | - | L | M | M | L | L | L | M | H | M | M | M | L | L | H | H | L |
| AKI 03 | 12,400 | M | - | - | L | L | M | M | L | M | M | M | L | M | M | L | L | H | M | M |
| CAC 04 | 1,600  | L | L | L | L | L | L | M | L | H | L | H | M | L | L | H | L | H | L | H |
| CHE 08 | 1,700  | L | L | L | L | L | H | M | L | H | M | L | M | M | L | L | L | H | L | H |

## DRAFT - April 26, 1994

## DRAFT - April 26, 1994

## DRAFT - April 26, 1994

| Potential for Benefit → |        | Pink Smn. | Sockeye Salmon | Cutthroat Trout | Dolly Varden | Pacific Herring | Bald Eagle | Black Oystercatcher | Common Murre | Harbor Seal | Harlequin Duck | Intertidal/Subtidal Biota | Marbled Murrelet | Pigeon Guillemot | River Otter | Sea Otter | Recreation/Tourism | Wilderness | Cultural Resources | Subsistence |
|-------------------------|--------|-----------|----------------|-----------------|--------------|-----------------|------------|---------------------|--------------|-------------|----------------|---------------------------|------------------|------------------|-------------|-----------|--------------------|------------|--------------------|-------------|
| Parcel #                | Acres  |           |                |                 |              |                 |            |                     |              |             |                |                           |                  |                  |             |           |                    |            |                    |             |
| ENB 01                  | 1,400  | L         | L              | L               | L            | M               | M          | L                   | L            | L           | L              | M                         | H                | M                | H           | L         | H                  | H          | L                  | L           |
| ENB 05                  | 7,600  | L         | L              | L               | L            | M               | L          | M                   | L            | L           | L              | M                         | H                | L                | L           | L         | M                  | H          | H                  | L           |
| ENB 07                  | 8,900  | L         | L              | L               | M            | M               | M          | L                   | L            | M           | L              | M                         | H                | L                | L           | L         | M                  | M          | M                  | L           |
| EYA 05                  | 7,600  | L         | L              | L               | L            | H               | H          | L                   | L            | L           | L              | L                         | M                | L                | M           | L         | L                  | H          | L                  | H           |
| OLD 02                  | 8,000  | L         | -              | -               | L            | H               | M          | M                   | L            | H           | M              | M                         | L                | M                | M           | L         | L                  | H          | M                  | H           |
| SEL 02                  | 10,100 | M         | L              | -               | L            | M               | H          | L                   | L            | L           | M              | H                         | M                | L                | M           | L         | H                  | M          | M                  | H           |
| EYA 07                  | 3,300  | M         | L              | M               | L            | L               | H          | L                   | L            | M           | L              | M                         | M                | L                | L           | H         | H                  | M          | L                  | H           |
| OLD 03                  | 7,300  | M         | -              | -               | L            | M               | H          | L                   | L            | L           | H              | H                         | L                | M                | M           | L         | M                  | L          | M                  | H           |
| ENB 03                  | 4,600  | L         | L              | -               | L            | M               | M          | M                   | L            | M           | M              | M                         | M                | M                | M           | L         | L                  | H          | L                  | L           |
| CAC 01                  | 3,200  | M         | L              | L               | L            | L               | L          | L                   | L            | L           | L              | M                         | M                | H                | L           | L         | L                  | H          | L                  | H           |

## DRAFT - April 26, 1994

## DRAFT - April 26, 1994

## DRAFT - April 26, 1994

| Potential for Benefit → |        | Pink Smn. | Sockeye Salmon | Cutthroat Trout | Dolly Varden | Pacific Herring | Bald Eagle | Black Oystercatcher | Common Murre | Harbor Seal | Harlequin Duck | Intertidal/Subtidal Biota | Marbled Murrelet | Pigeon Guillemot | River Otter | Sea Otter | Recreation/Tourism | Wilderness | Cultural Resources | Subsistence |
|-------------------------|--------|-----------|----------------|-----------------|--------------|-----------------|------------|---------------------|--------------|-------------|----------------|---------------------------|------------------|------------------|-------------|-----------|--------------------|------------|--------------------|-------------|
| Parcel #                | Acres  |           |                |                 |              |                 |            |                     |              |             |                |                           |                  |                  |             |           |                    |            |                    |             |
| CHE 06                  | 5,400  | M         | L              | L               | L            | L               | M          | L                   | L            | L           | L              | L                         | M                | L                | L           | L         | L                  | H          | H                  | H           |
| EYA 06                  | 4,000  | L         | L              | L               | L            | L               | H          | L                   | L            | M           | M              | M                         | M                | L                | L           | H         | H                  | M          | L                  | H           |
| AKI 07                  | 15,200 | L         | L              | -               | L            | L               | L          | M                   | L            | M           | H              | M                         | L                | M                | M           | L         | L                  | L          | M                  | H           |
| PTG 06                  | 12,400 | L         | L              | L               | L            | M               | L          | L                   | L            | M           | L              | L                         | H                | H                | L           | M         | M                  | M          | M                  | L           |
| SEL 01                  | 18,600 | M         | L              | -               | L            | M               | L          | M                   | L            | L           | M              | M                         | M                | L                | M           | L         | H                  | M          | H                  | H           |
| CAC 03                  | 12,900 | L         | L              | L               | L            | L               | H          | M                   | L            | H           | L              | M                         | M                | M                | L           | L         | L                  | M          | L                  | H           |
| PTG 09                  | 15,300 | H         | L              | L               | L            | L               | H          | M                   | L            | H           | L              | M                         | M                | L                | M           | M         | L                  | L          | H                  | H           |
| PTG 03                  | 3,400  | L         | L              | L               | L            | M               | L          | M                   | L            | L           | H              | L                         | H                | M                | L           | L         | L                  | H          | L                  | L           |
| CHE 05                  | 8,300  | M         | L              | L               | L            | L               | H          | L                   | L            | L           | L              | L                         | M                | H                | L           | L         | L                  | M          | H                  | H           |
| SEL 03                  | 13,100 | L         | L              | -               | M            | M               | M          | L                   | L            | L           | M              | L                         | M                | L                | M           | L         | H                  | L          | M                  | H           |

## DRAFT - April 26, 1994

## DRAFT - April 26, 1994

## DRAFT - April 26, 1994

| Potential for Benefit → |        | Pink Smn. | Sockeye Salmon | Cutthroat Trout | Dolly Varden | Pacific Herring | Bald Eagle | Black Oystercatcher | Common Murre | Harbor Seal | Harlequin Duck | Intertidal/Subtidal Biota | Marbled Murrelet | Pigeon Guillemot | River Otter | Sea Otter | Recreation/Tourism | Wilderness | Cultural Resources | Subsistence |
|-------------------------|--------|-----------|----------------|-----------------|--------------|-----------------|------------|---------------------|--------------|-------------|----------------|---------------------------|------------------|------------------|-------------|-----------|--------------------|------------|--------------------|-------------|
| Parcel #                | Acres  |           |                |                 |              |                 |            |                     |              |             |                |                           |                  |                  |             |           |                    |            |                    |             |
| EYA 08                  | 4,800  | L         | H              | H               | H            | -               | H          | -                   | -            | -           | L              | -                         | L                | -                | H           | -         | H                  | L          | L                  | H           |
| EYA 09                  | 5,100  | L         | H              | H               | H            | -               | H          | -                   | -            | L           | L              | -                         | L                | -                | H           | L         | H                  | L          | L                  | H           |
| ENB 09                  | 14,700 | M         | L              | -               | L            | L               | M          | M                   | L            | L           | L              | H                         | M                | L                | L           | M         | L                  | L          | M                  | H           |
| AJV 02                  | 2,100  | L         | L              | -               | L            | H               | H          | L                   | L            | L           | M              | M                         | M                | H                | M           | H         | L                  | M          | L                  | L           |
| ENB 04                  | 5,900  | L         | L              | L               | L            | M               | L          | M                   | L            | L           | M              | M                         | M                | M                | L           | L         | L                  | H          | M                  | L           |
| EYA 10                  | 3,800  | L         | M              | M               | H            | -               | H          | -                   | -            | L           | L              | M                         | L                | -                | M           | L         | H                  | L          | L                  | H           |
| EYA 13                  | 4,600  | L         | L              | L               | L            | L               | M          | L                   | -            | L           | L              | L                         | H                | L                | L           | M         | H                  | M          | L                  | H           |
| CHE 11*                 | 400    | L         | L              | L               | L            | L               | L          | L                   | L            | M           | L              | L                         | L                | H                | L           | L         | L                  | H          | L                  | H           |
| CHE 10                  | 3,700  | L         | L              | L               | L            | L               | H          | L                   | L            | L           | L              | M                         | M                | L                | L           | L         | L                  | L          | H                  | H           |
| CHE 07                  | 1,500  | L         | L              | L               | L            | L               | M          | L                   | L            | L           | L              | L                         | M                | M                | L           | L         | L                  | H          | L                  | M           |

**DRAFT - April 26, 1994**

**DRAFT - April 26, 1994**

**DRAFT - April 26, 1994**

| Potential for Benefit → |        | Pink Smn. | Sockeye Salmon | Cutthroat Trout | Dolly Varden | Pacific Herring | Bald Eagle | Black Oystercatcher | Common Murre | Harbor Seal | Harlequin Duck | Intertidal/Subtidal Biota | Marbled Murrelet | Pigeon Guillemot | River Otter | Sea Otter | Recreation/Tourism | Wilderness | Cultural Resources | Subsistence |
|-------------------------|--------|-----------|----------------|-----------------|--------------|-----------------|------------|---------------------|--------------|-------------|----------------|---------------------------|------------------|------------------|-------------|-----------|--------------------|------------|--------------------|-------------|
| Parcel #                | Acres  |           |                |                 |              |                 |            |                     |              |             |                |                           |                  |                  |             |           |                    |            |                    |             |
| PTG 04                  | 2,300  | L         | L              | L               | L            | M               | L          | M                   | L            | L           | L              | L                         | M                | M                | L           | L         | L                  | H          | L                  | L           |
| EYA 12                  | 6,900  | M         | L              | L               | L            | -               | L          | -                   | -            | L           | M              | L                         | M                | L                | H           | L         | L                  | H          | L                  | H           |
| ENB 10                  | 15,400 | M         | M              | -               | H            | L               | L          | L                   | L            | L           | L              | L                         | L                | L                | M           | L         | M                  | L          | L                  | H           |
| PTG 10                  | 28,400 | M         | L              | L               | L            | L               | L          | L                   | L            | L           | L              | L                         | L                | L                | L           | L         | L                  | H          | L                  | H           |

Total Acres Ranked as "Low" in the Large Parcel Evaluation Process = 310,000

Grand Total All Parcels = 863,100

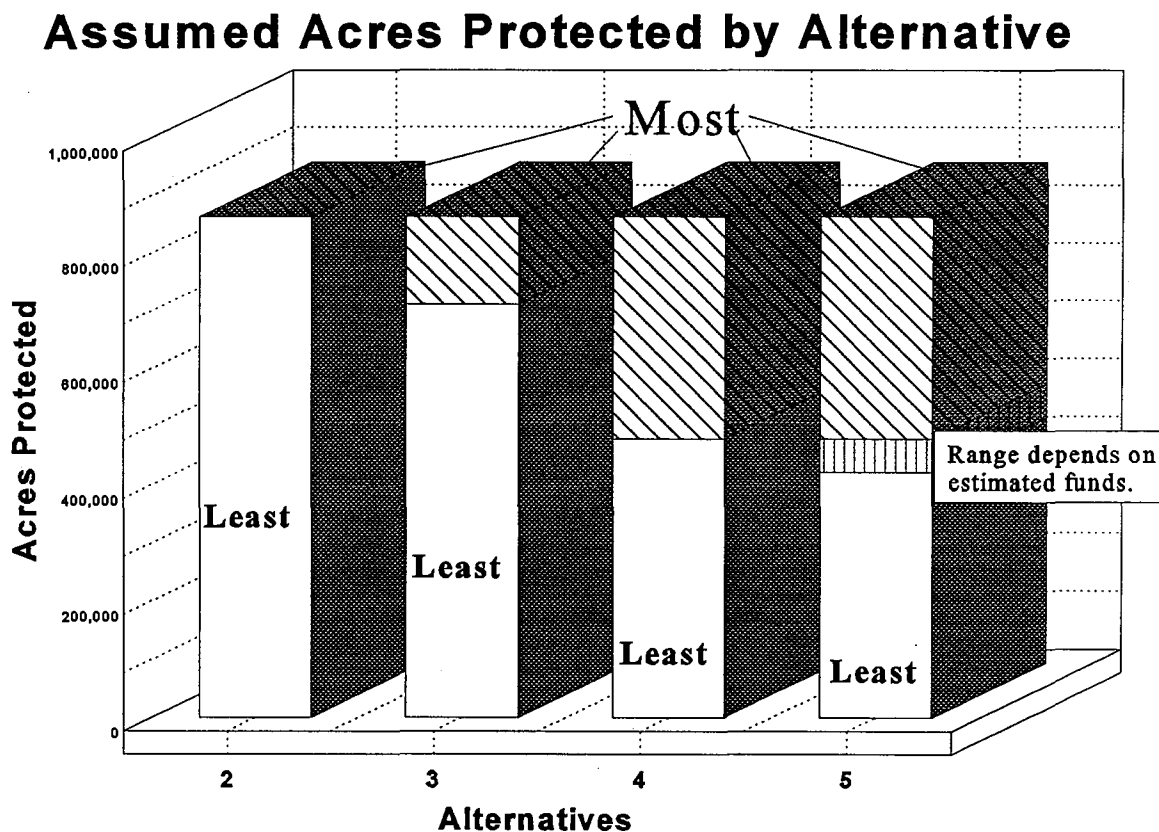
\* Listing says 400, parcel sheet says 422.



For comparison purposes, Figure A-1 displays the number of acres assumed protected for each of the action alternatives. The assumption made was that funds would be sufficient to protect all of the parcels shown in Chapter 2, Figures 2-1 through 2-3 if land or easement prices are low. It is also assumed that since prices and rights negotiated will vary widely that a smaller portion of the parcels shown could still be protected. These ranges of parcels are shown in Figure A-1.

The "Most" label represents the most acres assumed protected by each alternative if the unit price for the parcels is relatively low. The "Least" label represents the least acres protected assuming the unit price is higher. In Alternative 5 the funds estimated available for Habitat Protection is a range of 45 to 50 percent. This range affects the assumed least acreage and is represented by a band between the most and least acres.

Figure A-1



# **Appendix B**

## **Species Names**

# **Appendix B**

## **Common and Scientific Names**

Being Compiled

# **Appendix C**

## **Fish**

# APPENDIX C

## FISH

### Section 1. Procedures for Project Planning and Permitting

Any new fisheries project, regardless of the funding source, must undergo the scrutiny of one or more standard review processes, before it can be implemented, depending upon the type of proposed project. A project that will entail any form of stock manipulation, including a hatchery operations, stock introduction, egg incubation box, or eyed-egg planting is required, by regulation (5 AAC 41.005), to first have a Fish Transport Permit (FTP). This regulation makes it unlawful to transport, possess, export from the state, or release into the waters of the state, any live fish (or fish eggs) without an FTP which is issued for a fixed term and authorizes only that operation specified in the permit. Any change of species, brood stock, or location requires a new permit. Each applicant for a FTP submits the following information to the Alaska Department of Fish and Game (5 AAC 41.010): species and stock; incubation, rearing and release site(s); number and life history stage; disease history of the stock and inspection and certification; isolation measures planned to control disease; source of water for rearing and means of effluent discharge; identification and status of native stocks involved; method and time of transport or release; purpose and expected benefits of the proposed project; evaluation plans and other information.

Each FTP application is reviewed by the Alaska Department of Fish and Game and an FTP is issued only if it is determined that the proposed transport, possession or release of fish will not adversely affect the continued health and perpetuation of other native, wild, or hatchery stocks. Terms and conditions may be attached if necessary, to protect the continued health and perpetuation of native, wild, or hatchery stocks of fish (5 AAC 1.030).

In addition to regulations, there are Departmental policies that apply to fish stocking programs in Alaska. The State of Alaska genetic policy for salmon (Alaska Department of Fish and Game 1985) addresses stock transports, protection of wild stocks, and maintenance of genetic variability. The genetic policy is reviewed as part of the FTP application process. The State of Alaska has also adopted a policy relating to fish health and disease control (Meyers, *et al.*, 1988). This policy is intended to prevent dissemination of infectious finfish and shellfish diseases within or outside the borders of Alaska without introducing impractical constraints for aquaculture and necessary stock-renewal programs. Another policy, the (draft) Wild Stock Protection Policy, also influences sport fish stocking programs in Alaska. Accordingly, Sport Fish Division will not accept stocking hatchery fish in locations where wild stocks of sport fish presently occur unless: a) the indigenous wild stock(s) is (are) incapable of supporting a recreational fishery or; b) the indigenous wild stock(s) is (are) important to sport anglers and is (are) found to be depressed or; c) adequate evaluation can be dedicated to the stocking project to maintain historical levels of natural production, run timing and spawning distribution.

Further, proposed projects that are intended to provide benefits for a sport fishery receive more detailed review. Each project is reviewed to ensure that hatchery production matches fish production demands according to fishery management plans. These management plans, which address fish stocking, are reviewed every 4 to 5 years and are incorporated into a Statewide Stocking Plan for Recreational Fisheries (SSP). The SSP contains specific information about each stocking location; region of the State, Division of Sport Fish Management Area; reference to a sport fishery management plan which covers the stocking location, release site, species to be released, whether the location is anadromous or landlocked, size of fish to be stocked, and

number of fish to be stocked by year. Time is allowed for public viewing of the draft plan as part of a separate NEPA review process before it is approved by the Commissioner of ADF&G (Peltz, 1994).

Any proposed project that may entail any form of aquatic habitat alteration (such as migration corridor improvements or stream habitat improvement) must be reviewed and approved through a multi-agency process, coordinated by the State of Alaska Division of Governmental Coordination, called the "project consistency review" based on the Alaska Coastal Management Program (ACMP) described in State of Alaska Regulations (Title 6, Chapter 50). This review is designed to improve management of Alaska's coastal land and water uses. Project proposals are reviewed to identify permits required by the State of Alaska Departments of Environmental Conservation, Fish and Game, and Natural Resources and to determine the project's consistency with the standards of the ACMP and enforceable policies of approved district coastal management programs. The purpose of these permits is to allow reasonable developmental activities while protecting the aquatic habitats. In addition, several federal agency permits may also be required. Because these types of projects occur on wetlands, a U.S. Army Corps of Engineers (Title 16) Permit is also required. If the proposed project location is on federally-owned lands, e.g., National Forest or National Wildlife Refuge) a special use permit from that agency may also be required. Where an effluent will be discharged, e.g., with a hatchery operation, a U.S. Environmental Protection Agency National Pollution Discharge Elimination System (NPDES) Permit and approval by the State of Alaska Department of Environmental Conservation are required.

Finally, Regional Planning Teams (RPT) have been established within each of the commercial fisheries management areas to develop coordinated plans for fisheries rehabilitation, enhancement and development projects. Voting members of the RPT include ADF&G (3 members), and 3 interested members of the public. These planning teams review proposals to assure that these potential projects are compatible with the existing fisheries and projects and to confirm that the projects will provide the expected benefits to the intended fishers. The Regional Planning Team also reviews the Annual Management plan that is required from each fish hatchery that may be located in that region. These Annual Management Plans include detailed information about the origin, numbers and release plan, evaluation plan and short and long-range harvest management plan for each stock of fish in the hatchery.

Consequently, before any proposed fisheries projects can be implemented, in addition to pre-implementation biological monitoring, a substantial amount of time and effort must be provided to assure that it will comply with all of the permitting and planning that is required. These requirements have been established to allow an orderly process to develop new projects that are compatible with existing biological resources and fisheries in that area.

## **Section 2. Restoration Activities**

### **Description of Actions.**

Alternatives 3, 4, and, 5 employ various types of restoration actions to assist natural recovery of wild-stock pink and sockeye salmon populations and commercial and sport fishing activities, but it is also assumed that the responsible resource management agencies will maintain their historic levels of activities.

**Pink Salmon.** Actions that may be implemented, in addition to habitat acquisition, to restore wild-stock pink salmon populations may include: migration corridor improvements, egg incubation boxes, net pen rearing, hatchery rearing, habitat improvement, and relocation of hatchery-produced runs (EVOS Trustee



Council, April 1993).

1. Migration corridor improvements entail mitigation of a barrier to fish migration that may prevent access to critical habitat for spawning or rearing. This typically involves installation of a fishpass or removal of a migration barrier. The construction of a fishpass (i.e., fish ladder or steep pass) is a permanent form of habitat modification to enable fish to access spawning and rearing habitat above an impassable barrier such as a steep waterfall or cataract.

Description: This technique can be applied as either a constructed fish ladder (i.e., made of concrete, steel, or aluminum) to bypass a barrier or as an alteration of the barrier itself (e.g. through explosives to provide a series of ascending resting pools); however, their success will depend on an adequate preconstruction studies and evaluation, including estimates of high- and low-water flows as well as the species and number of fish utilizing the system. Several agencies, including USFS and ADF&G have had experience throughout the EVOS area in these techniques over a broad range of conditions. Although these changes to the barrier are permanent, inspection and maintenance of the structures are required at regular intervals.

If a migration barrier is present upstream from a spawning population of pink salmon, after the barrier mitigated, the returning spawners will colonize the newly available habitat, although it may require several generations before the entire area of new habitat becomes fully utilized. Where a barrier may prevent migration above the intertidal reach, a pink salmon spawning population may not be present. A spawning stock may be introduced by any of several methods that may include introduction of mature adult fish or eggs (e.g., in the gravel or in incubation boxes) or emergent fry (Kohler,--).

Potential Applications: This technique has been widely applied throughout the EVOS area, especially in Prince William Sound, to increase populations of wild stock pink salmon and to establish new populations by providing access to new or additional spawning habitat (Kohler,---). (Blackett,---;) Pink salmon migrate directly to saltwater after they emerge from the spawning gravel so they do not require freshwater rearing habitat; consequently, population benefits will be accrued for pink salmon wherever access can be provided to new or underutilized spawning habitat.

Potential Benefits: Migration corridor improvements that create access to good quality spawning habitat for pink salmon is a proven technique to improve pink salmon populations. The potential benefit is in direct proportion to the amount of new spawning habitat that is accessed. The installation is usually permanent, with a long lifespan.

Potential Drawbacks: Installation costs may be high. Routine inspection and minor maintenance is required.

2: Egg incubation boxes have been used highly successfully in the Copper River drainage to develop a small wild-stock population of sockeye salmon into an estimated annual total return of approximately 200,000 adult fish with an estimated annual commercial harvest of over 100,000 fish (Roberson and Holder, 1993). Other experiments to incubate sockeye and chum salmon eggs in egg incubation boxes in Prince William Sound were less successful (Jackson, 1974), however, Mr. Pete Velsko, ADF&G, Nome (1993 oral comm.) has reported that egg incubation boxes have been used successfully in several drainages in the Nome area to incubate chum salmon eggs. These and other results demonstrate the importance of proper site selection, installation, and operational techniques. Egg incubation boxes have not been used widely to incubate pink salmon eggs, however, Mr. Terry Ellison (ADF&G, 1994, oral comm.) reports that egg incubation boxes

were used effectively for several years to increase the numbers of pink salmon returning Cannery Creek in Prince William Sound.

Description. The technique of egg incubation boxes involves use of a large box (e.g., 2x2x2 ft. to 4x4x8 ft.) in which fertilized eggs and selected gravel or artificial substrate are placed in alternating layers. Cool oxygen-rich water is fed by gravity from an intake box, through a plumbing system, and up through the gravel and eggs in the incubation box. When properly installed, these units control the water flow, substrate type, sedimentation, and predation to provide egg-to-fry survival rates as high as 90%. This compares quite favorably with an expected survival rate of 20% in redds of naturally-spawned sockeye salmon (Ref., ...).

In-stream egg incubation boxes provide a low-cost restoration or enhancement technique that is ideally suited for small-scale, low-technology operations at remote sites. After the brood stock is spawned and the eggs are placed in the unit, minimal care is required. When they are used for enhancement of indigenous stocks, these units can minimize the fish genetic and pathology concerns associated with transport of eggs or fry.

To successfully apply this technique, the following prerequisites are needed; (1) high-quality free-flowing (i.e., throughout the winter) spring water source; (2) adequate height differential to provide sufficient flow without installing excessive length of piping, (3) suitable stream bottom, and (4) protected area for the incubation units.

Potential applications: The potential contribution of egg incubation boxes for the restoration or improvement of wild pink salmon stocks in the EVOS area will be very good in drainages which have reasonably accessible spring areas or free-flowing water in winter, appropriate physical features, good water quality and quantity, and potential capacity to achieve a satisfactory benefit:cost ratio.

Extensive surveys to locate potential sites to implement this technique in the EVOS area have not been performed, however, large-scale potential sites have not been identified during routine surveys and monitoring for fisheries management activities or fish hatchery site identification. Potential sites are believed to exist, however, for application of this action in some drainages.

Potential benefits: Where an optimal location can be utilized, dramatic results can be attained (Roberson and Holder, 1993). Where suitable locations can be identified, this action may be applied to help restore or improve pink salmon populations without a major intrusion into the environment or the wild fish stocks. Within the EVOS area, there may be numerous drainages where this technique may be applied.

Potential drawbacks: This method will require substantial development to achieve dramatic, cost-effective results with pink salmon. Within individual drainages, it can be used to benefit individual stocks, however logistical costs may constrain widespread small-scale development.

3. Net-pen rearing is a practice that has been widely applied to increase the survival rate of all salmon species. This is a common technique that has been widely used in ADF&G and PNP programs in the EVOS area and throughout the State of Alaska to improve the survival rate of juvenile pink salmon. It is not commonly applied, however, for wild stocks of pink salmon.

Description. Net-pen rearing to improve the survival rate for wild-stock juvenile pink salmon will entail capturing the fry as they emigrate from a spawning stream and placing them in a rearing pen; or, emergent fry

may be reared from eggs in a hatchery and transported to the rearing site. On-site personnel feed the fry, protect against predators and physical damage and monitor the fish health to increase the survival rate of the fry until they are released. The increased survival rate and larger size contributes to better survival and an increased return of adult fish.

Potential applications: Net-pen rearing of wild-stock pink salmon fry to increase their survival rate potentially may be employed in many systems throughout the EVOS area. Only two key ingredients are necessary, a source of fry and a suitable site to anchor and service the net pens. The wild-stock fry may be captured as they emigrate from a spawning stream or they may be transferred through a hatchery operation. Although this action has not been widely applied for wild-stock pink salmon, the techniques of capturing emigrating fry and net-pen rearing are standard practices. Successful application will depend primarily upon appropriate site selection.

Potential benefits: NEED WILD FISH SURVIVAL RATES.

Careful application of the net-pen rearing technique can be expected to increase the survival rate of juvenile pink salmon and, consequently, returning adults (reference,---). The magnitude of the benefit will depend on the numbers of captive fry that can be accommodated.

Potential drawbacks: Whenever any organisms are held captive in high density, they become more susceptible to disease or other catastrophic loss; however, this risk can be reduced by adjusting the loading density (Schollenberger, 1993). Any fish cultural activity may have some genetic consequence on the natural population (e.g., because of selective egg-take practices), but this introgression is reduced by using the indigenous stock and minimal manipulation activities (ADF&G Genetic Policy, \_\_\_\_).

4: Hatchery rearing of pink salmon fry to increase the survival rate to the adult stage has had a long history in Alaska. Typically, these operations have been based on a large, established hatchery brood stock that was derived from a donor wild stock, however, individual wild stocks may be used annually to supply the eggs. As the fry emerge, they must be transported to an estuarine rearing site at the stream mouth where they can be held until they become imprinted to this stream and until the environmental conditions are satisfactory.

Description: Eggs are taken from the appropriate brood stock and incubated. As fry emerge from the incubators, they are transferred to floating net pens that are anchored in the estuary in a sheltered location where they are fed. The release timing is determined by either the appropriate growth and size of the fry or when the natural rearing conditions in nearshore nursery areas are optimal. If the rearing and release location is not adjacent to the hatchery, it must be in the freshwater plume of the target drainage to achieve proper imprinting and homing.

Potential applications: Hatchery rearing for pink salmon fry may be a useful technique to restore pink salmon populations in many drainages in the EVOS area, however, the wild stocks must be selected for egg takes and the fry rearing pens must be operated at the mouth of the systems that are selected. Candidate locations must have enough spawners to supply the eggs and the physical features of the stream mouths must accommodate the net pens.

Potential benefits: Damaged wild stocks may be helped directly by a rearing and release program for that stock; or the wild stocks may be helped indirectly by creating an alternate opportunity for the commercial fishers to divert fishing pressure away from the damaged wild stocks. For direct restoration, fry-rearing programs will be limited to those drainages which can provide brood stock and accommodate a rearing

program. Typically, the survival rate from fry to adult may be increased ---% (reference, \_\_\_\_).

Potential drawbacks: Whenever any organism is held captive in high density, it becomes more susceptible to disease or other catastrophic loss; however, this risk can be reduced by adjusting the loading density (Schollenberger, 1993). Any fish cultural activity may have some genetic consequence on the natural population (e.g., selective egg-take practices), but this introgression is reduced by using the indigenous stock and minimal manipulation activities (ADF&G Genetic Policy, \_\_\_\_).

the success of this action depends on a combination of biological, physical, logistical and technological factors and no project application can be expected to become fully operational without appropriate site selection, testing and evaluation.

5. Habitat improvement techniques are employed to overcome a factor in the fishes environment that may limit the full potential production from that system. Habitat improvement to achieve increased production usually entails one of the fishes life history needs that may limit production within that drainage. Consequently, it is important to determine what aspect of the life history is the limiting factor and what must be done to improve conditions for increased production. Because pink salmon utilize the freshwater environment only for spawning, habitat improvement opportunities are limited primarily to improving migration corridors and creating new spawning habitat.

Description: Before any habitat improvement method should be applied, at least one year of monitoring and evaluation with a systematic approach should be scheduled. Seasonal visits will be most critical during low-flow seasons and the coldest season. The most important parameters to evaluate include water temperature, water volume and velocity and dissolved oxygen. If a fish population is not now present, other water quality parameters must also be evaluated. A map of existing and new habitat should be drawn. Engineering plans may be necessary to design a fish pass or spawning channel. If new spawning areas are to be developed, it is crucial to know the amount of water and to verify that the water is well-oxygenated and that it does not freeze in winter. In addition, after habitat improvement has been completed, it must be monitored on a regular basis to assure that it is operating as designed and to perform periodic maintenance.

If migration corridor habitat is poor, a fishpass may be installed to mitigate a migration barrier to provide access for pink salmon spawning habitat. Migration corridors may also be improved with techniques such as stabilizing stream banks or installing structures (e.g., boulders, wood debris) to maintain riffles and pools in a stream. This may also create resting areas for spawning adults, but these factors rarely limit production. Selective removal of a portion of a barrier sufficient to allow passage of fish upstream without substantially altering the flow of water or downstream conditions may also improve access to spawning habitat.

If lack of adequate spawning habitat limits production, a spawning channel may be designed to increase and enhance natural spawning habitat thorough control of such factors as water flow, substrate, sedimentation, and predation to increase the egg-to-fry survival rates. While the average egg-to-fry survival rates in a natural stream may be as little as from 10% to 15%, the introduction of spawning channels can increase those survival rates significantly. Implementation of this action requires a stable source of high quality water (usually from groundwater) that is protected from surface runoff, proper terrain, and sufficient brood stock to utilize the spawning channels. Although numerous spawning channels have been constructed in other parts of the United States for various species of salmon (Bell, 1986) and Canada (reference, ----), few have been installed in Alaska and these have usually been designed to benefit chum salmon (Bachen, ---: Garrison, 1993, oral comm.).

Potential Applications: Surveys have been performed to identify potential locations for habitat improvement projects in the EVOS area and no potential sites have been discovered for large-scale projects (Willette, *et al*, 1993). Potential sites may exist, however, for limited application for some wild stocks of pink salmon in some drainages.

Potential Benefits: Pink salmon will benefit from access or development of any new spawning habitat, however, because of the cost of installation and the value of pink salmon, opportunities and benefits are probably limited.

Potential Drawbacks: Wherever fish stocks are created or increased, there may be an interference with other stocks that are already present. There may be a risk of overharvesting the existing stocks. Returning adult fish may stray into adjacent drainages, interbreed with naturally-reproducing populations, and disturb the genetic makeup of those populations.

6. Relocation of hatchery runs will provide a benefit for wild-stock pink salmon by providing an alternate location, timing, or stock for commercial fishing activities. If the locations to establish these new runs are carefully selected, there will be little or no interception of the wild stocks. Combined with good fishery management practices and a redistribution of the commercial fishing fleet, fishing pressure can be diverted away from the wild stocks that need additional protection and refocused on the relocated hatchery runs which will allow the wild stocks to recover. This type of action has been employed already in portions of the EVOS area (Table IV-\_\_\_). Fish hatcheries provide a tool to relocate or establish fish runs; however, as with any tool, it must be used properly. First, the release location must be selected carefully. Juvenile fish must be transferred from the hatchery to the release site and, at the time of release, provisions must be made to assure that the young fish are imprinted properly to the release site to minimize straying by returning adult fish. After the adult fish return, the site for the terminal harvest must contain the fish (and the fishers) until the fish have been harvested with little or no impact on the wild stocks. Second, the donor brood stock must be appropriate for the need (i.e., species, stock, size, age, run timing, etc.) and the escapement of that stock must be sufficient to provide enough eggs for the new project. Third, guidelines established in the ADF&G Genetics Policy and the Fish Health and Disease Control Policy must be followed. Finally, any proposed action must be consistent with permitting, planning and review procedures for all fishery projects. These procedures assure that new fishery projects will not interfere with wild-stock management practices and a fishery management plan is established before the first fishery is allowed.

Potential applications: ADF&G and PNP aquaculture organizations have established a modern fisheries enhancement program that began in the mid-1970's that has included the establishment of salmon runs in new areas, however some locations are available that will provide opportunities for juvenile fish imprinting and adult fish terminal harvest areas that are readily accessible to the fishing fleets.

Potential benefits: Fish hatcheries have been used in Alaska to relocate runs or establish runs of salmon for harvest by commercial fishers. Excellent success has been achieved with pink salmon; however, at times, these results have not been consistent (Alaska Fish and Game Magazine); apparently because year-class strength appears to be dependent on annual differences in the quality of the nearshore nursery habitat (Willette/Wertheimer/ Heard). Other new runs at new locations can be developed as well.

Potential drawbacks: Hatchery-produced fish typically can be harvested at a higher rate than most wild stocks. Consequently, if wild stocks are mixed with hatchery-produced fish and this mixture is harvested at the rate for hatchery stocks, the wild stocks will be overharvested. The wild stocks may become depleted unless the relocated hatchery-produced stocks can be harvested in a time or place that is separated from the

wild stocks. Every fish-culture program must be carefully structured and controlled to avoid or minimize potential changes in the genetics makeup and health of the wild stocks that may be caused by the fish cultural program (Hindar, Ryman and Utter, 1991; Hilburn).

### **Sockeye salmon**

Restoration actions that may be implemented, in addition to habitat protection, to assist natural recovery of wild-stock sockeye salmon populations include: lake fertilization, migration corridor improvements and actions that may improve survival rates of sockeye salmon eggs by using egg incubation boxes, net pen rearing or hatchery rearing (EVOS Trustee Council, April 1993).

1. Lake fertilization is a potential action that may be taken to improve the rearing success of juvenile sockeye salmon during their one to three years in the lake environment and increase their survival to the smolt stage. ADF&G began a lake limnology and lake fertilization program in the late 1970's and a number of lake systems in the area have been treated to improve sockeye salmon production (Kyle, 1994) (Table IV- ).

Description: ADF&G has an established Lake Limnology and Lake Enrichment Policy (1979) that is presently being revised and updated (Kyle, 1994, oral comm.). According to this policy, a candidate lake system requires at least two years of study and evaluation before a project can be implemented. These research studies are designed to evaluate the status of the sockeye salmon fry populations, that these populations will benefit from nutrient enrichment, and to prescribe the appropriate blend and amount of chemicals that are needed to stimulate the food chain. Each lake system has unique characteristics. Some systems, such as Leisure Lake, on the lower Kenai Peninsula, have barrier falls on their outlet streams which prevent immigration of adult salmon, but which allow successful emigration of smolts. Fry must be stocked annually to replace the spawning adults and fertilizer must be added annually to replace the nutrients usually preceded by the carcasses of spawners (Dudiak,---). ALSO IN CANADA...?

Potential Applications: The technology of lake nutrient enrichment to fertilize lakes to improve rearing, growth, and survival of wild stocks of sockeye salmon has been developed in Alaskan waters and in other areas. Within the EVOS area, some successes have already been achieved in the present lake enrichment program and where new opportunities exist, this action can be expected to improve the rearing habitat and produce additional sockeye salmon.

Potential benefits: Lake nutrient enrichment has been used successfully to improve the freshwater survival rates of juvenile sockeye salmon and to produce more adult fish in Canada and the United States (Canada, --; Koenings and Kyle,---). Within the EVOS area, benefits from this action will depend primarily on the ability to identify new candidate lake systems in areas where returning adult fish may be harvested without risk of overharvesting existing wild stocks.

Potential Drawbacks: Wherever fish stocks are created or increased, there may be an interference with stocks that are already present. There may be a risk of overharvesting the existing stocks. Returning adult fish may stray into adjacent drainages, interbreed with naturally-reproducing populations, and disturb the genetic makeup of those populations.

-----2: Migration corridor improvements entail mitigation of a barrier to fish migration that may prevent access to critical habitat for spawning or rearing and typically includes installation of a fishpass or removal of a



migration barrier. The construction of a fishpass (i.e., fish ladder or steep pass) is a permanent form of habitat modification to enable fish to access spawning and rearing habitat above an impassable barrier such as a waterfall or cataract.

Description: This technique can be applied as either a constructed fish ladder (i.e., made of concrete, steel, or aluminum) to bypass a barrier or as an alteration of the barrier itself (e.g. through explosives to provide a series of ascending resting pools); however, successful design, installation, and operation will depend on adequate preconstruction studies and evaluation, including estimates of high- and low-water flows and the geology of the area. Several agencies, including USFS and ADF&G have had experience throughout the EVOS area in these techniques over a broad range of conditions. Although these changes to the barrier are permanent, inspection and maintenance of the structures are required at regular intervals.

If a migration barrier is located upstream from an established population of salmon, after the barrier mitigated, the returning spawners will usually colonize the newly available habitat, although it may require several generations before it is fully utilized. If there is no spawning population, a new spawning stock may be introduced by any of several methods that may include introduction of mature adult fish or eggs (e.g., in the gravel or in incubation boxes) or emergent fry (Kohler,--).

For sockeye salmon, a fishpass to access new spawning habitat will be of no value unless rearing habitat that is presently underutilized will be available for the fry that will be produced. If a spawning population must be introduced to colonize a newly-accessible spawning area, that brood stock must be carefully chosen for the proper size, run timing, and behavior. Blackett (1978; 1984) described the installation and operation of a fishpass to establish chinook and sockeye salmon runs into the Frazer Lake system on Kodiak Island. This system, which had been blocked to anadromous salmon runs by a ten-meter high falls, required four 64-meter long runs of fishpass to maintain the new runs of fish.

Potential Applications: This technique has been widely applied throughout the EVOS area, especially in Prince William Sound; primarily, to increase populations of wild stock pink salmon and to establish new populations by providing access to new or additional spawning habitat (Kohler,---). It has been less widely applied for sockeye salmon because the juvenile sockeye salmon require the lake rearing habitat. Because this technique has been widely applied, in the EVOS area, many good locations have already been utilized (Willette *et al.*, 1993).

Potential Benefits: Migration corridor improvements that create access to good quality spawning habitat is a proven technique to improve salmon populations, however, it will be effective for sockeye salmon only if the newly-produced fry have access to rearing habitat that is presently underutilized. The potential benefit will usually be limited by the amount of rearing habitat rather than the amount of new spawning habitat that is accessed. The installation is usually permanent, with a long lifespan.

Potential Drawbacks: Installation costs may be high. Routine inspection and minor maintenance is required. If substantial new populations are created, they may interfere with management of other nearby wild stocks.

3: Egg incubation boxes have been used highly successfully in the Copper River drainage to develop a small wild-stock population of sockeye salmon into an estimated annual total return of approximately 200,000 adult fish with an estimated annual commercial harvest of over 100,000 fish (Roberson and Holder, 1993). Other experiments to incubate sockeye and chum salmon eggs in egg incubation boxes in Prince William Sound were less successful (Jackson, 1974), however, Mr. Pete Velsko, ADF&G, Nome (personal

communication) has reported that egg incubation boxes have been used successfully in several drainages in the Nome area to incubate chum salmon eggs.

Description. The technique of egg incubation boxes involves use of large box (e.g., 2x2x2 ft. to 4x4x8 ft.) in which fertilized eggs and selected gravel or artificial substrate are placed in alternating layers. Cool oxygen-rich water is fed by gravity from an intake box, through a plumbing system and up through the gravel and eggs in the incubation box. When properly installed, these units control the water flow, substrate type, sedimentation, and predation to provide egg-to-fry survival rates as high as 90%. This compares quite favorably with an expected survival rate of 20% in redds of naturally-spawned sockeye salmon (Ref., ...).

In-stream egg incubation boxes provide a low-cost restoration or enhancement technique that are ideally suited for small-scale, low-technology operations at remote sites. After the brood stock is artificially-spawned and the eggs are placed in the unit, minimal care is required. When they are used for enhancement of indigenous stocks, these units can minimize the fish genetic and pathology concerns associated with transport of eggs or fry.

To successfully apply this technique, the following prerequisites are needed; (1) high-quality free-flowing (i.e., throughout the winter) spring water source; (2) adequate height differential to provide sufficient flow without installing excessive length of piping, (3) suitable stream bottom, and (4) protected area for the incubation units. This technique will not be successful for sockeye salmon, however, unless the fry that are produced can migrate into an under-utilized lake rearing system with an adequate supply of zooplankton for forage.

Potential applications: The potential contribution of egg incubation boxes for the restoration of sockeye salmon stocks in the oil-spill area will be limited to drainages with: 1) limited successful reproduction; 2) spring areas with appropriate physical features and water quality and quantity; 3) underutilized rearing capacity for the sockeye salmon fry that are produced; and, 4) potential capacity to achieve a satisfactory benefit:cost ratio.

Although extensive surveys to locate potential sites to operate this technique have not been performed, good potential sites have not been discovered during routine surveys and monitoring for fisheries management activities or fish hatchery site identification. Potential sites are believed to exist, however, for limited application in some drainages.

Potential benefits: Where an optimal location can be utilized, dramatic results can be attained (Roberson and Holder, 1993). Where suitable locations can be identified within drainages that presently support small populations of sockeye salmon, this technique may be applied to help restore those populations without a major intrusion into the environment or the fish stock.

Potential drawbacks: This method requires substantial development to achieve dramatic results. Within individual drainages, it can be used to benefit individual stocks, however, logistical costs may constrain small-scale development.

4: Net-pen rearing is a practice that has been widely applied to increase the survival rate of all salmon species. This technique, however, has only recently been applied successfully for sockeye salmon because most previous attempts failed because sockeye salmon are particularly susceptible to the disease infectious hematopoietic necrosis virus (IHNV). (Mr. Terry Ellison, ADF&G, personal communication).

Although the net-pen rearing technique has been applied in both freshwater and in saltwater, most success has been achieved with freshwater rearing because the early lifestages from only a few stocks of sockeye salmon can survive in saltwater. Burke (1993), however, described a highly successful program for rearing juvenile sockeye salmon in saltwater net pens to the smolt stage, but only after they had been fed first in freshwater hatchery raceways. Consequently, although net-pen rearing of sockeye salmon in saltwater may have excellent potential for a hatchery-based application, it is of limited value for protection and restoration of wild stocks except where it may be used to create an alternate opportunity for commercial fishermen.

Juvenile sockeye salmon typically require rearing in freshwater for up to three years (Burgner, 1991). During this period, the mortality rate between the fry and smolt stages may range from 86 to 99% (Roberson and Holder, 1993), but fry held in net pens are largely protected from predators and food is provided, so the mortality rate is low while they are in the pens. Net-pen rearing of sockeye salmon fry in freshwater has not been widely applied; however, it appears to have been quite successful in English Bay lakes as a means to increase the freshwater survival rates (Schollenberger, 1993).

Description. Net-pen rearing to improve the survival rate for juvenile wild-stock sockeye salmon first requires a source of captive fry. Fry may be captured as they emigrate from a spawning stream and placed in the rearing pen or emergent fry may be reared from eggs in a hatchery and transported to the rearing site. On-site personnel feed the fry, protect against predators and physical damage and monitor the fish health. The objective of net-pen rearing is to increase the survival rate of the fry to the smolt stage by providing protection and food to increase their growth and survival rates. With a faster growth rate, fry are expected to achieve a threshold size for smoltification during their first year of life (Koenings?, \_\_\_\_). The increased survival rate contributes to a larger smolt population and, consequently, an increased return of adult fish. After the fry attain sufficient size, they are released; usually, in the fall so they can overwinter naturally, smoltify and emigrate to the ocean.

Potential applications: Net-pen rearing of sockeye salmon fry to increase their survival rate potentially may be employed in many systems throughout the EVOS area. Only two key ingredients are necessary: a source of fry and a suitable site to anchor and service the net pens. Fry may be captured from a spawning stream or transferred from a hatchery. Schollenberger (1992, 1993) reported encouraging results from a net-pen rearing project to restore a sockeye salmon run in English Bay lakes in lower Cook Inlet. The English Bay lakes sockeye salmon run fluctuated widely and had declined since the mid-1970's and lake rearing conditions were poor. After the implementation of the net-pen rearing projects, the estimated percentage of age-1 smolts increased from 63 to 97% and the average sizes of age-1 smolts increased 10% in length and 31% in weight.

Potential benefits: NEED WILD FISH SURVIVAL RATES.

Careful application of the net-pen rearing technique will increase the numbers of emigrating sockeye salmon smolts and returning adults with minimal undesirable effects on the population or the lake rearing system. The magnitude of the benefit will depend on the numbers of captive fry that can be accommodated.

Potential drawbacks: Whenever any organisms are held captive in high density, they become more susceptible to disease or other catastrophic loss; however, this risk can be reduced by adjusting the loading density (Schollenberger, 1993). Any fish cultural activity may have some genetic consequence on the natural population (e.g., selective egg-take practices), but this introgression is reduced by using the indigenous stock and minimal manipulation activities (ADF&G Genetic Policy, \_\_\_\_).

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5: Hatchery rearing of sockeye salmon has had a long history in Alaska, however, during the last decade, this

strategy has been improved and it has produced dramatic innovations and results (Ellison, 1993). In Alaska, cultured juvenile sockeye salmon have been released as fed fry, presmolts and smolts. Each lifestage has its own particular logistical, biological and fish cultural constraints and advantages. Fry are less expensive to rear, transport and release, but they require at least one year of rearing in a lake before they smoltify and they will not survive to the adult stage as well as presmolts or smolts. Fry that are retained and fed in hatchery raceways may be released in late-fall as presmolts. These young fish require few resources from the lake system during the winter and emigrate as smolts in the spring. Smolts are expensive to rear and transport, but they will survive better to the adult stage; however, they can be released as migrants without reliance on freshwater rearing.

Description: The hatchery rearing technique requires a source of fry from eggs taken from the wild-stock spawners. After the eggs are incubated, the fry are held and fed in freshwater raceways until they are ready to release as fry, presmolts, or smolts (Burke, 1993). Emergent fry or short-term reared fry may be released into the nursery lake provided that the naturally-spawning population cannot fully stock the system. Fry that are released as presmolts are reared longer; nearly to the size of a smolt.

If the carrying capacity for sockeye salmon in nursery lakes is achieved by natural spawning, additional production cannot be achieved by releasing additional fry, but more adult fish can be produced by rearing and releasing sockeye salmon at the presmolt or smolt stages. Fish released late in the growing season (immediately before freeze up) as presmolts have a low metabolism and they place little demand on the rearing environment in the lake (Carpenter, 1991). In spring, the fish feed and grow only slightly before they emigrate as smolts. Carpenter (1991) reported that sockeye salmon stocked as fry into Prince William Sound lakes had survival rates to age-1 smolts of 8.5 and 12.2 percent and presmolts survived to age-1 smolts at rates of 63.3 percent.

Sockeye salmon can be reared successfully to the smolt stage in hatcheries in approximately one year after they are hatched (Burke, 1993). Smolts are released at a larger size than presmolts so they are more difficult and expensive to transport. They begin their migration immediately, however, so they will not compete with fry that may be in the nursery system. Care must be taken, in all cases, to ensure that the smolts are properly imprinted for good homing of returning adults.

Each hatchery-rearing strategy will improve the survival of sockeye salmon fry compared to those that are naturally-produced (Reference)(Table IV-F 1). Each strategy, however, relies on different intensities of human intervention, cost and logistical constraints.

Potential applications: Hatchery-reared sockeye salmon fry may be a useful technique to restore sockeye salmon populations in many drainages in the EVOS area, however, fry can be stocked only into those systems that are presently underutilized by juvenile sockeye salmon.

Potential benefits: Damaged wild stocks may be helped directly by a rearing and release program for that stock; or the wild stocks may be helped indirectly by creating an alternate opportunity for the commercial fishers to divert fishing pressure away from the damaged wild stocks. For direct restoration, fry-rearing programs will be limited to those drainages where the forage is underutilized by the naturally-produced fry. Presmolt- and smolt-rearing programs, however, can provide direct restoration with little or no effect on plankton populations.

Potential drawbacks: Whenever any organism is held captive in high density, it becomes more susceptible to disease or other catastrophic loss; however, this risk can be reduced by adjusting the loading density

(Schollenberger, 1993). Any fish cultural activity may have some genetic consequence on the natural population (e.g., selective egg-take practices), but this introgression is reduced by using the indigenous stock and minimal manipulation activities (ADF&G Genetic Policy, \_\_\_\_).

6. Eyed-egg planting (i.e., burying salmon eggs that have been incubated to the eyed stage in a stream bed) has been used successfully in Alaska to rehabilitate the early-run population of sockeye salmon in the Karluk River drainage (White, 1988). Historically, the Karluk River sockeye salmon run ranged from 1,000,000 to 5,000,000 fish, but escapements declined to an average of 323,000 fish from 1978 to 1984. Recently, however, escapements have ranged from 440,000 to 996,000 sockeye salmon, after a total of 85,000,000 eyed sockeye salmon eggs were planted between 1978 and 1987 (White, 1988). This program became the largest eyed-egg planting project ever conducted in the north Pacific (White, 1988) and it demonstrates the effectiveness of this technique.

The principle for this strategy is to improve the survival rate of the eggs that are delivered by the spawning female salmon. Fertilized sockeye salmon eggs, spawned and buried naturally in the stream bed, survive to the eyed stage at a rate of about 14% (Drucker, 1970), compared to a survival rate of 84%, for those incubated in a controlled system (White, 1988). Eggs survived from the eyed stage to emergent fry at an average rate of 42% after planting by hand compared to 30% of those spawned naturally (White, 1988). A higher survival rate from the egg to fry stage can be achieved by hatchery-rearing methods, however, the technique of eyed-egg planting is a more natural method and it avoids the need for a costly transport of the young fish.

Description. The technique of planting eyed salmon eggs in an acceptable stream substrate involves two steps. First, eggs are collected from the brood stock and incubated to the eyed stage. Second, the eyed eggs are introduced into a good-quality stream gravel substrate after the gravel has been cleaned of fine materials. Bams (1985) and Harshbarger and Porter (1982) discuss several methods, including the most conventional method of digging with a shovel, but White (1980) described a simple, but highly effective device to plant large numbers of eyed eggs quickly and efficiently with a high survival rate. This device injects a jet of water into the substrate to cleanse the gravel before the eggs are delivered.

Eyed-egg plants may be a simple, low-cost restoration or enhancement technique that is ideally suited for small-scale operations at remote sites. After the brood stock is spawned and the eggs are delivered, no other care is required. When this is used with indigenous stocks, this method can minimize the fish genetic and pathology concerns associated with transport of eggs or fry. To successfully apply this technique for sockeye salmon, however, underutilized rearing habitat must be available for the fry that will be produced.

Potential applications: The potential contribution of eyed-egg planting for the restoration or improvement of wild sockeye salmon stocks in the EVOS area will be very good in drainages which have spawning type habitat that is reasonably accessible for egg planting and, for sockeye salmon, rearing habitat for the fry that are produced.

Although extensive surveys to locate potential sites to operate this technique have not been performed, large potential sites have not been identified during routine surveys and monitoring for fisheries management activities or fish hatchery site identification. Potential sites are believed to exist, however, for application of this action for pink or sockeye salmon in some drainages.

Potential benefits: Where an optimal location can be utilized, dramatic results can be attained and, where suitable locations can be identified, this action may be applied to help restore or improve pink or sockeye

salmon populations without a major intrusion into the environment or the wild fish stocks. Within the EVOS area, there may be drainages where this technique may be applied.

Potential drawbacks: This method will require a substantial program to achieve dramatic, cost-effective results with pink salmon. Within individual drainages, it can be used to benefit individual stocks, however logistical costs may constrain widespread small-scale development.

### **Commercial Fishing**

For commercial fishing resources, the primary restoration action that is being considered will replace lost harvest opportunities by creating new runs of salmon. Other actions that may be considered should either alone, or collectively, produce sufficiently large numbers of wild stocks of adult pink or sockeye salmon to accommodate a reasonable portion of the fishing fleet to provide a harvest that is separated in time or space from existing harvests. These may include relocation of hatchery runs or development of new hatchery runs (e.g., stock fry, presmolts or smolts) or habitat manipulation to increase production of selected stocks (e.g., lake fertilization, egg incubation boxes, etc.). Actions that are designed to increase fish production by habitat manipulation are described according for that damaged resource and action.

Development of new runs of hatchery-produced salmon will provide a benefit for commercial fishing by providing an alternate location, species, or stock of salmon for harvest by commercial fishing activities. If the brood stock selection for these new runs and the release site is carefully selected, there will also be minimal risk of interception of damaged wild stocks. Combined with good fishery management practices, and a redistribution of the fishing fleet, an intensive commercial fishery can harvest these new runs.

This type of action has been employed already in the EVOS area (Table IV-\_\_\_). Fish hatcheries provide a tool to establish new fish runs; however, as with any tool, it must be used properly. First, the release location must be selected carefully. Juvenile fish must be transferred from the hatchery to the release site and, at the time of release, provisions must be made to assure that the young fish are imprinted properly to the release site to minimize straying by returning adult fish. After the adult fish return, the site for the terminal harvest must contain the fish (and the fishers) until the fish have been harvested. Second, the donor brood stock must be appropriate for the need (i.e., species, size, age, run timing, etc.) and the escapement of that stock must be sufficient to provide enough eggs for the new project. Third, guidelines established in the ADF&G Genetics Policy and the Fish Health and Disease Control Policy must be followed. Finally, any proposed action must be consistent with permitting, planning and review procedures for all fishery projects. These procedures assure that new fishery projects will not interfere with wild-stock management practices and a fishery management plan is established before the first fishery is allowed.

Potential applications: Potential opportunities to relocate or establish new hatchery runs in the EVOS area may be limited. ADF&G and PNP aquaculture organizations have established a modern fisheries enhancement program that began in the mid-1970's that has included the establishment of new runs. Few locations remain that provide ideal opportunities for juvenile fish imprinting and adult fish terminal harvest areas that are readily accessible to the fishing fleets. Similarly, most systems that may have underutilized rearing lakes for potential sockeye salmon production have already been incorporated into an enhancement program.

Potential benefits: Fish hatcheries have been used successfully in Alaska to establish new runs of salmon for harvest by commercial fishers. Excellent success has been achieved with sockeye salmon (Ellison, 1993).



Excellent success has also been achieved with both pink and chum salmon; however, these results have been less consistent (Alaska Fish and Game Magazine); apparently because survival rates of the small pink salmon fry is more dependent on annual differences in nearshore water temperatures, food availability and predator abundance (Willette/Wertheimer/ Heard/ chum). Other new runs at new locations or additional fish production at existing facilities or locations can be developed as well.

Potential drawbacks: Hatchery-produced fish typically can be harvested at a higher rate than most wild stocks. Consequently, if wild stocks are mixed with hatchery-produced fish and this mixture is harvested at the rate for hatchery stocks, the wild stocks will be overharvested. The wild stocks may become depleted unless the hatchery-produced stocks can be harvested in a time or place that is separated from the wild stocks. Every fish-culture program must be carefully structured and controlled to avoid or minimize potential changes in the genetics makeup and health of the wild stocks that may be caused by the fish cultural program (Hindar, Ryman and Utter, 1991; Hilburn).

### **Sport Fishing**

Sport fishing was disrupted throughout most of the EVOS area because of the oil spill and damage was sustained by several important sport fish species. Lost sport fishing opportunities may be replaced by creating new sport fish fisheries for salmon or trout.

Establishment of hatchery runs will provide some benefit for all fishers by providing new opportunities with new locations and stocks that anglers may utilize, however, the greatest benefits to sport fishermen will accrue from new fisheries that are designed specifically for anglers. Typically, a run of a few thousands of fish will provide tens of thousands of angler/days of recreation (Mills, 1993) compared to a commercial fishery which often requires hundreds of thousands of salmon for a successful fishery. Sport fisheries, however, will be successful only if they are located where they can be accessible by anglers.

This type of action has been employed already by ADF&G to improve sport fishing opportunities for trout and salmon in the EVOS area (Table IV-\_\_\_). Hatchery-produced salmon and trout are released in locations with public access that are selected to minimize or avoid interactions with wild stocks. New anadromous runs depend primarily on releases of coho or chinook salmon smolts. Land-locked lakes are usually stocked with fry or catchable-sized rainbow trout, but coho and chinook salmon, Arctic char, Arctic grayling and lake trout are also stocked to provide recreational angling.

Fish hatcheries provide an excellent tool to establish new runs of fish; however, as with any tool, it must be used properly. First, the release location must be selected carefully. Juvenile fish must be transferred from the hatchery to the release site and, at the time of release, provisions must be made to assure that the young fish are imprinted properly to the release site to minimize straying by returning adult fish. After the adult fish return, the harvest site must contain the fish (and the fishers) until the fish have been harvested with little or no impact on the wild stocks. Second, the donor brood stock must be appropriate for the need (i.e., species, stock, size, age, run timing, etc.) and the escapement of that stock must be sufficient to provide enough eggs for the new project. Third, guidelines established in the ADF&G Genetics Policy, Wild-Stock Policy and the Fish Health and Disease Control Policy must be followed. Finally, any proposed action must be consistent with permitting, planning and review procedures for all fishery projects. These procedures assure that new fishery projects will not interfere with wild-stock management practices and a fishery management plan is

established before the first fishery is allowed.

Potential applications: The existing sport fisheries enhancement program has already incorporated many good locations. Some barren lakes (e.g., in Prince William Sound) may be candidates for establishment of new sport fisheries, however, these would also require simultaneous development of an access trail from tidewater and an educational program to alert anglers about the new opportunities. If the hatchery program is expanded, the production of catchable-sized fish can be increased to supply more fish and recreation in lakes that are already included in the existing ADF&G sport fishery enhancement program.

Potential benefits: A small number of fish in a good location can provide angling to accommodate a substantial number of angler-days of recreation.

Potential drawbacks: Wherever large number of fishers concentrate to harvest a concentrated population of fish, the riparian zone habitat may be damaged by the heavy foot traffic and access trails will become established. Pristine areas may become disturbed by increased numbers of people. It is also unlikely that the lost sport fishing opportunities will be replaced directly by new opportunities. New sport fisheries will create new opportunities, but most likely will be different species in new locations.

A number of years will be required to expand hatchery production and refine transport, release and management strategies. After a new run has been established, it may also require several years before anglers learn about and take advantage of new opportunities.

Table C-1.

Survival rates for wild and hatchery-produced juvenile sockeye salmon.

| Expected Survival Rate |          |          |      |                   |      |          |
|------------------------|----------|----------|------|-------------------|------|----------|
| Lifestage              |          | Wild     |      | Hatchery-produced |      |          |
| From                   | To       | To Stage | Cumm | To Stage          | Cumm | To Smolt |
| green egg              | eyed egg | 20       | 20   | 80                | 80   |          |
| eyed egg               | fry      | 80       | 16   | 80                | 64   | 10       |
| fry                    | presmolt | 30       | 5    | 90                | 60   | 35       |
| presmolt               | smolt    | 60       | 3    | 90                | 50   | 50       |

Reference:

Table C-2. Representative projects that have established new fisheries to improve sport-fishing opportunities in the EVOS area.

| Release              |               |                |                   |        |
|----------------------|---------------|----------------|-------------------|--------|
| Area                 | Species       | Lifestage      | Site              | Source |
| Prince William Sound | Coho          | Smolt          | Cordova           | 1      |
| Prince William Sound | Coho          | Smolt          | Whittier          | 4      |
| Prince William Sound | Chinook       | Smolt          | Seward            | 5      |
| Prince William Sound | Chinook       | Smolt          | Seward            | 6      |
| Cook Inlet           | Coho          | Smolt          | Homer             | 7      |
| Cook Inlet           | Chinook       | Smolt          | Homer             | 2      |
| Cook Inlet           | Pink          | Fry            | Homer             | 3      |
| Cook Inlet           | Chinook       | Smolt          | Kasilof           | 8      |
| Cook Inlet           | Coho          | Smolt          | Kasilof           | 9      |
| Cook Inlet           | Steelhead     | Smolt          | Kasilof           | 10     |
| Kodiak               | Chinook       | Smolt          | Kodiak            | 11     |
| Region-wide          | Salmon        | Fry, Postsmolt | Land-locked lakes | 12     |
| Region-wide          | Rainbow trout | Fry, Catchable | Land-locked lakes | 13     |

Sources:

**Release**

| <b>Area</b>          | <b>Species</b> | <b>Lifestage</b> | <b>Site</b>            | <b>Results</b>      | <b>Source</b> |
|----------------------|----------------|------------------|------------------------|---------------------|---------------|
| Prince William Sound | Pink           | Fry              | Hobo Creek             | run established     | 1             |
| Prince William Sound |                |                  |                        |                     | 2             |
| Prince William Sound | Pink           | Fry              | Cannery Creek          | hatchery from stock | 3             |
| Prince William Sound | Sockeye        | Smolt            | Main Bay               | create fishery      | 4             |
| Prince William Sound | Chum           | Fry              | Montague Island        | run restored        |               |
| Cook Inlet           | Pink           | Fry              | Halibut Cove Lagoon    | relocate run        | 6             |
| Cook Inlet           | Sockeye        | Fry              | Leisure Lake           | create fishery      | 5             |
| Cook Inlet           | Sockeye        | Fry              | Packers Lake           | improve fishery     | 7             |
| Cook Inlet           | Sockeye        | Fry              | Lower Cook Inlet Lakes | create fishery      | 8             |
| Kodiak               | Sockeye        | Fry              | Spiridon Lake          | create fishery      | 9             |
| Kodiak               | Sockeye        | Fry              |                        |                     | 10            |
| Kodiak               | Pink           | Fry              | Kitoi Bay              | improve fishing     | 11            |

**Sources:**

1. McDaniel
2. Ellison/PWSAC
3. Main Bay (Burke 1993)
4. PWSAC/Kate Wedemeyer
5. Dudiak
6. Dudiak/CIAA
7. CIAA
8. Dudiak
9. White/Honnold
10. ?

11. Joyce



# **Appendix D**

## **Economic Analysis**

## Appendix D

### Economics Methodology

In preparing data for use as input in the IMPLAN economic model, several factors that are unique to the *EVOS* area have been considered. The first factor involves Section 7(i) of ANCSA that requires the sharing of proceeds from timber sales by one Native Corporation with the other Native Corporations. Accordingly, spending the proceeds of timber sale monies within the *EVOS* area would be less than the amount spent from monies received from habitat purchase (i.e., some of the money from the proceeds of timber sales would be distributed and spent by Native Corporations outside the oil spill area). Another factor considered involves an assumption that most habitat purchases are from stocks of commercial timberland. This assumption is based on the criteria used for determining potential parcels available for acquisition under the habitat protection option presented in the Draft Restoration Plan. Timberland purchases reduce economic activity more than purchases of non-commercial land because timberland provides regional employment, non-commercial land does not. On the other hand, proceeds from non-commercial land are not shared and are more likely to remain in the regional economy, thus creating jobs within the region. With regard to the funds received from the sale of timber, the sharing requirements of ANCSA represent a significant expenditure outside the regional economy, or as economists describe this phenomenon, there is a "strong leakage" from the regional economy.

By inputting the various allocation of expenditures into the IMPLAN model, different measures of economic performance (output) are produced. For the purposes of this economic impact analysis, six measures of economic performance are used in the economic analysis. These measures are presented numerically in tables of economic analysis for each of the alternatives.

The dollar value change is determined by: the lump sum amount of the remaining funds; the percent allocation each category receives of the remaining funds; a deflator to turn the settlement's 1993 dollars into IMPLAN's 1990 dollars; and a factor that turns the lump sum amount into an annual amount. For the purpose of this analysis, spending occurs over the ten year period during which restoration funds are being received.

The results of the IMPLAN economic impact analysis for allocating (spending) the remaining \$620 million of the civil settlement funds in five alternatives spending scenarios were analyzed. The spending represents annual average amounts continuing for ten years. The results are given for the six economic indicators described previously, and by sector.

Table 3-3 in Chapter 3 depicts the regional economy as it currently exists with no consideration of restoration fund spending. Analysis of the spending alternatives identify absolute change from the baseline year of 1990.

In recent decades in the *EVOS* area the timber industry has shown cyclical fluctuations while the recreation industry has shown a relatively steady increase. The economic analysis of alternatives

is of annual averages over a ten-year period. These different trends for the timber and recreation industries are averaged out also.

The analysis considers direct, indirect and induced spending for each alternative. Direct spending is spending for the demand change. Indirect spending is spending in the industries linked to the direct spending. Induced spending is caused by the changes in income that were generated by the direct and indirect spending. For example, the purchase of commercial timberland for habitat decreases output and employment in the forest product industry (direct effect) and in the industries that supply the forest product industry (indirect effects). These decreases cause regional income and employment to fall and further reduce spending in the economy (induced effects). However, habitat purchases increase the income of landowners. The spending of this income increases demand for the products they buy (direct effects) and for the industries that supply the directly affected industries (indirect effects). The increase in demand increases employment and income and stimulates the economy (induced effects). The impact analysis models these spending flows and reports the results in total and by sector.

IMPLAN's data is from the 1990 U.S. Census, the U.S. Department of Labor and the Bureau of Economic Analysis of the U.S. Department of Commerce. Although the data comes from sampling, the results approximate the characteristics of the population. Probability theory shows that the results of the repeated sampling vary around the population value in a normal distribution. For example, under a normal distribution, 95 percent of the sampled estimates are within (plus or minus) 1.96 standard deviations of the population characteristic. In other words, a value greater than plus or minus 1.96 standard deviations is not the result of a random event.

These considerations suggest assessing the significance of the modeling results by reference to the standard deviation of the underlying data. The impact procedure: first, samples baseline regional employment; then, spends the civil settlement; then, calculates regional employment. A statistically significant change occurs if, for example, two employment estimates differ by roughly two standard deviations. Alternatively, assume employment changes are assessed by sampling employment before and after the spending of the civil settlement. The two estimates do not differ significantly if they are within two standard deviations. Any change in sampled employment could be attributed to a random factor such as sampling error.

For comparison purposes, the standard deviation for 1990 employment in the boroughs of Anchorage, Kenai, Kodiak and Valdez-Cordova is 684. A significant change in regional employment is an increase or decrease of 1368. Any change between zero and 1368 could be the result of sampling and not attributable to settlement spending according to this statistical analysis.

For the regional economy as a whole, each alternative leaves the baseline unchanged. The employment changes are not more than twice the standard error for the underlying employment data.

Since total employment changes are insignificant and since employment changes are the largest relative changes, then, a first conclusion is that the performance of the regional economy is left

unchanged by each of the five spending alternatives.

There are sector changes that may be statistically significant. However, information is unavailable to assess quantitatively the statistical significance of these results. The sectoral changes, however, are larger in relative terms than the total changes. Accordingly, it is likely that the sectoral shifts cannot be attributed to chance. The sectoral changes reflect (1) the purchase of commercial timberland for habitat preservation, (2) the spending of the sale proceeds, and (3) the spending of the remainder of the settlement for other goods and services. Thus, a second conclusion is that the spending alternatives may change the economy's reliance on specific sectors.

A limitation of these results and those from any economic analysis is that only market commodities are included and they are valued at market prices. Non-market activities such as barter, subsistence fishing/hunting, experiences whose price is essentially zero, or the willingness-to-pay for the simple existence of wilderness, are not addressed. The implication of this is simply that economic analysis should be supplemented with other, non-market analyses.

The category "Responding of Habitat Protection" is part of the modeling exercise but does not appear in the tables for the Alternatives. However it should be noted that habitat purchases put dollars in the hands of resource owners. This category specifies a spending pattern for these funds that saves/invests part (securities, construction) and consumes part (social services).

## Bibliography-Economics

Economic Projections: Alaska and the Southern Railbelt 1992-2020, Institute for Social and Economic Research University of Alaska Anchorage, 1992.

th. Contact Mike Kavanaugh for proper information for citing for IMPLAN.

IMPLAN

# **Appendix E**

## **FY 1992-1994 Project Status Reports**



# Status Report: 1992 Exxon Valdez Oil Spill Restoration Projects **DRAFT**

(for the period March 1, 1992 - February 28, 1993)

| <u>No.</u>            | <u>Title</u>                     | <u>Agencies</u> | <u>Amount<br/>Budgeted*</u> | <u>Amount<br/>Spent*</u> | <u>Status</u> | <u>Results and References</u> |
|-----------------------|----------------------------------|-----------------|-----------------------------|--------------------------|---------------|-------------------------------|
| <b>Administration</b> |                                  |                 | <b>\$5,076.1</b>            | <b>\$3,821.0</b>         |               |                               |
| AD                    | Administrative Director's Office |                 | \$2,248.7                   | \$1,960.0                | Ongoing.      | Not applicable.               |
| RT                    | Restoration Team                 |                 | \$2,827.4                   | \$1,861.0                | Ongoing.      | Not applicable.               |

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|--------------------------|----------------------|-----------------|-----------------------------|--------------------------|------------------------|---|
| <b>Damage Assessment</b> |                      |                 | <b>\$7,331.8</b>            | <b>\$4,978.3</b>         |                        |   |
| ARC00                    | Archeological Survey | ADNR            | \$248.8                     | \$118.7                  | Final report accepted. | See Reger, D.R., J.D. McMahon, and C.E. Holmes. 1992. Effect of Crude Oil Contamination on Some Archaeological Sites in the Gulf of Alaska, 1991 Investigations.  |
| AW001                    | Surface Oil Maps     | ADEC            | \$17.0                      | \$8.4                    | Report overdue.        | Maps have been developed depicting the spread of oil on a daily basis for the first three months following the spill.   |
| B002                     | Boat Surveys         | DOI             | \$48.5                      | \$48.5                   | Report being revised.  | Populations of 9 species or species groups (black oystercatcher, pigeon guillemot, cormorants, harlequin duck, loons, scoters, newgull, arctic tern, northwestern crow) declined more than expected in the oiled zone of Prince William Sound suggesting an oil effect. Most injured species were ecologically tied to intertidal or nearshore areas. |

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|------------|--|-----------------|-----------------------------|--------------------------|--|--|
| B004       | Eagles Damage Assessment Closeout            | DOI             | \$60.6                      | \$60.6                   | Report revised and submitted for final approval. | Reproductive success of Prince William Sound bald eagles was significantly impaired in 1989, and nest failures were correlated with the distribution of crude oil on beaches. Although estimated direct mortality throughout the spill area was relatively large (about 300 - 900 eagles), no change in the population could be detected due to wide variation in population counts. The Prince William Sound eagle population was expected to return to its prespill level by 1993. |
| B006       | Marbled Murrelets Damage Assessment Closeout | DOI             | \$24.8                      | \$24.8                   | Report being revised.                            | The marbled murrelet population at a site within the path of the oil (Naked Island) was lower in 1989 than in prespill years, but returned to normal in 1990. Murrelet numbers in Kachemak Bay where oiling was minimal did not change following the spill.  |
| B007       | Storm Petrels Damage Assessment Closeout     | DOI             | \$7.5                       | \$7.5                    | Final report accepted.                           | At the largest storm-petrel colony within the spill trajectory (Barren Islands), no evidence of adverse effects to breeding petrels was found. Burrow occupancy rates were above average, nesting chronology was not delayed, and productivity was normal.   |

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|------------|---|-----------------|-----------------------------|--------------------------|----------------------------------|--|
| B008       | Kittiwakes Damage<br>Assessment Closeout        | DOI             | \$7.5                       | \$7.5                    | Revised report in review.        | The number of breeding pairs did not decline at colonies in the oiled area of Prince William Sound but reproductive success in 1989 was less than expected, apparently due to low hatching success. Reproductive success did not recover by 1992 but whether the decline was due to the spill is unknown.                                      |
| B009       | Pigeon Guillemots Damage<br>Assessment Closeout | DOI             | \$18.0                      | \$18.0                   | Report being revised.            | The population at a major breeding site within the spill trajectory (Naked Island) declined by 50% compared to 1972-1973 levels. The long-term decline predated the spill and, therefore, could not be attributed to the spill. Reproduction was largely normal following the spill.   |
| B011       | Harlequin Ducks Damage<br>Assessment Closeout   | ADFG            | \$22.9                      | \$21.7                   | Final report in second revision. | Petroleum exposure confirmed in four species of sea ducks. Hydrocarbons in food, liver and bile. Diverse intertidal prey used by ducks. Blue mussels are a key contaminated prey. 1990-1992 low harlequin breeding densities and negligible harlequin stream activity and production in western Prince William Sound. Report not yet accepted. |

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|------------|--|-----------------|-----------------------------|--------------------------|---|--|
| B012       | Shorebirds Damage<br>Assessment Closeout | DOI             | \$20.7                      | \$20.7                   | Report revised and<br>submitted for final<br>approval. Revised<br>report in review. | Spring migrant shorebirds (surfbirds and black<br>turnstones) escaped impacts because shorelines<br>used by these species (particularly around<br>Montague Island) were largely unoiled. Black<br>oystercatcher breeding was disrupted and<br>hatching success reduced. Chicks raised on oiled<br>beaches grew more slowly than chicks raised on<br>unoiled beaches, perhaps due to ingestion of<br>contaminated food. |
| CH001      | Coastal Habitat Damage<br>Assessment     | USFS            | \$2,358.5                   | \$1,454.7                | Final report submitted<br>and in review.  | Serious and long-term lasting effects on<br>intertidal algae. Recovery occurring but slow to<br>none in upper intertidal habitat. Full recovery<br>expected. Intertidal invertebrates indicate<br>negative effects from spill. Intertidal fish<br>findings were inconclusive.  |
| CH001      | Hydrocarbons in Mussels                  | NOAA            | \$51.4                      | \$31.1                   | Report being drafted.   | <i>Exxon Valdez</i> oil is located in oiled mussel beds.<br>Mussels are concentrating the oil.   |
| FS001      | Spawning Area Injury                     | ADFG            | \$64.3                      | \$32.8                   | Report being drafted<br>(combined with R60B).                                       | Documented oil contamination of Prince<br>William Sound pink salmon spawning area.<br>Improved current and historic pink salmon<br>escapement estimates which are necessary for<br>accurate estimates of total wild returns. For<br>preliminary results, see 1989, 1990 and 1991<br>NRDA Drafts Status Reports.  |
| FS002      | Pre-emergent Fry                         | ADFG            | \$29.3                      | \$11.4                   | Final report being<br>reviewed.   | Measured higher embryo mortalities in<br>oil-contaminated streams than in unoiled<br>streams.  |

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|------------|---------------------------------------|-----------------|-----------------------------|--------------------------|---|--|
| FS003      | Coded-Wire Tags Damage Assessment     | ADFG            | \$126.7                     | \$38.7                   | Final report being reviewed.              | Unable to detect significant differences in survival to adults from fry emerging from oiled and control streams. Also unable to detect significant difference in survival of hatchery fish reared in oiled versus unoled areas of Prince William Sound.                |
| FS004      | Early Marine Salmon Damage Assessment | ADFG            | \$145.2                     | \$99.1                   | Report being revised.                     | Detected reduced growth and survival of fry rearing in oiled areas in 1989. No significant differences in growth and survival between oiled and nonoiled areas in subsequent years. Rate of adult returns to unoled hatcheries twice that of oiled hatcheries in 1990. |
| FS004B     | Juvenile Pinks                        | NOAA            | \$119.4                     | \$121.2                  | Revised report in review.                 | Documented exposure and contamination of juvenile salmon in Prince William Sound. Contamination was associated with reduced growth. Ingestion of oil or oiled prey was route of contamination.   |
| FS005      | Dolly Varden Damage Assessment        | ADFG            | \$22.2                      | \$4.2                    | Report being revised (combined with R90). | See R90.   |

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|------------|-------------------------------------|-----------------|-----------------------------|--------------------------|-----------------------|--|
| FS011      | Herring Injury                      | ADFG            | \$303.6                     | \$212.2                  | Report being revised. | Adult herring migrating to the spawning grounds in 1989 were exposed to oil. Exposure to oil continued throughout 1989 and into 1990. Internal tissues were damaged but the short- and long-term effects are speculative. There may have been a short-term effect which inhibited egg deposition and a long-term reproductive impairment (reduced survival of offspring). Eggs were deposited in oiled areas in 1989. Larvae hatched from exposed embryos suffered reduced survival. |
| FS013      | Effects of Hydrocarbons on Bivalves | ADFG            | \$75.8                      | \$51.8                   | Report being revised. | This study needs more extensive analyses of the data on which the conclusions are based and proper interpretations of the results.   |

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|------------|----------------------------------|-----------------|-----------------------------|--------------------------|------------------------|--|
| FS027      | Sockeye Salmon<br>Overescapement | ADFG            | \$630.0                     | \$354.6                  | Final report accepted. | Approximately ten- to fifteenfold reduction in Kenai River smolt when compared to brood year 1987. Reduced smolt production from Akalura and Red Lakes, Kodiak Island. Reduced harvests for the Kenai are forecast for 1994 with returns below escapement levels possible for 1995 and 1996. Minimal harvests of Kenai River sockeye salmon are likely. Reduced harvest are forecast for Red and Akalura Lakes for 1994 through 1996. See Schmidt, D.C. and K.E. Tarbox. 1993. Sockeye Salmon Overescapement. State/Federal Natural Resource Damage assessment Status Report. FRED Technical Report 136. 65 pp.; and Schmidt, D.C., J.P. Koenings, and G.B. Kyle. In press. Predator induced changes in diet vertical migration of copepods in Skilak Lake, Alaska; a hypothesis to explain the decrease in overwinter survival of juvenile sockeye salmon ( <i>Onchorhynchus nerka</i> ). |
| FS028      | Run Reconstruction               | ADFG            | \$250.6                     | \$126.4                  | Report being revised.  | Estimated losses to adult populations from oil damages to early life stages at 2 to 3 million in 1990, and 40 to 70 thousand in 1991. Projected losses of 100 to 200 thousand adults in 1993 and 1994.   |

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|------------|-----------------------------------|-----------------|-----------------------------|--------------------------|------------------------|--|
| FS030      | Database Management               | ADFG            | \$202.5                     | \$151.1                  | Final report accepted. | Software was written to provide access to fish harvest database using the ADFG commercial fisheries Wide-Area Network (WAN). Procedures were implemented to provide reports in numerous database, spreadsheet, and statistical formats. Documentation and guidelines for using the harvest database were completed. WAN capability is now available between Juneau, Cordova, Anchorage, Kodiak, Soldotna, and Homer. See DiCostanzo, C. and B.P. Simonson. 1993. Database Management. Final Report, State/Federal Natural Resource Damage Assessment. 14 pp. |
| MM001      | Humpback Whales Damage Assessment | NOAA            | \$17.3                      | \$13.6                   | Report being revised.  | No documented injury.  |
| MM002      | Killer Whales Damage Assessment   | NOAA            | \$33.3                      | \$23.9                   | Final report accepted. | Whales missing from AB and AT pods. A total of 14 AB pod members lost from 1988-1990 due to unknown causes.  |

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|------------|------------------------------|-----------------|-----------------------------|--------------------------|--|---|
| MM006      | Sea Otters Damage Assessment | DOI             | \$199.7                     | \$199.7                  | The results of this project will be reported in 17 documents. Six final reports have been accepted. All other reports are being revised. | Direct mortality was probably on the order of 4000 sea otters, and the majority of the mortality probably occurred within Prince William Sound. In late 1991, patterns of mortality, as reflected in a relatively high number of prime-age carcasses, were abnormal compared to prespill patterns. Surveys showed no increase in abundance, and juvenile survival was low in oiled areas of western Prince William Sound. Preliminary data from 1992-1993 indicate some improvement in survival of juvenile and middle-aged sea otters. |
| ST001      | Subtidal Sediments           | NOAA            | \$103.5                     | \$96.5                   | Report being drafted.  | Subtidal sediments have been found to be contaminated at no fewer than 15 sites within Prince William Sound by June 1990. Contamination had reached at least 20 meters at some sites. Evidence of hydrocarbon movement downslope into subtidal sediments was detected by 1991.  |

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|------------|--------------------|-----------------|-----------------------------|--------------------------|-----------------------------|---|
| ST001      | Subtidal Microbial | ADEC            | \$17.1                      | \$3.2                    | Final report accepted.      | The numbers and activity of oil-degrading microorganisms were measured in sediments periodically for two years after the oil spill. Populations of oil-degrading microorganisms were significantly higher in sediments collected at oiled sites relative to reference sites. This information is useful in establishing the extent of contamination of the oil with time and also provides evidence that biodegradation is occurring naturally in Prince William Sound. |
| ST002      | Shallow Benthic    | ADFG            | \$109.8                     | \$68.9                   | Final report being revised. | At oiled sites there was a decrease in some subtidal organisms relative to unoiled sites. Partial recovery observed in 1991.  |
| ST002      | Deep Water Benthic | ADFG            | \$44.9                      | \$54.0                   | Report being revised.       | Analyses of 1990 data collected approximately 16 months after the oil spill indicate that the deep benthic environment within the spill region appeared healthy. It appears that movement of water within the region of the oil trajectory was sufficient to flush out toxic fractions, resulting in minimal damage to life at depths of 40 to >100 meters.   |

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|------------|-------------------------------------|-----------------|-----------------------------|--------------------------|-------------------------------|---|
| ST003      | Caged Mussels Damage Assessment     | NOAA            | \$39.1                      | \$24.2                   | Report being revised.         | Mussels transplanted along spill trajectory accumulated particulated oil at concentrations that decreased with depth, elapsed time, and distance from heavily oiled beaches. In 1990 and 1991, low concentrations of polynuclear aromatic hydrocarbons were sporadically detected at locations adjacent to heavily oiled beaches. Petroleum hydrocarbons were detected only sporadically in mussels deployed in locations outside Prince William Sound in 1989. |
| ST003      | Sediment Traps Damage Assessment    | ADEC            | \$50.9                      | \$24.5                   | Report being drafted.         | The subtidal sediment trap study demonstrated that oiled particulated matter derived from oil-impacted beaches in Prince William Sound contaminated adjacent subtidal sediments. The study further showed that the transfer rate of oil from beach to subtidal sediment was highest the year following the spill, and declined steadily thereafter.   |
| ST004      | Fate and Toxicity Damage Assessment | NOAA            | \$52.6                      | \$55.1                   | Report returned for revision. | Results indicate that some toxicity was still associated in 1990 and 1991 with sediments from lower intertidal zones of heavily oiled sites. The fate of <i>Exxon Valdez</i> oil will include transformation of most constituents (through biodegradation and photooxidation) mainly into carbon dioxide and water, although some constituents may persist indefinitely.  |

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|------------|-----------------------------------|-----------------|-----------------------------|--------------------------|-----------------------------|--|
| ST005      | Shrimp                            | ADFG            | \$47.7                      | \$15.9                   | Final report accepted.      | Hydrocarbon analyses did not detect oil contamination with sampled spot shrimp. Shrimp collected in unoiled areas had more inflammatory gill lesions than did shrimp from the oiled area. These results indicate that oil contamination had little or no effect on spot shrimp.  |
| ST006      | Rockfish Damage Assessment        | ADFG            | \$16.6                      | \$17.3                   | Final report being revised. | Oil was determined to be the cause of death for a small number of demersal rockfish in Prince William Sound. Dead and dying rockfish were reported from the spill area. Of the five fish that were fresh enough to be necropsied, exposure to crude oil was found to be the cause of death. These results prompted additional testing for hydrocarbons in live fish. These tests showed at least 11 of 36 rockfish tested from oiled sites had been exposed to oil within 2 weeks prior to testing. None of the 13 fish from unoiled sites were exposed to oil. Subsequent studies showed some indications of sublethal injuries to rockfish from exposure to oil. |
| ST007      | Demersal Fishes Damage Assessment | NOAA            | \$60.4                      | \$55.1                   | Report being reviewed.      | Results show continuing exposure of several benthic fish species and pollock, suggesting continuing petroleum contamination of subtidal sediments, water and food in 1990 and 1991 at sites up to 400 miles from the spill origin.   |

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|------------|--|-----------------|-----------------------------|--------------------------|---|--|
| ST008      | Sediment Data Synthesis  | NOAA            | \$205.6                     | \$168.2                  | Report being drafted.<br>Project continued as<br>93053. | Analyzed several thousand environmental<br>samples, provided numerical correlations<br>directly related to oil, and assessed associations<br>of observed biological effects with concentrations<br>of <i>Exxon Valdez</i> oil. |
| TM003      | River Otter and Mink<br>Damage Assessment in<br>Prince William Sound | ADFG            | \$74.0                      | \$16.1                   | Report being revised.                                   | The results indicate that differences in home<br>range, habitat selection, and latrine site<br>abandonment, as well as changes in food habits,<br>occurred in river otters.  |
| TS001      | Hydrocarbon Analysis   | NOAA<br>DOI     | \$1,028.3                   | \$847.6                  | Report being reviewed.                                  | Coordinated the chemical analysis of all<br>samples collected by damage assessment studies<br>to develop a single set of analytical data<br>comparable across projects.  |
| TS003      | GIS Mapping and Analysis:<br>Damage Assessment                       | ADNR<br>DOI     | \$375.2                     | \$268.8                  | Completed. No report<br>necessary.                      | Provided mapping and database support for<br>damage assessment projects.   |

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|----------------------------|--|-----------------|-----------------------------|--------------------------|---|---|
| <b>General Restoration</b> |  |                 | <b>\$4,097.4</b>            | <b>\$3,077.2</b>         |   |   |
| R053                       | Kenai River Sockeye Salmon Restoration | ADFG            | \$674.2                     | \$434.6                  | Report being revised.   | Successful collection of baseline and fishery samples for genetic stock identification. Unsuccessful in choosing new adult inriver hydroacoustic equipment. Successful hydroacoustic enumeration of returning adult salmon in Upper Cook Inlet.   |
| R059                       | Genetic Stock Identification           | ADFG            | \$320.9                     | \$257.2                  | Report being revised.   | Genetic data were collected during 1992 from spawning populations contributing to mixed-stock harvests of sockeye salmon in Cook Inlet. These data can be used to estimate the presence of Kenai River stocks in mixed-stock areas of Upper Cook Inlet.   |
| R060A                      | Prince William Sound Pink Salmon       | ADFG            | \$1,479.7                   | \$1,204.3                | Final R60A report being revised. R60C report being drafted (combined with FS1). | The CWT program (R60A) helped reduce the commercial harvest on damaged pink salmon populations by providing fishery managers with timely inseason fishery stock composition estimates. The escapement project (R60B) provided improved pink salmon escapement information which was essential for the precise fisheries management required to protect damaged wild stocks. |

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|------------|---------------------------------------|-----------------|-----------------------------|--------------------------|--|---|
| R073       | Harbor Seals                          | ADFG            | \$25.0                      | \$2.5                    | No final report for R73. A final report for MM5 is being reviewed. | Harbor seals continue to use heavily oiled haulouts even when unoiled sites were available nearby. They were observed to give birth and care for their pups on these sites. The pelage of both pups and adults became oiled when they used these sites or contacted oil in the water. however, the pelage became cleaner with time if they did not continue to use oiled sites. Many carcasses recovered were either stillborn or died shortly after birth. Observations suggest that stress and/or toxic effects of oil resulted in abortions, premature births, and increased mortalities in heavily oiled areas. |
| R092       | GIS Mapping and Analysis: Restoration | ADNR<br>DOI     | \$125.5                     | \$105.4                  | Completed. No report necessary.                                    | Provided mapping and database support for restoration projects. Developed timber harvest database and land status and parcel maps for imminent threat parcels. Contributed to a 3-volume data dictionary produced for the Trustee Council by the Nature Conservancy.  |

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|------------|------------------|---------------------|-----------------------------|--------------------------|--|---|
| R103       | Oiled Mussels    | ADFG<br>NOAA<br>DOI | \$874.0                     | \$740.1                  | Report being revised.<br>Project continued as<br>93036.  | Identified 27 mussel beds with total petroleum hydrocarbons greater than 10,000 mg/g wet weight. Minimally intrusive site manipulation was conducted at three heavily oiled mussel beds. Black oystercatchers fed in oiled mussel beds. Chicks raised on oiled sites grew more slowly than chicks raised on unoiled sites. Differences in levels of blood haptoglobin and Interleukin-6 ir, which were previously found to be elevated in river otters inhabiting oiled compared to nonoiled areas in Prince William Sound, were not observed in Summer 1992. Additionally, river otters from oiled areas continued to regain body size from levels noted in 1990. This suggests that river otters may be recovering from chronic effects that were observed in 1990 and 1991. Consequently, no adverse effects in 1992 could be attributed to oiled mussel beds from areas where river otters were captured. |
| R104A      | Site Stewardship | ADNR<br>USFS        | \$159.2                     | \$114.1                  | Project is complete.<br>Report awaiting final<br>review. | Increased public knowledge of archaeological sites following the spill led to increased vandalism. A stewardship program to train local residents to protect cultural resources was developed. A site stewardship manual and field notebook were written.   |

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|------------|---|-----------------|-----------------------------|--------------------------|---|--|
| R105       | Instream Survey<br>Restoration Implementation<br>Planning | ADFG<br>USFS    | \$348.1                     | \$148.5                  | Final report in<br>preparation. USFS<br>transmitted report to<br>Chief Scientist. | Results of Cost:Benefit Study Implementation<br>has been integrated and design planning has<br>been completed. Awaiting construction funding.<br>Cost:Benefit analysis for improved barrier<br>bypass for Little Waterfall Creek on Afognak<br>Island is positive.   |
| R106       | Dolly Varden Restoration                                  | ADFG            | \$34.9                      | \$16.2                   | Final report being<br>revised.  | The nature and extent of injury to Dolly Varden<br>and cutthroat trout was documented in FS5.<br>The goal of R106 was to provide information for<br>developing a management plan to protect<br>impacted stocks, while allowing for continued<br>recreational fishing for sport anglers where<br>stocks could support fisheries. Sixty-one<br>streams were surveyed to provide this<br>information. |
| R113       | Red Lake Sockeye Salmon<br>Restoration                    | ADFG            | \$55.9                      | \$54.3                   | Report being reviewed.  | Red Lake does not need restoration effort but<br>Ayakulik does.  |

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|---------------------------|------------------------------------|-----------------|-----------------------------|--------------------------|----------------------------------|--|
| <b>Habitat Protection</b> |                                    |                 | <b>\$1,319.1</b>            | <b>\$1,027.7</b>         |                                  |  |
| B003                      | Murres Damage Assessment Closeout  | DOI             | \$75.7                      | \$75.7                   | Final report accepted.           | Numbers were reduced, nesting was delayed, and productivity rates were far below normal at major colonies within the spill trajectory. Reproductive success improved slightly in 1991.   |
| R015                      | Marbled Murrelet Restoration Study | DOI             | \$419.3                     | \$428.5                  | Annual progress report reviewed. | Using ground search techniques, 10 tree nests were found on Naked Island in 1991 and 1992. Nest trees were in stands of high volume and size class trees, and upland activity of murrelets throughout Prince William Sound was highest in such stands.   |
| R047                      | Stream Habitat Assessment          | ADFG            | \$399.6                     | \$323.9                  | Final report accepted.           | About 250 km of shoreline and 260 km <sup>2</sup> of uplands were surveyed for anadromous fish streams on private lands on Afognak Island, resulting in discovery of 167 anadromous streams totaling about 56 km. Stream habitat parameters and upper extents of anadromous distribution were documented, and streams were mapped by GPS. Kuwada, M. and K. Sundet. 1993. Stream Habitat Assessment Project: Afognak Island. Habitat and Restoration Division Technical Report No. 93-3, Exxon Valdez Restoration and Habitat Protection Planning. 104 pp. |

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|------------|---|-----------------|-----------------------------|--------------------------|-----------------------|---|
| R071       | Harlequin Duck Restoration and Monitoring | ADFG            | \$424.5                     | \$199.6                  | Report being revised. | Comparative harlequin data in eastern Prince William Sound for B11. 1991-1992 harlequin production in eastern Prince William Sound similar to prespill. Techniques devised to capture and track harlequins. Breeding stream parameters and nest sites described. Additional oiled mussel beds identified. |

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|--------------------------------|---------------------------|-----------------|-----------------------------|--------------------------|--|---|
| <b>Monitoring and Research</b> |                           |                 | <b>\$1,386.6</b>            | <b>\$985.4</b>           |  |   |
| R011                           | Murre Recovery Monitoring | DOI             | \$316.7                     | \$274.0                  | Report being revised.  | Numbers of murre breeding at major colonies within the trajectory remained lower in 1992. Breeding chronology was delayed. Productivity at the Barren Islands was higher than in other postspill years, but still lower than normal. Productivity at Puale Bay was normal.  |
| R060C                          | Pink Salmon Egg/Fry       | ADFG<br>NOAA    | \$492.8                     | \$352.9                  | Report being revised. Project continued as 93003. Expected to be continued into 1994 and 1995. | Oil exposures completed for 1992 and 1993 brood years. Persistence of elevated mortalities among embryos in oiled streams versus those in nonoiled streams suggests genetic damage. Spawning of surviving adults is scheduled for September 1994 with possible long-term genetic damage and survival of progeny to be determined in early 1995. |

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|------------|--|-----------------|-----------------------------|--------------------------|--|--|
| R090       | Dolly Varden Char<br>Monitoring                  | ADFG            | \$91.5                      | \$34.2                   | Report being revised<br>(combined with FS5). | Two populations of Dolly Varden and cutthroat trout emigrated from lakes into the wake of the spill. Growth from 1989-1990 was 24% and 22% slower for recaptured subadult and adult Dolly Varden and 36% to 43% slower for subadult and adult populations of cutthroat trout in populations associated with the oil. This difference persisted through 1991 for cutthroat trout but not for Dolly Varden. Chronic starvation and direct exposure to petrogenic hydrocarbons were hypothesized as effects leading to reduced growth and accelerated mortality of both Dolly Varden and cutthroat trout. |
| R102       | Herring Bay Experimental<br>and Monitoring Study | ADFG            | \$485.6                     | \$324.3                  | Report being revised.                        | Cover of the dominant intertidal alga, <i>Fucus gardneri</i> , was reduced at oiled/cleaned sites. <i>Fucus</i> recruitment was poor in the mid- to upper intertidal, probably due to lack of shelter from desiccation and heating by adult plants. Limpet densities continued to be lower in the upper intertidal. Recovery appeared to be occurring in the lower intertidal zone in 1990-1991 and in the upper intertidal in 1993. Results have been incorporated into an interaction web to elucidate potential oil spill effects on community dynamics.  |

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|------------|--------------|-----------------|-----------------------------|--------------------------|---------------|-------------------------------|
|            | 1992 Total   |                 | \$19,211.0                  | \$13,889.6               |               |                               |

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**Status Report: 1993 Exxon Valdez Oil Spill Restoration Projects**  
(for the 7 month period March 1, 1993 - September 30, 1993)

**DRAFT**

| <u>No.</u>            | <u>Title</u>                        | <u>Agencies</u> | <u>Amount<br/>Budgeted*</u> | <u>Amount<br/>Spent*</u> | <u>Status</u> | <u>Results and References</u> |
|-----------------------|-------------------------------------|-----------------|-----------------------------|--------------------------|---------------|-------------------------------|
| <b>Administration</b> |                                     |                 | <b>\$4,135.8</b>            | <b>\$2,792.3</b>         |               |                               |
| 93AD                  | Administrative<br>Director's Office |                 | \$1,702.2                   | \$1,268.9                | Ongoing.      | Not applicable.               |
| 93FC                  | Financial Committee                 |                 | \$105.2                     | \$52.6                   | Ongoing.      | Not applicable.               |
| 93RT                  | Restoration Team<br>Support         |                 | \$2,328.4                   | \$1,470.8                | Ongoing.      | Not applicable.               |

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| <u>No.</u>               | <u>Title</u>                  | <u>Agencies</u> | <u>Amount<br/>Budgeted*</u> | <u>Amount<br/>Spent*</u> | <u>Status</u>  | <u>Results and References</u>   |
|--------------------------|-------------------------------|-----------------|-----------------------------|--------------------------|--|---|
| <b>Damage Assessment</b> |                               |                 | <b>\$782.1</b>              | <b>\$699.2</b>           |  |   |
| 93002                    | Sockeye Salmon Overescapement | ADFG            | \$714.6                     | \$637.1                  | 1993 field data collection completed. Laboratory analysis approximately 50% completed. Final 1993 progress report will be submitted in March 1994. | 1993 Kenai smolt demonstrated continued high overwintering mortality with less than 500,000 smolt estimated to migrate, while Tustumena Lake produced approximately 9 million smolt. Red and Akalura lakes demonstrated poor smolt production on Kodiak Island. Fall 1992 Tustumena and Skilak Lake dry fat content support poor nutrition going into winter as probable cause of mortality in Skilak Lake. Adult 1992 returns to the Kenai River were consistent with smolt estimates. However, primary age class of the 1989 brood year will return in 1994 and will determine accuracy of smolt estimates. (Recent |
| 93057                    | Damage Assessment GIS         | ADNR            | \$67.5                      | \$62.1                   | Completed. No report necessary.  | Provided mapping and database support for damage assessment studies. Cataloged and plotted over 160 maps for public access at OSPIC.  |

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|----------------------------|---|---------------------|-----------------------------|--------------------------|---|--|
| <b>General Restoration</b> |   |                     | <b>\$3,927.7</b>            | <b>\$1,706.8</b>         |   |  |
| 93006                      | Site Specific<br>Archaeological<br>Restoration                | DOI<br>ADNR<br>USFS | \$260.1                     | \$100.9                  | Fieldwork is complete.<br>Report is under preparation<br>and expected to be<br>submitted 1/15/94. | Not available.   |
| 93015                      | Kenai River Sockeye<br>Salmon Restoration                     | ADFG                | \$512.6                     | \$402.3                  | Draft report due 3/31/94.   | Successful collection of baseline and fishery<br>genetic samples. Successful inseason<br>hydroacoustic survey of Upper Cook Inlet<br>by subcontractor.   |
| 93016                      | Chenega Bay Chinook<br>and Silver Salmon<br>(NEPA Compliance) | ADFG                | \$10.7                      | \$10.7                   | Final document due to lead<br>federal agency (NOAA) on<br>1/14/94.                                | Not applicable.  |
| 93017                      | Subsistence Food Safety<br>Survey and Testing                 | ADFG<br>NOAA        | \$307.1                     | \$243.2                  | Analysis of samples<br>collected is ongoing.  | First round of tests for hydrocarbon<br>contamination of subsistence resources<br>showed little or no contamination. Results<br>of second round of testing are pending. The<br>observations of abnormalities in the tested<br>resources caused a shift in concerns of<br>subsistence users from oil contamination to<br>what effects these abnormalities have on<br>these resources. |
| 93024                      | Restoration of Coghill<br>Lake Sockeye Salmon<br>Stock        | ADFG<br>USFS        | \$191.9                     | \$143.1                  | Lake fertilization completed<br>for 1993 season. Lake<br>morphology completed.                    | Monitoring showed the need for modifying<br>both the type and concentrations of<br>fertilizer.   |

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|------------|--|---|-----------------------------|--------------------------|--|---|
| 93032      | Cold Creek Pink Salmon Restoration (NEPA Compliance) | ADFG  | \$5.0                       | \$0.0                    | Final report accepted.   | Cost:benefit analysis showed project to be marginal.  |
| 93038      | Shoreline Assessment                                 | ADEC<br>ADNR<br>ADFG<br>NOAA<br>USFS<br>DOI | \$539.2                     | \$353.0                  | Report being drafted. Results presented to the Trustee Council 11/30/93.                 | Surface oil has become stable. Subsurface oil has decreased substantially since 1991. Oiling is discontinued throughout the study site.   |
| 93062      | Restoration GIS                                      | ADNR  | \$123.3                     | \$122.1                  | Completed. No report necessary.  | Provided technical mapping and database support for restoration projects. Generated spill area map and land status maps for Kachemak Bay, Seal Bay, and Eyak lands.   |
| 93063      | Anadromous Stream Surveys                            | ADFG<br>USFS                                | \$59.4                      | \$59.0                   | Report for R105 is being revised.  | This project was funded only for retrieving stream thermometers and completion of report for R105, not for field work. See R105 status report.  |
| 93065      | Prince William Sound Recreation                      | ADNR<br>USFS                                | \$72.0                      | \$40.8                   | Continued as 94217. Analysis of findings and final report being drafted.                 | Recreation Injury Statement (10/93) was incorporated into the Draft Restoration Plan. Recreation restoration projects for Prince William Sound were prioritized through a public consensus process; high priority projects were included in the Draft 1994 Work Plan. |
| 93066      | Alutiiq Archeological Repository                     | ADEC  | \$1,500.0                   | \$0.0                    | About to issue grant to Kodiak Area Native Association for construction of the facility. | Facility expected to open in early 1995.  |

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|------------|--|-----------------|-----------------------------|--------------------------|------------------------|---|
| 93067      | Pink Salmon Coded<br>Wire Tag Recovery     | ADFG            | \$220.0                     | \$147.1                  | Report being reviewed. | Reduced commercial exploitation of damaged wild pink salmon populations through timely inseason estimates of hatchery and wild contributions to harvest. Accurate and timely stock composition estimates were used by fisheries managers to justify restriction of fishing fleet to areas where interception of damaged wild populations in mixed-stock fisheries could be minimized. |
| 93068      | Non-Pink Salmon Coded<br>Wire Tag Recovery | ADFG            | \$126.4                     | \$84.6                   | Report being drafted.  | Timely and accurate inseason estimates of hatchery and wild stock contributions to commercial harvest for improved management of wild stocks in mixed-stock fisheries.  |

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|---------------------------|---|-----------------|-----------------------------|--------------------------|--|---|
| <b>Habitat Protection</b> |   |                 | <b>\$39,732.2</b>           | <b>\$8,826.2</b>         |  |   |
| 93033                     | Harlequin Duck<br>Restoration               | ADFG            | \$300.0                     | \$193.0                  | Draft final report in<br>preparation. Completed<br>habitat evaluation<br>assistance. | Only 3 harlequin broods observed in<br>western Prince William Sound; 14 in<br>eastern Prince William Sound. Decreased<br>numbers of harlequins molting in western<br>Prince William Sound in July. Suspect<br>incomplete gonadal development in<br>prenesting western Prince William Sound<br>harlequins. Blood/physiological analysis<br>and hydrocarbon analyses in process.<br>Harlequin breeding stream/nest site model<br>in preparation. Harlequin breeding<br>assessment completed on North Afognak<br>Island. |
| 93034                     | Pigeon Guillemot<br>Recovery                | DOI             | \$165.8                     | \$134.4                  | Draft report in review.  | One hundred eighty-four colonies,<br>concentrated in southwest Prince William<br>Sound and in the Naked Islands were<br>identified. Guillemots continue to decline in<br>Prince William Sound from a high of<br>15,000 in 1970 to a present population of<br>3,000 - 4,900.   |
| 93035                     | Black Oystercatchers /<br>Oiled Mussel Beds | DOI             | \$107.9                     | \$51.0                   | Draft report in revision<br>prior to submission to<br>Chief Scientist.               | Growth rates of oystercatcher chicks were<br>lower on oiled than unoiled nest sites.<br>Some alphatic compounds were detected in<br>1992 fecal samples from oiled sites.<br>Breeding pairs increased on oiled Green<br>Island from 1992 to 1993 but decreased on<br>Knight Island from 1991 to 1993.  |

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|------------|---|---------------------|-----------------------------|--------------------------|---|---|
| 93051      | Stream Habitat Assessment and Habitat Information for Murrelets | ADFG<br>USFS<br>DOI | \$1,222.3                   | \$790.3                  | This is the second and final year of the project. It is a continuation of R47. Draft report on habitat information for murrelets is in internal Fish and Wildlife Service review. First draft report on stream habitat assessment is being revised. | Late season surveys, sites at the heads of bays, low elevations, high percentages of forest cover, and large trees were all consistent predictors of high murrelet activity. Radar performed better than humans in detecting murrelets and was cheaper than boat-based or ground-based surveys by humans. About 995 km of shoreline and 117 km <sup>2</sup> of uplands were surveyed for anadromous fish streams on private lands on the lower Kenai Peninsula and in Prince William Sound, resulting in discovery of 186 anadromous streams totaling about 57 km. Stream habitat parameters were collected along all |
| 93059      | Habitat Identification Workshop                                 | USFS                | \$42.3                      | \$23.1                   | Final report accepted.  | Identified parcels of nonpublic land containing critical habitat necessary for the recovery of injured resources and services.  |
| 93060      | Accelerated Data Acquisition                                    | USFS                | \$43.9                      | \$43.9                   | Project completed. Data collected.  | Collected and organized existing resource data needed for the analysis of private lands in the oil spill area.  |

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| <u>No.</u> | <u>Title</u>                       | <u>Agencies</u>      | <u>Amount<br/>Budgeted*</u> | <u>Amount<br/>Spent*</u> | <u>Status</u>   | <u>Results and References</u>   |
|------------|------------------------------------|----------------------|-----------------------------|--------------------------|---|---|
| 93064      | Imminent Threat Habitat Protection | ADNR<br>ADEC<br>USFS | \$37,850.0                  | \$7,590.5                | Completed. The Comprehensive Habitat Protection process was reviewed at a workshop; recommendations were incorporated into the process. | Imminent Threat Evaluation and the first round of Large Parcel Evaluation were completed. \$7.5 million from settlement funds were combined with \$14.5 million from other sources for the purchase of private inholdings in Kachemak Bay. \$29,950,000 was committed from the most recent court request for the initial payment for purchase of private land near Seal Bay on Afognak Island. The total purchase price of this transaction is \$38,700,000 with the balance to be paid in three annual installments. References: "Opportunities for Habitat Protection/Acquisition" (2/16/93) and "Comprehensive Habitat |

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|--------------------------------|--|-----------------|-----------------------------|--------------------------|---|---|
| <b>Monitoring and Research</b> |  |                 | <b>\$4,335.2</b>            | <b>\$3,666.5</b>         |   |   |
| 93003                          | Salmon Egg to<br>Pre-emergent Fry<br>Survival                    | ADFG<br>NOAA    | \$686.0                     | \$686.2                  | Report being revised.<br>Continuation of R60C.<br>Expected to continue into<br>1994 and 1995. | Oil exposures completed for 1992 and 1993<br>brood years. Spawning of surviving adults<br>is scheduled for September 1994 with<br>possible long-term damage to genetics and<br>survival of progeny to be determined in<br>early 1995. Persistence of elevated embryo<br>mortalities in oiled streams in 1992<br>indicate possible genetic damage to wild<br>pink salmon populations from the <i>Exxon<br/>Valdez</i> oil spill. Preliminary laboratory<br>studies support the genetic hypothesis.<br>Additional laboratory studies demonstrate<br>dose response of pink salmon embryos<br>when incubated in gravel exposed to crude<br>oil from the <i>Exxon Valdez</i> . |
| 93012                          | Genetic Stock<br>Identification of Kenai<br>River Sockeye Salmon | ADFG            | \$300.6                     | \$292.6                  | Report being drafted.   | Genetic data were collected during 1992 and<br>1993 from spawning populations<br>contributing to mixed-stock harvest of<br>sockeye salmon in Cook Inlet. These data<br>were used in a pilot study to estimate the<br>component of Kenai River stocks harvested<br>in mixed-stock areas of Upper Cook Inlet.   |
| 93022                          | Monitor Murre Colony<br>Recovery                                 | DOI             | \$177.2                     | \$135.7                  | Project report in<br>preparation.   | Murre productivity in the Barren Islands<br>was 0.4 - 0.6 chicks per nest site in 1993,<br>up from near zero in 1989. Population<br>counts on plots were similar to or higher<br>than in previous postspill years.  |

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|------------|---|-----------------|-----------------------------|--------------------------|--|--|
| 93036      | Oiled Mussel Beds                             | DOI<br>NOAA     | \$404.8                     | \$389.1                  | Report in preparation.<br>Continuation of R103.  | Identified 27 mussel beds with total petroleum hydrocarbons greater than 10,000 mg/g wet weight. Minimally intrusive site manipulation was conducted at three heavily oiled mussel beds.   |
| 93039      | Herring Bay<br>Experimental and<br>Monitoring | ADFG            | \$507.5                     | \$504.6                  | Draft report due by end of February 1994.  | Recovery patterns and rates continued to be monitored and studied experimentally. Recruitment and growth rates of organisms at oiled and unoled sites were studied relative to currents to test the hypothesis that oil tended to ground on the most productive coastal locations.   |
| 93041      | Comprehensive<br>Monitoring                   | NOAA            | \$237.9                     | \$0.0                    | Request for proposals withheld by Trustee Council.   | Not applicable.  |
| 93042      | Killer Whale Recovery                         | NOAA            | \$127.1                     | \$113.3                  | Report being drafted.  | AB pod number has increased by one (a calf) to a total of 26. The 14 missing pod members were not present in 1993.   |
| 93043      | Sea Otter Demographics<br>and Habitat         | DOI             | \$291.9                     | \$79.3                   | Field work and data collected complete; data analysis and report writing ongoing. Reports will be completed 3/1/94. Habitat component dropped. | Aerial survey of sea otters in Prince William Sound completed Summer 1993; estimated abundance is approximately 18,000. Age distribution of sea otter carcasses recovered in Spring 1993 in western Prince William Sound is similar to prespill distribution. Age- and sex-specific survival rates generated from carcass data for sea otters in Prince William Sound. |

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| <u>No.</u> | <u>Title</u>   | <u>Agencies</u> | <u>Amount<br/>Budgeted*</u> | <u>Amount<br/>Spent*</u> | <u>Status</u>  | <u>Results and References</u>  |
|------------|--|-----------------|-----------------------------|--------------------------|--|--|
| 93045      | Marine Bird / Sea Otter Surveys  | DOI             | \$262.4                     | \$257.2                  | Draft report in internal Fish and Wildlife Service review. | Overall marine bird population estimates in Prince William Sound have not changed significantly since 1989, but were 41% lower than 1972-1973 estimates. Rates of increase of goldeneyes and surfbirds were higher in the unoiled zone of Prince William Sound than in the oiled zone, whereas oystercatchers increased more rapidly in the oiled zone.  |
| 93046      | Habitat Use, Behavior, and Monitoring of Harbor Seals in PWS (NEPA Compliance) | ADFG            | \$233.5                     | \$215.3                  | Progress report has been completed.                        | Counts of seals at 25 trend sites in Prince William Sound were similar during pupping and molting in 1992 and 1993. However, 1993 pupping counts were 23% lower than in 1989. Molting counts were similar to 1989 postspill counts, but 27% lower than 1988 counts. Sixteen seals satellite-tagged since 1992 indicate that seals in central Prince William Sound haul out and feed near the same sites with little movement to other areas. Feeding usually occurs in depths of 100-200 meters, with a maximum recorded dive depth of 404 meters. |

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|------------|----------------------|----------------------|-----------------------------|--------------------------|--|---|
| 93047      | Subtidal Monitoring  | ADEC<br>ADFG<br>NOAA | \$1,000.8                   | \$871.8                  | Draft final report on<br>1989-1991 and 1993 due on<br>6/30/94. | As a follow-up to previous studies from<br>1989-1991, the numbers and activity of<br>oil-degrading microorganisms were<br>measured in sediments collected in 1993.<br>Preliminary results suggest some<br>contamination remains in subtidal<br>sediments. However, generally very low<br>numbers and activities were found where<br>visible oil was present (e.g., subsurface<br>sediments, Northwest Bay). These results<br>support the hypothesis that populations of<br>oil-degrading microorganisms are good<br>indicators of the presence of biodegradable<br>(e.g., relatively "fresh") oil in Prince<br>William Sound. 1993 infaunal samples |
| 93053      | Hydrocarbon Database | NOAA                 | \$105.5                     | \$121.4                  | Report being drafted.<br>Continuation of ST8.                  | Analyzed several thousand environmental<br>samples, provided numerical correlations<br>directly related to oil, and assessed<br>associations of observed biological effects<br>with concentrations of <i>Exxon Valdez</i> oil.  |
| 1993 Total |                      |                      | \$52,913.0                  | \$17,691.0               |  |   |

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# Status Report: 1994 *Exxon Valdez* Oil Spill Restoration Projects **DRAFT**

(for the period October 1, 1993 - September 30, 1994)

| <u>No.</u>                 | <u>Title</u>                             | <u>Agency</u> | <u>Amount<br/>Budgeted</u> | <u>Amount<br/>Spent</u> | <u>NEPA<br/>Req'd.*</u> | <u>NEPA Status</u> | <u>Comments</u>   |
|----------------------------|--|---------------|----------------------------|-------------------------|-------------------------|--------------------|---|
| <b>Administration</b>      |  |               | <b>\$4,200.0</b>           |                         |                         |                    |   |
|                            | Administration                           |               | \$4,200.0                  |                         | N                       |                    |   |
| <b>General Restoration</b> |  |               | <b>\$5,415.0</b>           |                         |                         |                    |   |
| 94007                      | Site Specific Archaeological Restoration | ADNR          | \$599.5                    |                         | Y                       | EA Completed       | Combined with Project 94386 (Artifact Repositories - Planning and Design) to develop cost-effective plan for protection of injured resources on public lands while involving local communities in determination of appropriate strategy. Explore use of private organizations to implement. |
| 94041                      | Introduced Predator Removal from Islands | DOI           | \$84.0                     |                         | Y                       | EA Completed       | Reduction to two islands.   |

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\* Y=EA or EIS required; N=project anticipated to qualify for categorical exclusion.

**DRAFT**

| <u>No.</u> | <u>Title</u>   | <u>Agency</u> | <u>Amount<br/>Budgeted</u> | <u>Amount<br/>Spent</u> | <u>NEPA<br/>Req'd.*</u> | <u>NEPA Status</u> | <u>Comments</u>  |
|------------|--|---------------|----------------------------|-------------------------|-------------------------|--------------------|--|
| 94043      | Cutthroat and Dolly Habitat<br>Restoration In Prince William<br>Sound                            | USFS          | \$3.5                      |                         | Y                       | EA In Preparation  | NEPA compliance only. No<br>implementation prior to full NEPA<br>compliance. Combine with 94139<br>(Salmon Instream Habitat and<br>Stock Restoration) and eliminate<br>overlapping costs.  |
| 94090      | Mussel Bed Restoration and<br>Monitoring   | NOAA          | \$681.1                    |                         | Y                       | EA In Preparation  | No implementation prior to full<br>NEPA compliance. Coordinate<br>with Project 94266 (Shoreline<br>Assessment) for additional cost<br>savings.   |
| 94137      | Stock Identification of Chum,<br>Sockeye, Chinook, and Coho<br>Salmon in Prince William<br>Sound | ADFG          | \$261.6                    |                         | N                       |                    | Approved as final expenditure to<br>recoup previous Trustee Council<br>investment in this project. Will<br>only identify chum and sockeye.   |
| 94139      | Salmon Instream Habitat and<br>Stock Restoration   | USFS          | \$761.3                    |                         | Y                       | EA In Preparation  | No implementation prior to full<br>NEPA compliance. Combine with<br>Project 94043 (Cutthroat and Dolly<br>Restoration) and approve with two<br>years funding. Subject to NEPA<br>compliance (EAs) and review of<br>benefit:cost ratio. |

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| <u>No.</u> | <u>Title</u>   | <u>Agency</u> | <u>Amount<br/>Budgeted</u> | <u>Amount<br/>Spent</u> | <u>NEPA<br/>Req'd.*</u> | <u>NEPA Status</u> | <u>Comments</u>  |
|------------|--|---------------|----------------------------|-------------------------|-------------------------|--------------------|--|
| 94166      | Herring Spawn Deposition<br>and Reproductive Impairment              | ADFG          | \$466.3                    |                         | N                       |                    |  |
| 94184      | Coded Wire Tag Recoveries<br>from Pinks in Prince William<br>Sound   | ADFG          | \$47.8                     |                         | N                       |                    | Integrate with 94320 (PWS System<br>Investigation).  |
| 94185      | Coded Wire Tagging of Wild<br>Pinks for Stock Identification         | ADFG          | \$34.8                     |                         | N                       |                    | Funding is for completion of the<br>1993 report. Additional funding<br>will be integrated with 94320 (PWS<br>System Investigation).  |
| 94217      | Prince William Sound Area<br>Recreation Implementation               | USFS          | \$76.3                     |                         | N                       |                    | Funding is for completion of the<br>1993 report.   |
| 94244      | Harbor Seal and Sea Otter<br>Co-op Subsistence Harvest<br>Assistance | ADFG          | \$54.5                     |                         | N                       |                    | Recommend that Council staff work<br>with DCRA and subsistence users<br>to examine opportunities to fund<br>community-based implementation<br>of this project with criminal funds. |
| 94255      | Kenai River Sockeye Salmon<br>Restoration                            | ADFG          | \$406.1                    |                         | N                       |                    |  |

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|------------|--|---------------|----------------------------|-------------------------|-------------------------|--------------------|--|
| 94259      | Coghill Lake Sockeye<br>Salmon Restoration | ADFG          | \$324.1                    |                         | Y                       | EA Completed       | Coordinate with Project 94320<br>(PWS System Investigation) to<br>obtain project smolts.   |
| 94266      | Shoreline Assessment and Oil<br>Removal    | ADEC          | \$403.1                    |                         | Y                       | EA In Preparation  | No implementation prior to full<br>NEPA compliance. Project is<br>limited to beach rehabilitation in<br>PWS and site assessment on<br>Alaska Peninsula. Coordinate with<br>Project 94090 (Oiled Mussel Bed<br>Restoration) for additional cost<br>savings. |
| 94272      | Chenega Chinook Release<br>Program         | ADFG          | \$57.4                     |                         | Y                       | EA Completed       | Recommend that Council staff work<br>with DCRA and subsistence users<br>to examine opportunities to fund<br>community-based implementation<br>of this project with criminal funds.   |
| 94279      | Subsistence Food Safety<br>Testing         | ADFG          | \$379.2                    |                         | N                       |                    | Recommend that Council staff work<br>with DCRA and subsistence users<br>to examine opportunities to fund<br>community-based implementation<br>of this project with criminal funds.   |

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|---------------------------|---|---------------|----------------------------|-------------------------|-------------------------|--------------------|--|
| 94417                     | Waste Oil Disposal Facilities                       | ADEC          | \$232.2                    |                         | Y                       | EA In Preparation  | No implementation prior to full NEPA compliance. Approved with understanding that future operating and maintenance cost will be assumed by communities and a full report on the project results will be given to the Trustee Council before further funding. |
| 94423                     | Oil Spill Public Information Center (OSPIC)         |               | \$280.0                    |                         | N                       |                    |  |
| 94504                     | Genetic Stock Identification of Kenai River Sockeye | ADFG          | \$262.2                    |                         | N                       |                    | Closeout of a 1993 project.  |
| <b>Habitat Protection</b> |   |               | <b>\$2,245.1</b>           |                         |                         |                    |  |
| 94110                     | Habitat Protection - Data Acquisition and Support   | ADNR          | \$678.7                    |                         | N                       |                    | Approved in conjunction with development of a comprehensive habitat protection plan that covers the spill area and is linked to protection of key injured resources.   |

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|--------------------------------|--|---------------|----------------------------|-------------------------|-------------------------|--------------------|--|
| 94126                          | Habitat Protection and<br>Acquisition Fund         | ADNR          | \$1,160.3                  |                         | N                       |                    | Approved in conjunction with<br>development of a comprehensive<br>habitat protection strategy covering<br>the spill area, linked to protection<br>of injured resources. Negotiation<br>process, final fund allocation to be<br>worked out by Executive Director. |
| 94505                          | Information Needs for<br>Habitat Protection        | USFS          | \$406.1                    |                         | N                       |                    | Closeout of a 1993 project.  |
| <b>Monitoring and Research</b> |  |               | <b>\$12,076.4</b>          |                         |                         |                    |  |
| 94020                          | Black Oystercatcher<br>Interaction with Intertidal | DOI           | \$17.3                     |                         | N                       |                    | Funding is for completion of 1993<br>report. The need for additional<br>funding will be reviewed as part of<br>1995 Work Plan.   |
| 94039                          | Common Murre Population<br>Monitoring              | DOI           | \$227.2                    |                         | N                       |                    | Evaluate further study needs in 3 -<br>5 years.  |
| 94064                          | Harbor Seal Habitat Use and<br>Monitoring          | ADFG          | \$270.2                    |                         | N                       |                    |  |

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|------------|--|---------------|----------------------------|-------------------------|-------------------------|--------------------|--|
| 94066      | Harlequin Duck Recovery<br>Monitoring                                    | ADFG          | \$139.3                    |                         | N                       |                    | Deferred funding pending<br>completion of 1993 report and<br>synthesis of available information.<br>Review as part of the 1995 Work<br>Plan. Strongly urge federal and<br>state agencies consider further<br>restriction on sport hunting. |
| 94086      | Herring Bay Experimental<br>and Monitoring Studies                       | ADFG          | \$729.4                    |                         | N                       |                    | Approved contingent upon a revised<br>scope of work and budget focused<br>on intertidal resources.   |
| 94092      | Killer Whale Recovery<br>Monitoring                                      | NOAA          | \$33.7                     |                         | N                       |                    | Funding is for completion of the<br>1993 report. Addition funding will<br>be deferred until 1995.  |
| 94102      | Marbled Murrelet Prey and<br>Foraging Habitat in Prince<br>William Sound | DOI           | \$231.5                    |                         | N                       |                    | Approved contingent on integration<br>with Projects 94163 (Forage Fish)<br>and 94173 (Pigeon Guillemot) and<br>elimination of overlapping costs.   |
| 94159      | Marine Bird & Sea Otter<br>Boat Surveys                                  | DOI           | \$107.0                    |                         | N                       |                    | Spring survey approved.<br>Disapproved summer surveys<br>pending review of survey frequency<br>needs.  |

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|------------|--|---------------|----------------------------|-------------------------|-------------------------|--------------------|---|
| 94163      | Forage Fish Influence on<br>Recovery of Injured Species            | NOAA          | \$606.6                    |                         | N                       |                    | Integrate with Projects 94320 (PWS<br>System Investigation), 94102<br>(Murrelet Prey), and 94173 (Pigeon<br>Guillemot).   |
| 94165      | Herring Genetic Stock<br>Identification in Prince<br>William Sound | ADFG          | \$62.2                     |                         | N                       |                    | Approved contingent upon Chief<br>Scientist/peer review acceptance of<br>damage assessment studies.   |
| 94173      | Pigeon Guillemot Recovery<br>Monitoring                            | DOI           | \$201.1                    |                         | N                       |                    | Approved contingent on reduction<br>in scope and integration with<br>Projects 94163 (Forage Fish) and<br>94102 (Murrelet Prey) and<br>elimination of overlapping costs.   |
| 94191      | Oil Related Egg and Alevin<br>Mortalities                          | ADFG          | \$782.9                    |                         | N                       |                    |   |
| 94199      | Institute of Marine Science -<br>Seward Improvements               | ADFG          | \$50.0                     |                         | Y                       | EIS In Preparation | Approved up to \$50.0 for initial<br>work, including NEPA compliance.<br>Project funding level<br>recommendation to be developed by<br>Executive Director for further<br>consideration by Trustee Council.<br>Estimated cost of project is<br>\$24,984.0. |

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|------------|---|---------------|----------------------------|-------------------------|-------------------------|--------------------|--|
| 94246      | Sea Otter Recovery<br>Monitoring                | DOI           | \$207.4                    |                         | N                       |                    | Funding is for completion of the 1993 report. Deferred additional funding pending synthesis of existing data. Review for consideration as part of 1995 Work Plan. Disparity in boat and aerial survey results needs to be resolved.                            |
| 94258      | Sockeye Salmon<br>Overescapement                | ADFG          | \$854.9                    |                         | N                       |                    |  |
| 94285      | Subtidal Sediment Recovery<br>Monitoring        | NOAA          | \$629.2                    |                         | N                       |                    | Approved contingent upon Chief Scientist/peer review approval of reports from prior years.   |
| 94290      | Hydrocarbon Data Analysis<br>and Interpretation | NOAA          | \$130.2                    |                         | N                       |                    |  |
| 94320      | PWS System Investigation                        | ADFG          | \$6,350.0                  |                         | Y                       | EA Completed       | Approved conditionally (see Trustee Council minutes) and subject to successful integration of this project with Projects 94163, 94184, 94185, 94187, 94192, 94259, and those portions of Project 94421 that involve research. Consists of 19 related projects. |

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| <u>No.</u>                 | <u>Title</u>  | <u>Agency</u> | <u>Amount<br/>Budgeted</u> | <u>Amount<br/>Spent</u> | <u>NEPA<br/>Req'd.*</u> | <u>NEPA Status</u> | <u>Comments</u>  |
|----------------------------|---|---------------|----------------------------|-------------------------|-------------------------|--------------------|--|
| 94422                      | Environmental Impact<br>Statement for the Restoration<br>Plan | USFS          | \$343.4                    |                         | N                       |                    | Total project cost for FFY 94 and<br>FFY 95 is \$343.4. FFY 94 cost is<br>\$323.5. |
| 94425                      | Marine Mammal Book  | NOAA          | \$20.0                     |                         | N                       |                    | Will make publication more widely<br>available to the public.                      |
| 94506                      | Pigeon Guillemot Recovery                                     | DOI           | \$13.9                     |                         | N                       |                    | Closeout of a 1993 project.  |
| 94507                      | Symposium Proceedings<br>Publication                          | NOAA          | \$69.0                     |                         | N                       |                    |  |
| <b>Restoration Reserve</b> |   |               | <b>\$12,000.0</b>          |                         |                         |                    |  |
| 94424                      | Restoration Reserve   | DOL           | \$12,000.0                 |                         | N                       |                    | Will provide funding needed to<br>undertake long-term restoration<br>activities.   |
| <b>1994 Total</b>          |   |               | <b>\$35,936.5</b>          |                         |                         |                    |  |

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