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Restoration Framework Volume I - April, 1992

Restoration Plan Brochure - April, 1993

Supplement to Draft Restoration Plan
June, 1993

Summary of Public Comment on Alternatives
September, 1993

Walcoff Contract PDEIS
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November, 1993

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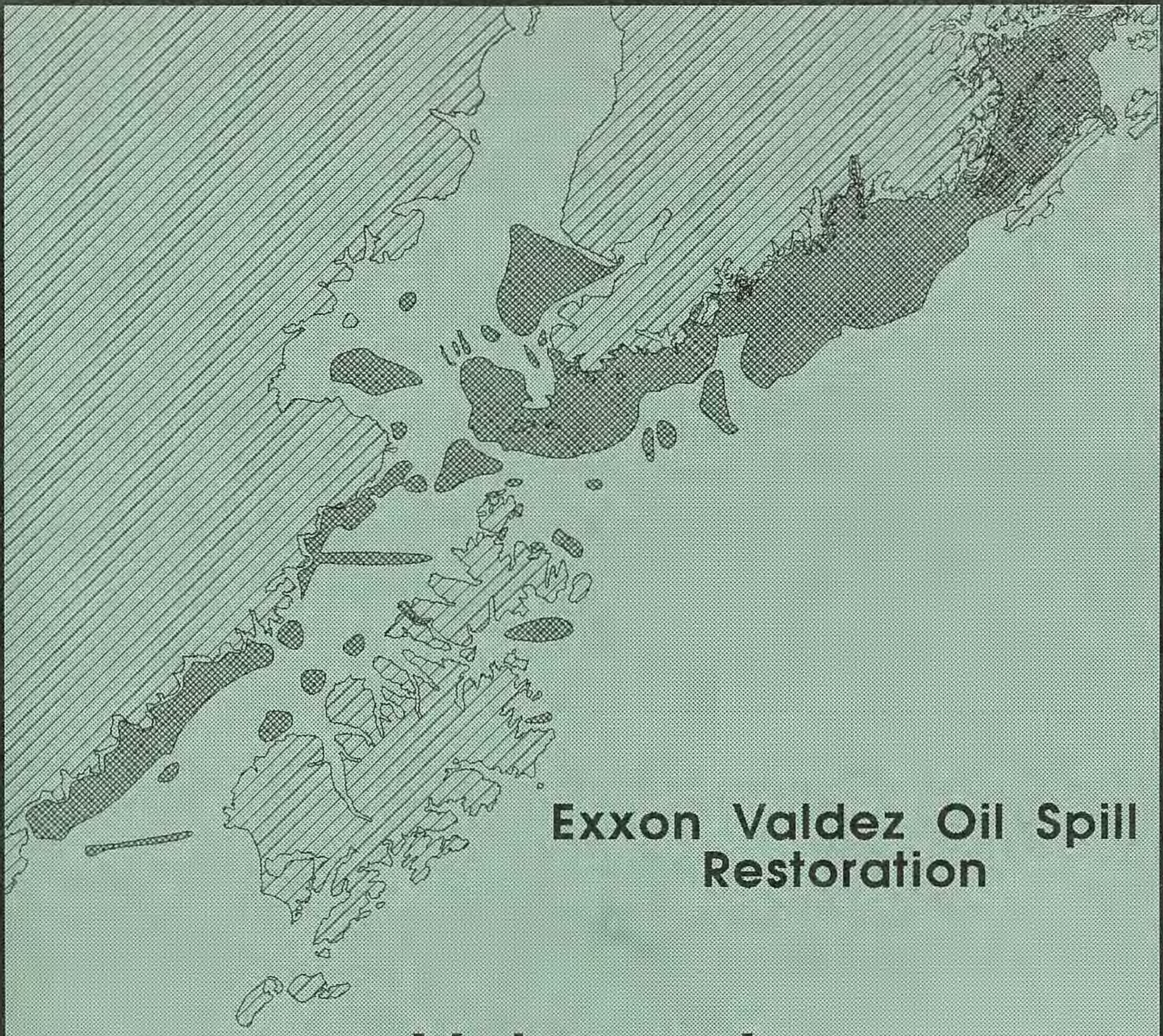

Exxon Valdez Oil Spill Restoration

Volume I
Restoration Framework

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

April 1992

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

April 1992

Dear Reviewer:

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

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

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

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

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

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

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

Sincerely,

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

Mike Barton

Charles E. Cole
Attorney General
State of Alaska

Curtis V. McVee
Special Assistant to the Secretary
Office of the Secretary
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Steven Pennoyer
Director
Alaska Region
National Marine Fisheries Service

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Carl L. Rosier
Commissioner
Alaska Department of Fish and Game

Carl L. Rosier

John A. Sandor
Commissioner
Alaska Department of Environmental Conservation

John A Sandor

COMMENTS

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

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

Additional Comments:

--(fold here)--

Return Address:

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Place
Stamp
Here

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

Attn: Restoration Framework

Restoration Framework
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EXECUTIVE SUMMARY

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

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

Post Settlement Administration (Chapter I)

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

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

Public Participation (Chapter II)

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

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

Restoration Planning Before the Settlement (Chapter III)

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

Summary of Injury (Chapter IV)

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

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

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

Restoration Alternatives and Options (Chapter VII)

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

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

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

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

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

Appendices A and B

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

CHAPTER I
INTRODUCTION

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

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

Proposed Action

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

Identification of Issues

The Trustees are addressing a number of issues as they develop the oil spill restoration program. Among the issues identified in the Restoration Framework are the following:

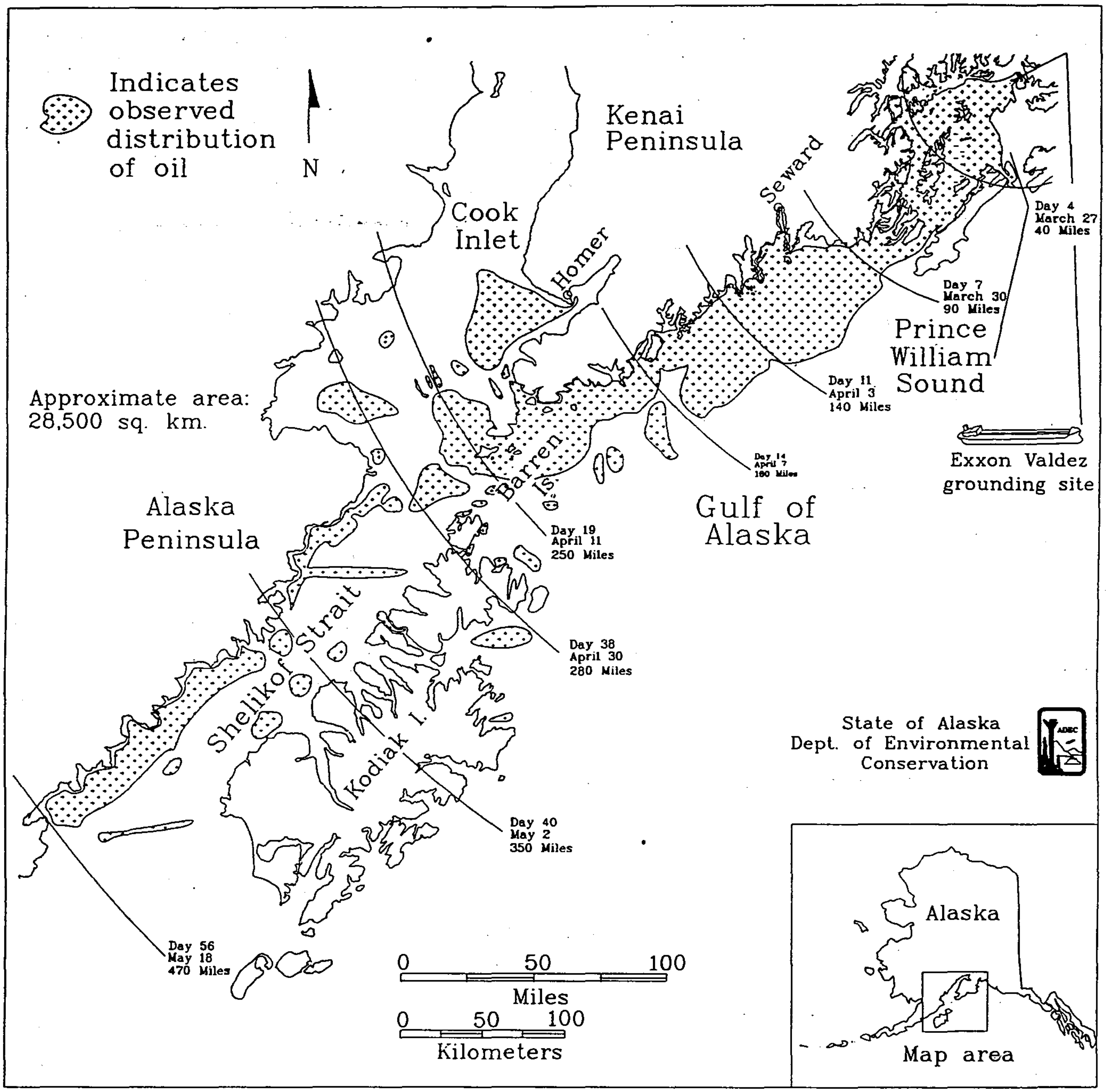
- establishing an administrative structure that enables the maximum amount of settlement funds to be spent on effective restoration (Chapter I);
- providing meaningful public involvement and establishing a public advisory group (Chapter II);
- determining when injuries are sufficient to warrant restoration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

Background

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

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

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



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

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

Summary of the Settlement

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

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

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

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

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

Criminal Plea Agreement

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

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

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

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

The Civil Settlement and Restoration Fund

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

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

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

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

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

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

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

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

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

MEMORANDUM OF AGREEMENT GUIDELINES

- all decisions shall be made by the unanimous agreement of the six Trustees;

- a joint trust fund will be established;

- within 90 days after the receipt of funds, the Trustees shall agree to an organizational structure for decision making;

- within 90 days after the receipt of funds, the Trustees shall establish procedures for meaningful public participation, which shall include a public advisory group;

- the Trustees "...shall jointly use all natural resource damage recoveries for purposes of restoring, replacing, enhancing, rehabilitating, or acquiring the equivalent of natural resources injured as a result of the Oil Spill and the reduced or lost services provided by such resources..." (except for the reimbursement of certain expenses to the governments); and

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

Organization

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

The State of Alaska Trustees are:

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

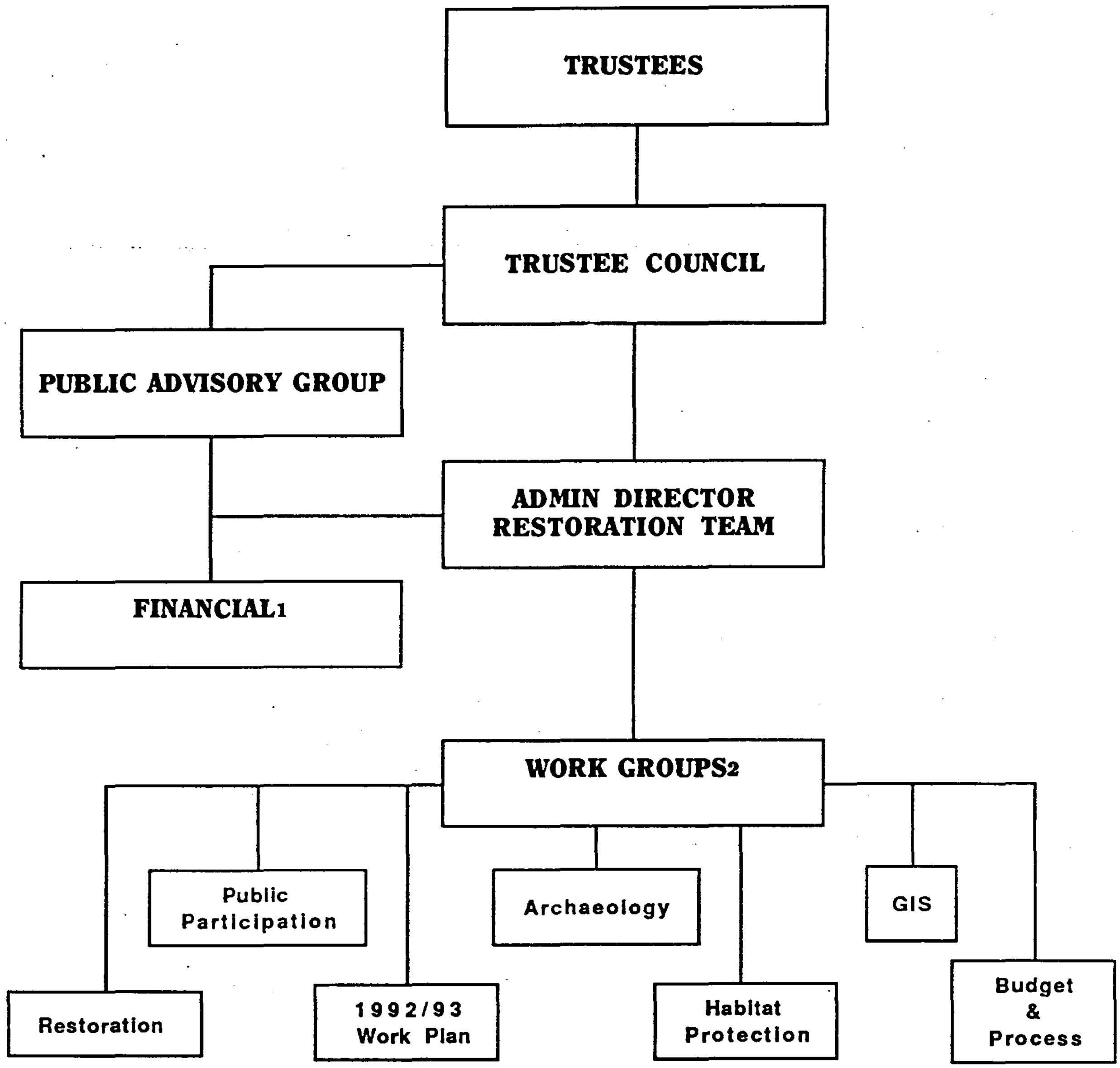
The Federal Trustees are:

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

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

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

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



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

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CHAPTER II
PUBLIC PARTICIPATION

Public Participation Plan

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

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

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

Goals and Objectives

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

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

Information Availability

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

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

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

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

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

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

Community Meetings

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

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

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

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

Public Advisory Group

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

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

Restoration Plan

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

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CHAPTER III
RESTORATION PLANNING TO DATE

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

Scoping Activities

Public Involvement

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

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

Technical Workshop

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

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

Issues and Concerns Identified

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

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

Peer Review

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

Review of Recovery Literature

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

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

Field Studies

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

Three types of studies were conducted:

- feasibility studies, to test the practicality and effectiveness of proposed direct restoration techniques;

- technical support studies, to provide biological or other information necessary to identify, evaluate or conduct potential restoration activities; and

- monitoring studies, to document the extent and rate of natural recovery of an injured resource.

RESULTS?

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

Habitat Protection

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

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

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

CHAPTER IV
SUMMARY OF INJURY

Introduction

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

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

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

Marine Mammals

<u>Introduction</u>

Following the spill, humpback whales, Steller sea lions, sea otters, harbor seals, and killer whales were studied. Field work on Steller sea lions and humpback whales was completed in 1990. Humpback whale studies included photo-identification of individual whales, estimations of reproductive success, and documentation of possible displacement of whales from their preferred habitat within Prince William Sound. Exposure of this species to oil was not observed, nor were tissues sampled and analyzed for hydrocarbons. The data do not indicate an effect of the spill on mortality or reproduction of humpback whales in Prince William Sound. However, in 1989 humpback whales were not seen in Lower Knight Island Passage, a preferred habitat.

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

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

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

<u>Sea Otters</u>

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

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

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

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

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

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

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

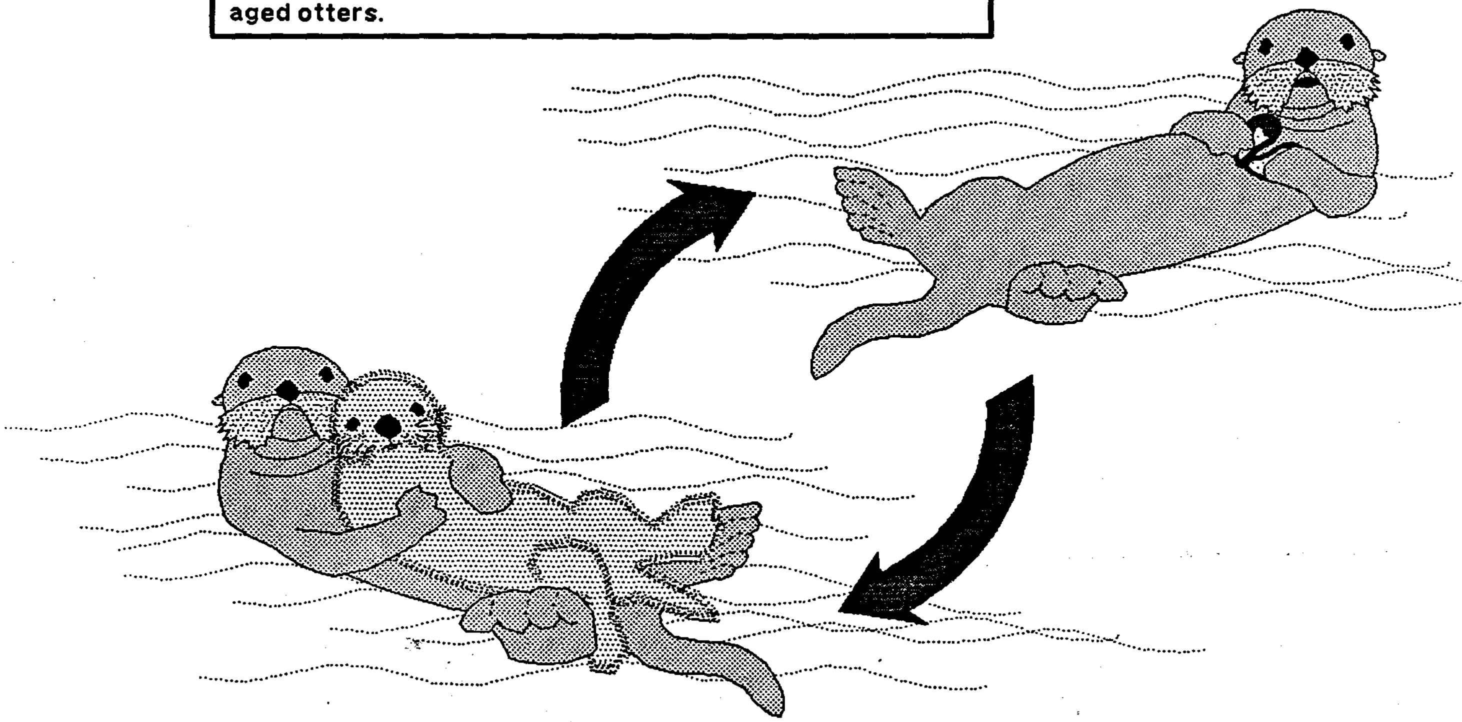
Figure 3. Summary of the major injuries in relation to the life history of sea otters.

Sea Otters

Adults

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

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



Pups

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

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

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

Harbor Seals

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

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

Killer Whales

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

The AB pod had 36 whales when last sighted before the spill in September 1988. When sighted on March 31, 1989, seven days after the spill, seven individuals were missing. Six additional whales were missing from the AB pod in 1990. Assuming that whales missing for two consecutive years are dead, the mortality rates for the AB pod were 19.4 percent in 1988-1989 and 20.7 percent in 1990-1991. The average annual mortality in AB pod from 1984 to 1988 was 6.1 percent. An additional whale was missing in 1991, but a calf also was born into the pod. The approximate calving interval of killer whales is four years. Accordingly, some long-term effects may not be obvious for many years.

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

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

Terrestrial Mammals

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

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

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

Mink and other small mammals living in coastal areas may feed in and spend part or all of their time in the intertidal zone. When mink are sick or injured, they are known to crawl into inaccessible burrows or the brush. For this reason the effect of the spill on mink populations could not be determined. Also, information on pre-spill populations of mink and other small mammals is minimal. To determine if mink reproduction may have been affected by oil in their diet, a laboratory exposure study of ranch-bred mink was conducted. The mink were fed food mixed with small, non-lethal amounts of weathered oil. No changes in reproductive rates or success resulted from this exposure. It was found, however, that oil-contaminated food moved through the intestines of the animals at a more rapid rate than did clean food, possibly providing less nutrition to the animals.

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

River Otters

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

Birds

Introduction

Birds were among the most conspicuous victims of the oil spill. Seabirds are particularly vulnerable to oil, as they spend much of their time on the sea surface while foraging. Oiled plumage insulates poorly and loses its buoyancy, and oiled birds often die from hypothermia or drowning. Birds surviving initial acute exposure to oil may ingest oil by preening. About 36,000 dead birds were recovered after the spill; at least 31,000 of these deaths were attributable to oil. In addition to the large number of murres, sea ducks and bald eagles recovered after the spill, carcasses of loons, cormorants, pigeon guillemots, grebes, murrelets and other species were also recovered. The recovered birds represent only a small proportion of the total number of birds killed by the spill. Many oiled birds undoubtedly floated out to sea and sank. Many oiled birds that were washed onto beaches may have been scavenged, hidden in masses of oil buried under sand and gravel by wave actions, decomposed or simply washed onto a beach that was not searched. In a number of cases carcasses found shortly after the spill were not turned in to receiving stations. The results of analyses using computer models that account for some of these variables suggest that the total number of birds killed by the spill ranged from 300,000 to 645,000, with the best approximation that between 375,000 and 435,000 birds. These estimates reflect only direct mortality occurring in the months immediately following the spill, and do not address chronic effects or loss of reproductive output.

Common and thick-billed Murres

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

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

These changes in numbers of birds and their behavior have caused complete reproductive failure in several of the large colonies during 1989, 1990 and 1991, and thus lost production of at least 300,000 chicks. There are some indications that normal breeding occurred in isolated areas of the Barren Island colonies in 1991, but it is uncertain when the whole colony will start to produce significant numbers of viable chicks. Murre colonies in unoiled areas displayed none of these injuries and had normal productivity in the years since the spill.

Bald Eagles

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

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

Sea Ducks

More than 2,000 sea duck carcasses were recovered after the spill, including more than 200 harlequin ducks. Studies concentrated on harlequins, goldeneyes, and scoters--species that use the intertidal and shallow subtidal habitats most heavily affected by the spill. All of these species feed on invertebrates, such as mussels, which in 1991 continued to show evidence of petroleum hydrocarbon contamination. Harlequin ducks, which feed in the shallowest water of all these species, were most affected. In 1989 and 1990 about 40 percent of the harlequin ducks sampled had tissues contaminated with petroleum hydrocarbons, and about 33 percent of the harlequins collected in the spill area had poor body condition and reduced body fat. The 1991 survey indicates harlequin population declines and a near total reproductive failure in oiled areas of Prince William Sound (Figure 4). Oil-contaminated mussel beds may be the source of this apparent continuing problem.

Other Birds

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

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

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

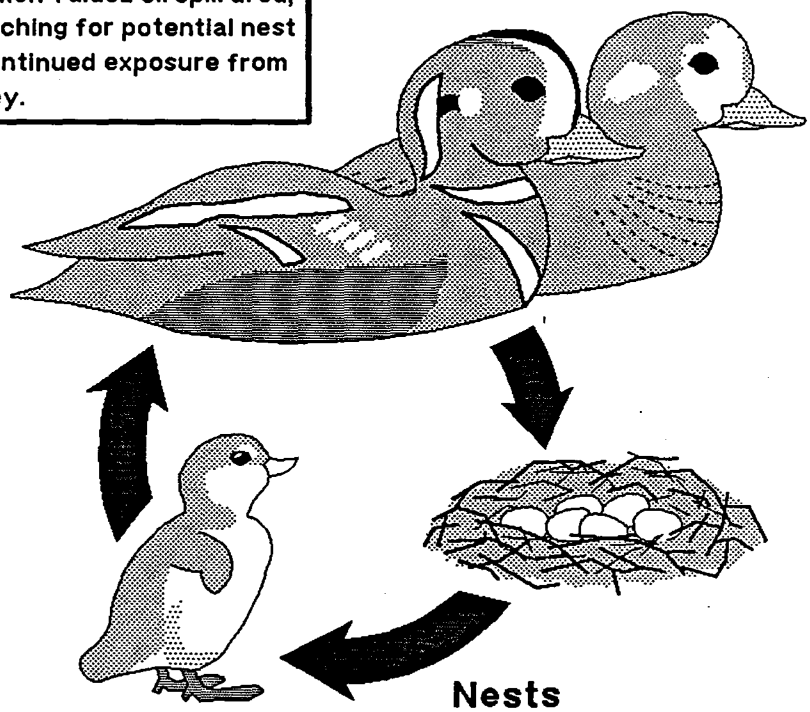
Figure 4. Summary of the major injuries in relation to the life history of harlequin ducks.

Harlequin Ducks

Adults

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

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



Broods

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

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

Nests

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

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

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

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

Fish and Shellfish

Introduction

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

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

The deaths of some rockfish, a deepwater species, also were attributed to oil. Several species of coastal and offshore fish, including pollock, halibut, sablefish, cod, yellowfin and flathead sole and rockfish, showed evidence of continuing exposure to petroleum hydrocarbons over a large geographic area, but significant injury has not been documented. Because salmon and other fish species can metabolize petroleum hydrocarbons, these contaminants are unlikely to concentrate in fish tissues. Indicators of exposure in fish include increased concentrations of hydrocarbon metabolites in bile and activities of mono-oxygenates in liver tissue.

Pink Salmon

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

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

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

Fry growth was decreased in oiled streams as compared to unoiled streams over the winter of 1989-1990 and larvae from some heavily oiled streams showed gross morphological abnormalities, including club fins and curved vertebral columns. The pink salmon that returned to Prince William Sound in the summer of 1990 were hatched prior to the spill and were exposed to oil as larvae. Although there is great uncertainty, some analyses suggest that the 1990 return of both wild and hatchery pink salmon was 20 to 25 percent lower than expected without the spill, resulting in a return of 15 to 25 million fewer fish. Fish that returned in 1991 were the first that were exposed to oil as eggs. The returns of wild salmon to oiled and unoiled streams in 1991 are still being analyzed.

Sockeye Salmon

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

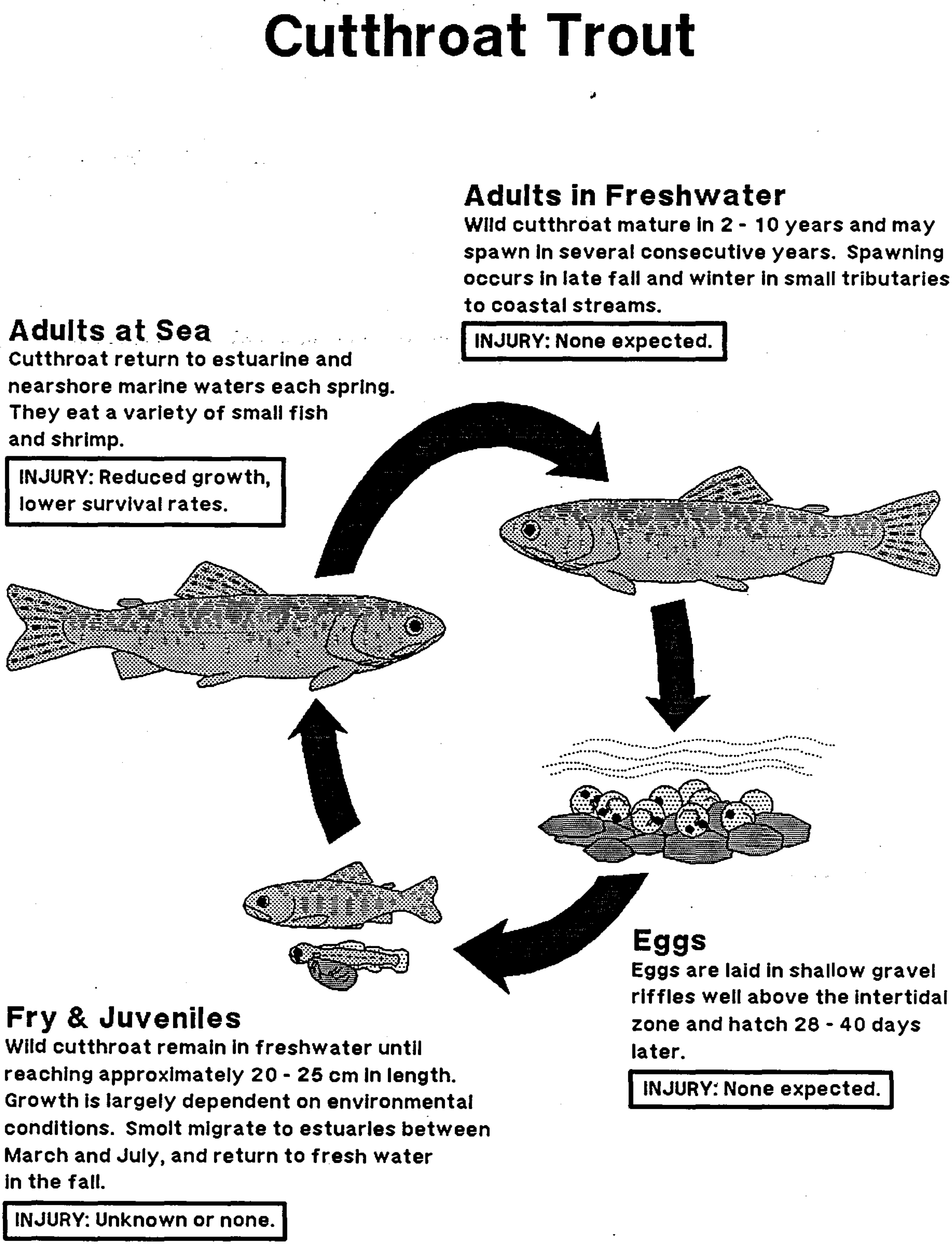
Dolly Varden and Cutthroat Trout

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

Pacific Herring

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

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



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

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

Rockfish and Other Fish

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

Coastal Habitat

Introduction

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

Supratidal

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

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

Intertidal

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

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

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

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

Subtidal Habitat

Between 1989 and 1991, oil concentrations declined in intertidal sediments sampled at most oiled locations, while the concentration in shallow subtidal sediments at depths of 3-20 meters remained about the same or in some cases, rose slightly. Petroleum hydrocarbon accumulation in filter-feeding mussels experimentally placed in the water column in various oiled areas was significant during the summer of 1989, but decreased in 1990. Patterns of sediment toxicity to marine amphipods and larval bivalve molluscs, used as test organisms, reflected similar patterns. In 1990 significant toxicity to these organisms was associated only with intertidal sediment samples from heavily oiled sites, but in 1991 toxicity was associated primarily with sediment samples from the shallow subtidal zone. The current evidence from analyses of petroleum hydrocarbons in the bile of bottom-dwelling fishes suggests that animals living on or near the sea floor continue to be exposed to petroleum hydrocarbons. In this connection the analysis of samples of bottom-dwelling organisms at the 100-m depth is continuing to see if there was a detectable effect of oil deep communities.

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

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

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

Other Resources and Services

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

Archaeological Resources

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

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

Subsistence

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

Recreation

Following the oil spill, recreational use of public lands and waters declined. Recreationists (e.g., sport fishermen, hunters, campers and sea kayakers) avoided oiled areas and many adjacent areas that were affected by clean-up activity. Many users canceled their plans or pursued their activities in other areas within the state. For example, visitor use in the coastal area of the Kenai Fjords National Park dropped by about 50 percent in 1989, compared to 1988. This disruption continued in 1990, because oil remained present in many areas and some clean-up activity continued. In 1991 oil remained in many areas used by recreationists.

Wilderness and Intrinsic Values

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

CHAPTER V
PROPOSED INJURY CRITERIA

Settlement Guidance

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

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

Proposed Criteria

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

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

The concepts underlying these criteria are described below.

Injury to Natural Resources

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

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

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

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

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

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

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

Injury to Natural Resource Services

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

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

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

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

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

Recovery Concept

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

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

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

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CHAPTER VI
EVALUATION OF RESTORATION OPTIONS

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

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

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

- Potential to improve the rate or degree of recovery:

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

- Technical feasibility:

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

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

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

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

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

- Cost effectiveness:

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

- Consistency with applicable Federal and State laws and policies:

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

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

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

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

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

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

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

- Importance of starting the project within the next year:

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

Further Evaluation of Restoration Options

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

Information Review and Evaluation

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

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

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

Evaluation of Options for Identifying and Protecting Marine and Upland Habitats

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

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

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

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

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

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

5. Incorporation of acquired property rights into public management.

<u>Recovery Monitoring</u>

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

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

CHAPTER VII
SCOPE OF POTENTIAL RESTORATION ALTERNATIVES

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

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

Possible Restoration Alternatives

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

A. No Action

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

B. Management of Human Uses

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

Examples:

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

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

C. Manipulation of Resources

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

Examples:

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

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

D. Habitat Protection and Acquisition

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

Examples:

- designate protected marine habitats (Option 22); and

- acquire additional marine bird habitats (Option 23).

E. Acquisition of Equivalent Resources.

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

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

Examples:

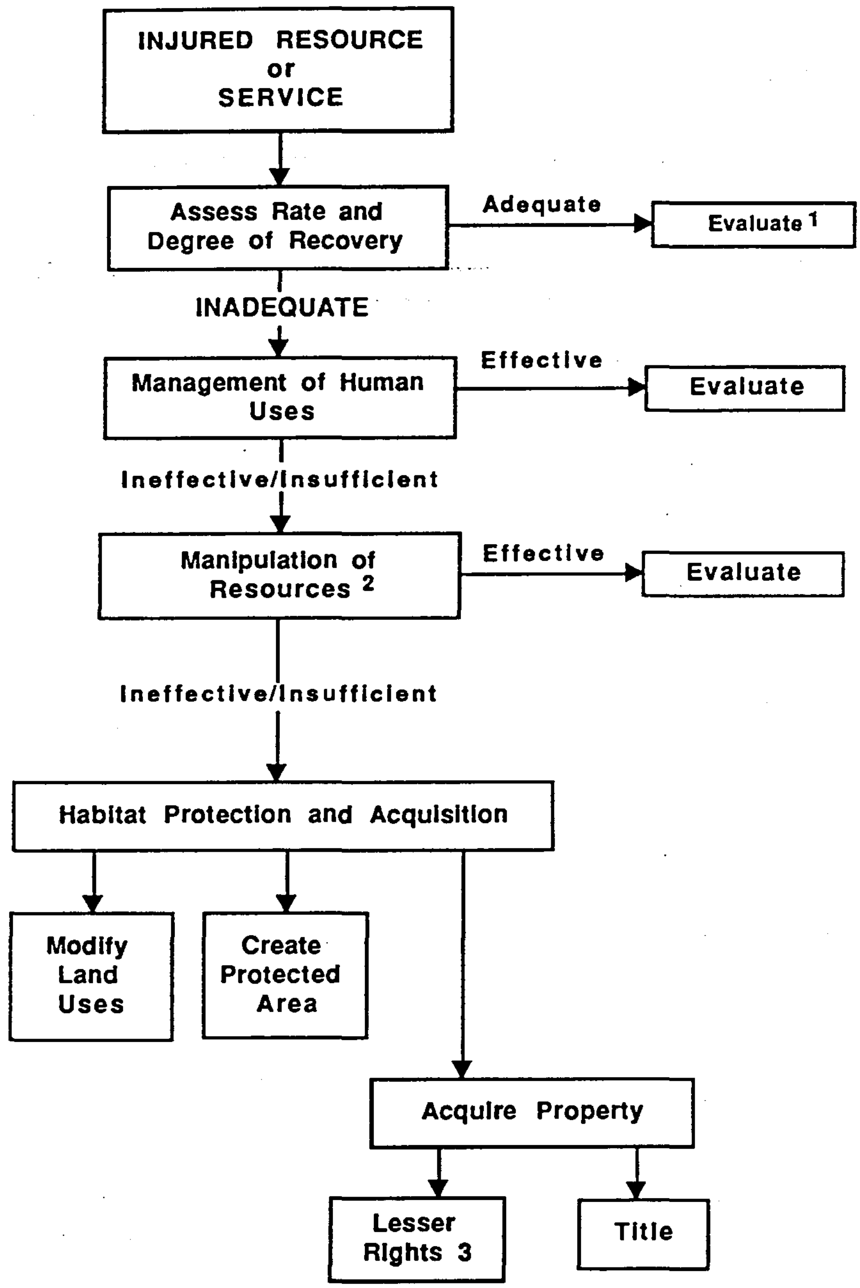
- creation of new recreation facilities (Option 12); and
- acquire tidelands (Option 21).

F. Combination Alternatives

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

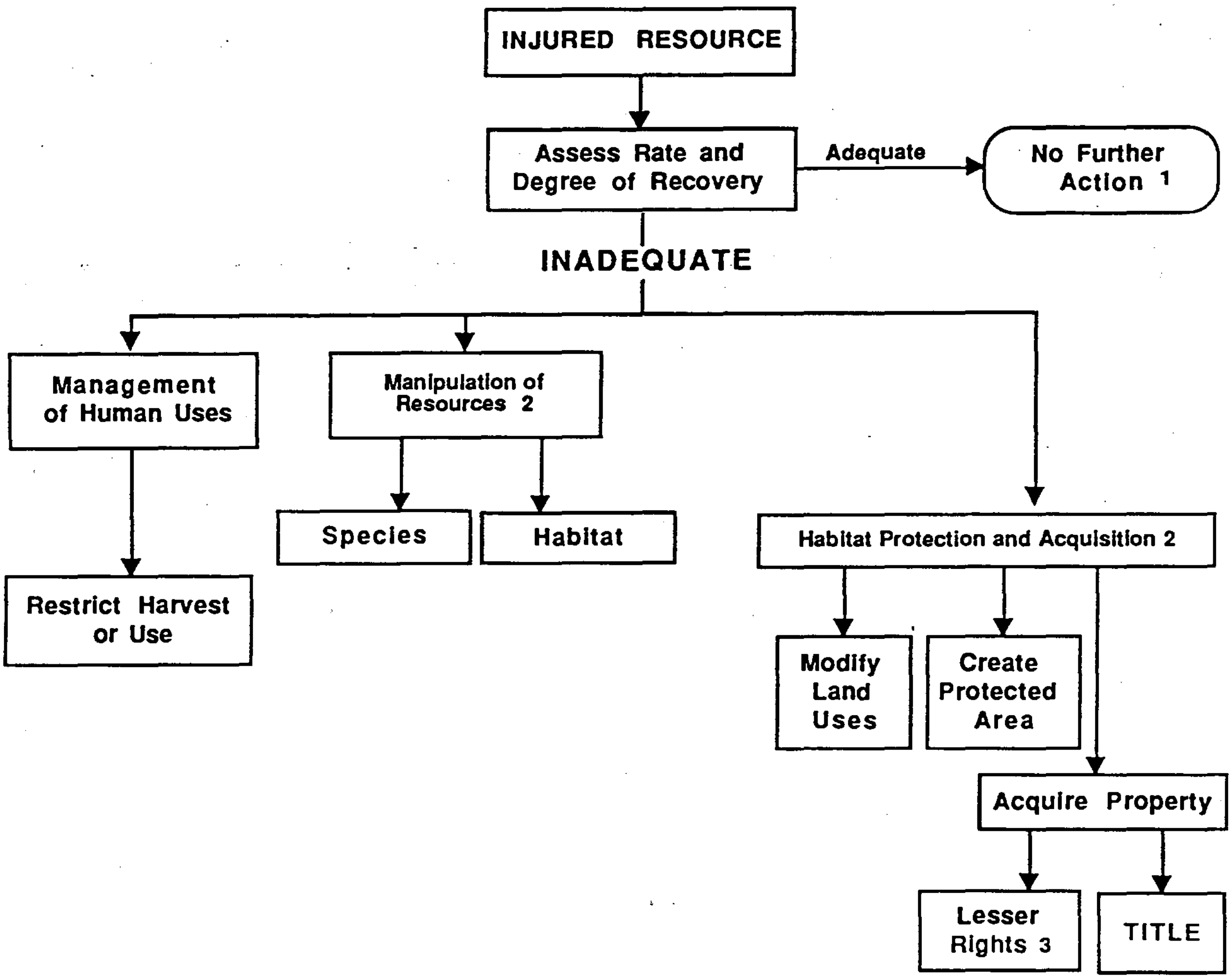
The Trustees seek comment about the likely feasibility and efficacy of these possible restoration alternatives, and any other alternatives and approaches that should be considered in a draft environmental impact statement.

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



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

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



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

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APPENDIX A

BACKGROUND ON INJURED RESOURCES AND SERVICES

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APPENDIX A
BACKGROUND ON INJURED RESOURCES AND SERVICES

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

Life History Summaries

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

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

Sea Otter *(Enhydra lutris)*

Range

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

Reproduction

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

Habitat Use and Requirements

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

Food Habits

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

Human Interactions

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

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Harbor Seal *(Phoca vitulina richardsi)*

Range

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

Reproduction

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

Habitat Use and Requirements

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

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

Food Web Interrelationships

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

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

Human Interactions

The Marine Mammal Protection Act of 1972 placed a moratorium on harvesting marine mammals, including harbor seals. An exemption for Alaska Natives allows take for subsistence. Harbor seals are harvested by numerous Alaska villages, but the magnitude of the subsistence harvest is not known. Conflicts with commercial fishermen, competition with humans for food, and disturbance from haul-out sites pose the greatest threats to harbor seals. Seals are especially vulnerable to disturbance during the molt and during pupping, when a separation may cause the mother-pup bond to weaken resulting in the death of the pup.

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Brown Bear (*Ursus arctos*)

Range

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

Reproduction

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

Habitat Use

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

Food Habits

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

Human Interactions

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

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River Otter (*Lutra canadensis*)

Range

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

Reproduction

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

Habitat Use

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

Food Habits

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

Human Interactions

River otters are trapped for their fur.

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Killer Whale *(Orcinus orca)*

Range

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

Reproduction

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

Social Structure and Habitat Use

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

Food Habits

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

Human Interactions

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

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Common Murre (*Uria aalge inornata*)

Range

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

Migration

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

Breeding Chronology

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

Breeding Behavior

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

Food Web Interrelationships

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

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

Human Interaction

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

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Harlequin Duck (*Histrionicus histrionicus*)

Range

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

Migration

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

Breeding Chronology

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

Habitat Use

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

Food Web Interrelationships

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

Human Interactions

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

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Black Oystercatcher *(Haematopus bachmani)*

Range

Inhabits coastal areas from the Aleutian Islands to Baja California.

Migration

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

Breeding Chronology

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

Habitat Use

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

Food Web Interrelationships

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

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

Human Interactions

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

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Marbled Murrelet (*Brachyramphus marmoratus*)

Range

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

Migration

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

Breeding Chronology

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

Habitat Use and Requirements

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

Food Web Interrelationships

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

Human Interactions

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

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Pigeon Guillemot (*Cepphus columba*)

Range

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

Migration

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

Breeding Chronology

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

Habitat Use and Requirements

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

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

Food Habits

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

Human Interactions

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

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Bald Eagle (*Haliaeetus leucocephalus*)

Range

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

Migration

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

Reproduction

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

Habitat Use

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

Food Habits

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

Human Interaction

A bounty for bald eagles was in effect in Alaska from 1917 to 1953. With statehood in 1959, bald eagles in Alaska received federal protection under the Bald Eagle Protection Act of 1940. This Act prohibits harming or harassment of eagles. Land management agencies have included additional restrictions on activity near nest sites which has further helped the stability of populations. For example, the Chugach National Forest currently requires a 330 feet buffer zone around any bald eagle nest tree, with an additional 330 feet of restricted activity; the U.S. Fish and Wildlife Service proposes extending restrictions to 990 feet from bald eagle nests.

References

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Coastal Cutthroat Trout (*Onchorhynchus clarki*)

Range

California to Prince William Sound, Alaska

Migration

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

Reproductive Period

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

Spawning/Hatching

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

Survival/Life Span

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

Habitat Use and Requirements

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

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

Food Web Interrelationships

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

Fry and Juveniles - Fry feed primarily on insects and crustaceans. Larger sized juveniles prey on small sticklebacks and salmon.

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

Human Interactions

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

References

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

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Pink Salmon (*Oncorhynchus gorbuscha*)

Range

Pacific Ocean north of 40° N Latitude.

Migration

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

Reproductive Period

Mature at 2 years. Adults die after spawning.

Spawning/Hatching

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

Survival/Life Span

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

Habitat Use and Requirements

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

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

Food Web Interrelationships

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

Fry and Juveniles - In nearshore nursery areas, fry feed on copepods and other zooplankton. Juveniles eat larger invertebrates and small fishes.

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

Human Interactions

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

References

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

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Sockeye Salmon (*Oncorhynchus nerka*)

Range

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

Migration

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

Reproductive Period

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

Spawning/Hatching

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

Habitat Use and Requirements

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

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

Food Web Interrelationships

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

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

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

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

Human Interaction

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

References

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

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Pacific Herring (*Clupea pallasi*)

Range

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

Migration

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

Reproductive Period

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

Spawning/Hatching

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

Survival/Life Span

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

Habitat Use and Requirements

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

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

Food Web Interrelationships

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

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

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

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

Human Interactions

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

References

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

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

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

Range

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

Migration

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

Reproductive Period

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

Spawning/Hatching

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

Survival/Life Span

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

Habitat Use and Requirements

Very little life history information is available.

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

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

Food Web Interrelationships

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

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

Human Interactions

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

References

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

Dolly Varden (*Salvelinus malma*) - Anadromous populations

Range

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

Migration

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

Reproductive Period

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

Spawning/Hatching

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

Survival/Life Span

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

Habitat Use and Requirements

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

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

Food Web Interrelationships

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

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

Human Interactions

Dolly Varden are an important sport fish.

References

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

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

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Spot Shrimp *(Pandalus platyceros)*

Range

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

Migration

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

Life Cycle

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

Reproductive Period

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

Mating/Hatching

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

Habitat Use and Requirements

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

Food Web Interrelationships

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

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

Human Interactions

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

References

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

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

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

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

Archaeological Resources

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

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

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

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

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

Recreation and Wilderness and Intrinsic Values

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

These designated wilderness lands and thousands more acres of undesignated wildlands and developed lands provide, in part, the basis for Alaska's tourist economy. A wide range of activities take place on these lands, some by individuals or small groups seeking a personal experience, and others with the aid of businesses that provide a variety of professional services enabling visitors to use and enjoy the wilderness. Recreational activities include: hunting, fishing, hiking, camping, skiing, sightseeing, power boating, kayaking and photography.

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

Subsistence Use

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

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

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

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

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

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

ANILCA Section 801 (2) states:

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

Commercial Fisheries

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

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

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

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

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

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

References

Archaeological Resources Protection Act of 1979, 16 USC 470.

Alaska Historic Preservation Act, Alaska Statute 41.35.010.

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

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

Wilderness Act, 16 USC 1131.

Kachemak Bay State Park Wilderness Act, Alaska Statute 41.21.140.

Alaska Constitution, Article VIII, Section 3.

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

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APPENDIX B

POTENTIAL RESTORATION OPTIONS

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APPENDIX B
POTENTIAL RESTORATION OPTIONS

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

TABLE OF CONTENTS FOR APPENDIX B

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

14. accelerate recovery of upper intertidal zone

15. supplement intertidal substrates for spawning herring

16. test feasibility of enhancing murre productivity

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

18. replace fisheries harvest opportunities by establishing alternative salmon runs

Habitat Protection and Acquisition

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

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

21. acquire tidelands

22. designate protected marine areas

23. acquire additional marine bird habitats

24. acquire "inholdings" within parks and refuges

25. protect or acquire upland forests and watersheds

26. acquire extended buffer strips adjacent to anadromous fish streams

27. designate and protect "benchmark" monitoring sites

28. acquire access to sport-fishing streams

29. establish or extend buffer zones for nesting birds

Other Options

30. test subsistence foods for hydrocarbon contamination

31. develop comprehensive monitoring program

32. endow a fund to support restoration activities

33. develop integrated public information and education program

34. establish a marine environmental institute

35. replacement of archaeological artifacts

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

1. sea otters and harbor seals

2. killer whales

3. river otters

4. common murres and marbled murrelets

5. marbled murrelets

6. harlequin ducks

7. harlequin ducks and black oystercatchers

8. bald eagles

9. pink salmon and sockeye salmon

10. rockfish

11. spot shrimp

12. coastal habitat

13. archaeological resources

14. multiple resources

OPTION 1: Archaeological Resource Protection

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Archaeological sites and artifacts

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

No further information is needed to accomplish this work.

OPTION 2: Intensify Management of Fish and Shellfish

APPROACH CATEGORY: Management of Human Uses

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Rockfish, spot shrimp

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Marine birds and marine mammals

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 5: Reduce Harvest by Redirecting Sport-Fishing Pressure

APPROACH CATEGORY: Management of Human Uses

INJURED RESOURCES AND SERVICES: Dolly Varden and cutthroat trout

BACKGROUND AND JUSTIFICATION:

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

ACTION:

- prepare a fisheries management plan that includes some or all of the following alternatives:

  - close oiled streams in Prince William Sound;

  - redirect recreational fishing to non-oiled streams and drainages; and

  - reduce creel limits in the affected area.

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

APPROACH CATEGORY: Management of Human Uses

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 7: Increase Management in Parks and Refuges

APPROACH CATEGORY: Management of Human Uses

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

- hire and train additional staff to patrol and monitor spill-affected public lands; and
- provide interpretive services to educate the public about the spill and explain how they can minimize their chances of impeding resource recovery.

INFORMATION NEEDED TO IMPLEMENT OPTION:

This option needs no additional information to implement.

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

APPROACH CATEGORY: Management of Human Uses

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

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

INFORMATION NEEDED TO IMPLEMENT THE OPTION:

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

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

APPROACH CATEGORY: Management of Human Resources

INJURED RESOURCES AND SERVICES: Marine birds

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 10: Preservation of Archaeological Sites and Artifacts

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Archaeological sites and artifacts

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

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

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Pink and sockeye salmon

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT THE OPTION:

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

OPTION 12: Creation of New Recreation Facilities

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Recreation

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

APPROACH CATEGORY: Manipulation of Resources

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 14: Accelerate Recovery of Upper Intertidal Zone

APPROACH CATEGORY: Manipulation of Resources

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 15: Supplement Intertidal Substrates for Spawning Herring

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Pacific herring

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 16: Test Feasibility of Enhancing Murre Productivity

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Common murres

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Marine birds

BACKGROUND AND PURPOSE:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

APPROACH CATEGORY: Manipulation of Resources

INJURED RESOURCES AND SERVICES: Pink and sockeye salmon

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

APPROACH CATEGORY: Habitat Protection and Acquisition

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 21: Acquire Tidelands

APPROACH CATEGORY: Habitat Protection and Acquisition

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

Identify tidelands eligible for acquisition and subsequent special designation.

OPTION 22: Designate Protected Marine Areas

APPROACH CATEGORY: Habitat Protection and Acquisition

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 23: Acquire Additional Marine Bird Habitats

APPROACH CATEGORY: Habitat Protection and Acquisition

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 24: Acquire "Inholdings" Within Parks and Refuges

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 25: Protect or Acquire Upland Forests and Watersheds

APPROACH CATEGORY: Habitat Protection and Acquisition

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 26: Acquire Extended Buffer Strips Adjacent to Anadromous Streams

APPROACH CATEGORY: Habitat Protection and Acquisition

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 27: Designate and Protect "Benchmark" Monitoring Sites

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 28: Acquire Access to Sport Fishing Streams

APPROACH CATEGORY: Habitat Protection and Acquisition

INJURED RESOURCES AND SERVICES: Recreation, anadromous fish

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 29: Establish or Extend Buffer Zones for Nesting Birds

APPROACH CATEGORY: Habitat Protection and Acquisition

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 30: Test Subsistence Foods for Hydrocarbon Contamination

APPROACH CATEGORY: Other Options

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

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 31: Develop Comprehensive Monitoring Program

APPROACH CATEGORY: Other Options

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 32: Endow a Fund to Support Restoration Activities

APPROACH CATEGORY: Other Options

INJURED RESOURCES/SERVICES: All

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

  - spending only the investment income;

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

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

OPTION 33: Develop Integrated Public Information and Education Program

APPROACH CATEGORY: Other Options

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

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

ACTION:

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

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 34: Establish a Marine Environmental Institute

APPROACH CATEGORY: Other Options

INJURED RESOURCES AND SERVICES: All

BACKGROUND AND JUSTIFICATION:

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

ACTION:

- establish and equip a marine environmental science institute.

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

OPTION 35: Replacement of Archaeological Artifacts

APPROACH CATEGORY: Other Options

INJURED RESOURCES AND SERVICES: Archaeological sites and artifacts

BACKGROUND AND JUSTIFICATION:

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

ACTION:

- identify institutions and individuals with artifacts from the spill area and offer to purchase specific pieces for public institutions; and
- investigate the incidents of looting and vandalism and strive to regain possession of publicly owned artifacts.

INFORMATION NEEDED TO IMPLEMENT OPTION:

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

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

Sea Otters and Harbor Seals:

Option: Supplementing winter foods

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

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

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

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

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

Option: Establish international wildlife rehabilitation/public education center

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

Killer Whales:

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

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

River Otters:

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

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

Common Murres and Marbled Murrelets:

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

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

Marbled Murrelets:

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

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

Harlequin Ducks:

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

Although this method has been used effectively for other species of waterfowl, it has not been tested for harlequins. Population problems within the oil-spill area appear to be contaminant related and cannot be altered by augmenting the population of harlequins.

Harlequin Ducks and Black Oystercatchers:

Option: Mariculture of shellfish to supplement prey base

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

Bald Eagles:

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

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

Pink Salmon and Sockeye Salmon:

Option: Control predators on fish eggs and juveniles

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

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

Identical results could be obtained through management practices.

Rockfish:

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

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

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

Identical results could be obtained through management practices.

Spot Shrimp:

Option: Mariculture and shore/intertidal habitat enhancements

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

Coastal Habitat:

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

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

Archaeological (Cultural) Resources:

Option: Inventory beach and upland sites for cultural resources

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

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

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

Multiple Resources:

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

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

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

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

For any or all of the above options it would be difficult to establish direct linkage to the recovery of injured resources. If such a linkage is established, these options may become appropriate. Meanwhile, public education may be an avenue for addressing chronic pollution problems.

Option: Initiate reforestation programs wherever logging has occurred (e.g. Afognak Island)

The injured species which utilize forested habitats rely primarily on mature forests. For this reason, reforestation practices will not help the near-term restoration of populations injured by the *Exxon Valdez* oil spill.

Option: Establish stronger regulations, improved planning, and better response in order to minimize additional effects from future oil spills

The criminal court settlement provisions allow for expenditures towards planning for, and response to, future oil spills. This option is beyond the scope of the civil settlement. In addition, the Oil Pollution Act of 1990 will require new regulations and contingency planning.

Option: Reduce energy consumption through improved efficiency and conservation

This is beyond the scope of the civil settlement.

Option: Buy back Bristol Bay oil leases

This does not apply to the restoration of resources injured by the *Exxon Valdez* oil spill.

Option: Buy "net operating losses" (NOLs) of timber sales or change laws to disallow NOLs

Legislative action has already disallowed "net operating losses" of timber sales.

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EXXON VALDEZ OIL SPILL RESTORATION PLAN

Summary of Alternatives for Public Comment

What is in this Brochure?

In 1989, *the Exxon Valdez oil spill contaminated thousands of miles of Alaska's coastline.* It killed birds, mammals, and fish, and damaged other resources. In 1991, Exxon agreed to pay the United States and the State of Alaska $900 million over a period of ten years to restore resources and human uses injured by the spill. This brochure describes alternative ways to help the animals, plants, and people injured by the spill. We are distributing this brochure by mail, by newspaper, and at public meetings. Please take a moment to fill out and return the response form on Page 8 of this brochure, or present your views at a public meeting in your community. The information you provide will help us prepare a Final Restoration Plan that will be presented to the public this fall. We would appreciate receiving your comments as soon as possible, but we will use all comments received by **August 6, 1993.**

The National Environmental Policy Act requires that an Environmental Impact Statement be part of any significant federal action such as the restoration program. In addition to including information found here, the Draft Environmental Impact Statement will analyze the impacts of these alternatives on the physical, biological, social, and economic aspects of the environment. It will help the Trustee Council and the public understand the consequences of alternative ways of restoring injuries caused by the spill.

Photo by ED KLINKHART

The Draft Environmental Impact Statement and the full text of the Draft Restoration Plan will be ready in June 1993. Because many people are busy during the summer, this summary is being released now to gather your ideas. If you prefer, you may wait to see the Draft Environmental Impact Statement and Draft Restoration Plan this June before you respond.

The information you provide will be used to prepare a Final Restoration Plan that will be presented to the public this fall. The final plan may contain parts of several of the alternatives presented here plus new information you provide.

inside LOOK

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EXXON VALDEZ OIL SPILL RESTORATION PLAN

Summary of Alternatives for Public Comment

Public Meetings

Chignik Lagoon	School Cafeteria	April 12 • 2:00 p.m.
ChignikLake	School Cafeteria	April 12 • 7:00 p.m.
Chenega Bay	Community Building	April 19 • 11:00 a.m.
Kodiak	Kodiak Borough Assembly Chambers	April 19 • 7:00 p.m.
Port Graham	Community Center	April 20 • 1:00 p.m.
Ouzinkie	Community Center	April 20 • 1:00 p.m.
Port Lions	Community Hall	April 20 • 7:00 p.m.
Seldovia	Multi-purpose Room, City Building	April 21 • 7:00 p.m.
Larsen Bay	Tribal Council Office	April 21 • 7:00 p.m.
Homer	City Council Chambers	April 22 • 7:00 p.m.
Akhiok	City Offices	April 22 • 2:00 p.m.
Old Harbor	City Hall	April 22 • 7:00 p.m.
Nanwalek	IRA Village Office	April 23 • 2:00 p.m.
Anchorage	Simpson Building, 645 G Street	April 26 • 7:00 p.m.
Valdez	City Council Chambers	April 26 • 7:00 p.m.
Seward	City Council Chambers	April 27 • 7:00 p.m.
Tatitlek	Community Center	April 27 • 3:00 p.m.
Juneau	Centennial Hall, Hickel Room	April 28 • 7:00 p.m.
Cordova	Council Chambers, Cordova Library	April 28 • 7:00 p.m.
Fairbanks	Wood Center, Univ. of AK, Fairbanks	April 29 • 7:00 p.m.
Whittier	Fire Hall	April 30 • 5:00 p.m.

Photo by ROB SCHAEFER

inside LOOK

Exxon Valdez Oil Spill Public Information Center
645 "G" Street, Anchorage, Alaska 99501
(907) 278-8008
Inside Alaska (800) 478-7795 • Outside Alaska (800) 283-7745

Exxon Valdz
Oil Spill Restoration Office
645 "G" Street
Anchorage, Alaska 99501

POSTAL CUSTOMER

Introduction

What is the Restoration Plan?

The Exxon Valdez Restoration Plan will provide long-term guidance for restoring resources and human uses injured by the oil spill. Each year the Restoration Plan will be implemented through an Annual Work Plan. The Annual Work Plan is a mix of restoration activities to be funded that year based on the policies and spending guidelines of the plan, future public comments, and changing restoration needs. Once the Restoration Plan is adopted, it may be changed in response to new information about the injuries and recovery, new technologies, or other changing conditions.

Who are the Exxon Valdez Oil Spill Trustees?

A council of six federal and state trustees was established to administer the $900-million civil settlement to restore resources and services injured by the oil spill.

State of Alaska Trustees

- Commissioner of the Department of Environmental Conservation
- Commissioner of the Department of Fish and Game
- Alaska Attorney General

Federal Trustees

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

The Federal Trustees have appointed their lead representative in Alaska to serve on the Trustee Council.

The Trustee Council uses funds from the civil settlement for activities to restore injured resources and services. It does not manage fish and wildlife resources or make land-use decisions. Fish and game management decisions or land-use decisions are made by fish and game boards, or by appropriate federal or state agencies. The Trustee Council may make recommendations to state and federal agencies, provide funds for state and federal management, or fund research to provide information to those agencies or other groups. The Trustee Council may also purchase private land or private property rights.

The Spill and the Court Settlements

Shortly after midnight on March 24, 1989, the T/V Exxon Valdez ran aground on Bligh Reef in Prince William Sound spilling 11 million gallons of North Slope crude oil. This was the largest oil spill in United States history. All through the spring, the oil moved along the coastline of Alaska contaminating the shoreline of Prince William Sound, the Kenai Peninsula, lower Cook Inlet, the Kodiak Archipelago, and the Alaska Peninsula. Portions of 1,200 miles of coastline were oiled, including part of one National Forest, four National Wildlife Refuges, three National Parks, five State Parks, four State Critical Habitat Areas, and one State Game Sanctuary. Oil eventually reached shorelines nearly 600 miles southwest of Bligh Reef.

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

CIVIL SETTLEMENT AND RESTORATION FUND

In the civil settlement, Exxon agreed to pay the United States and the State of Alaska $900 million over a period of 10 years. The use of the civil settlement funds is the subject of this plan.

THE CRIMINAL PLEA AGREEMENT

As part of the criminal plea agreement, the court fined Exxon $250 million — the largest fine ever imposed for an environmental crime. Of this amount, $125 million were forgiven due to their cooperation with the governments during the cleanup, timely payment of many private claims, and environmental precautions taken since the oil spill. Of the remaining $125 million, $50 million each were paid to the United States and the State of Alaska. The state and federal governments separately manage these $50 million payments. The remaining $25 million were paid into the North American Wetlands Conservation Fund, and into the Victims of Crime Act Account.

Funds from the criminal plea agreement are not under the authority of the Trustee Council and are not considered by this plan. However, they must be used exclusively for restoration activities, within the State of Alaska, relating to the Exxon Valdez oil spill.

Photo courtesy of NATIONAL PARKS SERVICE

Rules for Spending the Civil Settlement Funds

1. The Trustee Council must use the settlement funds "...for the purposes of restoring, replacing, enhancing, or acquiring the equivalent of natural resources injured as a result of the Oil Spill and the reduced or lost services provided by such resources..." (except for reimbursements to the state and federal governments in settlement of past costs).

2. The settlement funds must be spent on restoration of natural resources in Alaska unless the Trustees unanimously agree that spending funds outside of the state is necessary for effective restoration.

3. All decisions made by the Trustee Council (such as spending settlement funds) must be made by unanimous consent.

The settlement defines **NATURAL RESOURCES** as the land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to or managed by the state or federal governments. Examples of natural resources are birds, fish, mammals, subtidal plants and animals, and archaeological resources.

In addition to restoring natural resources, funds may be used to restore reduced or lost **SERVICES (human uses)** provided by injured natural resources. For example, subsistence, commercial fishing, and recreation including sport fishing, sport hunting, camping, and boating are services that were damaged by injuries to fish and wildlife. Other injured services include commercial tourism, and the enjoyment that people receive from undisturbed wild areas.

Funding

The Civil Settlement Funds as of March 1993

The civil settlement requires Exxon to deposit funds each year beginning December 1991 and ending September 2001. The table below shows uses and commitments of that money. It shows that of the $900 million civil settlement, approximately $610 to $630 million remain for funding restoration activities.

PAYMENTS

Past Exxon Payments

$240 million

- $210.1 million in 1991 and 1992
- $39.9 million credited to Exxon for cleanup costs after January 1, 1991

Future Exxon Payments

$660 million by 2001

TOTAL EXXON PAYMENTS
$900 million

EXPENSES

Past Reimbursements, Deductions, Withdrawals & Commitments

$200.2 million

- $107.5 to reimburse the federal and state governments for past damage assessment, clean-up, litigation, response, and restoration expenses;
- $19.5 for the 1992 work plan;
- $33.3 for the 1993 work plan (including $7.5 for Kachemak Bay purchase); and
- $39.9 credited to Exxon for cleanup costs after January 1, 1991.

Future Commitments

An unknown amount probably between $70 - $90 million

To reimburse the governments for past expenditures

Total Remaining

Aproximately $610-$630 million

TOTAL EXPENDITURES
$900 million

The Planning Process

The restoration planning process has used the results of many scientific studies, meetings, and symposia conducted during the four years that have elapsed since the oil spill.

Information presented here will be developed further and presented for public review and comment in the Draft Restoration Plan and Draft Environmental Impact Statement to be published in June 1993. A Final Restoration Plan and Final Environmental Impact Statement will be released in late Fall 1993.

Restoration Planning Process has used results derived from:

- Natural Resource Damage Assessment Studies: 1989-1992
- Restoration Science Studies: 1990-1992
- Technical Workshop 1990
- Public Symposium 1990
- Restoration Planning Progress Report 1990
- Public meetings 1990-1993
- Restoration Framework and Supplement 1992
- *Exxon Valdez* Oil Spill Symposium 1993

Information to understand the alternatives

Summary of Injury

The Exxon Valdez oil spill occurred in March, just before the most biologically active season of the year. It affected the migration of birds, and the primary breeding season for most species of birds, mammals, fish, and marine invertebrates in the spill's path. Much of southcentral Alaska's intricate coastline was oiled, frequently with devastating impact to intertidal and shallow subtidal resources. It also affected human use of the spill area, including subsistence, recreation, commercial fishing, and other uses. Some resources and services remain exposed to oil persisting below high tide.

Oil affected each resource and use differently. For some resources, the population measurably declined. By measurably declined, we mean a measurable decline in abundance that will persist for more than one generation. For example, an estimated 3,500 to 5,000 sea otters were killed by the spill, and the population will not recover for many generations. Other species were killed or otherwise injured by the spill, but the injury did not measurably lower the overall population. Deaths of individual animals or sublethal injuries, which do not result in death, may not be reflected in a lower population because the natural variability of the species may mask the injury, or the resource may have some mechanism to compensate for the injury.

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 may also influence long-term trends in the health and populations of these and other species.

The spill also directly affected human uses of the spill area including commercial fishing, commercial tourism, recreation, passive use, and subsistence. The nature and extent of the injury varied by user group and by area

More information about injury and recovery
See p.6

Injured by the Oil Spill

The table below summarizes injuries caused by the spill. It does not include resources, such as sea lions and brown bears, that were studied but for which clear injuries were not determined.

RESOURCES: Population Decline	RESOURCES: Injured, but No Population Decline	RESOURCES: Other	SERVICES (Human use)
Black oystercatcher	Bald eagle	Air, water, and sediments	Commercial fishing
Common murre	Cutthroat trout ◆	Archaeological resources	Commercial tourism
Harbor seal	Dolly Varden ◆	Designated wilderness areas	Passive use
Harlequin duck	Killer whale ◆		Recreation including sport fishing, sport hunting, and other recreation use
Intertidal organisms	Pacific herring		Subsistence
Marbled murrelet	Pink salmon ◆		
Pigeon guillemot	River otter		
Sea otter	Rockfish		
Sockeye salmon			
Subtidal organisms			


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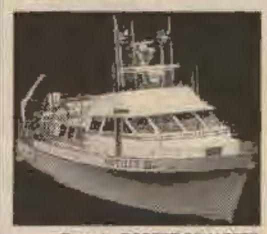


Photo by ROBERT SCHAEFER

◆ For these species, the Trustee Council's scientists have considerable disagreement over the conclusions to be drawn from the results of the damage assessment studies.

NOTE: The table may change if sublethal injuries result in population declines, or as new information about other resources is obtained.

Categories of Restoration Actions

Restoration actions fall into four categories. The alternatives place different emphases on these categories. Not all categories are included in every alternative.

HABITAT PROTECTION and ACQUISITION

This category includes protection and acquisition of habitat on private land as well as protection of habitat on public land.

▼ Habitat protection and acquisition on private land.

Resource development on private land, such as harvesting timber or building subdivisions, can sometimes harm already injured resources or services that rely on the land. The object of protecting and acquiring land is to prevent further injury to resources and services and allow recovery to occur at its natural rate. For example, the recovery of harlequin ducks may be helped by protecting nesting habitat from future changes that may hamper recovery.

The Trustee Council may purchase private land or partial interests such as conservation easements, mineral rights, or timber rights as methods of restoration. These lands would be managed to protect injured resources and services. The Council's recent decision to purchase inholdings in Kachemak Bay State Park is an example of habitat protection and acquisition on private land. However, the settlement requires that any purchases must benefit resources or services injured by the spill.

The following injured resources and services might benefit from the purchase of private land or property rights: salmon, trout, bald eagle, black oystercatcher, common murre, harbor seal, harlequin duck, marbled murrelet, pigeon guillemot, river otter, sea otter, areas adjacent to particularly productive intertidal areas, recreation and commercial tourism, archaeological resources, and subsistence. Types of habitat that might be protected or acquired include:

- **Habitats important to injured species**
- **Scenic areas such as those viewed from important recreation and tourist routes**
- **Areas important for recreation, including sport fishing and hunting**
- **Important subsistence harvest areas**

Since there will not be enough money in any alternative to buy or protect all habitat important to recovery, it is necessary to prioritize available land. Some of the most important criteria are the degree of importance of the land to the recovery of injured resources or services and the number of resources or services that rely on a given parcel. Costs will vary depending on the land, and the private rights being purchased. For example, timbered land will often be more expensive than similar land without marketable timber. Also, purchase of partial interests such as easements or mineral rights may be less expensive and could increase the number of acres that can be protected.

▼ Habitat protection on public land

Changes in management practices on public land and water may protect injured resources and services from further injury. Examples of these changes include amending agency management plans, changing regulations, and designating public land and water as special areas. Examples of special areas include scientific research reserves, recreation areas, parks, critical habitat areas, and marine sanctuaries. Any management changes must be approved and implemented by the appropriate government agency, or in some cases by the Alaska State Legislature or the U.S. Congress. Since land and water management actions could extend to any public upland, intertidal area, or marine waters, the actions could potentially benefit most injured resources and services. Management changes necessitated by spill injuries may be funded with settlement monies, but the costs are not expected to be a significant portion of the total settlement funds.

GENERAL RESTORATION

Since 1989, agencies and the public have proposed hundreds of ideas for restoration. Some ideas restore injured resources and services by directly manipulating resources. Examples include building fish passes and public-use cabins or replanting seaweed in the intertidal areas. Other ideas focus on managing human use to aid restoration. Examples include redirecting hunting and fishing harvest, or reducing human disturbance around sensitive bird colonies. General Restoration does not include Monitoring and Research or Habitat Protection and Acquisition.

In each alternative, enough money is potentially allocated to General Restoration to fund all activities that have been identified and that meet the policies of that alternative. Each alternative also identifies enough additional funds to provide a reserve for General Restoration activities that may be identified in the future.

MONITORING AND RESEARCH PROGRAM

A monitoring and research program will help the Trustee Council decide how resources and services are recovering, and whether restoration activities are effective. It could also be used to monitor the general health of affected ecosystems, or provide basic and applied scientific research about how to protect, manage, or restore resources or services injured by the spill. The program could include one or more of the following, although its components vary among alternatives.

▼ **Recovery Monitoring** would assess the rate of recovery of injured resources and services, and determine when recovery has occurred.

▼ **Restoration Monitoring** would evaluate the effectiveness of specific restoration activities, identify where additional restoration activities may be appropriate, and determine if delayed injury occurs.

▼ **Ecosystem Monitoring** would follow long-term trends in the distribution and abundance of injured resources and the quality and quantity of services. Monitoring could also detect residual spill effects and provide ecological baseline information to assess the impacts of future disturbances.

▼ **Restoration Research** would focus on the design, development and implementation of new technologies and approaches to restore resources not recovering or recovering at lower than expected rates.

ADMINISTRATION AND PUBLIC INFORMATION

Funding is required to manage the restoration program and to provide the public with information about recovery and restoration. As the number of restoration projects increases and the complexity of management duties grows, the percentage of funds needed for Administration and Public Information increases.

Issues and Policy Questions

The planning process raised five significant issues. Different answers to these questions will influence which restoration actions are conducted.

Injuries Addressed by Restoration Actions: Should restoration actions address all injured resources & services or all except those biological resources whose populations did not measurably decline because of the spill?

Some injured resources declined in population. For example, the loss of 35-70% of the breeding common murres in the Gulf of Alaska resulted in a decline that will persist through future generations. Other injuries, such as reduced growth rates, may not have resulted in a lower population. However, over time these injuries might also cause populations to decline.

If an injury was not severe enough to produce a detectable change in population, then perhaps settlement funds should not be spent to address it. On the other hand, if something can be done to address less serious injuries that might eventually cause populations to decline, perhaps it should be done before more serious effects occur.

Restoration Actions for Recovered Resources: Should restoration actions cease when an injured resource has recovered, or continue in order to enhance the resource?

None of the injured resources has recovered from a population decline. If a goal of the settlement is to restore injured resources, then perhaps restoration actions should cease once the resource has recovered to where it would have been had no spill occurred. On the other hand, if restoration actions were to continue after a resource has recovered, they may offset other disturbances or improve its condition. As resources recover, this issue will become more important.

Effectiveness of Restoration Actions: Should the plan include only those restoration actions that produce substantial improvement over natural recovery or also those that produce at least some improvement?

One strategy is to consider only those restoration actions likely to produce substantial improvement over natural recovery. However, if the Trustee Council were to consider all restoration activities that offer at least some promise of helping injured resources and services, the cumulative effect may produce greater improvement overall.

Location of Restoration Actions: Should restoration actions take place in the spill area only or anywhere there is a link to injured resources or services?

If restoration actions were limited to the spill area, they could focus on the populations and uses directly affected. On the other hand, restoration actions outside the spill area may be more effective than those within the spill area. For example, increasing common murre populations at colonies outside the spill area may do more to increase the numbers of that species than would comparable projects within the spill area. The map of the oil spill area is on page 10.

Opportunities for Human Use: To what extent should restoration actions create opportunities for human use of the spill area?

Certain restoration actions may create opportunities for human use of the spill area. Some of these actions would protect existing use. Examples include constructing outhouses in over-used areas and improving trails where hiking is damaging wetlands. Other activities would increase existing use. Examples include installing a new mooring buoy in an anchorage or constructing new public-use cabins in a recreation area. Still other activities would encourage new uses in appropriate locations. Examples include providing a new visitor center or attracting new commercial facilities onto public land.

One view is that restoration actions should not create any opportunity for human use of the spill area. However, if restoration actions that create opportunities for human use were to be limited to those that would protect existing use, then restoration could proceed without changing the character of the area or impeding recovery of injured resources and services. On the other hand, increasing opportunities for human use through either increasing existing use or encouraging new use, would make the area more usable for more people and improve the quality of the experience for some users.

Any facilities built on public land would comply with existing land-use plans, and agency procedures such as those requiring public notice.

Issues and Policy Questions Addressed in the Alternatives

ISSUE	POLICY QUESTION
INJURIES ADDRESSED BY RESTORATION ACTIONS	? Should restoration actions address all injured resources and services or all *except* those biological resources whose populations did not measurably decline because of the spill?
RESTORATION ACTIONS FOR RECOVERED RESOURCES	? Should restoration actions cease when a resource has recovered or continue in order to enhance the resource?
EFFECTIVENESS OF RESTORATION ACTIONS	? Should the plan include only those restoration actions that produce substantial improvement over natural recovery or also those that produce at least some improvement?
LOCATION OF RESTORATION ACTIONS	? Should restoration activities take place in the spill area only or anywhere there is a link to injured resources or services?
OPPORTUNITIES FOR HUMAN USE	? To what extent should restoration actions create opportunities for human use of the spill area?

description of alternatives

FIVE ALTERNATIVES have been developed for your review. Each alternative presents a different way of approaching restoration. Each uses different policies and emphasizes different categories of restoration activities to restore resources and human uses injured by the spill. No single alternative is likely to match your vision of the ideal plan. The questionnaire on page 8 asks which policies you prefer and how you would combine categories of restoration activities.

ALTERNATIVE 1

NATURAL RECOVERY (No Action)

What would happen to resources and services injured by the oil spill if no restoration actions were taken? The table on page 7 describes expected times for natural recovery of injured resources and services, if expected patterns of use continue. They range from a few years to 120 years and are unknown for six resources. However, because recovery would not be monitored under this alternative, it would not be possible to confirm when recovery has occurred. Archaeological resources will not recover.

This alternative is the no-action alternative in the draft Environmental Impact Statement that will be released in June 1993. Consequently, none of the civil settlement funds would be spent.

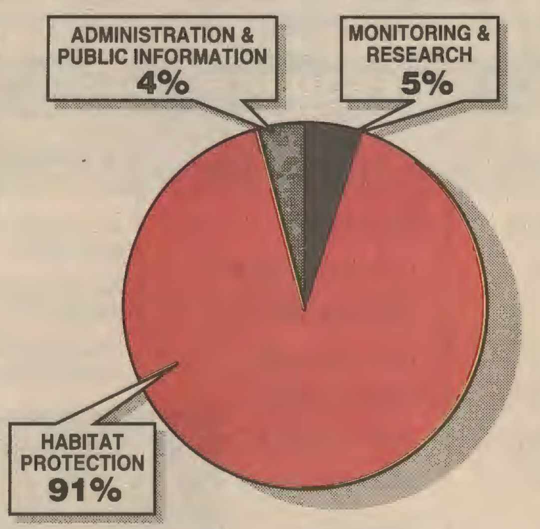
ALTERNATIVE 2

HABITAT PROTECTION

The goal of this alternative is to protect strategic lands and habitats important to resources and services injured by the spill. In this alternative, 91% of the remaining settlement funds would be available for habitat protection. Monitoring and Research and Habitat Protection and Acquisition are the only restoration actions included in this alternative. The Habitat Protection and Acquisition program includes the acquisition of private land interests and changes in public land management. The Monitoring and Research program would evaluate the effectiveness of habitat protection measures undertaken and follow the progress of natural recovery. Restoration activities would be limited to the spill area.

Protect injured resources and services within the spill area from further degradation or disturbance.

ISSUES	POLICIES
Injuries Addressed by Restoration Actions	Address all injured resources and services.
Restoration Actions for Recovered Resources	Continue restoration actions even after a resource has recovered.
Effectiveness of Restoration Actions	Conduct restoration actions that provide substantial improvement over natural recovery.
Location of Restoration Actions	Limit restoration actions to the spill area.
Opportunities for Human Use	Use habitat protection to protect or increase existing human use of the spill area.



ALTERNATIVE 3

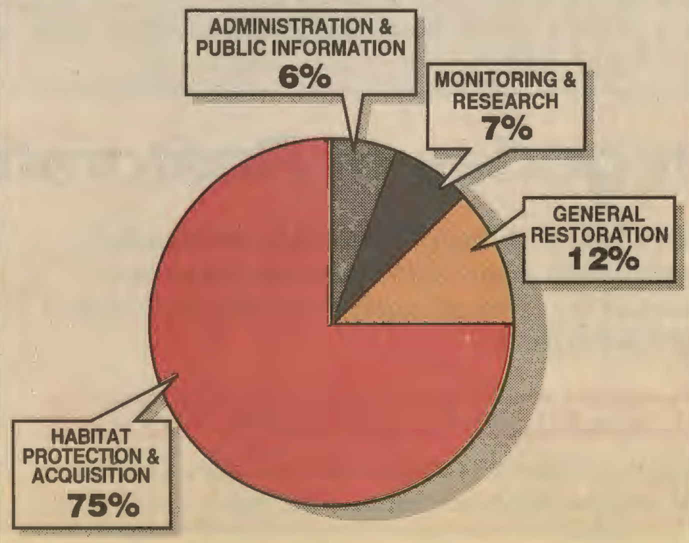
LIMITED RESTORATION

The goal of this alternative is to help the most injured resources and services recover as efficiently as possible. As its title implies, this alternative is ***limited*** in that it addresses only the most severe injuries until the resource or service recovers, includes actions most likely to produce substantial improvement over natural recovery, is limited to the spill area, and does not fund activities intended to increase human use of the spill area. Only a few restoration activities meet these standards.

In this alternative, 75% of remaining settlement funds would be available for Habitat Protection and Acquisition. Of the General Restoration options that have been evaluated, only 21 meet the criteria of this alternative. See page 9. The Monitoring and Research program would evaluate the effectiveness of restoration actions and follow the progress of natural recovery.

Take the most effective actions within the spill area to protect and restore all injured services and resources except those biological resources whose populations did not measurably decline. Maintain the existing character of the spill area.

ISSUES	POLICIES
Injuries Addressed by Restoration Actions	Address all resources and services ***except*** those biological resources whose populations did not measurably decline.
Restoration Actions for Recovered Resources	Cease restoration actions once a resource has recovered.
Effectiveness of Restoration Actions	Conduct restoration actions that provide substantial improvement over natural recovery.
Location of Restoration Actions	Limit restoration actions to the spill area.
Opportunities for Human Use	Use restoration actions to protect existing human use of the spill area.



ALTERNATIVE 4

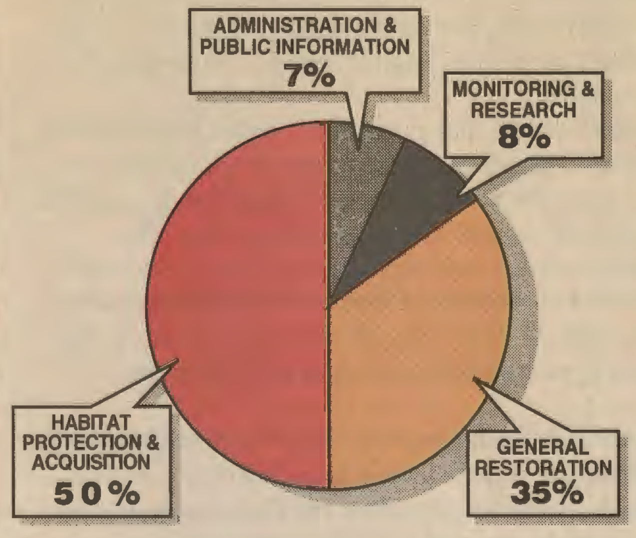
MODERATE RESTORATION

The goal of this alternative is to help all injured resources and services recover as efficiently as possible. It is similar to Alternative 3 in limiting restoration actions to resources not yet recovered and setting the same high standard of effectiveness. It differs from Alternative 3 by addressing additional injured species whose populations did not decline, including activities outside the spill area, and increasing opportunities for human use of the area to a limited extent.

In this alternative, 50% of remaining settlement funds would be available for Habitat Protection and Acquisition. Of the General Restoration options that have been evaluated, 31 meet the criteria for this alternative. The Monitoring and Research program would include ecosystem monitoring and restoration research in addition to evaluating the effectiveness of restoration actions and following the progress of natural recovery.

Take the most effective actions to protect and restore all injured resources and services. Increase, to a limited extent, opportunities for human use of the spill area.

ISSUES	POLICIES
Injuries Addressed by Restoration Actions	Address all injured resources and services.
Restoration Actions for Recovered Resources	Cease restoration actions once a resource has recovered.
Effectiveness of Restoration Actions	Conduct restoration actions that provide substantial improvement over natural recovery.
Location of Restoration Actions	Undertake restoration actions anywhere there is a link to injured resources or services.
Opportunities for Human Use	Use restoration actions to protect or increase existing human use of the spill area.



ALTERNATIVE 5

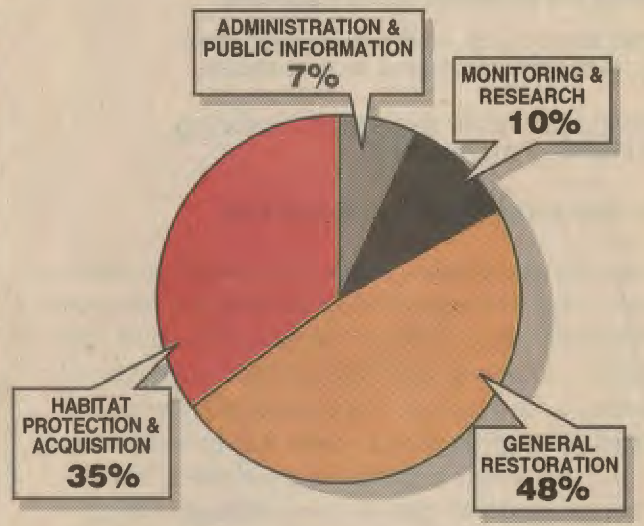
COMPREHENSIVE RESTORATION

The goal of this alternative is to help all injured resources and services return to or exceed prespill levels. It is similar to Alternative 4 in addressing ***all*** injured resources and services and including activities outside the spill area. It is more expansive than Alternative 4 because it allows restoration actions to continue in order to enhance a resource even after it has recovered, includes any action likely to produce at least some improvement over natural recovery, and encourages appropriate new human use of the spill area.

In this alternative, 35% of remaining settlement funds would be available for Habitat Protection and Acquisition. Of the General Restoration options that have been evaluated, 47 meet the standards of this alternative. The Monitoring and Research program would include ecosystem monitoring, and restoration research in addition to restoration monitoring and natural recovery monitoring.

Take all effective actions to protect, restore, and enhance all injured resources and services. Increase opportunities for human use of the spill area.

ISSUES	POLICIES
Injuries Addressed by Restoration Actions	Address all injured resources and services.
Restoration Actions for Recovered Resources	Continue restoration actions even after a resource has recovered.
Effectiveness of Restoration Actions	Conduct restoration actions that provide at least some improvement over natural recovery.
Location of Restoration Actions	Undertake restoration actions anywhere there is a link to injured resources and services.
Opportunities for Human Use	Use restoration actions to protect or increase existing use or encourage appropriate new use of the spill area.



Funding Methods: Endowments

Exxon has made deposits into the restoration fund since 1991 and will continue to do so until 2001. The Trustees could spend the entire settlement during that time or they could save some for future use. An endowment is a savings program to fund restoration after Exxon's payments end. It uses part of the settlement funds to create an interest-bearing savings account, which could fund a constant level of restoration activities indefinitely. An endowment could be used to fund some or all categories of restoration activities.

The size of an endowment determines the amount of income it earns and the amount of restoration activities it can fund. It is possible to place any portion of the remaining settlement funds into an endowment. For example, 20% of the remaining restoration funds could be placed into a savings account. If so, fewer restoration activities could be accomplished within ten years, but the interest from the account could annually fund approximately $3 to $5 million worth of restoration activities indefinitely.

Comparison of alternatives

Courtesy of NATIONAL PARK SERVICE

Courtesy of CHUGACH NATIONAL FOREST

In general, how does each alternative benefit recovery?

ALTERNATIVE 1 **NATURAL RECOVERY (No Action)**, would produce no improvement over natural recovery. This alternative includes no restoration activities. It would allow injured resources and services to recover naturally, but would not monitor their recovery.

ALTERNATIVE 2 **HABITAT PROTECTION**, would improve natural recovery by preventing some habitat disturbances that might otherwise occur. Benefits would accrue primarily to injured resources and services linked to upland habitat. The effectiveness of habitat protection would be monitored, as would the progress of natural recovery of injured resources and services for which no habitat protection measure is undertaken.

ALTERNATIVE 3 **LIMITED RESTORATION**, might improve recovery of the most injured populations within the spill area. It includes no restoration activities for those species whose populations did not measurably decline because of the spill (see table on page 3). By protecting existing human use, this alternative neither changes the character of the area nor impedes natural recovery of injured resources and services. Because this alternative allocates less to General Restoration actions than do Alternatives 4 and 5, more funds would be available for habitat protection.

Comparison of Potential Allocations to Restoration Categories by Alternative

The table compares potential allocations within the five alternatives. It also indicates the components of the Monitoring and Research program included in each alternative. Spending for each restoration category gives a sense of the emphasis of the restoration program by alternative. The allocations are illustrative only and are not a commitment of actual expenditures.

In general, as potential allocations to General Restoration increase, funds available for Habitat Protection and Acquisition decline. Furthermore, as the restoration program increases in complexity, so does the cost of Administration and Public Information, and of Monitoring and Research.

RESTORATION CATEGORY	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
ADMINISTRATION AND PUBLIC INFORMATION		4%	6%	7%	7%
MONITORING AND RESEARCH		5%	7%	8%	10%
• *Recovery Monitoring*		X	X	X	X
• *Restoration Monitoring*		X	X	X	X
• *Ecosystem Monitoring*				X	X
• *Restoration Research*				X	X
GENERAL RESTORATION (For examples of general restoration activities within each alternative see page 9)			12%	35%	48%
HABITAT PROTECTION & ACQUISITION		91%	75%	50%	35%
Balance	100%				
TOTAL	*100%*	*100%*	*100%*	*100%*	*100%*

NOTE: Diplay of potential allocations is illustrative only and not commitment of actual expenditures. Allocation expressed as a percent of remaining civil settlement fund.

Alternative #1 is the No-Action alternative for the Draft Environmental Impact Statement. Consequently, it includes a balance that would not be spent on any restoration activity.

X= Component of restoration category included in this alternative.

ALTERNATIVE 4 **MODERATE RESTORATION**, might improve recovery of all injured resources and services, reaching outside the spill area, if necessary, to find the most effective restoration actions. This alternative also addresses less severe injuries and prepares for future problems through ecosystem monitoring and restoration research. Finally, this alternative would increase opportunities for existing human use of the spill area, if doing so would improve recovery of an injured service. Because of the expanded scope of restoration actions in this alternative, fewer funds would be available for habitat protection than in Alternatives 2 and 3.

ALTERNATIVE 5 **COMPREHENSIVE RESTORATION**, might improve recovery of all injured resources and services and could enhance some of them. In addition to the restoration actions in Alternative 4, this alternative includes actions that are less certain to benefit recovery and encourages appropriate new human use of the spill area. If successful, these additional General Restoration actions could produce greater overall beneficial effects than those in Alternatives 3 and 4, but they would further reduce the availability of funds for habitat protection. Under this alternative, restoration actions would be undertaken anywhere there is a link to injured resources and services.

Murres nest in dense colonies on cliff ledges. This behavior helps reduce predation. Photo by ART SOLES

Photo by BOB LOEFFLER

Funding Methods: *Endowment*

Whether or not funds are placed into an endowment is a decision about the timing of when restoration activities should occur. The alternatives compared above assume that the funds are spent within approximately ten years. Some of the remaining funds could be placed into an endowment to fund restoration activities after Exxon payments end.

Habitat Protection on Private Lands: *How Much Land Could Be Protected?*

The alternatives indicate that 91% to 35% of the remaining settlement funds could be available for acquiring and protecting habitat. The Trustee Council is looking at many methods of protecting habitat. Some of the factors that would influence the actual amount of habitat protected include:

- **land costs, which are highly variable; and**
- **whether full or partial property rights are acquired.**

Under any alternative, the amount of available land exceeds available funding. Therefore, land parcels must be ranked according to their value in restoring injured resources and services. Acquiring fee title is the most expensive way of protecting private land. Assuming acquisition of fee title and a mix of land costs, approximately 275,000 acres of land could be protected under Alternative 2. This is equivalent to about 14% of the private land within the spill area. Under Alternative 5, this figure drops to 100,000 acres, or approximately 5% of the private land within the spill area. These acreage estimates could be even lower if a larger proportion of high-value land were acquired. The estimates could be higher, if the mix of land acquired included more low cost land or partial property rights.

Injury & recovery

MAMMALS

HARBOR SEALS The oil spill caused population declines and sublethal injuries in harbor seals. Many were directly oiled and an estimated 345 died. Oil residues found in seal bile were 5 to 6 times higher in oiled areas than unoiled areas in 1990. The population was declining prior to the oil spill which makes it difficult to determine the effects of the spill. There are some recent indications that the population may be stabilizing, but there is no indication of any increase.

KILLER WHALES Population decline and other injuries have been documented in one of the pods (extended family group) in the oil spill area. There is debate about whether the oil spill caused these injuries. Thirteen whales out of 36 in one whale pod in Prince William Sound are missing and presumed dead. Circumstantial evidence links the whale disappearance to the oil spill. Additionally, several adult males have collapsed dorsal fins and social disruption of family units has been observed. In that pod, no new births were recorded in 1989 or 1990; one birth was recorded in 1991; and two births were recorded in 1992. These births suggest that the pod is beginning to recover.

RIVER OTTERS There are differences in some indicators of health, feeding habits, and other aspects of river otter biology between oiled and unoiled areas. These differences may indicate an effect of the spill. Lacking prespill data and a measure of the population, there is great uncertainty about the nature of the injury. River otters feed in the intertidal and shallow subtidal areas and may still be exposed to oil persisting in the environment.

SEA OTTERS The oil spill caused population declines and sublethal injuries in sea otters. It is estimated that 3,500 to 5,000 otters died. The total sea otter population in the Gulf of Alaska is estimated at around 20,000. Surveys in 1989, 1990 and 1991 showed measurable differences in population and survival rates between oiled and unoiled areas. In 1992, lower juvenile survival rates and higher than normal numbers of dead, prime-age otters indicate that the populations in Prince William Sound continue to be stressed. Sea otters feed in the lower intertidal and subtidal areas and may still be exposed to oil persisting in the environment. Little or no evidence of recovery has been detected.

BIRDS

BALD EAGLES A minimum of 200 to 300 eagles were estimated to have been killed by the spill. However, because population census techniques are not accurate enough to detect population changes this small, no measurable population decline has been recorded. Productivity in Prince William Sound was disrupted in 1989, but returned to normal in 1990. Exposure to oil and some sublethal injuries were found in 1989 and 1990, but no continuing effects were observed on populations. Bald eagles are recovering, and may have recovered, from the effects of the oil spill.

Black Oystercatcher

Courtesy of US. FISH & WILDLIFE SERVICE

BLACK OYSTERCATCHERS The oil spill caused population declines and sublethal injuries in black oystercatchers. In 1989, smaller eggs and lighter weight chicks were found in oiled areas. Black oystercatchers feed in the intertidal areas and may still be exposed to oil persisting in the environment. The population is recovering although evidence of sublethal injuries persisted in 1992.

COMMON MURRES The oil spill caused population declines and sublethal injuries at murre colonies within the oil spill area. In 1989, between 175,000 to 300,000 murres were killed. Measurable impacts on populations were recorded in 1989, 1990 and 1991. Breeding was still inhibited in some colonies in the Gulf of Alaska in 1992. The degree of recovery varies between colonies and some colonies show little evidence of recovery.

HARLEQUIN DUCKS The oil spill caused population declines and sublethal injuries in harlequin ducks. In 1989, approximately 400 birds were killed. In the three years since the oil spill, it appears that harlequin ducks still are not successfully breeding in oiled areas of Prince William Sound. Harlequin ducks feed in the intertidal and shallow subtidal areas and may still be exposed to oil persisting in the environment.

MARBLED MURRELETS The oil spill caused population declines, but it is unknown if there were sublethal injuries. It is estimated that 8,000 to 12,000 birds died. Measurable population effects were recorded in 1989, 1990 and 1991 as a result of the oil spill. In 1989, oil contamination was found in livers of adult birds. Marbled murrelet populations were declining prior to the oil spill. In 1992, recovery was uncertain and no signs of an increasing population have been observed, but the decline may have stabilized.

PIGEON GUILLEMOTS The oil spill caused population declines in pigeon guillemots. In 1989, between 1,500 to 3,000 birds were estimated to have been killed. In 1989, oil contamination was found in birds and on eggs. The recovery status in 1992 is uncertain. There is no evidence of an increase in the population. Pigeon guillemot populations were declining prior to the spill.

What Was Injured By the Spill and Is It Recovering?

This page describes the injury and the status of recovery for each of the resources and services included in the alternatives. The table on page 3 categorizes the biological resource injuries into those that resulted in a measurable population decline and those that did not. These other injuries include higher mortality in early life stages (for example, eggs and very young animals) and sublethal injuries that do not result in death. These injuries have not resulted in measurable effects to the overall adult population.

Injuries to services (human uses) are more difficult to categorize. They depend in part on the injury to the resources as well as on the way people use and perceive areas and resources.

In addition to the resources described below, other species were studied as part of the damage assessment process but are not believed to have suffered notable injuries. These include sea lions, brown bears, Sitka black-tailed deer, black-legged kittiwakes, some sea birds, crab, shrimp, and many others.

FISH

CUTTHROAT TROUT AND DOLLY VARDEN The oil spill caused sublethal injuries and possibly population declines in these two species. Between 1989 and 1991, survival and growth in adult populations in oiled areas differed from those in unoiled areas. This difference persisted even though indications of exposure to oil decreased over these years. The persistence of different rates of survival and growth may have been due to continuing injury to the food base. However, scientists disagree as to whether these differences in survival and growth existed before the spill. It is unknown whether these species are recovering.

PACIFIC HERRING The oil spill caused sublethal injuries to Pacific herring. It is presently unknown whether these injuries will result in a population decline. Measurable differences in egg mortality between oiled and unoiled areas were found in 1989. Eggs and larvae were injured or killed in 1989 and, to a lesser extent, in 1990. In 1991 there were no differences between oiled and unoiled areas. Injuries to the 1989 year class may result in reduced recruitment to the adult population. If so, an adult population decline will not become apparent until 1993. Overall recovery status is unknown.

PINK SALMON The oil spill caused sublethal injuries to wild stock populations, and there is debate on whether the wild stock population has declined. Abnormal fry were observed in 1989 and egg mortality continued to be higher than expected in 1990 and 1991. The debate about population declines focuses on whether the observed injuries will result in reduced adult returns. Reduced growth of juveniles, which correlates with reduced survival, was found in 1989 and 1991. In 1992, there was continued evidence of sublethal injuries. Overall recovery status is unknown.

ROCKFISH The oil spill caused at least sublethal injuries; however, it is unknown whether or not population declines also occurred. Twenty dead fish were found in 1989, but only a few were in condition to be analyzed. Those analyzed showed exposure to oil with some sublethal injuries. Closures to salmon fisheries increased the fishing pressure on rockfish and the increasing catch may be affecting the population. It is unknown if the population has recovered from sublethal injuries, or from any population decline.

SOCKEYE SALMON Kenai River and Red Lake sockeye salmon stocks both suffered population declines as well as sublethal injuries. Smolt survival continues to be poor in both systems due to overescapements that occurred at Red Lake in 1989 and in the Kenai system in 1987, 1988, and 1989. In 1992, the estimated number of Kenai River smolt was only 3% of average. As a result of overescapement, adult returns are expected to be low in 1994 and successive years. Overall recovery status is unknown.

COASTAL HABITAT

COASTAL HABITAT - INTERTIDAL ZONE The oil spill caused population declines and sublethal injuries in the populations of plants and animals that live in the area between low and high tide. The lower intertidal and, to some extent, the mid-intertidal zones are recovering. However, in the upper intertidal zone, some species have not recovered, and oil persists in and under mussel beds. Intertidal organisms were affected by both oiling and clean-up, particularly the high pressure, hot water washing. Recovery varies by species largely based on their position within the intertidal zone.

COASTAL HABITAT - SUBTIDAL ZONE The oil spill caused population declines and sublethal injuries in the populations of plants and animals found below low tide. Eelgrass and some species of algae appear to be recovering. Amphipods in eelgrass beds recovered to prespill densities in 1991. Leather stars and helmet crabs showed little sign of recovery through 1991. Overall recovery is variable by species.

OTHER NATURAL RESOURCES

ARCHAEOLOGICAL RESOURCES
Twenty-four archaeological sites are known to have been harmed by oiling, clean-up activities, or looting and vandalism linked to the oil spill. An additional 113 sites are estimated to have been similarly affected. Injuries attributed to increased looting and vandalism linked to the oil spill are still occurring. Archaeological sites and artifacts cannot recover. They are finite, non-renewable resources.

DESIGNATED WILDERNESS AREAS
Many miles of coastlines were oiled in designated wilderness areas and wilderness study areas. Some oil remains embedded in the sediments of these areas. Until oil is completely removed or degrades naturally, injuries to these areas will continue.

SERVICES (HUMAN USES)

COMMERCIAL FISHING During 1989, emergency commercial fishery closures were ordered throughout the spill area. Closures affected salmon, herring, crab, shrimp, rockfish, and sablefish. The 1989 closures resulted in sockeye overescapement in the Kenai River and in the Red Lake system (Kodiak Island). In 1990, a portion of Prince William Sound was closed to shrimp fishing. Spill-related sockeye overescapement is anticipated to result in low adult returns in 1994 and 1995. This may result in closure or harvest restrictions during these and, perhaps, subsequent years. Injuries and recovery status of rockfish, pink salmon, shellfish and herring are uncertain.

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

PASSIVE USE In 1991, over 90% of those surveyed nationwide were aware of the oil spill. Over 50% believed that the oil spill was the largest environmental accident caused by humans anywhere in the world. There was also a perception that the value of wild areas had diminished. Some respondents reported that their perception of lost value was recovering as they sensed some recovery was occurring. The feelings of others have not changed as they did not believe recovery was occurring.

RECREATION The nature and extent of injury varied by user group and by area of use. About one quarter of respondents to a recreation survey in 1992 reported no change in their recreation experience, but others reported avoiding the spill area, reduced wildlife sightings, residual oil and more people. They also reported changes in their perception of recreation opportunities in terms of increased vulnerability to future oil spills, erosion of wilderness, a sense of permanent change, and concern about long-term ecological effects. However, some respondents reported a sense of optimism. There are indications that declines in recreation activities reported in 1989 appear to have reversed in 1990, but there is no evidence that they have returned to prespill levels.

RECREATION - SPORT FISHING AND HUNTING
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. In 1992, an emergency order restricting cutthroat trout fishing was issued for western Prince William Sound due to low adult returns. The closure is expected to continue at least through 1993. Sport hunting of harlequin ducks was reduced by restrictions imposed in 1991 and 1992 in response to damage assessment studies. It is likely that these restrictions will continue until the species shows signs of recovery. Kenai River sockeye overescapements may severely affect sport fishing as early as 1994.

Photo by RON STANEK

SUBSISTENCE Subsistence harvests of fish and wildlife in 9 of 15 villages surveyed declined from 4 to 78 percent in 1989 when compared to prespill averages. Seven of the 15 villages show continued decline in use in 1990 and 1991. This decline was particularly noticeable in the Prince William Sound villages of Chenega and Tatitlek. In 1989, chemical analysis indicated that most resources tested, including fish, marine mammals, deer, and ducks, were safe to eat, but that shellfish from oiled beaches should not be eaten. However, villagers believe that contamination of subsistence food sources continues to be dangerous to their health and that some subsistence species continue to decline.

Estimated Natural Recovery Rates of Injured Biological Resources

The estimates in the table contain a great deal of uncertainty. For some species there is substantial disagreement within the scientific community. The estimates are likely to change as recovery continues, more information is provided through monitoring, and scientists learn more about the species.

The table presents estimated natural recovery rates for injured biological resources. Predicting the amount of time needed for a species to recover is extremely difficult. Scientists often use models based on factors such as population numbers and growth rates. However, for many of the injured biological resources the background information was not available to develop these predictive models. For those resources, peer reviewers and agency scientists based their estimates on the best available information.

For example, for black oystercatchers there have been no studies to determine a population growth rate anywhere within the species' range. In this case, the experts are forced to rely on information from a related species, the Eurasian oystercatcher, to estimate a recovery time. Under certain circumstances, a population of Eurasian oystercatchers would be capable of growing at 6.25% annually. If the injured black oystercatcher population grows at the same rate, it could recover to prespill numbers in 15 years. The amount of time could be considerably less if the growth rate is higher, or if animals from adjacent areas move to the oiled area. On the other hand, the recovery time could be considerably longer if the growth rate is less than that of the Eurasian oystercatcher, or if the habitat quality is low. Where oil persists in the environment, habitat quality is likely to be low.

Recovery estimates for services are not provided in the table below. Recovery is linked, in part, to the resources that support the service, and can vary widely between user groups.

	RESOURCES	NATURAL RECOVERY ESTIMATES (Years from 1989)	COMMENTS
POPULATION DECLINE	**BLACK OYSTERCATCHER**	15 to 30 years	Recovering.
	COMMON MURRE	50 to 120 years	Recovery varies by colony.
	HARBOR SEAL	Unknown	In decline before spill. Population may have stabilized.
	HARLEQUIN DUCK	10 to 50 years	Still no reproduction within oiled areas studied in Prince William Sound.
	INTERTIDAL ORGANISMS	10 to 25 years	Recovery estimates are combined for all organisms in the upper intertidal zone. Recovery in lower and mid-intertidal zones is expected to be faster than that in the upper intertidal zone.
	MARBLED MURRELET	Unknown	In decline before spill. Estimates vary widely on when the population may stabilize. It may be stable now, or may take about 50 years to stabilize at lower population size.
	PIGEON GUILLEMOT	Unknown	In decline before spill. Probably still declining. Should stabilize in less than 50 years.
	SEA OTTER	15 to 40 years	Population stable, but not recovering.
	SOCKEYE SALMON	10 to 50 years	Estimates ar for attaining a 10-year average similar to prespill populations for Kenai River and Red Lake sockeye salmon.
	SUBTIDAL ORGANISMS	Less than 10 years	Recovering in most places.
INJURED, BUT NO POPULATION DECLINE	**BALD EAGLE**	4 to 6 years	Back to prespill population between 1993 and 1995.
	CUTTHROAT TROUT	10 to 20 years	
	DOLLY VARDEN	10 to 20 years	
	KILLER WHALE	10 to 20 years	Estimates are for the injured pod to return to its prespill size. Currently recovering.
	PACIFIC HERRING	Unknown	Population decline may be documented after 1993.
	PINK SALMON	Less than 20 years	Estimates represent recovery of wild stocks to a population level that may be less than 100% of the prespill population.
	RIVER OTTER	Unknown	Injury and actual population size are difficult to assess.
	ROCKFISH	Unknown	

STEP 1. fold on dotted line (top half, away from you)

Courtesy of CHUGACH NATIONAL FOREST

Photo by PAT MURPHY

STEP 2. fold on dotted line (left half, away from you)

Tape or Staple Here

RETURN ADDRESS:

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PLACE STAMP HERE

Exxon Valdez
Oil Spill Restoration Office
645 "G" Street
Anchorage, Alaska 99501

STEP 3 fold on dotted line (bottom half, away from you)

We would like to know your views about the appropriate policies, categories of restoration activities, and possible spending allocations. Please fill out the questions on the next page and let the Trustee Council know which approaches you believe will best restore the resources and services injured by the spill. If you need more information, please come to one of the public meetings. Also, feel free to comment on other parts of the plan alternatives. Attach additional sheets if you need more space.

Thanks for your help!

To be sure that you are on our mailing list and to receive further information when it is available, please put your name and address either here on or as the return address. If you would rather not list your name, please put the community where you live.

____

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☐ If you would like to receive a copy of the Draft Environmental Impact Statement and Draft Restoration Plan when it is avail able this June, please check the box.

While we would appreciate your comments as soon as possible, they must be received by **August 6, 1993.**

TELL US WHAT YOU THINK

NEXT PAGE

Questionnaire

Tell Us What You Think!

QUESTIONS ABOUT ISSUE AND POLICIES

The alternatives present policy questions. The answers to those questions will help guide restoration activities. The policy questions are reprinted below. Please mark the appropriate box to let us know your views. If you think that these policies should apply to some restoration activities but not others, please write your views in the space provided beneath each question. For example, if you think that some general restoration activities are appropriate outside the spill area but that habitat protection should concentrate only on the spill area, you would write that information in the comment space.

Injuries Addressed by Restoration Actions:

Should restoration actions address all injured resources and services, or all except those biological resources whose populations did not measurably decline because of the spill?

- ❑ Target restoration activities to all injured resources and services.
- ❑ Target all injured resources and services except those biological resources whose populations did not measurably decline because of the spill.
- ❑ No preference.

Comments:

Restoration Actions for Recovered Resources:

Should restoraction actions cease when a resource has recovered, or continue in order to enhance the resource?

- ❑ Cease restoration actions once a resource recovers.
- ❑ Continue restoration actions even after a resource has recovered in order to enhance the resource.
- ❑ No preference

Comments:

Effectiveness of Restoration Actions:

Should the plan include only those restoration actions that produce substantial improvement over natural recovery or also those that produce at least some improvement?

- ❑ Conduct only those restoration actions that provide substantial improvement over natural recovery.
- ❑ Conduct restoration actions that provide at least some improvement over natural recovery.
- ❑ No preference

Comments:

Location of Restoration Actions:

Should restoration activities take place in the spill area only, anywhere in Alaska provided there is a link to injured resources or services, or anywhere in the United States provided there is a link to injured resources or services?

- ❑ Limit restoration actions to the spill area only.
- ❑ Undertake restoration actions anywhere in Alaska there is a link to injured resources or services.
- ❑ Undertake restoration actions anywhere in the United States there is a link to injured resources or services.
- ❑ No preference

Comments:

Opportunities for Human Use:

To what extent should restoration actions be used to create opportunities for human use of the spill area?

- ❑ Do not conduct restoration actions that create opportunities for human use.
- ❑ Conduct restoration actions to protect existing human use. Examples are recreation facilities that protect the environment in over-used areas such as outhouses or improved trails.
- ❑ In addition to restoration actions that protect existing human use, also conduct actions that increase existing human use. Examples are increasing existing sport- or commercial fish runs, or constructing recreation facilities such as public-use cabins.
- ❑ In addition to activities that protect or increase existing human use, also conduct actions that encourage appropriate new uses. Examples are new fish runs, commercial facilities, or visitor centers.
- ❑ No preference

Comments:

COMMENTS

Please use the space below to describe an area you would like the Trustee Council to acquire or protect, or an area appropriate for any other restoration option such as locations for public-use cabins, or fish passes. Or use the space to write any comments you would like the Trustee Council to know about. If you do describe a particular location, please provide enough detail about the location so we can understand where it is, and which injured resource or service it would benefit. Any comment you write will be greatly appreciated.

QUESTIONS ABOUT RESTORATION CATEGORIES

The questions below discuss the different categories of restoration activities. The questions ask about what categories of activities you believe the Trustee Council should use.

Monitoring and Research To effectively conduct restoration, it is necessary to monitor recovery and to monitor the effectiveness of individual restoration activities. It is also possible to conduct other monitoring activities: Ecological monitoring and restoration research.

In addition to Recovery and Restoration monitoring, should the Trustee Council also conduct other monitoring activities?

- ❑ NO
- ❑ YES. Please indicate which monitoring and research activities you believe are appropriate (you may mark more than one answer):
  - ❑ Ecological monitoring (monitor general ecosystem health to identify problems and prepare for future spills)
  - ❑ Restoration Research (basic and applied research to benefit injured resources and services)
  - ❑ Other

Comments:

Habitat Protection and Acquisition Four of the alternatives identify habitat protection and acquisition as a means of restoring injured resources or services (human uses).

Do you agree that habitat protection and acquisition should be a part of the plan?

- ❑ NO
- ❑ YES. Protection and acquisition will include all habitat types, but may emphasize one over another. Please indicate the habitat types, if any, that should be emphasized. Suggest your own approach if it isn't covered here.
  - ❑ Emphasize acquiring and protecting habitat important to injured resources. Important scenic areas and human use areas with little habitat important to injured resources would be less likely to be acquired.
  - ❑ Emphasize acquiring and protecting habitat important for human use (important scenic areas and human use areas). Habitat important to injured resources, but seldom used or viewed by people, would be less likely to be acquired.
  - ❑ Place equal emphasis on acquiring the most important habitats for injured species and on the most important habitats for human use (scenic and human use areas). Parcels that are only moderately important for injured resources or services would be less likely to be acquired.
  - ❑ Other

Comment:

QUESTIONS ABOUT SPENDING

Funding Method: Endowment. The Trustee Council could save some of the civil settlement to fund restoration activities after Exxon payments end. It is possible to save any portion of the settlement. For example, if approximately 20% of the remaining settlement funds were placed into an endowment and the principal inflation-proofed, the endowment could fund $3-$5 million worth of restoration activities indefinitely.

Are you in favor of an endowment or savings account of some kind?

- ❑ NO, I believe the funds should be spent within approximately 10 years.
- ❑ YES. Please indicate the amount that you believe should be placed into an endowment
  - ❑ Less than 20%
  - ❑ 20%
  - ❑ 40%
  - ❑ More than 40%
  - ❑ Other Amount. If you know the amount please indicate: ______%.

Comments:

If you answered "Yes" to the previous question, please indicate what the annual endowment earnings should be spent on (you may mark more than one answer):

- ❑ Monitoring and Research
- ❑ General Restoration
- ❑ Habitat Protection and Acquisition
- ❑ No Preference

Comments:

Potential Allocations

The table shows potential allocations in the five alternatives. If one of the alternatives reflects your view of which activities should be emphasized, please circle the number of that alternative. If not, please put write in your percentages in the box provided under category "YOUR ALTERNATIVE". If you favor categories for restoration that are not listed below, please write your ideas in the space providied. If, in the question above, you marked "YES" to indicate you favor endowment, remember to put in a percentage for endowment. (Make sure your percentages add to 100%!).

ALTERNATIVE:	1 NATURAL RECOVERY	2 HABITAT PROTECTION	3 LIMITED RESTORATION	4 MODERATE RESTORATION	5 COMPREHENSIVE RESTORATION	YOUR ALTERNATIVE	*If none of our alternatives reflect your views about allocating the funds. Write percentages below.*
Administration & Public Information		4%	6%	7%	7%		Administration & Public Information
Monitoring & Research		5%	7%	8%	10%		Monitoring & Research
General Restoration			12%	35%	48%		General Restoration
Habitat Protection & Acquisition		91%	75%	50%	35%		Habitat Protection & Acquisition
							Other______________
							Other______________
Endowment							Endowment
Balance	100%						Balance
TOTAL	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*TOTAL*

General restoration

For some resources and services, no known restoration approach is likely to be effective. In these cases, the main agent of recovery is nature. For other resources and services, however, it may be possible to provide some improvement over natural recovery.

The General Restoration category of Alternatives 3 through 5 includes various restoration actions that have been suggested throughout the planning process. The suggestions were evaluated by scientists and peer reviewers. Those that were determined to be effective have been combined into general options and are listed below. Those general options may include a number of specific projects. The evaluation of options considered how recovery was aided and whether further potential injury could be prevented. Other considerations included potential negative effects and how many species benefit. No options were identified for restoring subtidal resources, air, water, sediment, designated wilderness or wilderness study areas. The list on this page provides examples of restoration options that received favorable evaluations. New options will continue to be evaluated as the restoration plan is implemented.

Specific projects will require legal review to ensure compliance with the civil settlement. The Trustee Council will only fund projects that are consistent with the civil settlement.

Some activities, such as habitat protection and acquisition, would have wide-ranging impacts throughout the spill area. Most options that help resources also help the services that are dependent upon them. An option targeted to improve the recovery of a single resource may greatly benefit other resources that occur in the same area. This is especially true of the activities that protect marine, coastal and upland habitats. In addition, options that benefit the foundation of a food web, such as marine invertebrates, would ultimately benefit top predators such as whales and eagles.

MAMMALS

		Alternatives 3	4	5
HARBOR SEAL	Determine the effects of disturbance on harbor seals and implement actions to reduce adverse effects.			X
	◆ Implement cooperative programs between fishermen and agencies to provide voluntary methods to reduce incidental take of harbor seals during fishing.	X	X	X
	◆ Implement cooperative programs between subsistence users and agencies to assess the effects of subsistence harvest.	X	X	X
KILLER WHALE	◆ Determine techniques for changing black cod fishery gear to avoid conflicts with fishermen and implement actions to remove adverse effects.		X	X
SEA OTTER	◆ Determine the effects of disturbance of upland activities on sea otters and implement actions to reduce adverse effects. This would have benefits in local areas only.	X	X	X
	◆ Determine if eliminating oil from mussel beds removes a potential source of continuing contamination to sea otter food and take appropriate action. This would have benefits in local areas only.	X	X	X
	◆ Implement cooperative programs between subsistence users and agencies to assess the effects of subsistence harvest.	X	X	X
RIVER OTTER	Develop sport and trapping harvest guidelines to aid in the recovery of injured populations.			X

FISH

		Alternatives 3	4	5
SOCKEYE SALMON	◆ Intensify management of sockeye salmon on the Kenai River and Red Lake to reduce the risk of overescapement.	X	X	X
	Improve access to salmon streams by building fish passes to increase the area where salmon can successfully spawn and rear. This would have benefits in local areas only.			X
	Fertilize lakes to improve sockeye rearing success within the lake and increase sockeye population.		X	X
	◆ Improve survival rates of salmon eggs to fry by using egg boxes, net pens or hatchery rearing.	X	X	X
PINK SALMON	◆ Intensify management by incorporating coded-wire tagging and stock separation to ensure and accelerate the recovery of the wild stock.		X	X
	Construct salmon spawning channels and other instream improvements to increase spawing production and provide long-term enhancement. This would have benefits in local areas only.			X
	Improve access to salmon streams by building fish passes to increase the area where salmon can successfully spawn and rear. This would have benefits in local areas only.			X
	◆ Relocate hatchery runs of pink salmon to reduce the interception rate of wild stocks of pink salmon.		X	X
	Improve survival rates of salmon eggs to fry by using egg boxes, net pens, or hatchery rearing. This would have benefits in local areas only.			X
	Update the Alaska Anadromous Streams Catalog to ensure that the necessary protection and regulation is provided for all listed salmon streams in the spill area.			X
CUTTHROAT TROUT	◆ Intensify management of cutthroat trout and its dependent sport fishery by determining local distribution, abundance, and productivity.		X	X
	Update the Alaska Anadromous Streams Catalogue to ensure necessary protection and regulation for all listed anadromous streams in the spill area.			X
DOLLY VARDEN	◆ Intensify management of Dolly Varden and its dependent sport fishery by determining local distribution, abundance and productivity.		X	X
PACIFIC HERRING	◆ Intensify management to improve recovery by allowing increased precision in stock assessment and manipulation of harvest levels.		X	X
ROCKFISH	◆ Intensify management of the rockfish fishery to modify the harvest to compensate for injury from the spill.		X	X

COASTAL HABITAT

		Alternatives 3	4	5
INTERTIDAL ORGANISMS	◆ Accelerate the recovery of the upper intertidal zone to aid intertidal resources in localized areas.	X	X	X
SUBTIDAL ORGANISMS	No restoration options have been identified.			

NOTE: ◆ denotes options that may produce substantial improvement in assuring recovery of a biological resource. Those without an asterisk may produce at least some improvement in recovery.

BIRDS

		Alternatives 3	4	5
BLACK OYSTERCATCHER	Accelerate the recovery of the upper intertidal zone to improve the rate of recovery in site-specific areas. This would have benefits in local areas only.			X
	◆ Remove predators from islands that previously supported black oystercatchers. Effectiveness varies by location.		X	X
COMMON MURRE	Reduce disturbance at breeding colonies to eliminate factors which could slow the recovery of affected murre colonies.			X
	◆ Use artificial stimuli such as decoys or vocalizations to encourage recovery at affected colonies and accelerate recolonization of historic colonies.	X	X	X
	◆ Remove predators at injured colonies or remove predators from islands that previously supported murres.	X	X	X
HARLEQUIN DUCK	Modify sport hunting harvest guidelines in the areas of injured populations to speed the rate of recovery during the recovery phase.			X
	◆ Determine if eliminating oil from mussel beds removes a potential source of continuing contamination in feeding areas and take appropriate action. This would have benefits in local areas only.	X	X	X
MARBLED MURRELET	◆ Minimize the incidental capture of birds in fishing nets by changes in gear or timing of fishing.	X	X	X
PIGEON GUILLEMOT	◆ Control predator access or remove predators from islands that previously supported birds.	X	X	X
BALD EAGLE	No options other than habitat protection have been identified.			

DESIGNATED WILDERNESS AREAS

Alternatives 3 4 5

No options have been identified for Designated Wilderness Areas or Wilderness Study Areas.

ARCHAEOLOGICAL RESOURCES

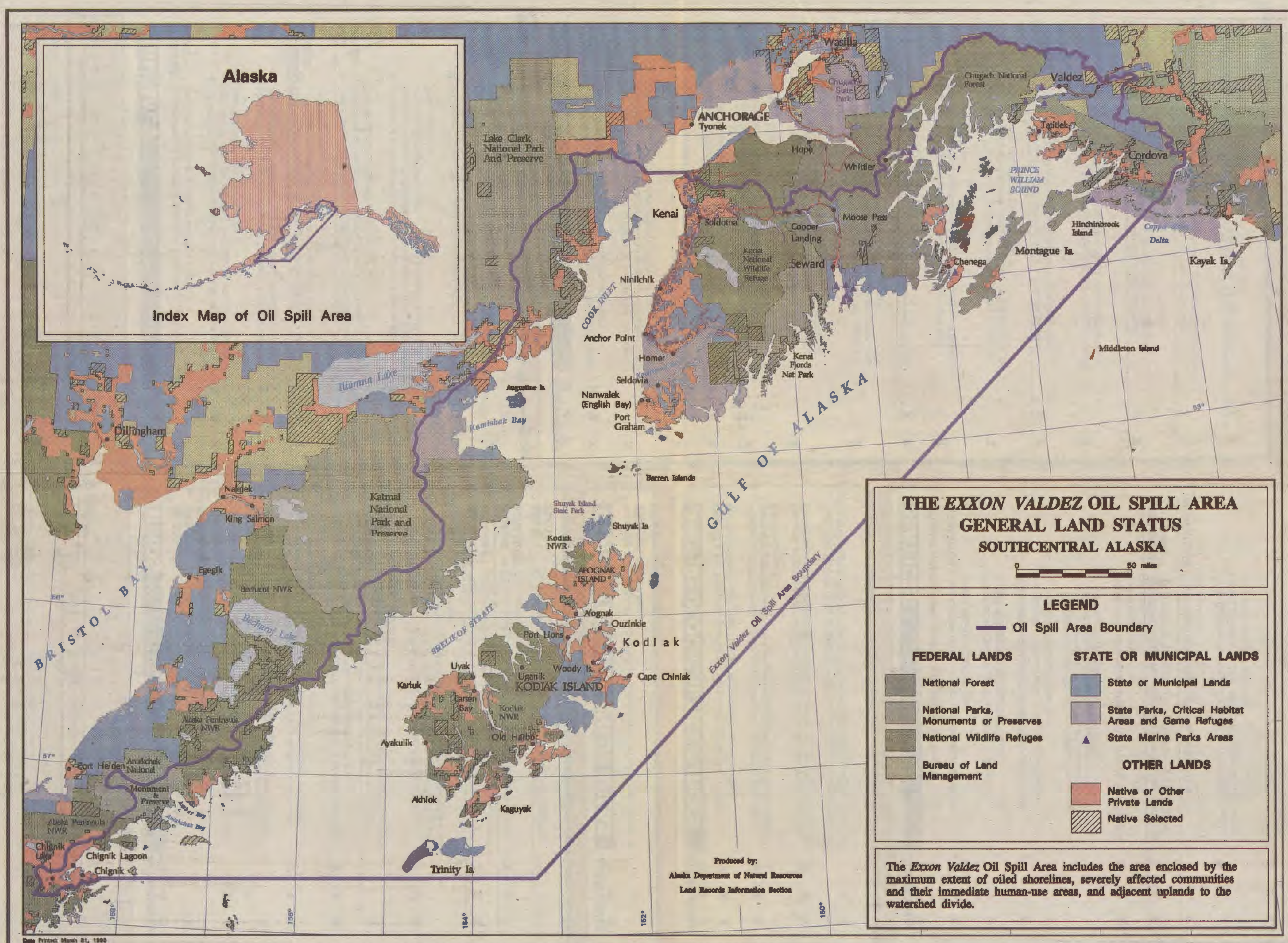
	Alternatives 3	4	5
Develop a site stewardship program using local residents to monitor nearby archaeological sites to discourage looting and vandalism.	X	X	X
Increase law enforcement and agency presence to patrol and monitor archaeological sites within the spill area would protect sites from looting and vandalism.	X	X	X
Preserve archaeological sites and artifacts within the spill area to provide some measure of permanent protection for select archaeological resources.	X	X	X
Acquire replacements for artifacts from the spill area as a means of preserving and studying artifacts which were taken from the spill area prior to the spill.		X	X

SERVICES

Resource options shown above also benefit many services.

		Alternatives 3	4	5
RECREATION	Develop new backcountry public recreation facilities to protect existing recreation use.	X	X	X
	Develop backcountry public recreation facilities to protect and increase existing resource use.		X	X
	Encourage appropriate new recreation use, such as: *Marketing public land for commercial operators and recreationists to use public lands.* *Creating new visitor centers or building a marine environmental institute to increase public awareness of the nature of injury and recovery and understanding of the ecosystem of that area.*			X
	Replace lost harvest opportunities by creating new fisheries for salmon or trout.	X	X	X
COMMERCIAL TOURISM	The restoration options, and the alternatives they appear in, are identical to those described above for RECREATION	X	X	X
SUBSISTENCE	Replace lost harvest opportunities by creating new salmon runs.			X
	Test subsistence foods for continued contamination as a means of restoring confidence in the safety of subsistence resources within the spill area.	X	X	X
	Provide new access to traditional foods in areas outside the spill area to restore lost use. This option will undergo legal review.	X	X	X
	Develop subsistence mariculture sites to benefit subsistence users by providing a source of uncontaminated shellfish for their diets.			X
	Develop a shellfish hatchery and technical research center to benefit subsistence users by providing a source of uncontaminated shellfish for their diets.			X
COMMERCIAL FISHING	Replace harvest opportunities by creating new fish runs to replace commercial fishing opportunities lost due to fishing closures or reduced harvest.	X	X	X
PASSIVE USE	No options other than habitat-protection have been identified for this resource.			

map of the oil spill area



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Notes

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Supplement

to

DRAFT

EXXON VALDEZ OIL SPILL RESTORATION PLAN

Summary of Alternatives for Public Comment

Prepared by:

***Exxon Valdez* Oil Spill**
Trustee Council

645 G Street
Anchorage, Alaska
99501
(907) 278-8012

June 1993

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Supplement to the

DRAFT *EXXON VALDEZ* OIL SPILL RESTORATION PLAN

Summary of Alternatives for Public Comment

In response to your request, this Supplement is being provided to help you understand and comment on the newspaper brochure that you previously received, the Draft *Exxon Valdez* Oil Spill Restoration Plan: Summary of Alternatives for Public Comment. The Summary of Alternatives asked you to express your opinion on how the Trustee Council should restore injured resources and lost or reduced services. It also specifically requested comment on policy questions and restoration alternatives. At public meetings and presentations in April and May, many people asked for more information before making comments. This Supplement to the Summary of Alternatives provides commonly requested information. Remember, public comments on the Summary of Alternatives are due by August 6th.

The Supplement consists of the following six sections.

SECTION A - Allocation of the Civil Settlement Fund (June 1993): This section describes expenditures from the $900 million civil settlement, including projects funded under the 1992 and 1993 Annual Work Plans.

SECTION B - Injury and Recovery: This section describes injuries to resources and lost or reduced services. Information on the recovery status of these resources and services is also presented. This section is based on the latest available data from injury assessment studies.

SECTION C - Habitat Protection and Acquisition: Section C describes the process used to date for protecting and acquiring habitat on private lands. Examples are provided of how land parcels are ranked. The section also explains likely changes in the habitat evaluation process and options for protecting habitat on land already in public ownership.

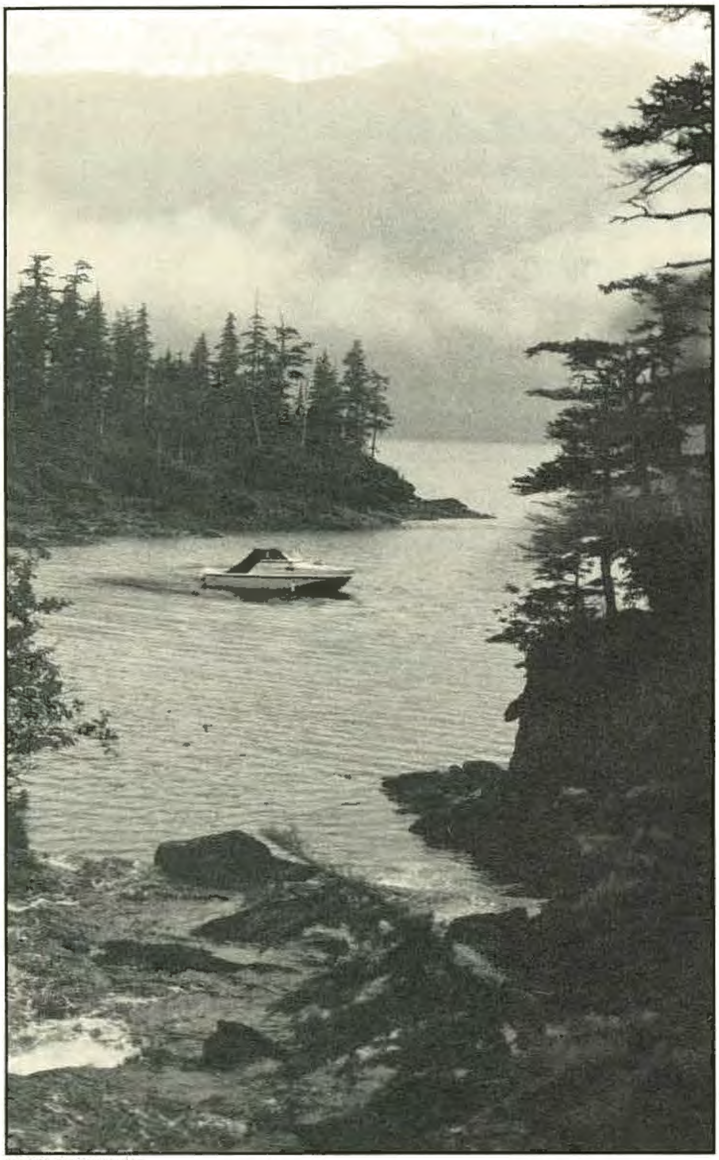
SECTION D - General Restoration Options: Section D provides examples of options for restoring injuries. Some options involve direct manipulation of resources, such as improving salmon spawning and rearing habitat. Others focus on managing human uses of resources, such as implementing cooperative programs to assess effects of subsistence harvests on marine mammals.

SECTION E - Restoration Monitoring and Research Program: The restoration program will likely include monitoring of recovery and restoration activities. Ecosystem monitoring and research on new restoration techniques may also be included. This section describes all of these components.

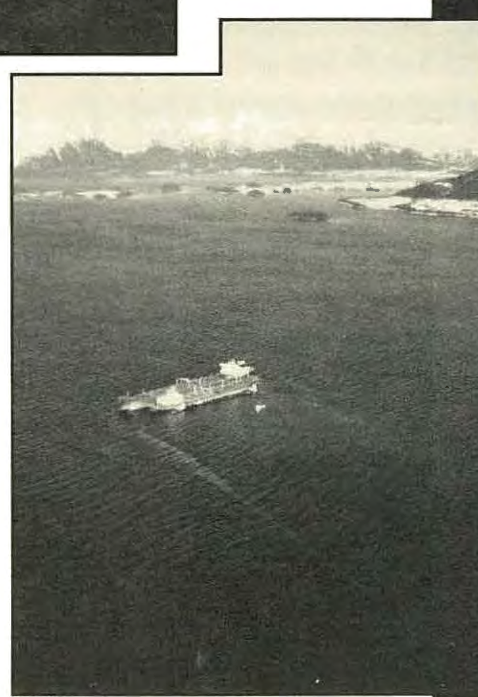
SECTION F - Boundaries of the Oil Spill Area: This section contains a map of the area affected by the oil spill. This map is a revised version of the one included in the Summary of Alternatives, and now includes Perryville and Ivanof Bay. These changes were made in response to public comments which pointed out that these areas met the established criteria for inclusion in the spill area.

Section A

ALLOCATION OF CIVIL SETTLEMENT FUND (June 1993)



U.S. FOREST SERVICE



JOHN STRAND

Section A

ALLOCATION OF THE CIVIL SETTLEMENT FUND

(June 1993)

In a civil settlement, Exxon Corporation agreed to pay the United States and the State of Alaska $900 million over a 10-year period to restore resources injured by the *Exxon Valdez* oil spill and reduced or lost services.

Table A-1 shows the schedule of payments over this period.

As of June 1993, $240 million of the $900 million civil settlement has been paid by Exxon Corporation. Exxon makes its restoration payments to a Joint Trust Fund held by the U.S. District Court for use by the Trustee Council. About $200 million has been reimbursed directly to accounts of the governments, credited to Exxon, or committed for restoration and damage assessment projects and administration. Some of the approved expenditures have not yet been withdrawn from the balance in the Joint Trust Fund. This section contains five more tables that describe how the Trustee Council has used these funds.

Table A-2 shows how the $240 million was allocated: 45% was reimbursed to the state and federal governments for expenses; nearly 23% was committed to Work Plans for 1992 and 1993; and 17% was credited to Exxon for cleanup expenses. About 16% is uncommitted. On May 13, 1993, the Trustee Council approved purchase of Seal Bay, Afognak Island, for $38.7 million pending results of negotiations and appraisal. This potential acquisition is not fully reflected in these figures.

Table A-3 shows how reimbursements to the state and federal governments have been allocated. Of the $58 million reimbursed to the state government, 30% was for litigation, 33% was for damage assessment, and 37% was for cleanup and response. The federal government received about $49 million. Data on the distribution of reimbursements to the federal government are not available. An additional $39.9 million was credited to Exxon for the cost of cleanup required by the U.S. Coast Guard after January 1, 1991.

Table A-4 shows how the 1992 Work Plan allocated funds among restoration projects, damage assessment, and administration **Table A-5** does the same for the 1993 Work Plan. The figures reported for the 1993 Work Plan are for the period 3/1/93 - 9/30/93. The 1993 Work Plan is for a 7-month period of transition to the federal fiscal year, which begins 10/1/93. The 1992 Work Plan emphasized completion of damage assessment studies; the 1993 Work Plan emphasizes restoration. Restoration includes monitoring, habitat protection, and general restoration projects.

Table A-6 combines allocations for both work plans. Of the $54 million approved by the Trustee Council for both work plans, 68% has been for restoration, 15% for damage assessment, and 17% for administration. Over half the allocation to restoration projects was for habitat protection.

TABLE A-1

Schedule of Payments

DATE	AMOUNT
December 1991	**$90 million**
December 1992	**$150 million**
September 1993	**$100 million**
September 1994	**$70 million**
September 1995	**$70 million**
September 1996	**$70 million**
September 1997	**$70 million**
September 1998	**$70 million**
September 1999	**$70 million**
September 2000	**$70 million**
September 2001	**$70 million**
TOTAL	**$900 million**

Table A-2

Allocation of Civil Settlement Received as of June 1993

PURPOSE	ALLOCATION	PERCENT	COMMENTS
Reimbursements to state and federal governments	**$107,500,000**	**44.8%**	See Table A-3 for details.
1992 Work Plan	**$19,211,000**	**8.0%**	See Table A-4 for details.
1993 Work Plan	**$35,054,000**	**14.6%**	See Table A-5 for details.
Credit to Exxon for cleanup costs after 01/01/91.	**$39,900,000**	**16.6%**	
Uncommitted	**$38,335,000**	**16.0%**	
TOTAL	**$240,000,000**	**100.0%**	

Funds not yet withdrawn from the Joint Trust Fund are earning interest.

Table A-3

REIMBURSEMENTS TO STATE AND FEDERAL GOVERNMENTS

PURPOSE	AMOUNT	PERCENT
STATE		
Litigation	$17,400,000	30%
Damage Assessment	$19,300,000	33%
Cleanup and Response	$21,600,000	37%
SUBTOTAL	**$58,300,000**	**100%**
FEDERAL	$49,200,000	
TOTAL	**$107,500,00**	

Table A-4

1992 WORK PLAN

The Trustee Council approved $19,211,000 for the 1992 Work Plan, which was undertaken during the period 3/1/92 through 2/28/93. Of that amount, 39% was used to close out or continue Natural Resource Damage Assessment, 26% was for administration, and 35% was for restoration. Because the focus of this planning process is restoration, this table describes only restoration projects approved in the 1992 Work Plan. It does not describe damage assessment or administration projects.

Restoration Projects

PROJECT NUMBER	PROJECT TITLE	PROJECT DESCRIPTION	AMOUNT APPROVED	PERCENT
R11 RM	**Murre Restoration Recovery Monitoring**	Document rate of recovery of murres breeding in the Barren Islands and Puale Bay.	**$316,700**	
R15 HP	**Marbled Murrelet Restoration Study**	Determine marbled murrelet nesting habitat in the spill area and identify their use of those habitats.	**$419,300**	
R47 HP	**Stream Habitat Assessment**	Identify and prioritize private lands where an imminent and significant habitat alteration threat exists.	**$399,600**	
R53 RM	**Kenai River Sockeye Salmon Restoration**	Restore injured Kenai River sockeye salmon stocks through im-proved stock assessment, capabilities, regulation of spawning levels, and modification of human use.	**$674,200**	
R59 RM	**Genetic Stock Identification**	Use genetic stock identification to protect injured Kenai River salmon in mixed-stock areas.	**$320,900**	
R60AB RM	**Prince William Sound Pink Salmon**	Recover coded-wire tags in the catches and spawning populations of pink salmon in Prince William Sound.	**$1,479,700**	
R60C	**Pink Salmon Egg/Fry**	Monitor recovery of wild pink salmon stocks in Prince William Sound	**$492,800**	
R71 HP	**Harlequin Duck Restoration and Monitoring**	Locate, identify and describe harlequin duck nesting habitat in PWS; determine width of forested buffer strips, and feasibility of stream habitat enhancement techniques	**$424,500**	
R73 RM	**Harbor Seals**	Monitor movements, hauling out, and diving behavior of harbor seals in Prince William Sound.	**$25,000**	

Table A-4 *continued*

PROJECT NUMBER	PROJECT TITLE	PROJECT DESCRIPTION	AMOUNT APPROVED	PERCENT
R90 RM	**Dolly Varden Char Monitoring**	Remove weir material and camp equipment from field locations and produce final report	$91,500	
R92 ? RM	**GIS Mapping and Analysis: Restoration**	Develop information as needed to evaluate or implement restoration projects.	$125,500	
R102 RM	**Herring Bay Experimental and Monitoring Study**	Determine what factors limit or facilitate recolonization of the intertidal by algae, especially Fucus, and invertebrates; and to provide controlled, long-term natural recovery monitoring of intertidal communities.	$485,600	
R103 RM	**Oiled Mussels**	Determine the geographical extent of oiled mussel beds in the spill area, the intensity of oil remaining in mussels, and the underlying organic mat in order to assess possible linkage with continuing injury to harlequin ducks, oystercatchers, juvenile sea otters, and river otters.	$874,000	
R104A HP	**Site Stewardship**	Recruit, educate, and involve local people to protect archaeological resources in their areas.	$159,200	
R105 RM	**Study and Evaluation of Instream Habitat and Stock Restoration Techniques for Anadromous Fish**	Determine preliminary restoration techniques for specific sites; select the most appropriate fish restoration projects.	$348,100	
R106 RM	**Dolly Varden Restoration**	Prepare final report for the data collected in this project through 1991.	$34,900	
R113 RM	**Red Lake Sockeye Salmon Restoration**	Increase survival of wild salmon in Red Lake (Kodiak Island) by incubating eggs and rearing fry in Pillar Creek Hatchery and transplanting them to the lake.	$55,900	
		RESTORATION PROJECTS - Subtotal	**$6,727,400**	**35%**
		DAMAGE ASSESSMENT	**$7,407,500**	**39%**
		ADMINISTRATION	**$5,076,100**	**26%**
		TOTAL	**$19,211,000**	**100%**

Table A-5

1993 WORK PLAN

The Trustee Council approved $35,054,000 for the 1993 Work Plan, which will be undertaken during the 7-month period 3/1/93 through 9/30/93. Of that amount, less than 2% will used for Natural Resource Damage Assessment, 12% will be for administration, and over 86% will be used for restoration. Because the focus of this planning process is restoration, this table describes only restoration projects approved in the 1993 Work Plan. It does not describe damage assessment or administration projects.

Restoration Projects

PROJECT NUMBER	PROJECT TITLE	PROJECT DESCRIPTION	AMOUNT APPROVED	PERCENT
93003 RM	**Salmon Egg to Pre-emergent Fry Survival**	Continue to monitor egg mortalities in the oiled and unoiled wild pink salmon streams.	**$686,000**	
93006	**Site-Specific Archaeological Restoration**	Assess injury at 24 sites and restore 19 of them.	**$260,100**	
93012	**Genetic Stock Identification of Kenai River Sockeye Salmon**	Develop a comprehensive database of sockeye salmon stocks in Cook Inlet.	**$300,600**	
93015	**Kenai River Sockeye Salmon Restoration**	Increased monitoring and management of the sockeye salmon stocks in the Kenai River and Upper Cook Inlet north of Anchor Point.	**$512,600**	
93016	**Chenega Bay Chinook and Silver Salmon (NEPA Compliance)**	NEPA compliance for the replacement of subsistence resources by permitted releases of chinook and coho salmon at designated sites near Chenega village from stocks of hatchery near Esther Island.[1]	**$10,700**	
93017	**Subsistence Food Safety Survey and Testing**	Work with communities to identify and map areas and resources of continuing concern to subsistence users; sample subsistence foods from these areas.	**$307,100**	
93022	**Monitor Murre Colony Recovery**	Monitor the recovery of murres in the Barren Islands.	**$177,200**	
93024	**Restoration of Coghill Lake Sockeye Salmon Stock**	Sockeye Salmon Stock Restore natural productivity of Coghill Lake for sockeye salmon through use of lake fertilization techniques.	**$191,900**	

[1] Although NEPA (National Environmental Policy Act of 1969, as amended) compliance was undertaken in 1993, the project itself will be deferred until 1994.

Table A-5 *continued*

PROJECT NUMBER	PROJECT TITLE	PROJECT DESCRIPTION	AMOUNT APPROVED	PERCENT
93033	**Harlequin Duck Restoration Monitoring Study in PWS, Kenai and Afognak Oil Spill Areas**	Study harlequin duck reproductive failure in western PWS; on outer Kenai coast and Afognak Island determine if there is reproductive failure and characterize their nesting habitat.	**$300,000**	
93034	**Pigeon Guillemot Colony Survey**	Identify and map pigeon guillemot colonies.	**$165,800**	
93035	**Black Oystercatchers/ Oiled Mussel Beds**	Determine whether black oystercatchers breeding on shorelines with persistent oil contamination in Prince William Sound are affected by their use of these habitats.	**$107,900**	
93036	**Oiled Mussel Beds**	Document continued bioavailability of petroleum hydrocarbons to consumers of contaminated mussels and determine the rate of recovery of oiled mussel beds.	**$404,800**	
93038	**Shoreline Assessment**	Assess the shoreline hydrocarbon concentrations and, where appropriate, carry out necessary treatment using local work crews.	**$539,200** [2]	
93039	**Herring Bay Experimental and Monitoring**	Determine what factors limit or facilitate recolonization of the intertidal by algae, especially Fucus, and invertebrates; and to provide controlled, long-term natural recovery monitoring of intertidal communities.	**$507,500**	
93041	**Comprehensive Monitoring**	Design the monitoring component of the Restoration Plan.	**$237,900**	
93042	**Killer Whale Recovery**	Obtain photographs of individual killer whales occurring in AB pod and document natural recovery.	**$127,100**	
93043	**Sea Otter Demographics and Habitat**	Restore sea otter populations by determining what is limiting their recovery and identifying important sea otter habitat in Prince William Sound for possible protection.	**$291,900**	
93045	**Marine Bird / Sea Otter Surveys**	Obtain annual estimates of the summer and winter populations of marine birds and sea otters in Prince William Sound to determine whether populations that had declined are recovering.	**$262,400**	

H

H

2 This amount includes $15,000 for U.S. Coast Guard transportation.

Table A-5 *continued*

	PROJECT NUMBER	PROJECT TITLE	PROJECT DESCRIPTION	AMOUNT APPROVED	PERCENT
H	93046	**Habitat Use, Behavior, and Monitoring of Harbor Seals in PWS**	Monitor the abundance and trends of harbor seals in oiled and unoiled areas of Prince William Sound and characterize habitat use, hauling out and diving behavior.	**$230,500**	
	93047	**Subtidal Monitoring**	Monitor recovery of sediments, hydrocarbon-degrading microorganisms, eelgrass beds, and shallow fish species in the subtidal environment.	**$1,000,800**	
H	93051	**Habitat Protection Information for Anadromous Streams and Marbled Murrelets**	Assess marbled murrelet nesting habitat; survey anadromous fish streams on candidate lands for habitat protection.	**$1,222,300**	
	93053	**Hydrocarbon Database**	Estimate the amount of Exxon Valdez oil that is present in environmental samples analyzed for hydrocarbons that are collected during restoration.	**$105,500**	
	93057	**Damage Assessment Geographic Information System**	Complete statistical analysis and geographic information system mapping support for existing damage assessment studies and provide a database for restoration.	**$67,500**	
H	93059	**Habitat Identification Workshop**	Identify parcels of nonpublic lands with habitat necessary for recovery of injured resources and services under imminent threat.	**$42,300**	
H	93060	**Accelerated Data Acquisition**	Collect and organize existing resource data needed to evaluate habitat protection and acquisition proposals.	**$43,900**	
	93062	**Restoration Geographic Information System**	Provide statistical and spatial analysis and geographic information system mapping support for approved restoration projects.	**$123,300**	
H	93063	**Anadromous Stream Surveys**	Develop proposals and designs for appropriate and cost-effective instream habitat and stock restoration projects.	**$59,400**	
H	93064	**Imminent Threat Habitat Protection**	Protect habitat under imminent threat.	**$20,000,000**	12.5 unobligated

Table A-5 *continued*

PROJECT NUMBER	PROJECT TITLE	PROJECT DESCRIPTION	AMOUNT APPROVED	PERCENT
93065	**Prince William Sound Recreation Project**	Develop proposals for restoration of recreation in Prince William Sound and evaluate recreation management by identifying and evaluating potential state and/or federal special recreation designation.	**$71,000**	
93066	**Alutiiq Museum and Culture Center**	Construct a Native museum and culture center to educate the public and provide a center for research and preservation.	**$1,500,000**	
93067	**Pink Salmon Coded-Wire Tag Recovery Program**	Recover coded-wire tags from pink salmon in Prince William Sound to distinguish between wild stocks and hatchery stocks.	**$220,000**	
93068	**Non-Pink Salmon Coded-Wire Tag Recovery Program**	Recover coded-wire tags from fish other than pink salmon.	**$126,400**	
		RESTORATION PROJECTS - Subtotal	**$30,203,600**	**86%**
		DAMAGE ASSESSMENT	**$714,600**	**2%**
		ADMINISTRATION	**$4,135,800**	**12%**
		TOTAL	**$35,054,000**	**100%**

Table A-6

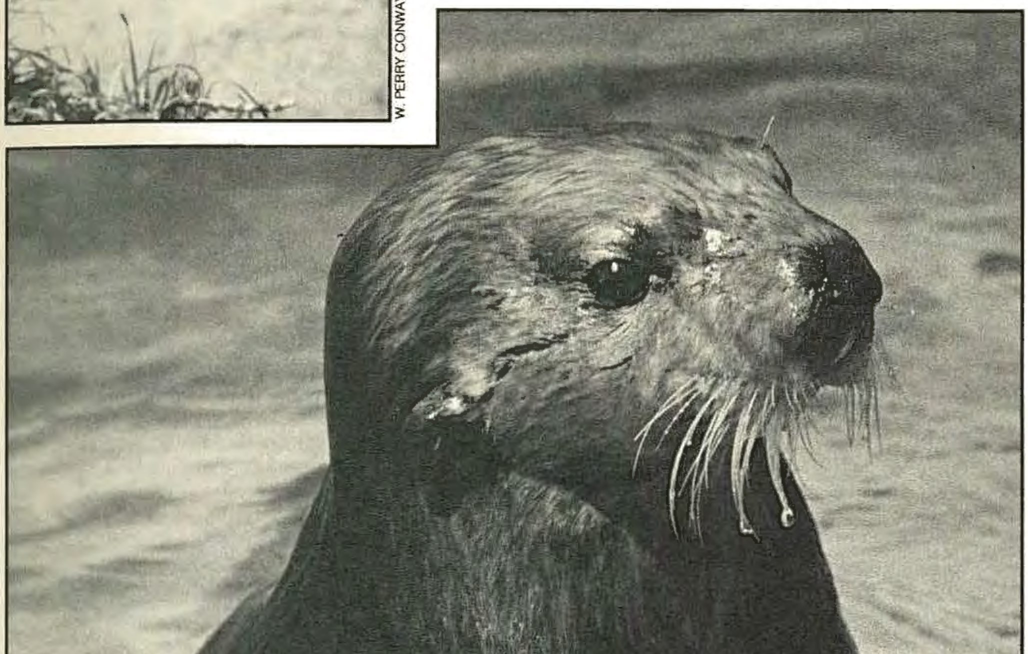
Combined Allocations for 1992 and 1993 Work Plans

PURPOSE	1992 ALLOCATION	1993 ALLOCATION (3/1/93-9/30/93)	TOTAL	PERCENT
RESTORATION PROJECTS	**$6,727,400**	**$30,203,600**	**$36,931,000**	**68%**
DAMAGE ASSESSMENT	**$7,407,500**	**$714,600**	**$8,122,100**	**15%**
ADMINISTRATION	**$5,076,100**	**$4,135,800**	**$9,211,900**	**17%**
TOTAL	**$19,211,000**	**$35,054,000**	**$54,265,000**	**100%**

Section B

INJURY AND RECOVERY

W. PERRY CONWAY



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Section B

INJURY AND RECOVERY

Background

The *T/V Exxon Valdez* struck Bligh Reef in March, just before the most biologically active season of the year. The resulting oil spill occurred during the seaward migration of salmon fry, major migrations of birds, and the primary breeding season of most species of birds, mammals, fish, and marine invertebrates in the spill's path. Approximately 1500 miles of southcentral Alaska's coastline were oiled (about 350 miles were heavily oiled), frequently with devastating impact to the upper intertidal zone. Direct oiling killed many organisms, and beach cleaning, particularly high pressure, hot water washing had a devastating effect on intertidal communities. The spill also affected human uses (services), including subsistence, recreation, commercial fishing, and other uses. Some resources and services remain vulnerable to persistent oil in intertidal areas.

This section describes in detail the injuries sustained by individual resources and services, and what scientists and resource managers know about the present status of recovery. **Table B-1** lists injured resources and lost or reduced services. Where possible expectations for the progress of natural recovery are also made. Information on injury and recovery is summarized in **Tables B-4, B-5** and **B-6** at the end of the section.

Table B-1
Injured Resources and Reduced or Lost Services

Resources: POPULATION DECLINE	Resources: INJURED, BUT NO POPULATION DECLINE	Resources: OTHER	Services (Human uses)
Black oystercatcher	Bald eagle	Archaeological resources	Commercial fishing
Common murre	Cutthroat trout	Designated wilderness areas	Commercial tourism
Harbor seal	Dolly Varden		Passive use
Harlequin duck	● Killer whale		Recreation including sport fishing, sport hunting, and other recreation use
Intertidal organisms	Pacific herring		Subsistence
Marbled murrelet	● Pink salmon		
Pigeon guillemot	River otter		
Sea otter			
Sockeye salmon			
Subtidal organisms			

● *For these species, the Trustee Council's scientists have considerable disagreement over the conclusions to be drawn from the results of the damage assessment studies.*

INJURY TO NATURAL RESOURCES

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

Loss includes:

1) ***direct mortality: animals killed by contact with oil or by the cleanup;***

2) ***sublethal and chronic effects: injuries to a life stage such as eggs or larvae, but that may not result in mortality; and***

3) ***degradation of habitat: alteration or contamination of flora, fauna, and the physical components of the habitat.***

In some cases, injuries result in measurable population declines that may persist for at least one generation. In other cases, they do not.

Population-Level Injuries

The most serious injuries are those that have resulted in measurable declines in population. In these cases, injury may persist for more than one generation; that is, the injury will not usually be repaired over the life span of the generation affected. For example, the common murre was the most severely impacted bird species; several large colonies in the Gulf of Alaska may have lost 35% to 70% of their breeding adults, a loss that may not be restored for many generations.

The oil spill and cleanup altered and contaminated the flora, fauna, and physical components of the habitats of many species. This is most pronounced in intertidal and shallow subtidal areas where populations of many species of plants and invertebrates declined as a result of oiling or cleanup. The persistence of oil in some intertidal habitats may continue to affect the many natural resources that use these habitats as well as the services they provide.

If serious enough, direct mortality, sublethal effect, or degradation of habitat may result in measurable population declines.

Injured But No Measurable Population Decline

There are several reasons why an oil spill injury may not result in a measurable population decline that persists for more than one generation. Natural variability associated with the estimate of abundance for a species may mask any effect of the injury; that is, available scientific measurement techniques may be insensitive to detection of some injuries. Also, some affected species may compensate for injury by increasing productivity. Other species did not suffer mortality. Rather, their injuries were sublethal.

INJURY TO OTHER NATURAL RESOURCES

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

The spill also resulted in oiling of waters adjacent to designated wilderness areas, with oil deposited above the high tide line in many cases. The intense cleanup that followed resulted in an unprecedented disturbance of the area's undeveloped and normally uninhabited landscape. The massive intrusion of people and equipment associated with cleanup has ended, but direct injury to wilderness and intrinsic values lingers.

REDUCED OR LOST SERVICES

Human use (service) has experienced reduction or loss if the *Exxon Valdez* oil spill or cleanup:

1) has significantly reduced the physical or biological functions performed by natural resources; or

2) has significantly reduced aesthetic and intrinsic values, or other indirect uses provided by natural resources.

This definition covers a wide range of services dependent upon the injured natural resources. Some examples are commercial fishing, subsistence (hunting, fishing, and gathering), passive use, commercial tourism and recreation. Some recreation examples include sea kayaking, backcountry camping, sport fishing, and hunting.

CONCEPTS CRITICAL TO UNDERSTANDING RECOVERY

Many resources and services will recover to prespill levels without intervention. For many resources and services, there is no known restoration approach that will effectively accelerate recovery. Other resources and services that were declining before the spill will continue to decline if present trends continue.

To maximize the benefits of restoration expenditures, the Trustee Council may consider the effects of natural recovery before investing restoration dollars. The Trustee Council has adopted the following definition of recovery to address this need.

In a scientific sense, full ecological recovery will have been achieved when the prespill population of flora and fauna are again present, healthy and productive, and there is a full complement of age classes at former abundances. A fully recovered ecosystem is one which provides the same functions and services as were provided by the prespill, uninjured system.

To predict the amount of time needed for a species to recover is extremely difficult. Scientists often use models based on factors such as population numbers and growth rates. However, for many of the biological resources injured by the *Exxon Valdez* oil spill, the background information was not available to develop these predictive models. For those resources, peer reviewers and agency scientists based their estimates of recovery on the best available information from the damage assessment and restoration studies, the scientific literature and other sources.

Estimates of recovery provided in this section should be used with caution, but they are the best that can be provided under the circumstances. For some estimates, there is also substantial disagreement within the scientific community. The estimates are likely to change as recovery continues, more information is provided through monitoring, and scientists learn more about the species. Recovery estimates for services are not provided. Recovery is linked, in part, to the resources that support the service, but is also linked to changes in human perception of injury and can vary widely among user groups.

MARINE MAMMALS

Harbor Seals

INJURY:

The oil spill caused population declines and sublethal injuries to harbor seals in Prince William Sound. Many were directly oiled and an estimated 345 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% of the seals seen in the postspill spring (April) survey were extensively oiled and a further 10% were lightly oiled. This included many pups. By late May, 74% 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.

RECOVERY:

Because harbor seal populations have declined precipitously since 1984, and the underlying causes of this decline are unknown, it is difficult to predict recovery from the oil spill. However, stable counts in 1990 to 1992 at haulouts within Prince William Sound may indicate an end to the ongoing decline within the Sound. There is evidence suggesting that the subsistence harvest has declined since the spill, which may contribute to the stabilization of the population. If the population has stabilized, growth may soon begin to replace the estimated 345 seals killed during the spill. However, additional information on the rate of exchange between seal populations in Prince William Sound and the Gulf of Alaska, particularly with the large Copper River Delta population, as well as a better understanding of the causes of the prespill decline, would be required to improve predictions of the time needed for recovery.

Humpback Whales

INJURY:

The only apparent effect of the spill on humpback whales was a temporary displacement from preferred habitat in Lower Knight Island Passage during the summer of 1989. There is no evidence that any humpbacks were killed by the spill, nor has reproduction been affected. Photodocumentation studies confirmed that normal use of lower Knight Island Passage resumed in late 1989.

RECOVERY:

Other than a temporary displacement, there is no evidence of injury. No estimate of recovery was made.

Killer Whales

INJURY:

Thirteen killer whales disappeared from one pod (extended family group) between 1988 and 1990, and are presumed to have died. Approximately 140 killer whales forming nine distinct pods regularly use Prince William Sound, and are considered resident pods. There are also transient pods and other resident pods with wider ranges that enter the Sound occasionally. The rate of natural mortality in killer whales in the North Pacific is about 2% per year, so it would be unusual for more than three to four individuals to be missing annually from Prince William Sound's resident pods.

In the summer of 1989, there were more than nine whales missing from resident pods. The AB pod, which had 36 individuals when last seen in the Sound in the fall of 1988, was missing 7 animals, for an unprecedented 19.4% mortality rate. In 1990, an additional six individuals were found missing from AB pod, resulting in an annual mortality rate of 20.7% (prespill mortality for the resident AB pod typically ranged from 3.1% to 9.1% from 1984 to 1988). All of the missing whales were either females or immature animals, and in several cases calves were orphaned. No births were recorded in 1989 or 1990. Due to the fidelity of killer whales to the pod, and the strong bonds observed between mothers and calves, the missing whales are presumed to have died. However, no dead individuals were ever recovered.

The cause of death is uncertain. Some experts think that the circumstantial evidence points to the spill. Other experts acknowledge that something very unusual happened to AB pod in 1989 and 1990, but that based on current knowledge of whale biology, the circumstances of the spill and the toxicity of crude oil, these deaths may not be due to contact with oil spilled by the *T/V Exxon Valdez*.

RECOVERY:

Despite the loss of a large number of reproductive females, AB pod is growing again. One birth was recorded in 1991; and two births were recorded in 1992. It is expected that AB pod may not recover to its prespill level of 32 to 36 individuals for more than a decade.

Sea Lions

INJURY:

Results from sea lion studies were inconclusive about the effects of the spill. Several sea lions were observed with oiled pelts, and oil was found in some tissues.

Sea lions have experienced a severe decline over the last 30 years in the north Pacific Ocean—as great as 93%. This decline combined with seasonal movements, which are significant but not well understood, hindered determining if the sea lion population in the Gulf of Alaska was affected by the spill. Sea lions were counted at eight haulout sites, located mainly in the Gulf of Alaska. Some of these sites were oiled, although oiling was patchy and generally short-lived, but away from these sites sea lions were observed swimming through oil. Ten sea lions were found dead in oiled areas, mainly on rocky beaches, but it is not known how many of these deaths were attributable to natural mortality, or if any were due to oiling.

RECOVERY:

Because it was not possible to establish that sea lions were injured by the oil spill, no estimate of recovery time was made.

Sea Otters

INJURY:

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. It also is estimated that there are a total of 150,000 animals in Alaska.

During 1989, 1013 sea otter carcasses were collected, including animals that died during capture and rehabilitation. Veterinarians determined that up to 95 percent of the deaths were attributable to oil. This information coupled with estimates of the probability of finding carcasses, data from boat surveys, and computer models, indicated that injuries were extensive, killing an estimated 3,500 and 5,500 sea otters in the first few months following the spill.

Studies conducted throughout the spill area in 1990 and 1991 indicated that sea otters were still being affected by the spill. Carcasses found in these years included an unusually large proportion of prime-age adult otters, rather than mainly juvenile and old otters, as were found before the spill. A study of survival of recently weaned sea otters also showed a 22% higher death rate during the winter of 1990-1991 and spring of 1991 in areas affected by the spill.

One possible cause of the relatively higher mortalities of weanling and prime-age animals is the ingestion of oil-contaminated prey. During 1992 surveys, fresh (unweathered) oil was found in beds of mussels on protected (low energy) beaches. Sea otters, particularly young sea otters, feed on mussels and other invertebrates and may still be exposed to oil persisting in intertidal habitats.

RECOVERY:
While little or no evidence of recovery has been detected, sea otters are expected to eventually recover to their prespill population. The rate of recovery will be dependent on the growth rate of the injured population. Under ideal habitat conditions (abundant high quality food and little competition) sea otters can expand their population at more than 10% per year. For sea otter populations already established in an area, the growth rate is probably closer to 2% to 3% per year.

Future habitat conditions and corresponding population growth rates are difficult to predict in the spill area. If the habitat remains degraded, the sea otter population may not recover for several decades. If their habitat recovers rapidly and stress remains negligible, recovery may take less than two decades. In order to achieve this recovery rate, the population would have to sustain a growth rate greater than 5% per year.

TERRESTRIAL MAMMALS

Brown Bear

INJURY:
In the Kodiak Archipelago and on the Alaska Peninsula, brown bears forage in the intertidal zone, where clams are a favorite food. Brown bears also apparently scavenged the carcasses of sea otters and birds that washed ashore after the spill. Analyses of fecal material and samples of bile indicated that some brown bears had been exposed to oil. High concentrations of oil were found in the bile of one yearling brown bear found dead in 1989. The mortality rate for cubs is close to 50% for the first two years, and it is uncertain if this death was associated with oil exposure.

RECOVERY:
Since there is no evidence that brown bears were injured by the spill, no estimate of recovery time was made.

Black Bear

INJURY:
There was an initial attempt to study the potential effects of the spill on black bears, but due to the difficulty of finding, tagging or observing this species in dense vegetation, the effort was quickly abandoned. No carcasses or other indications of oil spill-related injuries were ever reported.

RECOVERY:
Since there is no evidence that black bears were injured by the spill, no estimate of recovery time was made.

River Otters

INJURY:
Following the oil spill, eleven river otter carcasses were found on beaches. It is estimated that as many as 50 animals could have been killed if it is assumed that the recovery rate of carcasses is similar to that for sea otters. The bile from two river otters collected from oiled areas in 1989 was analyzed and found to contain elevated concentrations of hydrocarbons. This indicates that surviving river otters could have ingested contaminated food.

There are indications that chronic oil exposure may affect river otters in Prince William Sound, although there is uncertainty about the evidence. First, river otters captured in oiled areas after the winter of 1989-1990 weighed less than those captured in unoiled areas, while they were of the same overall length. Since the oiled population is an island population (Knight Island) and the unoiled population is from a mainland location (Esther Passage), and there are no comparative prespill length and weight data from the two areas, it is difficult to determine whether this represents an effect of the spill. Second, chemical factors in the blood show slight differences between study areas: in the oiled population, haptoglobin concentrations and some amino transferase enzyme activities are slightly elevated. These differences could be caused by oil exposure, but they also could be caused by disease, handling stress, and parasites.

A reduction in the number of prey species was noted in the diets of river otters in the oiled areas between 1989 and 1990; this reduction was not seen in the unoiled study areas. This reduction was probably due to the severe impact of the spill on the intertidal and shallow subtidal fauna in the oiled portions of Knight Island. Also, on Knight Island the average size of territories of river otters was larger than on the mainland, potentially a result of having to forage over a larger area to find sufficient food. Because of the lack of prespill data and follow-up study, however, there again is uncertainty.

Finally, data from an analysis of river otter droppings in latrine sites suggested that estimated populations sizes were not different between the study areas, although this conclusion also can be questioned because of the relatively small sample sizes employed.

RECOVERY:

Most of the evidence of injury to the river otters was gathered in 1989 and 1990, although some of the parameters that are designed to indicate continuing sublethal injury still showed differences in 1991, including length-weight differences. Without a reliable way to detect small changes in populations (an estimated 50 animals were killed), it is difficult to predict when the population will recover. With a population density of approximately one otter for every two to three kilometers of shoreline in suitable habitats, the percentage of the population that requires replacement appears to be relatively small. Without much further study, however, scientists cannot estimate a time to recovery.

Sitka Black-tailed Deer

INJURY:

Deer often forage in the intertidal zone on seaweed. Since seaweeds were extensively contaminated on oiled shores, deer were probably exposed to oil. In fact, tissues from deer taken by subsistence hunters and chemically analyzed were found to contain, in some cases, slightly elevated concentrations of oil. The deer were, however, determined to be safe to eat. No evidence was found that populations of Sitka black-tailed deer were injured by the spill. Most deer carcasses found in 1989 on islands in Prince William Sound were probably the result of winter kill.

RECOVERY:

Since there is no evidence that Sitka black-tailed deer were injured by the spill, no estimate of recovery time is required.

Mink

INJURY:

Mink forage in the intertidal zone and, therefore, could have been exposed to oil by contact or by ingestion of contaminated food. However, due to the lack of prespill information on population abundance and distribution and the difficulties of assessing population trends postspill, an assessment of injury to mink employing field studies was judged impractical. Instead, a laboratory study of mink was carried out to determine if oil-contaminated food affected reproduction. However, no reproductive effects were documented, even when high concentrations of weathered crude oil were added to their diet.

RECOVERY:

Since there is no evidence that mink or other small mammals were injured by the spill, no estimate of recovery time is required.

BIRDS

Bald Eagles

INJURY:

There are estimated to be 27,000 adult bald eagles in Alaska. About 2,000 of these are in Prince William Sound and about 6,000 are found along the northern coast of the Gulf of Alaska. Bald eagles encountered floating oil while preying on fish and oil-contaminated carcasses, and heavy oiling of the plumage led to loss of flight and probably also loss of body heat. Preening also exposed eagles to oil by ingestion. While 151 eagles were found dead after the spill, an estimated 200 to 300 may have been killed.

There is considerable uncertainty as to the total number of eagles killed by the spill. Seventy-four percent of radio-tagged eagles that died of natural causes in a postspill study were found in forests and other inland areas. If this carcass deposition pattern is representative of eagles dying from acute oil exposure, then total mortality based mainly on the recovery of carcasses during beach searches would be about 430 individuals. However, it seems unlikely that acutely oiled birds would die in similar locations as those that died of natural causes.

Most aerial surveys to estimate population size and productivity were conducted in Prince William Sound. Population estimates made in 1989, 1990 and 1991 indicate that there may have been an increase in the bald eagle population since the previous survey conducted in 1984, although considerable variability was associated with these data. Estimates for the three postspill years were not significantly different.

Estimates of productivity indicate that, in 1989, 85% of nests in moderately and heavily oiled areas failed, compared to 55% in lightly oiled and unoiled areas. In 1990, there were no differences between these areas. It is estimated that the loss of production in 1989 was equivalent to 133 chicks.

RECOVERY:

Since the number of eagles lost appears to be less than the change that can be detected by the aerial survey techniques, it may not be possible to follow recovery to prespill numbers. It also appears that the lost chick production in 1989 will not have a measurable impact on the population. Bald eagles are recovering, and may have already recovered from the effects of the spill.

Black Oystercatchers

INJURY:

The spill caused population declines and sublethal injuries to black oystercatchers. Nine black oystercatcher carcasses were recovered from beaches after the spill. It is unknown how many additional oystercatchers were killed by the spill but were not recovered. Prespill (1972-1973, 1984) and postspill population surveys suggest that within Prince William Sound, an estimated 120 to 150 black oystercatchers representing 12% to 15% of the total estimated population, died as a result of the spill. Mortality outside of Prince William Sound is unknown, but the total spill-area population is thought to be approximately 2,000 birds.

In addition to mortality caused directly by the spill, oiling also affected their reproductive success. Egg volume and the weight of chicks raised in oiled areas were lower compared to those raised in unoiled areas; however, there are no prespill data, and it is not known if those conditions existed before the spill. Other measures such as hatching success, fledgling success, and chick production were not different between oiled and unoiled areas. It is quite possible that in 1989 and 1990, disturbance associated with cleanup activities of oiled study areas, for example, Green Island, contributed to these differences.

RECOVERY:

While black oystercatchers are recovering, an estimate of their recovery time is difficult to make. There is significant uncertainty associated with any estimate of recovery made because the population growth rate for black oystercatchers is unknown. However, if the growth rate is equal to Eurasian oystercatchers (6.25%) and there are no lingering sublethal injuries, the calculated estimate of recovery is several decades. Finally, the potential contribution of immigration from unoiled areas on recovery is not easily estimated.

Murres

INJURY:

The oil spill caused population declines and sublethal injuries at murre colonies in the Gulf of Alaska. Including both common murres and thick-billed murres, there are about 12 million murres in Alaska, and 1.4 million in the Gulf of Alaska region. About 1.2 million of the total population in the Gulf of Alaska nest on the Semidi Islands, which were not directly impacted by the oil. Murres are particularly vulnerable to floating oil and have been killed in large numbers by oil spills elsewhere in the world.

At the major breeding colonies studied (Chiswell Islands, Barren Islands, Puale Bay, and the Triplets), an estimated 120,000 to 134,000 adult breeders were killed by contact with oil. The oil arrived in early April just as birds were beginning to congregate at the colonies in anticipation of breeding. If the rate of mortality is adjusted for birds not counted on the colonies, but feeding at sea, it is estimated that 170,000 to 190,000 breeding birds were killed. In general, it is estimated that between 35% and 70% of the breeding adults at the above colonies were killed by the spill. It is not known where prebreeding juveniles were at the time of the spill, or if many were killed.

The timing of reproduction also changed at oil-impacted colonies following the spill. At the Barren Islands and at Puale Bay, egg laying was about a month late in 1989, 1990, and 1991. In 1992 there were some indications that breeding was returning to normal at places in the Barren Islands colony. At the Chiswell Islands, laying was not observed in 1989, and laying was late in 1990. Due also to fewer birds occupying these colonies, it is likely that the rate of predation was much greater than normal, since these colonies rely on sheer numbers of birds to discourage predation by gulls and eagles. Furthermore, the delay in egg-laying (estimated to be one month) that has been seen in the Barren Islands, at Puale Bay and in the Chiswell Islands since the spill, may produce chicks that cannot survive the first autumn storms in the Gulf of Alaska. Conservatively, the estimate of lost production associated with delayed reproduction could exceed 300,000 chicks.

RECOVERY:

The degree of recovery necessarily varies among the affected colonies. There are preliminary indications of recovery at the Barren Islands in 1991 and 1992, but it is not yet known when the timing of reproduction will return to normal. Agency scientists estimate that it could take many decades and perhaps a century before the injured murre populations return to their prespill levels. These estimates assume that disturbance does not increase near the colonies over this time interval.

Harlequin Ducks

INJURY:

The oil spill caused population declines and appears to have caused sublethal injuries in harlequin ducks. Of the six species of sea ducks studied, harlequin ducks feed highest in the intertidal zone where most of the stranded oil was initially deposited and in some cases still persists. An estimated 1,000 harlequin ducks were killed by the spill. The resident prespill population of harlequin ducks in western Prince William Sound was estimated to be approximately 2,000. Wintering migrants increase this population in the western Sound annually by 10,000. With few exceptions since 1989, neither breeding adults nor fledglings have been located in the heavily oiled areas of western Prince William Sound. Evidence of breeding activity in the unoiled eastern Prince William Sound appears to be normal.

Elevated concentrations of hydrocarbons and their metabolites were found in the bile of harlequin ducks collected in western Prince William Sound in 1989. If residual oil in the diet is affecting reproduction, then the effect should begin to diminish once the threshold for toxicity is reached and the levels of persistent oil decrease in the environment.

Unfortunately, we have no information after 1989 that determined exposure levels in bile for harlequin ducks in western Prince William Sound. Also, there is so little known about how oil may affect reproduction and what physiological changes can be induced by feeding on oiled prey. For these reasons, the possible causes of breeding failure have not been established.

RECOVERY:

There appears to be diminished reproduction in harlequin ducks in oiled areas of western Prince William Sound. There are no indications that recovery has occurred. Scientists disagree on the time it will take harlequin ducks to recover to their prespill levels, but estimates suggest that recovery may not occur for several decades. Recovery could depend upon final degradation of oil in intertidal habitats where harlequin ducks feed, if it can be assumed that continued injury is due to ingestion of oil-contaminated food.

Marbled Murrelets

INJURY:

Approximately 612 marbled murrelets were recovered from beaches following the spill. Based on other carcass recovery studies, this suggested that between 8,000 and 12,000 birds may have been killed by the oil spill, which appears to be about 5% to 10% of the current population in the affected area. The available postspill data indicated that the marbled murrelet population has declined since the last census conducted in the middle 1980s. The oil spill probably increased the rate of decline for this species in the spill area, although the magnitude of incremental injury is difficult to estimate.

RECOVERY:

Since the spill, surveys conducted in Prince William Sound have resulted in population estimates of 107,000 in 1989, 81,000 in 1990, and 106,000 in 1991. With such variation in postspill population estimates, it is not yet possible to determine a trend in marbled murrelet abundance in Prince William Sound. The data collected in the 1970s and 1980s indicate that the population was declining before the spill. Although there is uncertainty associated with the causes of this decline, scientists expect it to continue. There are several factors that could account for this decline including a diminished food supply, increased predation, reduced nesting habitat, or fishery interactions, but there are no conclusive data that indicate if any or all of these factors affected the population.

Because of the population decline, the marbled murrelet population is not expected to return to prespill population levels. Estimates of when the population may stabilize vary widely among experts but may be more than a decade. Estimates of further decline range from 20% to 50%, but again there is much uncertainty.

Pigeon Guillemots

INJURY:

Because these birds forage near shore and often congregate on rocky beaches, they were vulnerable to the spilled oil. Five hundred and sixteen guillemot carcasses were recovered after the spill. Total mortality is estimated to be between 1,500 to 3,000 individuals, and may be as much as 10% to 15% of the pigeon guillemot population in the Gulf of Alaska. The results of boat surveys in Prince William Sound indicate that the population of this species was 14,600 in 1973. After the spill, the populations were 4,000 in 1989; 3,000 in 1990; and 6,600 in 1991. The population in Prince William Sound was probably declining prior to the spill, but the survey data indicate that the decline in oiled areas was greater than in unoiled areas. For the Naked Island group, results of postspill surveys indicated a 40% decline in abundance compared to the latest prespill surveys in the mid-1980s. The decline showed a correlation with degree of shoreline oiling. The oil spill probably increased the rate of decline for this species in the spill area, although the magnitude of incremental injury is difficult to estimate.

RECOVERY:
Pigeon guillemots may not return to prespill population levels, as their population was probably declining prior to the spill. The reasons for the long-term decline are unknown which makes predictions of future population trends extremely difficult. The population is expected to stabilize sometime over the next several decades, but estimating the population size when it stabilizes is even more uncertain.

Other Birds

INJURY:
There were numerous other birds affected by the spill. The most direct evidence of injury comes from the carcasses of birds found on the beaches after the spill in 1989. Some of the other species found dead included falcons, ducks, sandpipers, phalaropes, gulls, terns, auklets, puffins, various passerines, loons, grebes, shearwaters, petrels, cormorants, kittiwakes, and geese. Other important information comes from boat surveys carried out after the spill using similar techniques to those used in 1972-1973 and 1984-1985 surveys. Other birds that declined more in oiled than in nonoiled areas since the early 1972-1973 surveys include the Northwest crow and cormorant. A similar comparison based on the 1984-1985 surveys showed that cormorant, Arctic tern and tufted puffin declined more in oiled areas.

Injuries to murres, eagles, marbled murrelets, pigeon guillemots, black oystercatchers, and harlequin ducks are discussed individually above; however, these are only six of the approximately 90 species of birds represented in the collections of dead birds recovered after the spill. A list of the species recovered during the spill can be found in **Table B-4**. In general, the number of dead birds recovered probably represents only 10% to 15% of the total numbers of individuals killed. For most species, there are no reliable prespill data that will allow accurate assessment of the significance of estimated losses.

RECOVERY:
There is a great deal of uncertainty about the recovery of populations of individual species because many were not studied.

FISH

Cutthroat Trout and Dolly Varden

INJURY:
Both Dolly Varden char 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. Both species were captured at weirs on five stream 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.

While survival of Dolly Varden returning to oiled streams in 1990 was 32% less than those returning to unoiled streams, and survival appeared to be 57% less for cutthroat trout returning to oiled streams in 1990, these differences are not statistically significant. There also are no prespill data with which to compare these results. However, it was determined that larger cutthroat trout grew significantly less in oiled areas in 1989, 1990 and 1991. Dolly Varden growth rates were also reduced between 1989 and 1990.

RECOVERY:
Dolly Varden and cutthroat trout in oiled areas may have sustained a sublethal injury (slower growth in oiled areas). Scientists cannot estimate a recovery

time without much further study.

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Pacific Herring

INJURY:

The oil spill caused sublethal injuries to Pacific herring in Prince William Sound, but scientists do not know whether these injuries will result in a population decline. Pacific herring spawned in intertidal and subtidal portions of Prince William Sound shortly after the spill. Over 40% of areas used by herring to stage, spawn, or deposit eggs, and 90% of the areas used for summer rearing and feeding were lightly to heavily oiled. Oiled spawning areas included portions of Naked and Montague islands.

Studies conducted in 1989 and 1990 showed a slight but statistically significant higher rate of egg mortality in oiled areas, compared to unoiled areas. In 1989, rates of larval mortality, lethal and sublethal genetic damage, and physical deformities also were greater in oiled areas. There also is some evidence of differences in histopathological condition and reproductive success in oiled areas in 1989. However, all differences between oiled and unoiled study sites were less pronounced in 1990, and were not observed in 1991.

Three-year-old herring exposed as eggs or larvae in 1989 were underrepresented in the 1992 spawning migration. Compared to Sitka Sound, which correlates closely with Prince William Sound in herring recruitment, the 1992 returns of the 1989 year class were lower in Prince William Sound than expected. Data comparing herring biomass and age composition of Prince William Sound and Sitka Sound from 1969 to 1992 demonstrates a statistically significant correlation between the size and age structure of herring migrations in these two areas. However, since the 1989 year class was not fully recruited to the adult population until 1993, analysis of 1993 data could be more instructive. There also was an outbreak of viral hemorrhagic septicemia (VHS) in herring returning to Prince William Sound in 1993, but it is not known if the disease is linked to the oil spill.

RECOVERY:

The complex population dynamics of Pacific herring make it is very difficult to predict the extent of injury or estimate natural recovery rates. However, analysis of 1993 data may give a more complete picture of injuries suffered by the 1989 year class.

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Pink Salmon

INJURY:

The oil spill caused sublethal injuries to wild populations of pink salmon, but there is continuing debate on whether the wild stock population has been affected.

Seventy-five percent of the wild pink salmon spawn intertidally at the mouth of streams in Prince William Sound. There was no apparent change in the use of this habitat in the summer of 1989, and many salmon deposited their eggs in the intertidal portion of oiled streams. In the autumn of 1989, egg mortality in oiled streams averaged about 15%, compared to about 9% in unoiled streams. Since 1989, egg mortality has generally increased, until in 1991, there was an approximate 40% to 50% egg mortality in oiled streams, and 18% mortality in unoiled streams.

Although the differences between egg mortality in oiled and unoiled streams over the first two years are likely attributable to the effects of oil, the persistence of these differences three years after the spill was entirely unexpected and is not understood. In this regard, natural factors that vary between oiled and unoiled streams, e.g., the degree of wave exposure, have not been eliminated as possible causes of persistent differences. Also, the studies of pink salmon carried out after the spill have documented that adults released as fry from nearby hatcheries are wandering into streams and spawning with wild stocks. The potential effect of this phenomenon on egg survival has not been investigated. Some scientists suggest that the longer the differences in egg mortality persist, the less likely it will be that oil is the cause or a contributing cause.

Pink salmon fry released from hatcheries as well as wild pink salmon fry leaving their natal streams in the spring of 1989 were also exposed to oil in the open water. Both pink salmon and chum salmon larvae were exposed to sufficient amounts of oil to induce 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 is dependent on conditions during the larval stage; and lower food supply, temperature and growth will result in a lower return of adults the following year.

Despite the differences in egg mortality and larval growth, tagging data do not show that pink salmon populations were affected by the oil spill. For example, fry that were tagged as they left their streams in 1990, and were recaptured as returning adults in 1992, did not show differences in survival between oiled and unoiled streams. Fisheries experts disagree whether or not the increased egg mortality seen in the oiled streams is affecting the adult populations.

RECOVERY:

The most apparent injury to pink salmon is to egg survival. This difference in mortality rates between oiled and unoiled streams persisted in 1991. For at least the first three years after the spill, the rate appears to be worsening, both in oiled and unoiled areas. While there is disagreement among experts on whether population level injuries exist, those who do believe that the spill reduced the adult population estimate that recovery will take more than a decade.

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Rockfish

INJURY:

The oil spill may have caused sublethal injuries to rockfish, but it is unknown whether or not population declines also 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 five were in good enough condition to chemically analyze. All five 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 prevalances of organ lesions in 1989, 1990 and 1991, although there is some uncertainty associated with causes of these pathological changes. In 1990 and 1991, oil exposure was documented in fish collected from oiled but also unoiled sites.

An additional unknown is the degree to which post-spill increases in fishing pressure may be impacting rockfish. Partially due to numerous spill-related commercial fishing closures (salmon and 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. While harvests decreased since 1990, 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.

RECOVERY:

Because there is still considerable uncertainty that rockfish experienced significant direct mortality or sublethal effects, a natural recovery rate was not estimated.

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Sockeye Salmon

INJURY:

Kenai River and Red Lake-Kodiak sockeye salmon stocks may have suffered population declines as well as sublethal injuries. This potential injury is unique, since 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 (overescapement) of spawning fish to the Kenai and Red Lake systems in 1989, although this was the third consecutive year of overescapement to the Kenai River system. Public comments have indicated that sockeye overescapements may have occurred in the Chignik Lake system.

For the Kenai system, more than 900,000 spawning fish returned each year from 1987 through 1989, when the system was managed for a return of only 600,000 fish a year. The cumulative effect of too many spawning adults in the Kenai River system has been a decline in smolt production. Although the exact mechanism by which this occurred is not clear, it is believed that concentrations of food (planktonic crustacea) are insufficient to meet the needs of the greater number of fry produced. Fewer fry surviving their first winter in rearing lakes result in fewer outmigrant smolt in the spring. Smolt production in the Kenai River system has declined as follows: 1989, 30 million; 1990, six million; 1991, 2.5 million; and 1992, less than one million.

Outmigrations of smolt from the system have been on the decline since 1990, and the forecasted returns in 1994 and 1995 are below escapement goals.

RECOVERY:

There are no indications of recovery in either the Kenai River or Red Lake systems. Estimates of population recovery vary among experts but could exceed a decade to attain a 10-year population average similar to the prespill population levels. The Kenai River recovery could be prolonged if plankton populations do not recover to prespill population concentrations and salmon develop a cyclic pattern with large returns in some years followed by very small returns in others. Recovery could occur more quickly if plankton populations return to normal by 1993, and there is a normal adult escapement.

SHELLFISH

Crab, Shrimp, Sea Urchin and Oyster

INJURY:

While clams, mussels, crab, shrimp, sea urchins and oysters are all commonly referred to as shellfish, injuries to clams and mussels are addressed in the section on Intertidal Communities.

Dungeness crab and brown king crab studies ended early in 1989 due to the scarcity of these species in the spill area. Fishing pressure and natural predation may have reduced population levels prior to the spill.

There also is little conclusive evidence to suggest that spot shrimp were injured by the oil spill. There were no studies on sea urchins, and oyster studies (on farmed oysters) ended after a legal interpretation indicated that the Natural Resource Damage Assessment Rules (Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C 9601) did not apply. However, since oil is known to have impacted subtidal sediments and communities, it is possible that undocumented exposure and injury occurred for several shellfish species not studied.

RECOVERY:

Because it was not possible to establish that these species were injured by oil, no estimate of recovery was made.

INTERTIDAL COMMUNITIES

Intertidal Communities

INJURY:

The intertidal zone is the area of beach between the low and high tide extremes. The oil spill caused population declines and sublethal injuries to the community of plants and animals living in the intertidal zone. Portions of 1500 miles of coastline were oiled (350 miles heavily oiled) resulting in significant impacts to intertidal habitats, particularly the upper intertidal zone. With tidal action, oil penetrated deeply into cobble and boulder beaches that are relatively common on the rocky islands of the spill area. Cleaning removed much of the oil from the intertidal zone, but subsurface oil persisted in many heavily oiled beaches, and in mussel beds, which were avoided during the cleanup.

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 unoiled sites. Because of our ability to measure effects on common organisms, these have been emphasized in the injury studies.

The most significant impacts occurred in the upper and middle intertidal zones on sheltered rocky shores, where the greatest amounts of oil was stranded. In the upper and middle intertidal zones of rocky shores, the seaweed *Fucus gardneri* (rockweed or popweed), barnacles, limpets, periwinkles, clams, amphipods, isopods and marine worms were less abundant at oiled than unoiled sites. Although there were increased densities of mussels in oiled area, they were significantly smaller than mussels in the unoiled 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 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 littleneck clams and, to a lesser extent, butter clam also were significantly affected by the spill. Also, in 1990, comparisons of abundance of intertidal fishes indicated fewer fish in oiled areas, but such differences were not found in 1991.

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

RECOVERY:

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 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 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, since it may take several years for invertebrate species to return after *Fucus* has recolonized an area.

SUBTIDAL COMMUNITIES

Subtidal Communities

INJURY:

The oil spill caused population declines and sublethal injuries in the communities of plants and animals found below low tide. Several kinds of subtidal environments were studied after the spill: eel grass beds, *Laminaria* (kelp) beds, fjords and the deep bottom (40 to 100 meters). All these studies relied on comparisons between oiled and unoiled environments. Study sites also were matched for conditions (sediment grain size, depth., etc.) likely to affect the distribution and abundance of organisms.

The greatest differences were seen for small organisms living in the sandy sea bottom below eelgrass beds—they were less abundant in oiled environments. Among affected groups were amphipods, known from previous studies to be highly sensitive to oil. In addition, there were larger organisms that showed differences in abundance, most notably the crab *Telemesus* was less abundant in oiled areas. Two separate studies found that eelgrass in oiled areas did not bloom as well after the spill as in unoiled areas. Other organisms, however, were more abundant in oiled areas—some small mussels that live on eel grass and juvenile cod. Even greater differences were observed in the abundance of fauna at depths from six to 20 meters below the oiled eelgrass beds, where there were far fewer individuals in oiled areas.

The results of other subtidal studies were more equivocal. Chemical analyses show that *Exxon Valdez* oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases. Reduced abundances in fauna were encountered in several oiled bays at 100 m, but the causes of these differences are not clear. Some flatfish had elevated amounts of hydrocarbons in their bile in 1989 and 1990, and slightly elevated prevalences of gill damage.

RECOVERY:

Analysis of invertebrates associated with eelgrass beds collected in 1991 indicated that differences noted in 1990 between oiled and unoiled areas had started to converge. Another year of study in 1993 may indicate if this trend has continued. Because recovery has been observed in shallow (<20m) subtidal habitats, full recovery is expected in most cases within several years.

OTHER RESOURCES

Archaeological Resources

INJURY:

The oil spill area has been occupied by Native peoples for at least 11,000 years. The spill area also contains artifacts from the post-European contact era. It is estimated that the oil spill area contains between 2,600 and 3,137 historic properties, including 1,287 known sites that have been recorded in the Alaska Heritage Resources Survey.

Currently, 24 sites are known to have been adversely affected by oiling, cleanup activities, or looting and vandalism linked to the oil spill. One hundred thirteen sites are estimated to have been similarly affected. Injuries attributed to looting and vandalism (linked to the oil spill) are still occurring.

Injuries to archaeological sites include theft of surface artifacts and masking of subtle clues that archaeologists depend upon to identify and classify sites. Key diagnostic artifacts have been illegally taken, ancient burials have been violated and potholes dug by looters have destroyed critical evidence contained in the layered sediments. Additionally, vegetation has been disturbed which has exposed sites to accelerated erosion. The effect of oil on the soil chemistry and organic remains has reduced or eliminated the utility of radiocarbon dating. Other injuries to archaeological sites have not yet been reported and the actual extent of damage will not be known for decades.

Some injuries, particularly looting and vandalism, are continuing and are on the rise in the spill area because of ongoing human intrusion into previously pristine areas.

RECOVERY:

Archaeological sites cannot recover in the same sense as biological species or organisms. They represent a category of finite, nonrenewable resources. Injury to this resource results not only in the loss of important scientific data, but in an irretrievable loss of Alaska's cultural heritage. Restoration cannot regenerate what has been destroyed, but it can successfully prevent further degradation of both sites and the scientific information. Documentation of injured sites is necessary to preserve the artifacts and scientific data which remains in the vandalized sites.

Designated Wilderness Areas

INJURY:

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, a sense of 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 agencies' 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.

RECOVERY:

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 continue. The massive intrusion of people and equipment associated with oil spill cleanup has now ended.

SERVICES (HUMAN USES)

Commercial Fishing

INJURY:

During 1989, emergency commercial fishery closures were ordered in Prince William Sound, Cook Inlet, and the waters around Kodiak Island and the Alaska Peninsula. Harvests were closed or restricted for pink and sockeye salmon, herring, crab, shrimp, smelt, rockfish and sablefish. In 1990, portions of Prince William Sound were closed to shrimp and salmon fishing for the same reason. *(See **Table B-2**)* All of the 1989 and 1990 closures were done to prevent harvest of oiled fish and were not triggered by population reductions in these species. There are currently no spill-related commercial fishery closures in effect.

Significant impacts on fisheries may result from too many fish returning to the Kenai River and Red Lake (Kodiak Island) systems in 1989. During the 1989 commercial sockeye fishery closures, large numbers of fish escaped harvest to spawn. This resulted in an unusually large number of salmon fry moving into the lakes to feed. Sockeye fry spend up to two years feeding in fresh water before migrating to the ocean. It is hypothesized that the salmon fry overgrazed the zooplankton available to them in the upper layers of the lakes. This reduced rates of growth and survival for the fry. Previous Kenai River overescapements in 1987 and 1988 compounded the problem. Fry survival in the Kenai system was very poor for two years in a row, and Red Lake fry may have stayed in the lake an extra year to feed. This will probably result in severely reduced adult returns to these systems starting in 1994. It is also likely that 1995 returns to the Kenai River will be very low. Closure of Kenai River sockeye fisheries would have major impacts on many user groups.

The extent of injury to rockfish is not fully understood, although a few mortalities were caused by exposure to petroleum hydrocarbons and residual hydrocarbons have been found in tissues and bile. An additional, indirect injury may have been inflicted by significantly increased commercial fishing pressures. Following the multiple, spill-induced fishery closures, many commercial fishermen redirected harvest efforts towards rockfish. Little is known about current population levels and how well they will be able to withstand the increased pressure. However, rockfish are known to have low rates of reproduction and growth and have been seriously damaged by overfishing in other places. Thus, the possibility exists that the increased rockfish harvest may overfish the population.

Public comment indicated concern that the oil spill had caused or could cause the following fishery impacts:

1) ***poor Prince William Sound pink salmon returns in 1992;***

2) ***potential reductions of sockeye returns in Chignik Lake due to 1989 sockeye overescapements;***

3) ***poor Prince William Sound herring returns and disease problems in 1993; and***

4) ***decreased Prince William Sound spot shrimp populations.***

At this time, biologists do not know whether these events were caused by the oil spill.

RECOVERY:

Sockeye recovery status is unknown but will depend on recovery and availability of zooplankton populations in the lakes used by rearing fry. This will probably occur sooner in Red Lake than the Kenai system, although less is known about recovery in Red Lake. It is not yet known how many year classes of sockeye fry will be directly impacted by food shortages. However, the number of outmigrating Kenai River smolt was extremely low in 1991 and 1992, indicating that at least two consecutive year classes were impacted by overescapement. Kenai River smolt will return as adults in 1994 and 1995. The number of adults returning from these reduced outmigrations will almost certainly be lower than normal and may not be able to produce enough eggs to rebuild the runs within a single generation. If this turns out to be the case, adult returns to the Kenai in 1999 and 2000 may also be low.

Insufficient data exist to determine whether rockfish continue to be impacted by hydrocarbon contamination or if they are being harmed by overfishing. The lack of data could result in additional damage to the species. Likewise, the recovery status of herring and pink salmon is unknown.

Table B-2
Commercial Fishery Closures

PRINCE WILLIAM SOUND

PACIFIC HERRING	Gillnet and purse seine sac roe fisheries and pound and wild roe-on-kelp fisheries all closed April 3, 1989.
SHRIMP	Pot shrimp fishery closed while in progress on April 3,1989. Trawl shrimp fishery closed on April 9, 1989. A small pot shrimp harvest area near Knight, Eleanor and Smith Islands was closed in 1990.
SABLEFISH (BLACK COD)	Closed April 1, 1989. Reopened in inside waters only, in conjunction with the halibut opening on June 12, 1989.
DUNGENESS CRAB	Closed April 30, 1989.
KING CRAB	Closed on October 1, 1989.
GROUNDFISH	Closed April 30, 1989. Reopened with the June 12, halibut opening.
MISCELLANEOUS SHELLFISH	On April 24, 1989 it was announced that no miscellaneous shellfish permits would be issued.
PINK AND SOCKEYE SALMON	Closures of commercial drift and set net fisheries in Eshamy District, Northern District (surrounding Naked and Perry Islands), parts of Culross Island Subdistrict, Southwestern District, and parts of Montague Island District. In 1990, two set net areas near Eshamy Bay were closed for four days and then reopened. In addition, portions of the northern and eastern shorelines of Latouche Island,and waters around Eleanor and Ingot Islands were closed to fishing.

UPPER COOK INLET

SOCKEYE SALMON	With the exception of a very minor opening of a small portion of the Central District, the commercial drift gillnet season was closed because of oil. In addition, setnet fishing in the Upper Subdistrict south of the Kasilof River was closed for the 12 hour regular fishing period on July 7, 1989, due to the presence of oil on beaches.

LOWER COOK INLET

SHRIMP	Closed April 30, 1989. Reopened July 7, 1989.
MISCELLANEOUS SHELLFISH	On April 24, 1989, it was announced that no miscellaneous shellfish permits would be issued to harvest these species in the Outer and Eastern Districts until the danger of oil contamination had passed.
GROUNDFISH	The Outer and Eastern Districts were closed at noon, April 30, 1989. The fishery reopened to all species except sablefish, June 12 in conjunction with the 24-hour halibut opening.
SMELT	Smelt was closed along with groundfish in the Outer and Eastern Districts on April 30, 1989. When groundfish reopened, smelt fishing remained closed.
PACIFIC HERRING	The sac roe fishery in the Outer and Eastern Districts closed on April 15, 1989, prior to the anticipated opening date of April 20, 1989.

Table B-2 *continued*

LOWER COOK INLET *(continued)*	
PINK SALMON	The seine fishery in the Kamishak District opened on June 1, 1989 and was closed by emergency order on June 8, 1989. Portions of Kamishak District north of Contact Point were opened after July 20 based on run strength. The Tutka Bay Subdistrict north of the powerlines was closed to seining on July 10, and opened later the same day after further assessment showed the commercial fishery would not be impacted.

KODIAK	
PACIFIC HERRING	Approximately 34 of 56 management units were closed for the duration of the sac roe fishing season.
SOCKEYE AND PINK SALMON	The commercial season was scheduled to begin June 9,1989. The fisheries were postponed until June 19, when only the setnet fishery in the Alitak District opened; there were approximately 114 days fished in this setnet fishery by 87 fishermen. The only other commercial opening to occur during the 1989 salmon season was a two day seine opening in Karluk Lagoon, on the west side of Kodiak Island, in mid-September. The entire Kodiak Management Area closed to commercial salmon fishing at the conclusion of the Lagoon fishery.

CHIGNIK	
SOCKEYE SALMON	The Chignik fishery opened on June 12, 1989. However, portions of the Eastern District were closed due to the presence or close proximity of oil in the Kilokak Rocks area, and in Imuya and Wide Bays. The ADF&G announced a 24-hour fishing period on June 26 for a portion of the Chignik Bay District. The area was limited to a small portion of this district due to the presence of oil in surrounding areas, and was later closed the same day due to the presence of mousse and sheen. Additional closures occurred on July 27 and August 5,1989.

Commercial Tourism

INJURY:

Much of the injury to Commercial Tourism is similar to Recreation. For example, passengers on guided sailboats and those on recreation sailboats may experience similar changes. For this reason, much of the information listed under the Recreation and Recreation - Sport Fishing and Hunting applies to Commercial Tourism. After the spill, a consulting firm, McDowell and Associates, surveyed Alaskan tourism businesses to find out the effect of the spill. Approximately 43% of the tourism businesses surveyed by McDowell and Associates felt their businesses had been significantly or completely affected by the oil spill in Summer 1989. The net loss in visitor spending in Southcen-tral and Southwest Alaska in 1989 was $19 million. *[See also Recreation and Recreation - Sport Fishing and Hunting.]*

RECOVERY:

By 1990 only 12% of the tourism businesses surveyed felt their businesses had been significantly or completely affected by the oil spill. *[See also Recreation and Recreation -Sport Fishing and Hunting.]*

Passive Use

INJURY:

Passive uses of resources include the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other nonuse values. The areas of Alaska impacted by the oil spill supported a large diverse ecosystem that was valued by large numbers of the American public who did not visit the area. The spill killed substantial numbers of different bird species and marine mammals as well as oiling much of the coastline in the impacted areas. The spill also had substantial effects on the fish, bird, and wildlife populations. While some of these effects may be of relatively short duration, others such as recovery of various bird populations are likely to take decades. A contingent valuation study of the American public done in 1991 found that approximately 95% were still aware of the *Exxon Valdez* oil spill, and that over 50% spontaneously named the spill as one of the worst environmental accidents to occur in the world during their lifetime. The median household was willing to pay $31 to prevent a spill similar to the *Exxon Valdez* in the future. Multiplied by the number of U.S. households, this results in an estimate of spill damages of $2.8 billion.

RECOVERY:

The animals initially killed are irreplaceable. Fish and wildlife populations are recovering at different rates. Much of the oil in shoreline areas has been removed or has weathered to varying degrees.

Recreation

INJURY:

In 1992 a key informant study was conducted to obtain current information about abroad range of recreation uses. The study canvassed 92 users in the following ten user groups: air taxi operators, camping/kayaking, conservation/education, lodge-owner, Native corporations, public recreation managers, sailing/motorboating, sport fishing/hunting, tour operators, and tourism associations. The study was not based on a random sample of recreation users. Instead, it surveyed individuals knowledgeable about recreation in the spill area. The response rate was 45%.

Informants were asked how their recreation experience had changed. About a quarter of the respondents reported no change in their experience. However, others reported the following changes:

1) ***avoidance of heavily oiled areas and displacement to less affected areas, primarily northern Prince William Sound and parts of Kenai Fjords;***

2) ***reduced wildlife sightings and fewer fish;***

3) ***residual oil in the form of tar balls and sheens that affect the enjoyment of coastal areas and raise concerns about tainted fish; and***

4) ***more interest in the spill area and more people using it. Recreational use of Prince***

William Sound and the Outer Kenai Coast appeared to be most severely affected; less severe effects were reported in Kodiak and Kachemak Bay.

Informants were also asked whether there are changes not reflected in their experiences that concern the way they think about the area or perceive their recreation opportunities. Most of the respondents (80%) said their perceptions had changed. This group included at least half of each user group except air-taxi operators.

Those indicating a change in perception of recreation opportunities cited one or more of the following changes:

1) ***increased sense of vulnerability with regard to future oil spills, the fragility of the ecosystem, and threats to archaeological resources;***

2) ***erosion of wilderness caused by the spill itself as well as the intrusion of cleanup and restoration activities;***

3) ***a sense of permanent change;***

4) ***a sense of unknown or unseen ecological effects that may alter the environment in the future. Some of the respondents reported a sense of optimism about the future.***

RECOVERY:

Although the status of recovery of recreation was not asked in the key informant interview, respondents volunteered information. They 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.

Recreation - Sport Fishing and Hunting

INJURY:

While there were no sport fishery closures until 1992, ADF&G data documented a significant decline in sport fishing from 1989 to 1990 and quantified the losses at $31 million. Declines in the number of anglers, fishing trips and fishing days were noted for saltwater fisheries in Prince William Sound, Cook Inlet and the Kenai Peninsula areas. In addition, damages to public perception of the spill zone as a pristine environment may have been largely responsible for reductions in sport-fishing activities.

The only spill-related sport fish closure has resulted from a 1992 emergency order restricting cutthroat trout fishing in western Prince William Sound due to low adult returns. This closure will remain in effect until runs return to a sustainable level. Damage assessment from 1991 studies suggested that growth and survival rates of cutthroat were lower in oiled areas. This could be due to injuries to the food chain, which result in insufficient food for fish feeding in nearshore marine waters.

Significant impacts on fisheries may result from too many fish returning to the Kenai River and Red Lake (Kodiak Island) systems in 1989. Discussions of injury to sockeye salmon and rockfish are found under the description of injury to commercial fishing. Sport hunting of harlequin duck was affected by restrictions imposed in 1991 in response to damage assessment studies.

RECOVERY:

Sockeye recovery depends on recovery and availability of zooplankton populations in the lakes used by rearing fry. This will probably occur sooner in Red Lake than the Kenai system. It is not yet known how many year classes of sockeye fry will be directly impacted by food shortages. However, the number of outmigrating Kenai River smolt was extremely low in 1991 and 1992, indicating that at least two consecutive year classes were impacted by overescapement. These smolt will return as adults in 1994 and 1995. The number of adults returning from these reduced outmigrations will almost certainly be lower than normal and may not be able to produce enough eggs to rebuild the runs within a single generation. If this turns out to be the case, adult returns in 1999 and 2000 may also be low.

Cutthroat trout fishing may remain closed or restricted in the western Sound in 1993, and will not reopen until populations recover. Recovery may be contingent upon recovery of the ecosystem which supports the food chain in nearshore marine waters where these fish feed.

Insufficient data exist to determine whether rockfish continue to be impacted by hydrocarbon contamination or if they are being harmed by overfishing. The lack of data could result in additional damage to the species.

Harvest restrictions for harlequin duck are expected to continue through 1993.

Subsistence

INJURY:

The Division of Subsistence, Alaska Department of Fish and Game, determined before the *Exxon Valdez* oil spill, that 15 Native Alaskan communities (with about 2200 people) of Prince William Sound, Lower Cook Inlet, Kodiak and the Alaska Peninsula relied heavily on subsistence resources. These resources included salmon, halibut, cod, rockfish and Dolly Varden; marine invertebrates such as clams, chitons, shrimp, crabs, and octopus; marine mammals (harbor seals and sea lions); land mammals such as deer (Prince William Sound and Kodiak Island), black bear and goats (Prince William Sound and Lower Kenai Peninsula); birds including ptarmigan, waterfowl, and gulls eggs; and wild plants. Many of these species were studied after the spill, and the results of these studies are summarized in this section. The mean number of resources used per household ranged from 10 to 25, and generally every household participated in subsistence harvests. The per capita subsistence harvest ranged from nearly 200 pounds to over 600 pounds per year.

Table B-3 illustrates changes in harvest levels in the first year (April 1989 to March 1990) following the spill. Subsistence harvests of fish and wildlife in nine of these villages (Chenega Bay, Tatitlek, Nanwalek [English Bay], Port Graham, Karluk, Old Harbor, Ouzinkie, Port Lions, and Chignik Lagoon) declined from 4% to 78%, compared to prespill averages. The reasons for this decline varied among communities and households, but most dealt with the reduced availability of injured species and perceived consequences of the oil spill, especially the concern for potential health effects as a result of consuming subsistence resources from the spill area.

Chemical analytical studies conducted in 1989-1991 measured levels of petroleum hydrocarbon and metabolites in the bile and edible tissues of subsistence foods. These studies found that most resources tested (fish, some species of shellfish, deer, ducks, marine mammals) contained no or very low levels of petroleum hydrocarbons, and that eating foods with those levels posed no health risk. Exposure to oil did not necessarily render organisms unsafe to eat since some exposed animals were found to have low or nonexistent levels of hydrocarbons and their metabolites in their edible tissues. Some samples of shellfish, however, had unacceptably high levels of petroleum hydrocarbons prompting advisories in 1989-1991 that shellfish should not be collected from obviously oil-contaminated areas.

RECOVERY:

Table B-3 summarizes changes in harvest levels in Native villages following the oil spill. The finding that subsistence harvests had increased in five villages during the 1990-1991 timeframe suggested increased confidence in using some subsistence resources. However, the continued very low levels of harvest at Chenega Bay and Tatitlek, Nanwalek (English Bay) and Ouzinkie, and the continued concern in some households in many villages that some subsistence foods remained unsafe to eat, suggested that the injury persisted through the second year following the spill.

While published reports are not yet available for the period of April 1991 to the present, it is believed that subsistence harvests have not returned to prespill averages in all affected Native communities, especially Chenega Bay and Tatitlek. Concern over potential long-term health effects of consuming resources from the spill area, a loss of confidence on the part of subsistence hunters and fishermen in their abilities to determine if traditional foods are safe to eat, and the reduction in available resources, are all factors likely to affect recovery of subsistence use.

Table B-3

Subsistence Harvests Before and After the *Exxon Valdez* Oil Spill

COMMUNITY	PRE-SPILL YEAR ONE (per capita harvest in pounds)	PRE-SPILL YEAR TWO (per capita harvest in pounds)	OIL SPILL YEAR (per capita harvest in pounds)	PERCENT CHANGE (b)	POST-SPILL YEAR ONE (4/90-3/91) (per capita harvest in pounds)
PRINCE WILLIAM SOUND					
Chenega	308.8	374.2	148.1	-60.4	143.1
Tatitlek	351.7	643.5	214.8	-66.6	155.2
LOWER COOK INLET					
Nanwalek (English Bay)	288.8	(c)	140.6	-51.3	181.1
Port Graham	227.2	(c)	121.6	-46.5	213.5
KODIAK ISLAND					
Akhiok	519.5	159.3	297.7	+86.9	(d)
Karluk	863.2	381.0	250.5	-34.3	395.2
Larsen Bay	403.5	200.9	209.9	+4.5	340.4
Old Harbor	491.1	419.3	271.1	-35.2	(d)
Ouzinkie	369.1	405.7	88.8	-78.1	204.9
Port Lions	279.8	328.3	146.4	-55.4	(d)
ALASKA PENINSULA					
Chignik Bay	187.9	(c)	208.6	+11.1	(d)
Chignik Lagoon	220.2	(c)	211.4	-3.7	(d)
Chignik Lake	279.0	(c)	447.6	+60.1	(d)
Ivanof Bay	455.6	(c)	489.8	+8.4	(d)
Perryville	391.2	(c)	394.2	+1.0	(d)

(a) Prespill study years are: TATITLEK 1987-88 and 1988-89; CHENEGA, 1984-85 and 1985-86; NANWALEK (ENGLISH BAY) and PORT GRAHAM, 1987; KODIAK ISLAND BOROUGH, 1982-83 and 1986; ALASKA PENINSULA, 1984. The "spill year" is 1989 for all communities, except Chenega and Tatitlek, for which it is April 1989-March 1990.

(b) Based on most recent previous year.

(c) Only one previous measurement.

(d) Not determined.

The tables in this part of the supplemental information package summarize the results of the injury assessment studies for all natural resources and archaeology completed after the *Exxon Valdez* oil spill. For most resources, the "Description of Injury" columns focus on injury that took place during 1989 —just after the spill. **Table B-4** shows whether there was initial mortality caused by the spill, whether the spill caused a measurable population decline that will persist for more than one generation, and whether there is evidence of injury but without a measurable population decline. For some resources, an estimate is available for the total number of animals initially killed by the spill. If available, that estimate is shown in parentheses under the initial mortality column. For many resources, the total number killed will never be known. For other resources, and archaeology, listed in **Table B-5,** information on injury is not quantitative.

The "Status of Recovery" columns show the best estimate of recovery using information from 1992. (Most information comes from the 1992 summer field season). The columns show resources' progress toward recovery to the population levels that scientists estimate would have occurred in the absence of the spill. The "Current Population Status" column shows a resource's progress from any "Decline in Population after the Spill." Similarly, the column labeled "Evidence of Continuing Sublethal Effects" shows whether an initial sublethal injury is continuing.

Table B-4

Resources: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

RESOURCE	DESCRIPTION OF INJURY			STATUS OF RECOVERY IN DECEMBER, 1992		GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
	Oil Spill Mortality *(total mortality estimate) (b)*	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
MARINE MAMMALS										
Harbor Seals (c)	YES (345)	YES	YES	Possibly Stable, but Not Recovering (a)	Unknown	YES	YES (d)	Unknown	Unknown	Many seals were directly oiled. There was a greater decline in population indices in oiled areas compared to unoiled areas in PWS in 1989 and 1990. Population was declining prior to the spill and no recovery was evident in 1992. Oil residues found in seal bile were 5 to 6 times higher in oiled areas than unoiled areas in 1990.
Killer Whales	YES (13)	YES	Unknown	Recovering	Unknown	YES	Unknown	Unknown	Unknown	13 adult whales of the 36 in AB pod are missing and presumed dead. The AB pod has grown by 2 whales since 1990. Some experts think that the loss of 13 whales in 1989,1990 is unrelated to oil spill.
Humpback Whales	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Other than fewer animals being observed in Knight Island Passage in Summer 1989, which did not persist in 1990, the oil spill did not have a measurable impact on the north Pacific population of humpback whales.
Sea Lions (c)	Unknown	Unknown	NO	Continuing Decline	(e)	(e)	(e)	(e)	(e)	Several sea lions were observed with oiled pelts and oil residues were found in some tissues. It was not possible to determine population effects or cause of death of carcasses recovered. Sea lion populations were declining prior to the oil spill.
Sea Otters	YES (3,500 to 5,500)	YES	YES	Stable, but Not Recovering	YES, Possibly	YES	YES	YES (d)	YES (d)	Postspill surveys showed measurable difference in populations and survival between oiled and unoiled areas in 1989,1990 and 1991. Survey data have not established a significant recovery. Prime-age animals were still found on beaches in 1989, 1990 and 1991. Sea otters feed in the lower intertidal and subtidal areas and may still be exposed to hydrocarbons in the environment.

(a) There may have been an unequal distribution of injury within each region;
(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Table B-4 *(continued)*

RESOURCE	DESCRIPTION OF INJURY			STATUS OF RECOVERY IN DECEMBER,1992		GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
	Oil Spill Mortality *(total mortality estimate) (b)*	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic	PWS	Kenai	Kodiak	Alaska Penin.	
TERRESTRIAL MAMMALS										
Brown Bear	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Hydrocarbon exposure was documented on Alaska Peninsula in 1989 including high hydrocarbon levels in the bile of one dead cub. Brown bear feed in the inter-tidal zone and may still be exposed to hydrocarbons in the environment.
Black Bear	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	No field studies were completed.
River Otters	YES (Number Unknown)	Unknown	YES, Possibly	Unknown	YES	YES	Unknown	Unknown	Unknown	Exposure to hydrocarbons and possible sublethal effects were determined, but no effects were estab-lished on population. Sublethal indicators of possible oil exposure remained in 1991. River otters feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Sitka Black-tailed Deer	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Elevated hydrocarbons were found in tissues in some deer in 1989.
Mink	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Studies limited to laboratory toxicity studies.

(a) There may have been an unequal distribution of injury within each region;
(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Table B-4 *(continued)*

RESOURCE	DESCRIPTION OF INJURY			STATUS OF RECOVERY IN DECEMBER, 1992		GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
	Oil Spill Mortality *(total mortality estimate) (b)*	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
BIRDS										
Bald Eagles	YES (200 or more)	YES, Possibly	YES	Possibly Recovered	Unknown	YES	YES	YES (d)	YES (d)	Productivity in PWS was disrupted in 1989, but returned to normal in 1990. Exposure to hydrocarbons and some sublethal effects were found in 1989, but no continuing effects were observed on populations.
Black-legged Kittiwakes	YES (Number Unknown)	NO	NO	NO Change	NO	YES	YES (d)	YES (d)	YES (d)	Total reproductive success in oiled and unoiled areas of PWS has declined since1989. Hydrocarbon contaminated stomach contents were detected in 1989 and 1990. This species is known for great natural variation and reproductive failure may be unrelated to the oil spill.
Black Oystercatchers	YES (120-150 Adults, Unknown for Chicks (f)	YES	YES	Recovering	YES	YES	YES (d)	YES (d)	YES (d)	Differences in egg size between oiled and unoiled areas were found in 1989. Exposure to hydrocarbons and some sublethal effects were determined. Populations declined more in oiled areas than unoiled areas in postspill surveys in 1989, 1990 and 1991. Black oystercatchers feed in the intertidal areas and may be still be exposed to hydrocarbons in the environment.
Common Murres	YES (170,000 to 300,000)	YES	YES	Degrees of Recovery Varies in Colony	YES	NO	YES	YES	YES	Measurable impacts on populations were recorded in 1989, 1990 and 1991. Breeding is still inhibited in some colonies in the Gulf of Alaska.
Glaucous-winged Gulls	YES (Number Unknown)	Not Detected	NO	NO Change	NO	YES (d)	YES (d)	YES (d)	YES (d)	While dead birds were recovered in 1989, there is no evidence of a population level impact when compared to historic (1972,1973) population levels.

(a) There may have been an unequal distribution of injury within each region;
(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Table B-4 *(continued)*

RESOURCE	DESCRIPTION OF INJURY			STATUS OF RECOVERY IN DECEMBER, 1992		GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
	Oil Spill Mortality *(total mortality estimate) (b)*	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
BIRDS										
Harlequin Ducks	YES (Approx. 1,000)	YES	YES, Possibly	Unknown	YES	YES	YES (d)	YES (d)	YES (d)	Postspill samples showed hydrocarbon contamination. Surveys in 1990-1992 indicated population declines and possibly reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may still be exposed to hydrocarbons in the environment.
Marbled Murrelets (c)	YES (8,000 to 12,000)	YES	NO	Stable or Continuing Decline	Unknown	YES	YES (d)	YES (d)	YES (d)	Measurable population effects were recorded in 1989, 1990 and 1991. Marbled murrelet populations were declining prior to the spill.
Peale's Peregrine Falcons	Unknown	Unknown	NO	(e)	(e)	(e)	(e)	(e)	(e)	When compared to 1985 surveys a reduction in population and lower than expected productivity was measured in 1989 in the PWS. Cause of these changes are unknown.
Pigeon Guillemots (c)	YES (1,500 to 3,000)	YES	NO	Stable or Continuing Decline	Unknown	YES	YES (d)	YES (d)	YES (d)	Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found externally, on eggs.
Storm Petrels	YES (Number Unknown)	NO	NO	NO Change	Unknown	YES (d)	YES (d)	YES (d)	YES (d)	Few carcasses were recovered in 1989 although petrels ingested oil and transferred oil to their eggs. Reproduction was normal in 1989.
Other Seabirds	YES (Number Unknown)	Varies by Species	Unknown	Varies by Species	Unknown	YES (d)	YES (d)	YES (d)	YES (d)	Seabird recovery has not been studied. Species collected dead in 1989 include common, yellow-billed, Pacific, and red-throated loon; red-necked and horned grebe; northern fulmar; sooty and short-tailed shearwater; double-crested, pelagic, and red-faced cormorant; herring and mew gull; Arctic and Aleutian tern; Kittlitz's and ancient murrelet; Cassin's, least, parakeet, and rhinoceros auklet; and horned and tufted puffin.

(a) There may have been an unequal distribution of injury within each region;
(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Table B-4 *(continued)*

RESOURCE	DESCRIPTION OF INJURY			STATUS OF RECOVERY IN DECEMBER, 1992		GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
	Oil Spill Mortality *(total mortality estimate) (b)*	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
BIRDS										
Other Sea Ducks	YES (875) (b)	NO	Unknown	Unknown	Unknown	YES	YES (d)	YES (d)	YES (d)	Species collected dead in 1989 include Stellar's. king and common eider; white-winged, surf and black scooter, oldsquaw; bufflehead; common and Barrow's goldeneye; and common and red-breasted merganser. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil.
Other Shorebirds	YES (Number Unknown)	Unknown	Unknown	Unknown	Unknown	YES	YES (d)	YES (d)	YES (d)	Species collected dead in 1989 include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpiper; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.
Other Birds	YES (Number Unknown)	Unknown	Unknown	Unknown	Unknown	YES (d)	YES (d)	YES (d)	YES (d)	Species collected dead in 1989 include emperor and Canada goose; brant; mallard; northern pintail; green-winged teal; greater and lesser scaup; ruddy duck; great blue heron; long-tailed jaeger; willow ptarmigan; great- horned owl; Stellar's jay; magpie; common raven; north western crow; robin; varied and hermit thrush; yellow warbler; pine grosbeak; savannah and golden- crowned sparrow; white-winged crossbill.
FISH										
Cutthroat Trout	NO	NO	YES	(e)	Unknown	Unknown	NO	NO	NO	Differences in survival between anadromous adult populations in the oiled and unoiled areas were not statistically different; however, differences in growth between adult populations in the oiled and unoiled areas were found in 1989, 1990, and 1991.
Dolly Varden	NO	NO	YES	(e)	Unknown	Unknown	Unknown	Unknown	Unknown	Differences in survival between anadromous adult populations in the oiled and unoiled areas were not statistically different. Growth rates between 1989 and 1990 were reduced.

(a) There may have been an unequal distribution of injury within each region;
(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Table B-4 *(continued)*

RESOURCE	DESCRIPTION OF INJURY			STATUS OF RECOVERY IN DECEMBER,1992		GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
	Oil Spill Mortality *(total mortality estimate) (b)*	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic	PWS	Kenai	Kodiak	Alaska Penin.	
FISH										
Pacific Herring	YES, To Eggs and Larvae	NO (g)	YES	Unknown	NO	YES	Unknown	Unknown	Unknown	Measurable difference in egg counts between oiled and unoiled areas were found in 1989 and 1990. Lethal and sublethal effects on eggs and larvae were evident in 1989 and to a lesser extent in 1990; in 1991 there were no differences between oiled and unoiled areas. It is possible that the 1989 year class was injured and could result in reduced recruitment to the fishery.
Pink Salmon (Wild) (c)	YES, To Eggs	Possibly	YES	See Comments	YES	YES	Unknown	Unknown	Unknown	There was initial egg mortality in 1989. Egg mortality continued to be high in 1991. Abnormal fry were observed in 1989. Reduced growth of juveniles was found in the marine environment, which can be correlated with reduced survival.
Rockfish	YES (f) (20)	Unknown	YES	Unknown	Unknown	YES	YES	Unknown	Unknown	Few dead fish were found in 1989 in condition to be analyzed. Exposure to hydrocarbons with some sub-lethal effects were determined in those fish, but no effects established on the population. Closures to salmon fisheries increased fishing pressures on rockfish which may be impacting population.
Sockeye Salmon	Unknown	YES	YES	See Comments	YES	Unknown	YES	YES	YES	Smolt survival continues to be poor in the Red Lake and Kenai River systems due to over escapements in Red Lake in 1989, and in the Kenai River in 1987, 1988, 1989. As a result, adult returns are expected to be low in 1994 and successive years. Trophic structures of Kenai and Skilak Lakes have been altered by over escapement.

(a) There may have been an unequal distribution of injury within each region;
(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Table B-4 (*continued*)

RESOURCE	DESCRIPTION OF INJURY			STATUS OF RECOVERY IN DECEMBER, 1992		GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
	Oil Spill Mortality *(total mortality estimate) (b)*	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic	PWS	Kenai	Kodiak	Alaska Penin.	
SHELLFISH										
Clam	YES (Number Unknown)	Unknown	Possibly; Final Analyses Pending	Unknown	Unknown	YES	YES	YES	YES	Native littleneck and butter clams were impacted by both oiling and cleanup, particularly high pressure, hot water washing. Littleneck clams transplanted to oiled areas in 1990 grew significantly less than those transplanted to unoiled sites. Reduced growth recorded at oiled sites in 1989 but not 1991.
Crab (Dungeness)	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Crabs collected from oil areas were not found to have accumulated petroleum hydrocarbons.
Oyster	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Although studies were initiated in 1989, they were not completed because they were determined to be of limited value.
Sea Urchin	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Studies limited to laboratory toxicity studies.
Shrimp	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	No conclusive evidence presented for injury linked to oil spill.
INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	Variable by Species, See Comments	YES	YES	YES	YES	YES	Measurable impacts on populations of plants and animals were determined. The lower intertidal and, to some extent, the midintertidal is recovering. Some species *(Fucus)* in the upper intertidal zone have not recovered, and oil may persist in and mussel beds.
Subtidal Organisms/ Communities	YES	YES	YES	Variable by Species, See Comments	YES	YES	Unknown	Unknown	Unknown	Measurable impacts on population of plants and animals were determined in 1989. Eelgrass and some species of algae appear to be recovering. Amphipods in eel grass beds recovered to pre-spill densities in 1991. Leather stars and helmet crabs show little sign of recovery through 1991.

(a) There may have been an unequal distribution of injury within each region;
(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Table B-5

Other Natural Resources and Archaeology: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

RESOURCE	DESCRIPTION OF INJURY	STATUS OF RECOVERY IN DECEMBER,1992	GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
			PWS	Kenai	Kodiak	Alaska Penin.	
OTHER NATURAL RESOURCES AND ARCHAELOLOGY							
Air	Air quality standards for aromatic hydrocarbons were exceeded in portions of PWS. Health and safety standards for permissible exposure levels were exceeded up to 400 times.	Recovered	YES	NO	NO	NO	Impacts diminished rapidly as oil weathered and lighter fractions evaporated.
Sediments	Oil coated beaches and became buried in beach sediments. Oil laden sediments were transported off beaches and deposited on subtidal marine sediments.	Patches of oil residue remain intertidally on rocks and beaches and buried beneath the surface at other beach locations. Oil remains in some subtidal marine sediments and has spread to depths greater than 20 meters.	YES	YES	YES	YES	Unweathered buried oil will persist for many years in protected low-energy sites.
Water	State of Alaska water quality standards may have been exceeded in portions of PWS. Federal and State oil discharge standards of no visible sheen were exceeded.	Recovered	YES	YES	YES	YES	Impacts diminished as oil weathered and lighter fractions evaporated.
Archaeological Sites/ Artifacts	Currently, 24 sites are known to have been adversely affected by oiling, cleanup activities, or looting and vandalism linked to the oil spill. 113 sites are estimated to have been similarly affected. Injuries attributed to looting and vandalism (linked to the oil spill) are still occurring.	Archaeological sites and artifacts cannot recover; they are finite nonrenewable resources.	YES	YES	YES	YES	
Designated Wilderness Areas	Many miles of Federal and State Wilderness and Wilderness Study Area coastlines were affected by oil. Some oil remains buried in the sediments of these areas.	Oil has degraded in many areas but remains in others. Until the remaining oil degrades, injury to Wilderness areas will continue.	YES	YES	YES	YES	

(a) There may have been an unequal distribution of injury within each region.

Services: Summary of Results of Injury Assessment Studies

Table B-6 summarizes information concerning lost or reduced services damaged by the spill. Much of the damage to services and the information about those damages is not quantitative. The table reflects the qualitative content of the information. The "Description of Injury" column recounts the situation for each service in the year following the spill. The "Status of Recovery in 1992" shows the 1992 situation for that service.

The information used for this table is taken from injury assessment studies, information from agency managers, and, for recreation, a Key Informant Interview study conducted the Restoration Planning Working Group in December 1992.

Table B-6

Services: Summary of Reduced or Lost Services (As a Result of Injury to the Natural Resources) Following the *Exxon Valdez* Oil Spill

SERVICE	DESCRIPTION OF INJURY	STATUS OF RECOVERY IN DECEMBER, 1992	GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
			PWS	Kenai	Kodiak	Alaska Penin.	
Commercial Fishing	During 1989, emergency commercial fishery closures were ordered in PWS, Cook Inlet, Kodiak and the Alaska Peninsula. This affected salmon, herring, crab, shrimp, smelt, rockfish and sablefish. The 1989 closures resulted in sockeye over-escapement in the Kenai River and in the Red Lake system (Kodiak Island). In 1990 portions of PWS were closed to shrimp and salmon fishing.	Currently there are no area-wide oil spill-related commercial closures in effect. Management actions to try to compensate for the spill are still in effect. EVOS related sockeye over-escapement in the Kenai River and Red Lake system is anticipated to result in low adult returns in 1994 and 1995. These over-escapements may result in closure or harvest restrictions during these and perhaps in subsequent years.	YES	YES	YES	YES	Injuries and recovery status of rockfish,pink salmon, shellfish and herring are uncertain. Therefore, future impacts on these fisheries is unknown.
Commercial Tourism	Approximately 43% of the tourism businesses surveyed felt their businesses had been significantly affected by the oil spill in summer 1989. The net loss in visitor spending in the oil spill area in 1989 was $19 million.	By 1990, 12 % of the tourism businesses surveyed felt their businesses had been significantly affected by the oil spill.	YES	YES	YES	YES	
Passive Use	The areas of Alaska impacted by the oil spill supported a large diverse ecosystem that was valued by large numbers of the American public who did not visit the area. The spill killed substantial numbers of different bird species and marine mammals as well as oiling much of the coastline in the impacted areas. The spill also had substantial effects on the fish, bird, and wildlife populations. While some of these effects may be of relatively short duration, others such as recovery of various bird populations are likely to take decades.	The animals initially killed are irreplaceable. Fish and wildlife populations are recovering at different rates. Much of the oil in shoreline areas has been removed or has weathered to varying degrees.	YES	YES	YES	YES	A contingent valuation study of the American public done in 1991 found that approximately 95% were still aware of the *Exxon Valdez* oil spill, and that over 50% spontaneously named the spill as one of the worst environmental accidents to occur in the world during their lifetime. The median household was willing to pay $31 to prevent a spill similar to the *Exxon Valdez* oil spill in the future. Multiplied by the number of U.S. households, this results in an estimate of spill damages of $2.8 billion.

(a) There may have been an unequal distribution of injury within each region.

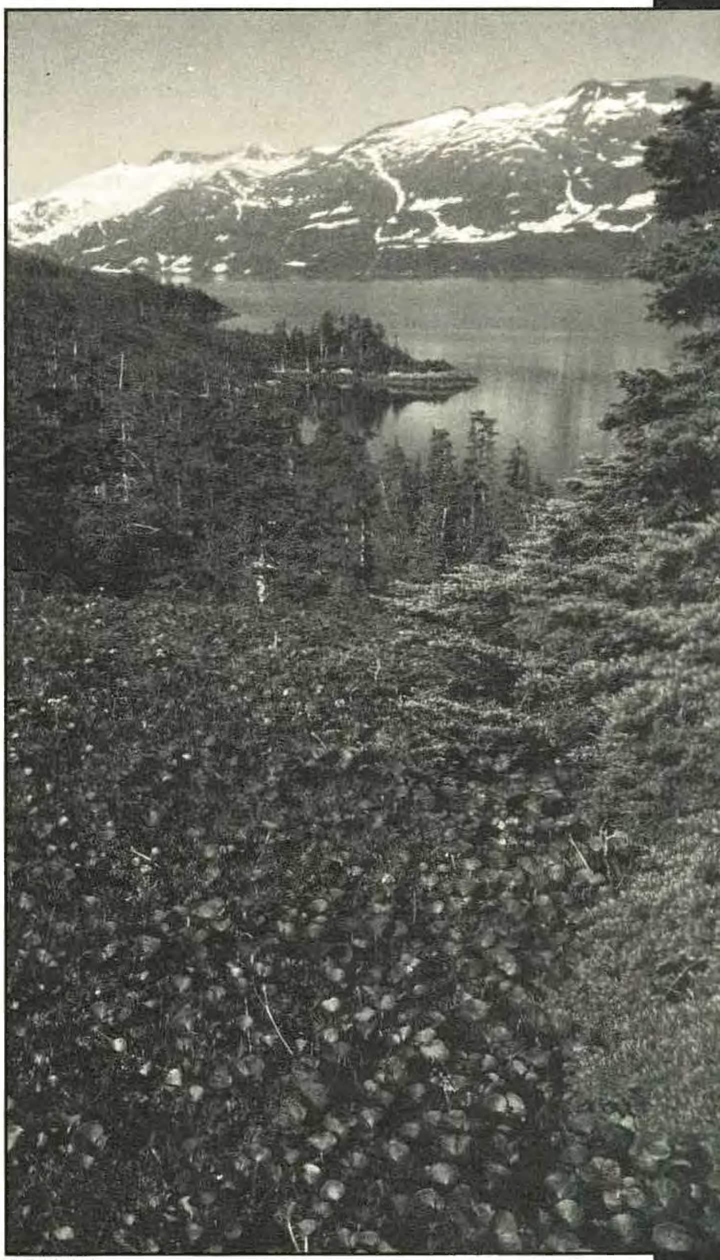
Table B-6 *(continued)*

SERVICE	DESCRIPTION OF INJURY	STATUS OF RECOVERY IN DECEMBER,1992	GEOGRAPHIC EXTENT OF INJURY (a)				COMMENTS/DISCUSSION
			PWS	Kenai	Kodiak	Alaska Penin.	
Recreation (e.g., hunting, fishing, camping, kayaking, sailboating, motorboating, environmental education)	The nature and extent of any reduction or loss of services varied by user group and by area. About a quarter of key informants interviewed reported no change in their recreation experience, but others reported avoidance of the spill area, reduced wildlife sightings, residual oil, and more people. Overall, recreation use declined significantly in 1989. Between 1989 and 1990 a decline in sport fishing (number of anglers, fishing trips and fishing days) were recorded for PWS, Cook Inlet and the Kenai Peninsula. In 1992, an emergency order restricting cutthroat trout fishing was issued for western PWS due to low adult returns. Sport hunting of harlequin duck was affected by restrictions imposed in 1991 in response	Declines in recreation activities reported in 1989 appear to be recovering for some user groups, but the degree of recovery is unknown. EVOS related sockeye over-escapement in the Kenai River and Red Lake system is anticipated to result in low adult returns in 1994 and 1995. These over-escapements may result in sport fishing closures or harvest restrictions during these and perhaps subsequent years. The 1992 sport fishing closure for cutthroat trout is expected to continue at least through 1993. Harvest restrictions are expected to continue for harlequin duck through 1993.	YES	YES	YES	YES	Survey respondents also reported changes in their perception of recreation opportunity in terms of increased vulnerability to future oil spills, erosion of wilderness, a sense of permanent change, concern about long-term ecological effects, and in some, a sense of optimism.
Subsistence	Subsistence harvests of fish and wildlife in 9 of 15 villages surveyed declined from 4 - 78% in 1989 when compared to pre-spill levels. At least 4 of the 9 villages showed continued lower than average levels of use in the period 1990-1991; this decline is particularly noticeable in the Prince William Sound villages of Chenega and Tatitlek. In 1989-1991, chemical analysis indicated that most resources tested, including fish, marine mammals, deer, and ducks, were safe to eat. In 1989-1991, health advisories were issued indicating that shellfish from oiled beaches should not be eaten.	Many subsistence users believe that continued contamination to subsistence food sources is dangerous to their health. In addition, village residents believe that subsistence species continue to decline or have not recovered from the oil spill.	YES	YES	YES	YES	For detailed information on village subsistence use, see Table B-3.

(a) There may have been an unequal distribution of injury within each region.

Section C

HABITAT PROTECTION AND ACQUISITION



PAT MURPHY

HABITAT PROTECTION AND ACQUISITION

This category of restoration actions includes protection and acquisition of habitat on private lands, and protection of habitat on public land. Most of this section explains the Habitat Protection and Acquisition process for *private* land. The last part of this section discusses Habitat Protection on public land.

Development, such as harvesting timber or building subdivisions, can sometimes harm resources or services that rely on the land. The object of protecting and acquiring land is to prevent further impacts to resources and services, and allow recovery to occur at its natural rate. For example, the recovery of harlequin ducks may be helped by protecting nesting habitat from future changes that could degrade the habitat or disturb the nests.

The Trustee Council may purchase private land or partial interests in land such as conservation easements, mineral rights, or timber rights as methods of restoration. The settlement requires that any purchase must benefit resources or services affected by the spill. These lands would be managed to protect the resources and services. The Council's decision to purchase inholdings in Kachemak Bay State Park is an example of habitat protection and acquisition on private land.

The process for Habitat Protection and Acquisition is different for public and private lands. Public lands are already protected by existing agency management and have as yet received little attention from Trustee Council staff. To protect habitats on public land, the Trustee Council may in the future recommend changing agency management practices, or recommend placing public land and waters into special protective designations.

INTRODUCTION

The goal of habitat protection and acquisition on private land is to prevent further damage to resources and services by protecting key fish and wildlife habitat or human use areas, or by providing habitat for equivalent resources or services. To accomplish this goal, the Trustee Council may provide for the purchase of key habitats to prevent development on private land, or they may use other protection techniques such as conservation easements, acquisition of partial interests, cooperative management agreements, and other mechanisms. After land and interests in land have been purchased, they will be managed by the appropriate state or federal agency in a manner that is consistent with the restoration of the affected resources and services.

Work Completed: *Imminent Threat Process*

To date, the Habitat Protection and Acquisition process has focused on lands for which some threat, usually logging, will occur soon. A longer evaluation process might have meant that some lands with habitat important to the recovery of injured resources or services would be developed while the evaluation was being conducted. Trustee Council staff evaluated only those lands for which the State of Alaska received forest practice notifications or other development plans were known. This process is called the Imminent Threat Process. As a result of this process the Trustee Council allocated funds to purchase inholdings in Kachemak Bay State Park, have approved purchase of private land surrounding Seal Bay on Afognak Island contingent on negotiations and appraisal, and are negotiating for other threatened habitat.

Work to be Done: *The Comprehensive Process*

Trustee Council staff is now beginning the Comprehensive Process. It is different from the Imminent Threat Process in two ways: it may use some improved procedures, and it will include many more private lands in the spill area.

Trustee Council staff are currently reviewing procedures used for the Imminent Threat Process. If staff, experts, or public review as part of this supplement provides better methods to evaluate lands for habitat protection and acquisition, the imminent threat lands will be re-evaluated using the improved procedures.

The Trustee Council also sent a letter asking private landowners with 160 or more acres in the spill area whether they would be willing to have their land considered by the Habitat Protection and Acquisition process. The letter did not ask for a commitment to sell, only whether the landowner was willing to have their land evaluated, and was willing to explore the possibility of cooperative agreements, or selling full or partial title. At this writing, responses are still being received. The Comprehensive Process will add to the imminent threat evaluations all private lands where the landowner is willing to participate.

The Comprehensive Process will complete an initial ranking and evaluation of private lands in the fall which will be circulated for public review.

This section describes the Imminent Threat Process. It also discusses some improvements to procedures that staff has already recommended for the Comprehensive Process. Further changes may also be made on the basis of public comment, further staff analysis, and expert review.

Linkage: *Which Resources and Services to Target*

Habitat Protection and Acquisition benefits the injured resources and services that are linked to upland and nearshore habitats. These resources and services are listed in **Table C-1**. The table shows that all but two of the injured resources summarized in the Summary of Alternatives are linked to upland and nearshore habitats: killer whale, and rockfish.

Linkage for resources means that they are dependent on upland and nearshore habitats during critical life history stages, such as reproduction, feeding, or molting. Linkage for services includes the habitats that injured species depend on, but it may also include areas for human use such as viewsheds, or camping and sport-fishing sites. For example, stream habitats support reproduction of anadromous fish. They are also movement corridors between spawning and rearing habitat and the open sea. Commercial and sport fisheries depending on the resources produced by those streams. Harlequin ducks nest in forest areas near streams, and use streams as a movement corridor to their intertidal feeding habitat.

Answers to the policy questions presented in the Summary of Alternatives will influence the process of evaluating lands for potential acquisition and protection. One issue is whether restoration activities, including Habitat Protection and Acquisition, should address all injured resources or exclude those biological resources whose population did not measurably decline because of the spill. A second issue is whether restoration should cease once a resource as recovered; that is, once a resource is recovered, should new acquisition or other measures be initiated specifically to protect that resource. If not all resources are addressed, then future Habitat Protection and Acquisition will not target some of the resources listed in **Table C-1.** These and other issues are more fully addressed in the alternatives. For more information, see the Summary of Alternatives.

Table C-1

Resources and Services that Use Upland or Nearshore Habitats and Would Benefit From Protection

Resources: POPULATION DECLINE	Resources: INJURED, BUT NO POPULATION DECLINE	Resources: OTHER	Services (Human uses)
Black oystercatcher	Bald eagle	Archaeological resources	Commercial fishing
Common murre	Cutthroat trout	Designated wilderness areas	Commercial tourism
Harbor seal	Dolly Varden		Passive use
Harlequin duck	● Killer whale		Recreation including sport fishing, sport hunting, and other recreation use
Intertidal organisms	Pacific herring		Subsistence
Marbled murrelet	● Pink salmon		
Pigeon guillemot	River otter		
Sea otter			
Sockeye salmon			
Subtidal organisms			

● *For these species, the Trustee Council's scientists have considerable disagreement over the conclusions to be drawn from the results of the damage assessment studies.*

Threat

Habitat Protection and Acquisition protects recovering resources and services from adverse impacts by human activity. Potential threats to the habitat of resources and services include both disturbance and habitat degradation. Habitat degradation may be caused by changes in land use such as development. An example of habitat degradation would be pollution of spawning or breeding habitat, cutting down of nesting habitat, or development harmful to a viewshed important to recreation or tourism. Human disturbance can disrupt reproductive activity or displace animals from important feeding areas. For example, marine mammals are sensitive to disturbance when hauled out on land.

Although upland areas were not oiled, they often contain key habitats of resources or services that were directly affected by the spill and clean-up activities. For example, in some cases timber harvest, mining, subdivisions or other development activities may jeopardize the nesting habitat of marbled murrelets or harlequin ducks. They may disturb animals that are dependent upon intertidal or nearshore habitats. Wilderness values and tourism may be adversely impacted by clearcutting, buildings, or other development activities. Habitat Protection and Acquisition measures are intended to lessen these and other threats to affected resources and thereby maintain recovery rate.

Although the goal of this process is to protect habitats linked to resources and services in **Table C-1**, other resources will also be affected, including water quality and other non-injured fish and wildlife.

THE IMMINENT THREAT PROCESS

This part of the section describes the Habitat Protection and Acquisition process as it was used for the Imminent Threat Process. Some changes in procedures may be made as a result of public, staff, and peer review.

Habitat Protection and Acquisition procedures characterize, locate, and evaluate habitat areas linked to the recovery or replacement of resources injured by the oil spill and the lost services that depend on those resources. The process is built around a sequence of steps beginning with characterizing habitats and leading to the protection of those key habitats. It evolved from discussions with local experts, literature reviews, public comment, and reviews of damage assessment and restoration studies, and collaboration with agency personnel. These steps can be grouped into three phases:

A) ***Evaluation and Selection;***

B) ***Acquisition and Protection; and***

C) ***Management.***

Table C-2 summarizes this process.

Table C-2

Key Steps in the Habitat Protection and Acquisition Process for Private Land

A EVALUATION AND SELECTION

1. Characterize essential habitat types for injured resources and services.
2. Identify key habitat types on specific parcels and determine the optimum boundary necessary to protect resource or service values.
3. Apply threshold criteria to private lands with linked habitats.
4. Evaluate and rank each candidate parcel.
5. Establish restoration objectives.

B ACQUISITION AND PROTECTION

6. Decide which land protection tools will accomplish the restoration objectives.
7. Secure management agreements or acquire fee title to, or partial interests in, the highest ranked parcels.

C MANAGEMENT

8. Implement a management plan for each acquired parcel that facilitates recovery of injured resources and services and provides for long term protection.

A EVALUATION AND SELECTION

The first part of the Habitat Protection and Acquisition process determines which habitats are linked to injured resources and services. And of these, which are the most important ones to protect. Of the five steps in this part of the process two are particularly important: applying threshold criteria, and evaluation and ranking criteria.

Step 1
Characterize habitat types

To protect key habitats for injured resources and services, it is necessary to define them. Examples of key habitats are reproduction and feeding habitats, spawning areas for anadromous fish, etc.

Step 2
Identify key habitats on specific parcels

The next step is to determine what key habitats exist on each parcel.

Step 3
Threshold Criteria

After a parcel has been nominated for protection, and biologists have determined which key habitats linked to injured resources and services exist on the parcel, staff evaluate the parcel against a set of Threshold Criteria. These criteria determine whether a nomination is acceptable for further consideration. A nomination will be rejected if it is not in compliance with ALL threshold criteria.

Table C-3 lists the Threshold Criteria used for the Imminent Threat Process. The criteria may be modified as a result of staff, peer, and public review.

Table C-3

Threshold Criteria for the Imminent Threat Process

- There is a willing seller of the parcel or property right;
- The parcel contains key habitats that are linked to, replace, provide the equivalent of, or substitute for injured resources or services.
- The seller acknowledges that the government can purchase the parcel or property right only at or below fair market value.
- Recovery of the injured resource or service would benefit from protection in addition to that provided by the owner and applicable laws and regulations; and
- The acquired property rights can reasonably be incorporated into public land management systems.

STEP 4
Evaluation and Ranking Criteria

Nominations that comply with all the threshold criteria become Candidate Lands. To determine which candidate lands are most important to protect, the lands are evaluated using Evaluation and Ranking Criteria. The first step in this assessment is to determine the parcel boundary that contain the habitats and support systems that need to be protected. Once the optimum boundary is determined, the parcel is evaluated and ranked using the criteria. These evaluation criteria are designed to determine the degree of linkage of injured resources and services to specific parcels, and the potential for benefit that implementation of habitat protection would have on each linked resource and service.

• • •

The next eight paragraphs discuss the evaluation and ranking criteria. They were developed using a mix of professional judgement and scientific data. They are interim criteria developed for the Imminent Threat Process and were used to develop a ranking of threatened habitats. They are currently being re-evaluated.

1) The parcel contains essential habitat(s) for injured resources or services.
Essential habitats include feeding, reproductive, molting, roosting, and migration concentrations; key areas known or presumed to be high public use areas. Factors for determining these habitat are:

a) population of animals or number of public users,

b) number of key habitats on parcel, and

c) quality of key habitats.

This criterion estimates the degree of linkage between the resource or service and the parcel. Each linked habitat, known to occur on the parcel, is rated as high, moderate or low. This rating is derived from the estimated benefit that the resource or service would get from protection of the parcel. Because it is the most important, it is the only one that is weighted.

2) The parcel can function as an intact ecological unit or essential habitats on the parcel are linked to other elements/habitats in the greater ecosystem. The parcel must contain enough connections to natural systems outside of its boundary so that it can sustain populations of linked species. Both the size and shape of the parcel must meet the area requirements of linked resources or services.

3) Adjacent land uses will not significantly degrade the ecological function of the essential habitat(s) intended for protection. The parcel must maintain the integrity of the injured species populations and services even if adjacent lands are developed.

4) Protection of the habitats on parcel would benefit more than one injured resource or service (unless protection of a single resource or service would provide a high recovery benefit). This criterion recognizes parcels that contain more than one linked resource or service. Example of high benefits to a single species would be the protection of an especially productive anadromous stream, or of a forest area with a dense nesting population of marbled murrelets.

5) The parcel contains critical habitat for a depleted, rare, threatened, or endangered species. This criterion recognizes the benefit of preserving both species and habitat diversity. Rare, threatened, depleted, or endangered species often have very specialized habitat requirements or exist only in a few small areas. Protection of habitat areas of these species, that are important to recreation or commercial uses, helps to maintain normal population levels.

6) Essential habitats on parcel are vulnerable or potentially threatened by human activity. Habitat alteration or destruction is a major cause in the reduction in species numbers. Injured, rare or species populations with low resilience are particularly vulnerable to changes in land use that affect essential habitats.

7) Management of adjacent lands is, or could easily be made compatible with protection of essential habitats on parcel. Management policies, on adjacent lands, that would facilitate both recovery and long term protection goals are recognized by this criterion. This criterion also considers management costs for potential acquisitions.

8) The parcel is located within the oil spill area. Linked habitats on parcels within the oil spill area are more likely to contain affected populations than those outside of the area. However, one of the issues addressed in the alternatives asks whether restoration activities should take place in the spill area only, or anywhere there is a link to injured resources and services. If the latter answer is chosen, the Habitat Protection and Acquisition Process may consider parcels outside the spill area as long as they benefit resources or services injured by the spill. However, most parcels considered by the process will likely be within the spill area.

STEP 5

Restoration Objectives

After establishing the parcel rankings, staff determine the objectives for each parcel. These objectives will help guide which protection and acquisition tool(s) are chosen. For example, if the objective is to maintain anadromous fish habitat, protecting larger stream buffers from development may be adequate. If the objective is public use, fee simple title may be a better tool.

For example, the restoration objectives for the purchase of inholdings in Kachemak Bay State Park were:

- ***maintain water quality of the estuary and associated riparian habitats for anadromous fish;***
- ***maintain bald eagle, marbled murrelet, and harlequin nesting habitat;***
- ***maintain and enhance recreational opportunities and scenic values; and***
- ***maintain public access to Leisure Lake stream.***

B ACQUISITION AND PROTECTION

Step 6

Decide Which Protection Tool(s) are Appropriate

The Trustee Council has a suite of tools at its disposal for habitat acquisition and protection. These tools range from the simple, voluntary land owner agreement, to the purchase of full title to land. Protection tools between these include management agreements, leases, and temporary and permanent conservation easements. Each tool has strengths and limitations. For example, while a voluntary management agreement may be simple to obtain and cost nothing, it is not enforceable. On the other hand, acquisition of an easement may provide the desired permanent protection, yet it may be costly to purchase and difficult to manage. Acquisition of fee simple interests in lands provides the maximum protection, but it is the most expensive to purchase. Care must be taken to apply the most appropriate protection tool to each situation.

The Trustee Council, in concert with any agency that may become responsible for managing the affected lands, will decide which land protection tool is most appropriate for each situation. The final decision on which protection tools are employed will be the result of negotiations with landowners.

For discussion of the complete range of available land protection tools, please refer to "Options for Identifying and Protecting Strategic Fish and Wildlife Habitats and Recreation Sites: A General Handbook," Section 3.3, The Nature Conservancy, December 1991, prepared for The Exxon Valdez Oil Spill Restoration Planning Work Group.

Step 7

Secure protection using the appropriate tool.

Acquisition will proceed for the highest-ranked parcels. Acquisition or protection of lands or interests in lands is based on standard realty principles and practices. Although there are minor differences in the ways the Federal government and the State of Alaska conduct acquisitions, the essential elements of real estate acquisitions are included in both processes. All acquisitions will require evidence of title, appraisals of fair market value, hazardous materials surveys, legal review of title, and negotiations. In addition, some acquisitions will require land surveys.

Once a tract is identified for acquisition and protection by the Trustee Council, it will be assigned as an acquisition and protection case to an agency, multi-agency team, or other group. In addition, assistance in acquisitions may be obtained from other groups such as non-profit land conservation groups. The party with responsibility for an acquisition will receive direction from the Trustee Council and staff to assure that acquisitions are conducted according to Trustee Council directives and will fulfill restoration objectives. Once an acquisition has been fully negotiated regarding all terms and conditions, and price, the Trustee Council will have final authority to approve funds for the acquisition and protection. The agency or group that would receive title to the tract would need to accept title.

From the time an acquisition and protection case begins negotiation to its completion will typically take six months to two years, depending on its complexity. Factors that influence the complexity include title conditions, potential contamination, need for land surveys, protracted negotiations, and approvals by corporate boards.

Acquisition and protection could involve land exchanges, if suitable federal or state lands can be identified for exchange. Identifying public lands that are agreeable for exchange is difficult. Land exchanges involve both the acquisition and disposal of lands, they are more complex than purchases. They typically take a minimum of two years.

C MANAGEMENT

Step 8

After the Trustee Council has secured for an agency the right to manage the protected habitat, the land must be managed to fulfill the identified restoration objectives. The Trustee Council will likely require that the federal or state agency that receives title manage the land for restoration purposes. The management actions needed for fulfilling these purposes will be specific to each parcel of land conveyed.

Land managers for the acquired habitat may be requested to produce or revise management plans. Special management designations may be recommended. Possible special designations include: Alaska State Parks, Alaska Department of Fish and Game special areas, State Public Use Areas, National Recreation Areas, National Marine Sanctuaries, Federal Wilderness areas, or a variety of administrative designations. As restoration objectives are accomplished over time, some restrictions imposed on management of the lands may be removed.

Intensive management of lands may be required to meet restoration objectives. It could require specific research and monitoring, public education, possibly enhancement activities, etc. Consideration will be given to providing funding for management from settlement funds and from the land managers.

EXAMPLES OF THE RANKING AND EVALUATION: IMMINENT THREAT PROCESS

The process described in this section is easiest to understand using examples. This part of the section shows examples of how the Imminent Threat analysis was applied to two highest-ranking parcels in the analysis: China Poot in Kachemak Bay, and Seal Bay on Afognak Island.

Tables C-4 and C-5 show how habitat protection and acquisition in these two areas would benefit the resources and services affected by the oil spill. They show the results of the analysis completed for these two areas during the Imminent Threat Process. **Table C-6** shows how the parcels were ranked using the Evaluation and Ranking Criteria explained earlier.

On December 11, 1992, the Trustee Council allocated funds to purchase China Poot in Kachemak Bay. On May 13, 1993, the Trustee Council directed staff to begin negotiations on the other four parcels. They have currently come to tentative agreement to purchase property at Seal Bay and Tonki Cape, on Afognak Island for $38.7 million, pending further negotiation and appraisal.

Table C-4

Example 1: China Poot, Kachemak Bay

Landowner:	**Seldovia Native Association** *(other owners may own partial rights such as timber or minerals)*
Parcel acreage:	**7,500 acres**
Total acreage held by owner in the spill area:	**106,000 acres**
Estimated area to be affected by imminent development activity:	**5,300 acres**

EXAMPLE PARCEL: CHINA POOT, KACHEMAK BAY

INJURED RESOURCE/SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	MODERATE	Five cataloged anadromous streams on parcel. Coho, chum, sockeye, and pink salmon and Dolly Varden spawning and rearing habitat; enhanced sockeye salmon runs in Leisure Lake and Hazel Lake.
Bald Eagle	HIGH	Intertidal foraging and feeding on anadromous fish. Thirty seven documented nest sites on parcel.
Black Oystercatcher	LOW	Likely that oystercatchers use gravel spit sand intertidal for feeding and nesting.
Common Murre	MODERATE	Murre colony (est. 5,075 birds) on Gull Rock may benefit from adjacent habitat protection.
Harbor Seal	MODERATE	Harbor seals feed in area and frequently haul-out on nearshore rocks and bars.
Harlequin Duck	MODERATE	Probable nesting in upper riparian areas; probable feeding in streams and estuaries.
Intertidal/Subtidal Biota	HIGH	China Poot Bay is documented as one of the most productive shallow benthic habitats in Kachemak Bay.
Marbled Murrelet	HIGH	High confidence that nesting occurs on parcel. Large numbers of murrelets forage on Kachemak Bay.
Pigeon Guillemot	LOW	Foraging occurs in adjacent marine waters.
River Otter	MODERATE	High use area for feeding and latrine sites; possible denning inland.
Sea Otter	LOW	Established population in area; feeding and possible pupping in adjacent marine waters.

Table C-4 *(continued)*

EXAMPLE PARCEL: CHINA POOT, KACHEMAK BAY

INJURED RESOURCE/SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Recreation/Tourism	HIGH	Neptune, Peterson, and China Poot Bay sand Gull Rock receive high use. Highly visible from Homer and Kachemak Bay. Adjacent to Kachemak Bay State Park.
Wilderness	LOW	Area is moderately developed, primarily recreational home-sites. High human use area.
Cultural Resources	MODERATE	Twenty eight documented archaeological sites on parcel.
Subsistence	MODERATE	Within resource use area of Port Graham and English Bay.

ECOLOGICAL SIGNIFICANCE:
China Poot, Neptune, and Peterson bays are highly productive estuaries that provide habitat for birds, anadromous fish, mammals, and intertidal marine life. This area receives very high recreational use, has significant archaeological sites, and is highly visible from Homer and adjacent marine waters. The timbered lands are probably important to marbled murrelets. This area also provides access to a recreational dip-net fishery at the outlet of Leisure Lake.

ADJACENT LAND MANAGEMENT:
This parcel is adjacent to Kachemak Bay State Park; the park receives a significant amount of recreational use by residents of Anchorage and the Kenai Peninsula and is also an important tourist attraction. The parcel is also adjacent to other Seldovia Native Association lands.

IMMINENT THREAT/OPPORTUNITY:
This parcel is proposed for logging in 1993. Permit approvals are pending additional information, Corps of Engineers Public Notice, and Alaska Coastal Management Review Preview.

PROTECTION OBJECTIVE:
1) Maintain water quality of the estuary and associated riparian habitats for anadromous fish; 2) maintain bald eagle, marbled murrelet, and harlequin nesting habitat; 3) maintain and enhance recreational opportunities and scenic values; and 4) maintain public access to Leisure Lake stream.

USEFUL PROTECTION TOOL(S):
Timber acquisition; fee simple purchase; conservation easement; cooperative management; public access acquisition.

RECOMMENDED ACTION:
The Trustee Council has approved a resolution to acquire fee title for Kachemak Park in holdings. Habitat and service values are among the highest for imminent threat lands evaluated. Request Seldovia Native Association to provide interim protection; begin negotiations to acquire long term protection; December 31, 1993 deadline.

Table C-5

Example 2: Seal Bay on Afognak Island

Landowner:	**Akhiok-Kaguyak-Old Harbor d.b.a. Seal Bay Timber Company** *(other owners may own partial rights such as timber or minerals).*
Parcel acreage:	**17,391 acres**
Total acreage held by owner in the spill area:	**253,000 acres**
Estimated area to be affected by imminent development activity:	**8,443 acres**

EXAMPLE PARCEL: SEAL BAY ON AFOGNAK ISLAND

INJURED RESOURCE/SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Anadromous Fish	MODERATE	Six documented anadromous streams; pink, sockeye, coho, Dolly Varden, steelhead.
Bald Eagle	HIGH	Eleven documented active nest sites; feeding and roosting along shoreline.
Black Oystercatcher	MODERATE	Feeding in intertidal; probable nesting along shoreline and nearshore islets.
Common Murre	NONE	
Harbor Seal	MODERATE	Area historically supported large numbers of seals. Feeding in nearshore waters and haul-outs on nearshore rocks.
Harlequin Duck	MODERATE	Up to 64 birds observed in Seal Bay. Nearshore habitat appears good for feeding and molting. Potential for nesting appears low.
Intertidal/subtidal biota	MODERATE	Productive sheltered rocky intertidal and shallow subtidal habitat. Steep slopes adjacent to intertidal may become source of erosion sedimentation. No documented oiling of shoreline.
Marbled Murrelet	HIGH	High confidence that nesting occurs on parcel; high use of adjacent marine waters for feeding; good nesting habitat characteristics in forest areas; adjacent area on Alaska Joint Venture land had highest nesting habitat characteristics in spill area; logging has fragmented some forest stands which has diminished nesting characteristics in some areas.
Pigeon Guillemot	MODERATE	Documented nesting of up to 36 birds on or immediately adjacent to parcel; feeding in nearshore waters.
River Otter	MODERATE	Probable feeding and latrine sires along shoreline. Possible denning. Habitat characteristics appear very favorable for river otters.
Sea Otter	MODERATE	Known concentration area off Tolstoi Point. Feeding in nearshore waters.

Table C-5 *(continued)*

EXAMPLE PARCEL: CHINA POOT, KACHEMAK BAY

INJURED RESOURCE/SERVICE	POTENTIAL FOR BENEFIT	COMMENT
Recreation/Tourism	MODERATE	Area has historically supported high value wilderness-based recreation for boats and lodge. Access was previously difficult but is now road accessible.
Wilderness	MODERATE	Wilderness characteristics have declined due to recent clearcuts and road; timber harvest and roads are visible from Seal Bay; wilderness characteristics in remaining portion of parcel will be maintained.
Cultural Resources	MODERATE	Six archaeological sites documented on parcel.
Subsistence	LOW	Marine invertebrates, deer, elk, marine mammals.

ECOLOGICAL SIGNIFICANCE: This parcel contains mature forest habitat adjacent to highly productive marine waters. An estimated 1,190 acres (7% of commercial forest habitat) have been logged. Streams within the parcel support a diversity of anadromous fish. Forests on this parcel are believed to provide high value marbled murrelet nesting habitat. Acquisition of entire parcel would stop fragmentation which is probably diminishing nesting use. Recreation values, particularly for fishing, hunting, and non-consumptive uses are high. Parcel supports high numbers of non-injured species including deer, elk, and brown bear.

ADJACENT LAND MANAGEMENT: Afognak Joint Venture to west; Ouzinkie Corporation to south (managed primarily for timber harvest and tree farming).

IMMINENT THREAT/OPPORTUNITY: Commercial forest stands on this parcel are being logged as part of ongoing timber management by Koncor Forest Products. Akhiok-Kaguyak has offered to sell this parcel to the Trustee Council as one of three options for habitat protection.

PROTECTION OBJECTIVE: 1) Maintain water quality and riparian habitat associated with five anadromous fish streams; 2) maintain marbled murrelet and bald eagle nesting habitat; 3) minimize disturbance to harbor seal, sea otter, river otter, harlequin duck, pigeon guillemot, and intertidal/subtidal biota; 4) maintain and enhance wilderness-based recreational opportunities; 5) maintain and promote continued use by non-injured wildlife including elk, deer, and brown bear; 6) rehabilitate logged areas to enhance wildlife use and service values.

USEFUL PROTECTION TOOL(S): Fee title acquisition; timber acquisition; conservation easement.

Ranking and Evaluating the Example Parcels

Two tables follow. **Table C-6** shows the summary rankings and the formula used to determine the two parcels' ranking scores. **Table C-7** shows the categories for Ranking and Evaluation Criteria #1. That is the criteria that estimates the benefit that the resource or service would get from protecting the parcel. Because it is the most important, it is the only one of the eight criteria that is weighted.

Table C-6

Parcel Ranking Analysis, Example Parcels

Imminent Threat Parcels

	RANKING AND EVALUATION CRITERIA [1]								
PARCEL NAME	1	2	3	4	5	6	7	8	SCORE [2]
China Poot; Kachemak Bay	4-H,7-M	Y	Y	Y	N	Y	Y	Y	45
Seal Bay; Afognak Island	2-H,11-M	Y	N	Y	N	Y	N	Y	30

Table Footnotes: For Criteria, refer to table in box at the bottom of this page.

1. Criteria 1:
   H = High Benefit
   M = Moderate Benefit
   L = Low Benefit

   Criteria 2 - 8:
   N = No (does not meet criteria)
   Y = Yes (does meet criteria)

2. Scoring Formula
   Parcel Score = (Sum of H + (0.5 x Sum of M)) x Sum of Y
   China Poot Score = (4 + (0.5 x 7)) x 6) = (4 + 3.5) x 6 = 45
   Note: Formula emphasizes degree of linkage to injured resource/service.

RANKING & EVALUATION CRITERIA

1. Parcel contains key habitat(s) for injured resources or services.
2. Parcel can function as intact ecological unit or essential habitats on the parcel are linked to other elements/habitats in the greater ecosystem.
3. Adjacent land uses will not significantly degrade the ecological function of the essential habitat(s)intended for protection.
4. Protection of the habitats on parcel would benefit more than one injured resource or service (unless protection of a single resource or service would provide a high benefit to recovery).
5. Parcel contains critical habitat for a depleted, rare, threatened, or endangered specie.
6. Essential habitats on parcel are vulnerable or potentially threatened by human activity.
7. Management of adjacent land is, or could easily be made compatible with protection of essential habitats on parcel.
8. Parcel is located within the oil spill area.

Table C-7 shows the categories for Ranking and Evaluation Criteria #1. They describe the benefit that each resources or services would get from protecting the parcel. In some cases they are not identical to the resources or services injured by the spill that would benefit from protection. That list is given in **Table C-1**. The differences are slight and facilitate the evaluation.

Table C-7

Criteria for Rating Benefit to Injured Resources and Services Imminent Threat Analysis

INJURED RESOURCE/SERVICE	HIGH	MODERATE	LOW
Anadromous Fish	High density of anadromous streams per parcel; multiple injured species, and/or system known to have exceptional productivity.	Average density of anadromous streams for area; two or more injured species present.	Few or no streams on parcel; one or less injured species.
Bald Eagle	High density of nests on parcel; and/or known critical feeding area.	Average density of nests on or immediately adjacent to parcel (at least one); important feeding area.	Few or no nests on parcel; may be used for perching and/or feeding.
Black Oystercatcher	Area known to support nesting concentration area for feeding.	Possible nesting; known feeding area.	Probable feeding.
Common Murre	Known nesting on or immediately adjacent to parcel.	Nesting in vicinity of parcel; known feeding concentration adjacent to parcel.	Possible feeding in area adjacent to parcel.
Harbor Seal	Known haul out on or immediately adjacent to parcel.	Probable haul outs in vicinity of parcel; probable feeding in near-shore waters adjacent to parcel.	Probable feeding in near-shore waters.
Harlequin Duck	Known nesting or molting on parcel; feeding concentration area.	Probable nesting on or adjacent to parcel; probable feeding instream, estuary, or intertidal adjacent to parcel.	Probable feeding and loafing in area adjacent to parcel
Intertidal/subtidal biota	Known high productivity/ species richness. Oiled or adjacent to oiled area where recruitment may be important.	High productivity/species richness; not oiled or near oiled area.	Average productivity/ species richness; no documented shoreline oiling.
Marbled Murrelet	Known nesting or high confidence that nesting occurs; concentrated feeding in near-shore waters.	Good nesting habitat characteristics; known feeding in near-shore waters adjacent to parcel.	Low likelihood of nesting; possible feeding in near-shore waters.
Pigeon Guillemot	Known nesting on or immediately adjacent to parcel; feeding concentrations in near-shore waters.	Low likelihood of nesting; possible feeding in near-shore waters.	Good nesting habitat characteristic; known feeding in near-shore waters adjacent to parcel.

Table C-7 *(continued)*

INJURED RESOURCE/SERVICE	HIGH	MODERATE	LOW
River Otter	Known high use of parcel for denning/latrine sites.	Known or probable latrine and/or denning sites; known feeding in adjacent intertidal/ streams/near-shore area.	Probable feeding in adjacent intertidal/streams.
Sea Otter	Known haul-out or pupping concentrations.	Concentration area for feeding and/or shelter; potential pupping.	Feeding in adjacent waters.
Recreation/Tourism	Receives high public use; highly visible to a large number of recreationists or tourists; area nominated for special recreational designation.	Accessible by road, boat, or plane; adjacent area used for recreational boating; adjacent area receives high public use.	Occasional recreational use; access may be difficult.
Wilderness	Area remote; little or no evidence of human development.	Area remote; evidence of human development.	Area accessible; high/moderate evidence of human development (roads, clearcuts, cabins).
Cultural Resources	Documented concentration or significant cultural resources/sites on parcel.	Evidence of cultural resources/sites on or adjacent to parcel.	Possible cultural resources/sites on parcel.
Subsistence	Known resource harvest area; multiple resource use.	Known harvest area for at least one resource.	Possible harvest area.

LIKELY CHANGES IN THE PROCEDURES FOR THE COMPREHENSIVE PROCESS

While this section has explained the Imminent Threat Process, the Trustee Council staff is evaluating not only the private lands for which development will occur soon, but all private lands in the spill area where the owner is a willing to participate in the process. They are also evaluating the process to see if it can be improved. Two changes in particular have already been suggested by staff and the public.

During the Imminent Threat Process, the parcels were sized to include the imminent development. For example: where timber harvest was expected, the parcel that was analyzed was an ecologic unit such as a small watershed that surrounds the land for which forest practice notifications had been received. Staff and the public suggested that in the Comprehensive Process, staff rate larger areas that protect more linked habitats. This change will reduce the problem that the parcel score is dependent on parcel size.

Many people suggested that the resources and services used in **Table C-7** lumped together categories with different habitat requirements. To solve this problem, the Anadromous Fish category in the table will be separately rated for pink salmon, sockeye salmon, cutthroat trout, and Dolly Varden trout. Also, Recreation and Tourism which were rated together will be subdivided into: Recreational Use (Non-consumptive), Recreational Use (Consumptive), Commercial Use (Non-consumptive), and Commercial Use (Consumptive).

The proposed changes to the rating categories are outlined in **Table C-8.**

Table C-8

Changes to Benefit Rating System for Injured Resources and Services:

Changes Proposed for Comprehensive Process

INJURED RESOURCE/SERVICE	HIGH	MODERATE	LOW
Pink Salmon	High density of pink salmon streams per parcel; system known to have exceptional productivity; pink salmon are unique to the area.	Average density of pink salmon streams on parcel; average productivity for the area.	Few or no pink salmon streams on parcel; low productivity for the area.
Sockeye Salmon	High density of sockeye salmon streams on parcel; system known to have exceptional productivity; sockeye salmon are unique to the area.	Average density of sockeye salmon streams on parcel; average productivity for the area.	Few or no sockeye salmon streams on parcel; low productivity for the area.
Cutthroat Trout	High density of cutthroat trout streams on parcel; system known to have exceptional productivity; cutthroat trout are unique to the area.	Average density of cutthroat trout streams on parcel; average productivity for the area.	Few or no cutthroat trout streams on parcel; low productivity for the area.
Dolly Varden	High density of Dolly Varden streams on parcel; system known to have exceptional productivity; Dolly Varden are unique to the area.	Average density of Dolly Varden streams on parcel; average productivity for the area.	Few or no Dolly Varden streams on parcel; low productivity for the area.
Recreational Use: *Non-consumptive*	Receives high public use primarily of a non-consumptive nature (hiking, nature and wildlife viewing, boating, photography, camping, etc.; secondary use may include fishing or hunting); area highly visible to the recreational user; area nominated for special recreational designation.	Accessible by road, boat, or plane; maintained foot or off-road vehicle trails in vicinity; adjacent waters used for recreational boating; adjacent area receives high public use.	Occasional recreational use; access may be difficult.
Recreational Use: *Consumptive*	Receives high public use primarily of a consumptive nature (fishing, hunting, berry-picking; secondary use may include camping, hiking, photography and nature viewing); area well known to support consistently high wild fish and game populations; area highly visible to the recreational user.	Accessible by road, boat, or plane; maintained foot or off-road vehicle trails in vicinity; adjacent waters used for recreational boating and fishing; adjacent area receives high recreational fishing and hunting use.	Occasional recreational fishing and hunting use; access may be difficult.

Table C-8 *(continued)*

INJURED RESOURCE/SERVICE	HIGH	MODERATE	LOW
Commercial Use: ***Non-consumptive***	Receives high use by tour guide operators primarily of a non-consumptive nature (hiking, nature and wildlife viewing, boating, photography, camping, etc.; secondary use may include fishing or hunting); area highly visible to the recreational user; area nominated for special recreational designation.	Parcel likely to be used by local tour guide operators because it is accessible by road, boat, or plane, and has maintained foot or off-road vehicle trails in vicinity; adjacent waters or lands used by tour guide operators.	Occasional use by tour guide operators; access may be difficult.
Commercial Use: ***Consumptive***	Receives high commercial outfitter or guide use primarily of a consumptive nature (fishing and hunting; secondary use may include camping, hiking, photography and nature viewing); area well known to support consistently high wild fish and game populations; area highly visible to the recreational user.	Accessible by road, boat, or plane; maintained foot or off-road vehicle trails in vicinity; adjacent waters used for guided fishing; adjacent area receives high guided or outfitted fishing and hunting use.	Occasional guided or outfitted fishing and hunting use; access may be difficult.

The Comprehensive Process may be different from the Imminent Threat Process in other ways as well. Staff, expert peer reviewers, and the public may suggest changes. Public review as part of this Supplement is an important way for staff to learn of problems or improvements.

Habitat Protection on Public Land

Habitat Protection on public lands can include making recommendations for changing agency management practices, modifying statutes and regulations, and putting public lands and waters into special designations. The goal is, in appropriate situations, to provide a level of protection for recovering resources and services, not provided by existing regulations and management activities. Appropriate protective actions on public land would be determined by first identifying injured resources and services on those lands whose recovery could be hampered by expected human activities. In cases where existing management practices did not provide appropriate protection, options for management would be analyzed for adequacy and feasibility. Management changes would only be funded to the extent that implementing the change was not already funded as part of normal agency management.

Many changes in management actions that increase protection to injured resources and services have costs to the economy and to one or more user groups. The decision that the benefit to recovery outweighs the cost to society must be made with public review by the Trustee Council, the implementing agency, or in some cases by the Alaska Legislature or the U.S. Congress.

One type of management action involves placing marine and intertidal areas, and publicly owned uplands into state or federal special designations which provide increased levels of regulatory protection. An important feature of special designations is that they can provide a regulatory basis for managing an area on an ecosystem level, with the primary objective of restoring spill injuries. Special designations may not be appropriate for restoration when they place burdensome restrictions on injured services or encourage intensive public use of recovering habitats.

Different management designations will place varying amounts of emphasis on providing resource protection, opportunities for public uses, and scientific research. The appropriate designation can be determined by examining which injured resources and services are present, what type of additional regulatory protection is required to continue recovery, existing and planned human uses, and public review. Possible special designations include: Alaska State Parks, Alaska Department of Fish and Game special areas, State Public Use Areas, National Recreation Areas, National Marine Sanctuaries, Federal Wilderness areas, or a variety of administrative designations. New types of special designations can also be created, if necessary. An important factor in the success of any special designation is sufficient funding to support management and enforcement activities.

Management actions need not involve a special designation. In many cases, agencies can take appropriate protective action under existing statutes and procedures.

At this time, the Trustee Council has not proposed changes in public land and water management, although it may do so in the future. In the meantime, agencies may be initiating some changes on the basis of their existing statutory authority. For example, the USDA Forest Service is evaluating the current direction provided by the Chugach National Forest Land Management Plan for Prince William Sound in light of new environmental information from oil spill activities, Forest Service monitoring efforts, and other existing data; and in light of possible restoration projects. The current version of the plan was completed in 1984, before the spill, and the revision is expected to be completed in 1997.

Section D

GENERAL RESTORATION


RON STANEK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Section
D

GENERAL RESTORATION

Introduction

Since 1990, agencies and the public have proposed hundreds of ideas for general restoration. Some of the suggested activities would restore injured resources and reduced or lost services through direct manipulation. Examples include building fish passes to benefit salmon runs, or replanting seaweed to restore the intertidal zone to prespill conditions. Other ideas focus on managing human use to aid restoration such as redirecting hunting and fishing harvest, or reducing human disturbance around sensitive bird colonies. This section provides information on the process used to develop and evaluate general restoration options, and descriptions of some general restoration options that received favorable evaluations. General Restoration does not include Habitat Protection and Acquisition or Monitoring and Research *(see Sections C and E respectively).*

Developing General Restoration Options

The restoration planning process has identified a wide range of restoration ideas and projects based on suggestions from the public and from state and federal agencies. These ideas and projects were grouped together by their objectives into categories called restoration options. **Figure D-1** provides an example of how several ideas that accomplish the same objective are combined into a single restoration option. Fish ladders and removing barriers in streams allow fish to reach new spawning habitat. Constructing spawning channels provides new spawning habitat directly. Fertilizing sockeye rearing lakes improves food availability in existing habitat. All four accomplish the same objective: improving or providing more spawning or rearing habitat for wild stocks of salmon.

Figure D-1
Example of a General Restoration Option

The Public Suggested:

- **Fish ladders**
- **Spawning channels**
- **Remove barriers**
- **Fertilize lakes**

We Developed This Option:

- **Improve salmon spawning and rearing habitat**

One option may include similar activities for different resources or services. In the example above, the option could improve spawning and rearing habitat of pink salmon as well as sockeye salmon. In most situations, implementing the option would be different for each species because specific project designs would have to be tailored for the targeted resource or service. In this example, implementing this option could also benefit services (commercial fishing and sport fishing) that were lost or reduced as a result of the oil spill.

Option Evaluation

Many options have undergone extensive evaluation and review as part of the planning process. Initially, options were evaluated to determine if they met the terms of the civil settlement, were technically feasible (or warranted research on the feasibility), and were not likely to cause substantial harm to injured resources. Options which passed this evaluation went through a second evaluation using criteria developed from the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (42 U.S.C. 9601). Restoration ideas which failed any one of these criteria, from either evaluation process, were rejected from further consideration. These criteria include:

CRITERIA	ADDITIONAL INFORMATION
Technical feasibility	Are the technology and management skills available to successfully implement the restoration option in the oil spill area?
Potential to improve the rate or degree of recovery	Will the implementation of the restoration option make a difference in the recovery of an injured resource or service? This criterion was used to evaluate the effectiveness of options for benefiting resources.
The relationship of expected costs to expected benefits	Do benefits equal or exceed costs? Ability to meet this criterion was not based on a cost/benefit analysis, but on a broad consideration of the direct and indirect costs and the primary and secondary benefits.
Consistency with applicable federal and state laws and policies	Is the restoration option consistent with the directives and policies with which the Trustee agencies must comply?
The potential for additional injury resulting from the option, including long-term and indirect impacts	Will implementation of the restoration option result in additional injury to target or non target resources or services?

This part describes some examples of different General Restoration Options that have undergone a rigorous technical evaluation.

The descriptions include:

1) an explanation of how the option would help the injured resources or reduced or lost services,

2) a brief description of how the option can relate to policy questions, and

3) information on annual costs and project durations.

The costs are rough estimates expressed in 1993 dollars and may change when detailed project proposals are developed.

Some injured resources may benefit from changes in management such as harvest restrictions or manipulation of habitat such as creation of spawning channels. Unfortunately, there is very little that can be done directly for other species. Some options are experimental and must be tested before they can be considered for broad-scale application. These are identified as **Special Studies**. Other options may be effective only in certain areas and cannot be generally applied to the injured resource. These options are identified as providing "localized benefits only." Some options are most effective outside the spill area. However, activities outside the spill area would be undertaken only if consistent with the Final Restoration Plan. Several examples of general restoration options are provided. These represent a cross-section of the options that have been evaluated to date.

• • •

EXAMPLE 1
Marine Mammals

Implement cooperative programs between subsistence users and agencies to assess the effects of subsistence harvest on sea otters and harbor seals.

This example demonstrates a marine mammal option that involves management of human uses.

Harbor seals and sea otters are legally harvested by subsistence users in the spill area. In this option, agency wildlife biologists and subsistence users would cooperatively identify and gather needed information, and, possibly, assess the need for voluntary harvest reductions. If it was mutually agreed that an injured species was being overharvested, subsistence users and biologists could determine voluntary reductions in subsistence harvest levels which could remain in place until populations had recovered from oil-spill injuries. Harvest reductions could enhance the rate of natural recovery of injured species by reducing harvest pressures. Subsistence harvest and other services dependent on these species would also benefit in the long-run from population recovery.

Funding would be used to pay for biologists to travel to subsistence areas and meet with subsistence hunters and, possibly, to reimburse subsistence hunters for assistance provided in gathering relevant biological information or samples. This would facilitate regular, face-to-face discussion of the latest information on the injury status of subsistence species and would supplement on-going public information efforts, such as newsletters and videos put out by the Subsistence Division of the Alaska Department of Fish and Game. This option would be closely coordinated with all such on-going agency programs.

How will this help recovery?

If current subsistence harvest levels are slowing species recovery, and voluntary harvest reduction can be mutually agreed upon, reduced harvest pressures could enhance the rate of recovery. Increased communication between agency biologists and subsistence users could help the users decide if their traditional harvest activities might be slowing the recovery of the injured populations. Face-to-face contact between agency researchers and subsistence users increases community understanding of scientific data and facilitates discussion of the politically and culturally sensitive topic of subsistence harvest levels. In addition, biological and harvest information provided to agency biologists by subsistence hunters could provide useful supplements to existing data.

How does this relate to the policy questions?

This option is found in alternatives 3, 4, and 5 for harbor seals and sea otters because it may provide substantial benefit or protection to aid in recovery, and because both of these species suffered population declines.

Cost and Duration:

The cost estimates for implementing this option may be approximately $30,000 per year depending upon the effort and geographic scope. Implementation of this option may extend throughout the life of the settlement. (Estimates given in 1993 dollars.)

• • •

EXAMPLE 2
Fish

Improve freshwater wild salmon spawning and rearing habitats

This example demonstrates an option that involves the manipulation of habitat to benefit injured fish resources and the sport and commercial fisheries that rely on them. This is also an example of an option that provides "localized benefits only" because it may be effective only in certain areas and cannot be applied to the injured resource on a broad scale.

There are a variety of techniques for improving or supplementing spawning and rearing habitats to restore and enhance the wild salmon populations.

Three different techniques are described under this option:

1) construct salmon spawning channels and instream improvements;

2) fertilize lakes to improve sockeye rearing success; and

3) improve access to salmon spawning areas by building fish passes or removing barriers.

Surveys of the oil-spill area will determine where these options would be applied. This option could be used to restore injured pink and sockeye salmon runs to pre-spill levels or to enhance either injured or equivalent runs above pre-spill levels.

Pink salmon, which swim to sea in their first year, depend primarily on spawning and rearing habitat available within stream channels and intertidal areas. Upstream spawners may benefit from construction of improved spawning channels and fish passages, removal of barriers impeding access to upstream spawning habitats, and addition of woody debris to provide cover and food.

Young sockeye salmon grow in lakes for 1-3 years before emigrating to sea. Appropriate restoration and enhancement techniques for sockeye salmon are determined by the amount of spawning and rearing habitat in the lake and river system. In lake systems with inadequate spawning habitat, spawning channel or fish passage improvement may be appropriate to increase the amount of available spawning habitat. Fish passes are currently prohibited on the Kenai River system. In lake systems with damaged rearing habitat, chemical fertilizers may be added to lakes to temporarily supplement the nutrients needed to sustain the prey on which fry feed.

It is critical that use of any of these techniques be integrated into existing salmon management plans to prevent an overproduction of fry that could not be supported by available feeding, rearing and spawning habitats and to prevent management problems created by additional fish.

How will this help recovery?

Salmon runs in individual streams would increase due to greater availability of spawning areas following improvements to spawning channels or construction of fish passes. The egg-to-fry survival of salmon in spawning channels is 5 to 6 times greater than survival in unimproved streams. Lake fertilization will greatly improve sockeye over-winter survival and smolt-to-adult survival, by providing nutrients for prey species. Increased stock productivity and adult returns could result from these restoration techniques. This option would primarily benefit species with population level injuries by increasing the overall numbers of fish.

How does this relate to the policy questions?

The different techniques that are included in this option would apply to different alternatives based on their potential effectiveness. **Techniques 1 and 3** (spawning channels, fish passes and removing barriers), may be found under alternative 5 only, for pink and sockeye salmon since these techniques would only provide some benefit to recovering salmon. These techniques would have localized benefits only and would not provide substantial increases in overall productivity.

Technique 2, fertilizing sockeye salmon rearing lakes, is found in alternatives 3, 4 and 5 because it is highly effective for benefiting the sport and commercial fisheries dependent on specific sockeye salmon runs. Lake fertilization benefits the services, but not the injured populations. Lake fertilization is not needed, or is not feasible, in Red Lake and Kenai River systems. However, by increasing fish production in other lakes, this option could improve or create additional fishing opportunities.

Cost and Duration:

The cost estimates for implementing this option may range from $150,000 to $1,900,000 per year depending upon the effort and geographic scope. Implementation of this option may take from 3 to 10 years depending upon the species and the number of locations targeted. (Estimates given in 1993 dollars.)

• • •

EXAMPLE 3
Birds

Remove predators at injured colonies or remove predators from islands that previously supported murres, black oystercatchers or pigeon guillemots

Example 3 is an option that could be undertaken inside and outside the spill area to replace birds that were injured by the spill, if the Final Restoration Plan allows for restoration activities outside of the spill area.

Predation can have a significant affect on the productivity of seabirds. Fox, which are not indigenous to many of the islands of the Aleutian chain and Gulf of Alaska, were introduced on more than 400 islands to be raised and trapped for their furs. Introduced fox reduced and even eliminated populations of surface, burrow and in some cases cliff-nesting birds in a matter of years. Birds were also harmed by incidental introductions of rodents, many of which were released to the islands to provide food for the fox.

Eagles, gulls, ravens and crows are also known predators of murres and other seabirds.

The primary application of this option outside of the spill area would be to remove introduced fox from islands along the Alaska Peninsula, Pribilofs and the Aleutians. Several steps would need to be taken to accomplish this task including identifying and prioritizing target islands, and working with the Environmental Protection Agency and Department of Agriculture to secure registration for toxicants. Programs to eradicate red and arctic ("blue") fox on islands have been successful in the past and would increase Alaska's population of marine birds including species injured by the spill (common murres, black oystercatchers and pigeon guillemots) although it would not increase birds inhabiting colonies within the spill area.

Within the spill area, reducing avian predators such as ravens and gulls, and terrestrial predators such as fox and mink at injured colonies is feasible, but would be difficult to implement for long-term effects. Removing gulls from islands would require traps or poison baits but care would have to be taken to minimize killing non-target species. Eagle predation could also be reduced by providing young eagles to the eagle reintroduction program in the lower 48 states. Reducing predation for nesting pigeon guillemots would be more difficult due to the dispersed nest locations. Initial predation studies would need to be completed to determine the feasibility of benefiting guillemots through predator removal. At least one season of intensive research is needed to determine if this program can be justified.

How will this help recovery?

On some small islands, spectacular increases in breeding birds have been documented after the disappearance or removal of fox. Their removal allows a variety of native birds, including common murres, marbled murrelets, pigeon guillemots, black oystercatchers and various waterfowl, to re-inhabit these islands. Fox are voracious predators of chicks and eggs and climb among the nesting birds to feed. Their removal will allow the productivity of these islands to increase with increased survival of chicks and eggs.

Glaucous-winged gulls, northern ravens, and bald eagles are effective predators on murre colonies in the oil-spill area. Murre eggs and chicks are especially vulnerable when the colony density is reduced or when nesting is not synchronized. These are both problems at colonies injured by the oil spill. Gulls are believed to be a major source of egg mortality at some colonies, sometimes accounting for 40% of the egg loss. Reducing avian predator populations at murre colonies during recovery could increase the productivity.

How does this relate to the policy questions?

This particular option may be found under alternative 3, 4, and 5 for common murres and pigeon guillemots because both species suffered population decline and the option may provide substantial benefit to aid recovery. However, it is only in alternatives 4 and 5 for black oystercatchers since it would be applied only outside the spill area for this species.

Cost and Duration:

The cost estimates for implementing this option may range from $150,000 to $400,000 for each location. Implementation of this option may take from 4 to 10 years depending upon the intensity of the effort each year. (Estimates given in 1993 dollars.)

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EXAMPLE 4
Multiple Wildlife Resources

Determine if eliminating oil from mussel beds removes a potential source of continuing contamination to food for injured wildlife resources and take appropriate action. (Special Study)

This example is a Special Study option because it is experimental and must be tested before it can be considered for broad-scale application, or evaluated for its effectiveness.

Persistent oil in mussel beds represents a potential threat to living resources such as sea otters and harlequin ducks that utilize them as food or habitat. Chemical analyses of mussel tissue and sediments from contaminated mussel beds revealed very high levels of petroleum contamination.

The objective of this option is to determine the geographic extent of persistent oil in and adjacent to oiled mussel beds and to explore potential linkages to other injured resources. The study will also determine the concentration of oil remaining in mussels, the underlaying organic mat and substrate. This study will determine the most effective and least intrusive method of cleaning oiled mussel beds. Once the results of these studies are available, the most effective cleaning techniques will be used in certain areas with persistent oiling. This study would also provide chemical data to assess the possible linkages of oiled mussel beds to harlequin ducks and juvenile sea otters.

This option also includes a monitoring component designed to assess the efficacy of the stripping technique to eliminate oil from mussel beds. Both the fate of oil in mussels and in the substrate and the effects of oil on growth and reproduction of mussels will be followed at oiled and unoiled study sites.

How will this option help recovery?

Stripping or tilling of contaminated mussel beds could increase flushing of residual oil. By exposing buried oil to the air, residual oil would be eliminated through weathering and microbial degradation. Consequently, less oil would be available for bioaccumulation by mussels and other invertebrates. Less oil also would be available as contaminated prey for predator species such as harlequin duck, black oystercatcher, sea otter and river otter.

How does this relate to the policy questions?

Because this option is experimental and because the relationship between oiled mussels and continuing injury to sea otters and harlequin ducks is still unknown, the effectiveness of the option cannot be determined. At this time, this option is included in alternatives 3, 4, and 5 for sea otters and harlequin ducks because both species suffered population declines and the option has potential to provide substantial benefit to these injured resources.

Cost and Duration:

The cost estimates for implementing this option may range from $340,000 to $640,000 per year depending upon the effort and geographic scope.
Implementation of this option may take from 4 to 7 years depending upon the geographic scope.
(Estimates given in 1993 dollars.)

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EXAMPLE 5
Subsistence

Test subsistence foods for continued contamination as a means of restoring confidence in the safety of subsistence resources within the spill area.

This is an example of an option that follows the recovery of several resources that subsistence users rely on, and helps to restore lost subsistence opportunities.

The goal of this option is to restore the knowledge and confidence of subsistence users in the safety of the subsistence resources by monitoring hydrocarbon levels in selected subsistence species, communicating findings to subsistence harvesters, and integrating findings of other studies of spill-related injuries into previously developed health advice. Community participation in all aspects of this option is critical to ensure the credibility of results. Communities which rely substantially on subsistence in the spill area include: Akhiok, Ivanof Bay, Ouzinkie, Chenega Bay, Karluk, Perryville, Chignik Lagoon, Larsen Bay, Port Graham, Chignik Lake, Nanwalek, Port Lions, Chignik, Old Harbor, and Tatitlek.

This option is directly aimed at restoring the knowledge and confidence of subsistence users in the safety of traditional foods. The overall restoration monitoring program may achieve some of the same objectives.

Tissue and bile samples of subsistence species, including mussels, rockfish and harbor seals, will be collected from the harvest areas of impacted communities. Community representatives will assist in site selection, as well as collection of samples. The samples will be analyzed for hydrocarbon contamination. The results of the tests, along with findings from other damage assessment and restoration studies, will be reported to the communities in an informational newsletter and community visits.

This option could be implemented on a yearly basis. At the end of each year, the degree of recovery of the resources, as well as that of the subsistence economy, should be re-evaluated to determine whether the program should be continued. The confidence of the subsistence users in the safety of subsistence foods is likely to lag behind the recovery of the resources to some extent, if so, this option should be continued as long as it is necessary.

How will this help recovery?

Only limited recovery to pre-spill subsistence harvest levels has occurred. A primary reason for continued relatively low levels of subsistence harvests are the communities' concerns about the long-term health effects of using resources from the spill area. By involving the communities in the monitoring of the recovery of the resources, and by bringing information concerning the safety of the resources back to the communities, it is anticipated that subsistence harvests will begin to approach pre-spill levels, and anxiety about their use will be reduced.

How does this relate to the policy questions?

This option may be found under alternatives 3, 4, and 5 for subsistence because it is likely to produce substantial improvement in restoring lost opportunities for subsistence users by increasing confidence in the safety of traditional foods.

Cost and Duration:

The cost estimates for implementing this option may range from $300,000 to $350,000 per year depending upon the effort and geographic scope.
Implementation of this option may extend for 2 to 5 years, or until the subsistence resources have recovered. (Estimates given in 1993 dollars.)

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EXAMPLE 6
Multiple Services

Replace lost sport, commercial and subsistence fishing opportunities by creating new fisheries for salmon or trout

This is an example of an option that benefits fishing opportunities that were lost or reduced as a result of the spill.

This option would start new salmon or trout runs to replace fishing opportunities lost due to fishing closures or injuries resulting from the oil spill. For example, if Kenai River sockeye fishing is closed or restricted for multiple years, alternative runs could partially compensate the loss. The option restores services by providing replacement harvests, but does not restore the injured populations of fish. Commercial, sport and subsistence fishermen could potentially benefit.

The option consists of creating terminal runs, that originate from and return to hatcheries or remote marine release sites. Fish would not be stocked in streams. Returning fish would be harvested and brood stock would be used to artificially propagate the next generation. Since the runs would be dependent on artificial fertilization, the new runs could be terminated once recovery of target fisheries occurs.

Alaska Department of Fish and Game standards and requirements for genetic and disease screening and brood stock selection would have to be met. Also, Regional Planning Teams must approve any proposed actions. Planning concerns include avoiding harmful interactions with wild stocks, interceptions of existing stocks and interference with other fisheries. There are some areas for which this option is not appropriate.

How will this help recovery?

The aim of this option is to minimize additional injuries to user groups by providing alternative fishing opportunities when historical fishing areas are restricted. As an alternative to completely closing fisheries, fishing pressures could be redirected to target these new runs until injured stocks recover. This option could also be used to enhance fishing opportunities above prespill levels if new runs were continued after target species recover.

How does this relate to the policy questions?

Based on its potential effectiveness, this option may be found under alternatives 3, 4, and 5 for Commercial Fishing and Recreation. It is likely to produce substantial improvement in recovery of these services by efficiently producing large salmon runs to replace or create new fisheries.

It is found only in alternative 5 for Subsistence because it is likely to produce only some improvement in reduced or lost subsistence use. The primary damages to subsistence are due to a general loss of confidence in food safety as well as decreased opportunity to harvest species other than salmon.

Cost and Duration:

The cost estimates for implementing this option may range from $250,000 to $1,000,000 per fish run. Implementation of this option may extend for up to 10 years depending upon the number of runs targeted. (Estimates given in 1993 dollars.)

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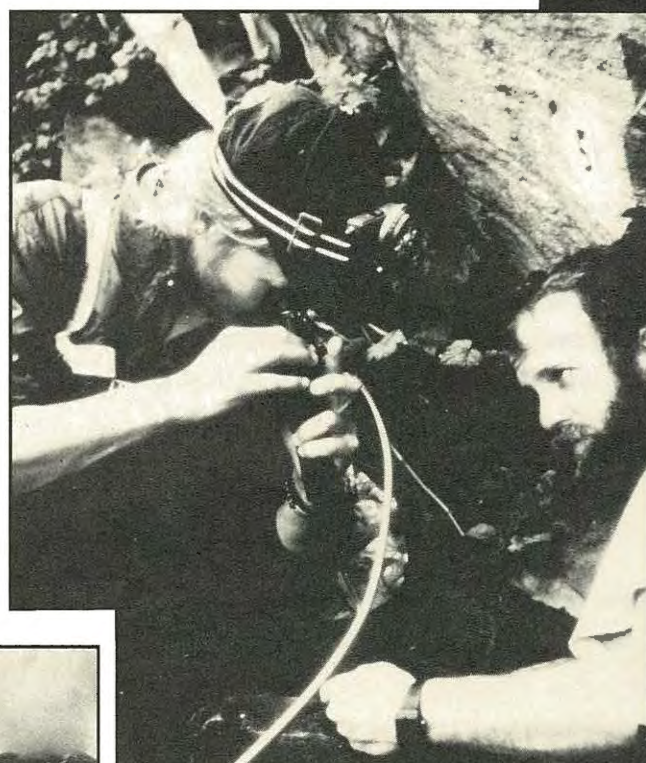
Section E

RECOVERY MONITORING AND RESEARCH PROGRAM



JOHN STRAND

U.S. FOREST SERVICE

Section E

RECOVERY MONITORING AND RESEARCH PROGRAM

Background

The *Exxon Valdez* Oil Spill Trustee Council is developing an initial (conceptual) design for monitoring and research of injured resources and reduced or lost services. With an approved conceptual design, the Trustee Council will next develop a detailed technical design for monitoring and research that will be implemented as part of the Restoration Plan.

GOAL

The goal is to design a monitoring component for the Restoration Plan. A comprehensive and integrated monitoring component is necessary to follow the progress of recovery and evaluate the effectiveness of proposed restoration activities. Monitoring also is needed to improve the information base from which future disturbances can be evaluated. When necessary, research will be to required to develop new restoration technologies and approaches.

OBJECTIVES

This program will assist the Trustee Council in developing a comprehensive, interdisciplinary and integrated approach to monitoring and research aimed at:

1) ***assessing the rate and adequacy of recovery.***

Monitoring is necessary to assess the rate and adequacy of natural recovery as well as recovery assisted by restoration. Resources and associated services that are found to be recovering at an unacceptable rate may have to be considered as candidates for restoration action. Likewise, resources that are found to be recovering faster than anticipated may allow for earlier completion of a restoration action.

2) ***developing an environmental (information) baseline.***

Monitoring of important physical, chemical, biological properties and human services (cultural and economic) can be used to improve upon or establish anew an environmental baseline. This information can be used to document long-term trends in the quality and quantity of affected resources and services and assess the effects of future development and natural disturbance.

3) ***understanding the relationships among ecological and human components of the affected ecosystem.***

To better understand the environmental health of the affected ecosystem, it is essential to first understand the linkages among natural and human components and the causes of natural and human change. Based on measurements of the rates of important natural and human processes, understanding can be expanded to include quantitative relationships that define the dynamics of the affected ecosystem. Basic information on ecosystem dynamics can be used to assess the anticipated effects of future human development and improve our ability to manage affected resources and services over the long-term.

4) ***developing a restoration research capability.***

Research could be employed to better understand the causes of failure to recover. Research also could be used to develop new restoration technologies to restore resources not recovering or recovering at lower than expected rates.

Proposed Program Components

The Trustee Council's monitoring and research program could include one or more of the following components, although the components vary among the five alternatives of the Draft Restoration Plan:

1) RECOVERY MONITORING ***would assess the rate of recovery of injured resources and reduced or lost services, and determine when recovery has occurred, or when injury is delayed;***

2) RESTORATION MONITORING ***would evaluate the effectiveness of individual restoration activities and identify where additional restoration activities may be appropriate;***

3) ECOSYSTEM MONITORING ***(including human uses) would follow long-term trends in distribution and abundance of injured resources and the quality and quantity of human uses. Monitoring of this type could also detect residual oil spill effects and provide ecological as well as human services baseline information useful in assessing the impacts of future disturbances, and;***

4) RESTORATION RESEARCH ***would clarify the causes of poor or slowed recovery, and design, develop, and implement new technologies and approaches to restore injured resources and reduced or lost services.***

Resources and Services to be Monitored

At minimum, monitoring should follow recovery for all injured resources and reduced or lost services listed in **Table E-1**. For some of these resources, there is documentation of declines in abundance that will persist for more than one generation, decades in some cases.

While mortality and other injuries occurred to other resources, population abundance was not always affected. There also is evidence of diminished human services in the spill area including commercial fishing, commercial tourism, recreation, passive use, and subsistence.

Table E-1

Injured Resources and Reduced or Lost Services

Resources: POPULATION DECLINE	Resources: INJURED, BUT NO POPULATION DECLINE	Resources: OTHER	Services (Human uses)
Black oystercatcher	Bald eagle	Archaeological resources	Commercial fishing
Common murre	Cutthroat trout	Designated wilderness areas	Commercial tourism
Harbor seal	Dolly Varden		Passive use
Harlequin duck	● Killer whale		Recreation including sport fishing, sport hunting, and other recreation use
Intertidal organisms	Pacific herring		Subsistence
Marbled murrelet	● Pink salmon		
Pigeon guillemot	River otter		
Sea otter			
Sockeye salmon			
Subtidal organisms			

● *For these species, the Trustee Council's scientists have considerable disagreement over the conclusions to be drawn from the results of the damage assessment studies.*

Should the Trustee Council decide to implement ecosystem monitoring, the population dynamics of other ecological components would need to be followed, for example, those species important in the food webs of injured species. To better manage injured marine birds, marine mammals, and some species of fish (salmon, halibut, rockfish) in the spill area over the long-term, it may be useful to follow the abundance and distribution of their prey species (herring, sandlance, candle fish, pollock). Changes in the patterns of prey abundance and distribution may effect changes in abundance and distribution of predator species. This kind of information will assist the Trustee Council in better understanding the dynamics of recovery of injured species, or potentially the lack thereof, but also is intended to document long-term trends in the environmental health of the affected ecosystem.

Because of the complexities of both institutional and technical issues associated with developing a meaningful monitoring program for the spill area, a phased planning approach is being undertaken. In **Phase 1**, a consultant is assisting the Trustee Council in developing a "conceptual" design for a monitoring plan. This is intended to guide more detailed, technical planning in a subsequent **Phase 2.**

PHASE 1
Conceptual Design

Key elements of the conceptual design for the Trustee Council's proposed monitoring plan include:

Conceptual Framework

In Phase 1, the objective is to develop a conceptual framework that can be used by the Trustee Council as a tool for developing and refining effective monitoring, which addresses what to monitor, where, when and how. It also establishes the relationships among those who require and those who produce monitoring information, as well as establishing how monitoring is integrated and coordinated among the various activities. This approach borrows significantly from the National Research Council's conceptual methodology for developing more effective and useful monitoring programs (National Research Council, 1990).

As with any tool, it is both how well the tool is constructed and how well the tool is used that determines its effectiveness. The Trustee Council's approach has been to construct a framework with the contributions of as many interested parties as possible. Through telephone interviews, analysis of case histories, and a technical workshop, the Trustee Council has obtained participation of a large number of individuals representing the Trustee agencies, universities, consultants, and peer reviewers.

Conceptual Model(s)

A conceptual model is the central feature of this approach and can be used to develop either monitoring or research strategies. In application, a conceptual model will identify the links among resources at risk; the physical, chemical and biological processes of the affected ecosystem; and, the human and natural causes of change. Essentially, conceptual models help define cause-and-effect relationships and permit testable hypotheses to be formulated and evaluated. By providing a framework for organizing existing scientific information, conceptual models can also identify important sources of uncertainty.

A conceptual model can be used to develop and refine effective research strategies to understand why resources and their associated services are not recovering. For example, designing and applying a conceptual model to illustrate how residual oil in mussel beds could affect harlequin ducks, juvenile sea otters, river otters, and oystercatchers, all of which are known to feed on mussels and show signs of continuing injury, could be an important first in step in understanding the recovery of these species. Mussel beds were not cleaned or removed after the spill and may be potential sources of fresh (unweathered) oil for these and other species.

Management Structure

Implementation of the proposed multifaceted program requires central coordination and management. In order to successfully implement an ambitious and wide-ranging program as contemplated, a high degree of organization is needed to create the final design, to analyze, interpret and disseminate the data generated, and to ensure that all aspects of the program are carried out as designed.

The Trustee Council is presently considering several management options. A decision on the type of management structure to implement will be made once the public has had opportunity to comment on the scope of the proposed program.

Data Dissemination

It is the intent of the Trustee Council that monitoring information be accessible and in a format that can be readily utilized by scientists, resource managers, and the general public. The final configuration of the data management system, and how and where the system can be accessed, however, have not been decided.

Avoiding Duplication of Effort

Integration and coordination with other monitoring programs in the spill area is essential to avoid duplication of effort, but also could result in benefit to each program where there is potential overlap. For example, both the Prince William Sound and Cook Inlet Regional Citizens Advisory Councils presently conduct monitoring within the spill area. Other major programs with geographic as well as potential technical overlap will soon be implemented by the Oil Spill Recovery Institute (Prince William Sound Science Center) and the Regional Marine Research Program (Coastal Regional Monitoring Act/Program). While the specific goals and objectives of these programs (including the Trustee Council's program) may be different, each program could benefit from integration such as conducting monitoring (where appropriate) at common stations, agreeing to follow standardized sampling and analytical protocols, and sharing logistics as well as data, etc. Every attempt, then, will be made to integrate and coordinate these different monitoring efforts.

PHASE 2
Detailed Design

With an approved conceptual design, the Trustee Council will next consider developing detailed technical specifications for monitoring and research that will be implemented as part of the Restoration Plan. This proposed planning effort focuses on the technical requirements of an integrated monitoring and research plan and again assumes a close working relationship among the Trustee Agencies. The Final Restoration Plan will include at least a summary of the technical design for each monitoring and research component.

This proposed final phase of planning would establish:

a) ***the locations where monitoring and research should be conducted;***

b) ***a technical design for each monitoring and research element (sediments, invertebrates, fish, birds, mammals, and services [commercial fishing, tourism, recreation, subsistence]) that specifies how, when data will be collected, analyzed, interpreted, and reported, which will be based on the design of appropriate conceptual models;***

c) ***a design for a data management system to support the needs of the Trustee Council and other decision makers, planners, researchers and the general public.***

d) ***a rigorous quality assurance program to ensure that monitoring and research data produce defensible answers to management questions and will be accepted by scientific researchers and the public;***

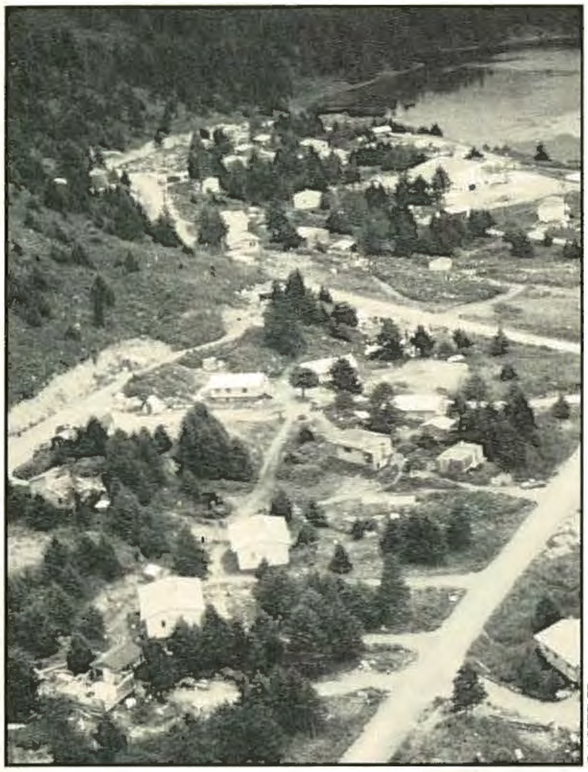
e) ***cost estimates for each monitoring and research component; and***

f) ***a strategy for review and update to ensure that the most appropriate and cost-effective monitoring and research approaches are applied.***

After completion of a Draft Recovery Monitoring and Research Plan, a program of peer review would be organized and implemented. Subsequently, it will be included in the final Restoration Plan.

Section
F

MAP OF THE *EXXON VALDEZ* OIL SPILL AREA



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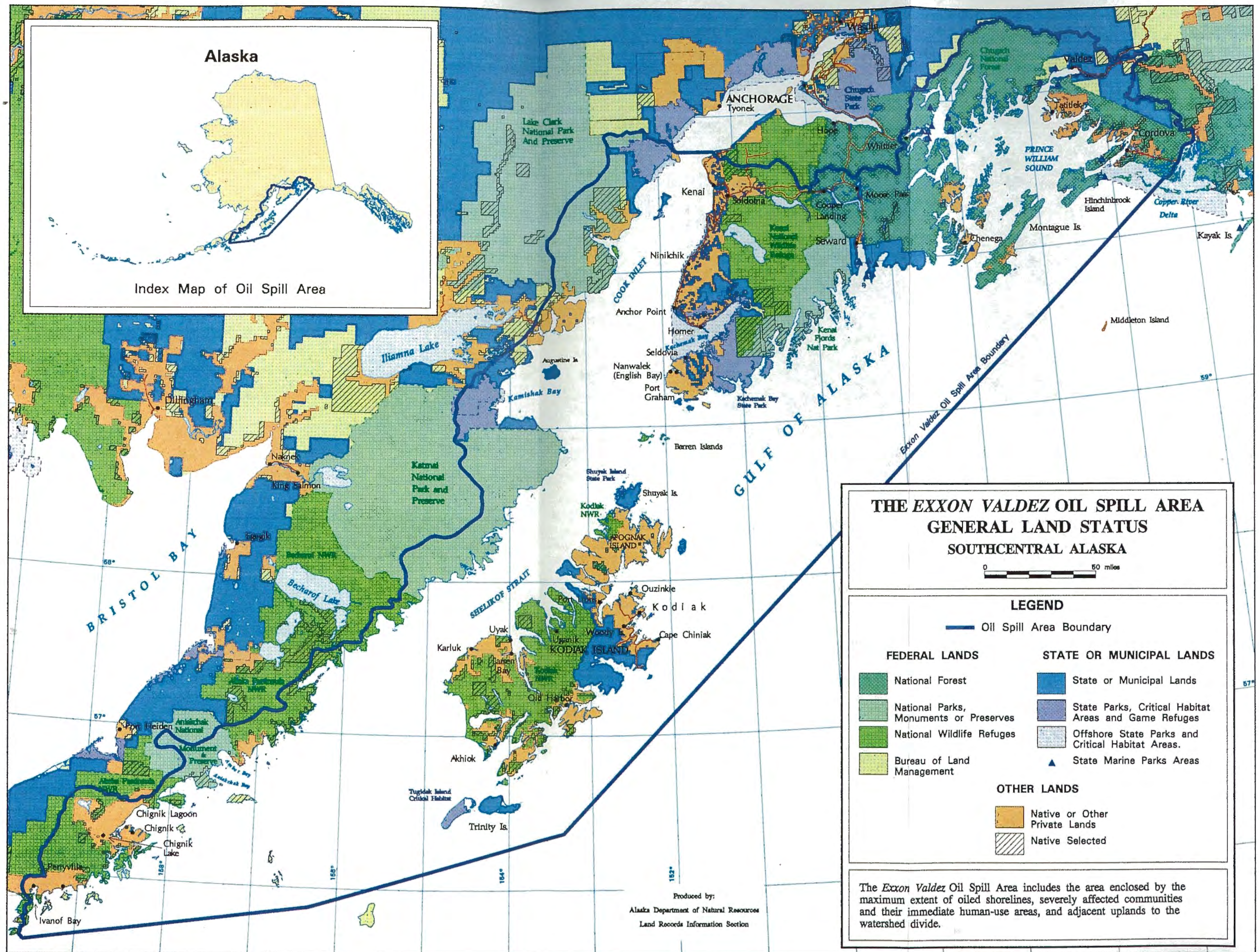

Date Printed: June 08, 1993

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Notes

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A

SUMMARY OF PUBLIC COMMENT ON ALTERNATIVES

of the Draft *Exxon Valdez* Oil Spill Restoration Plan

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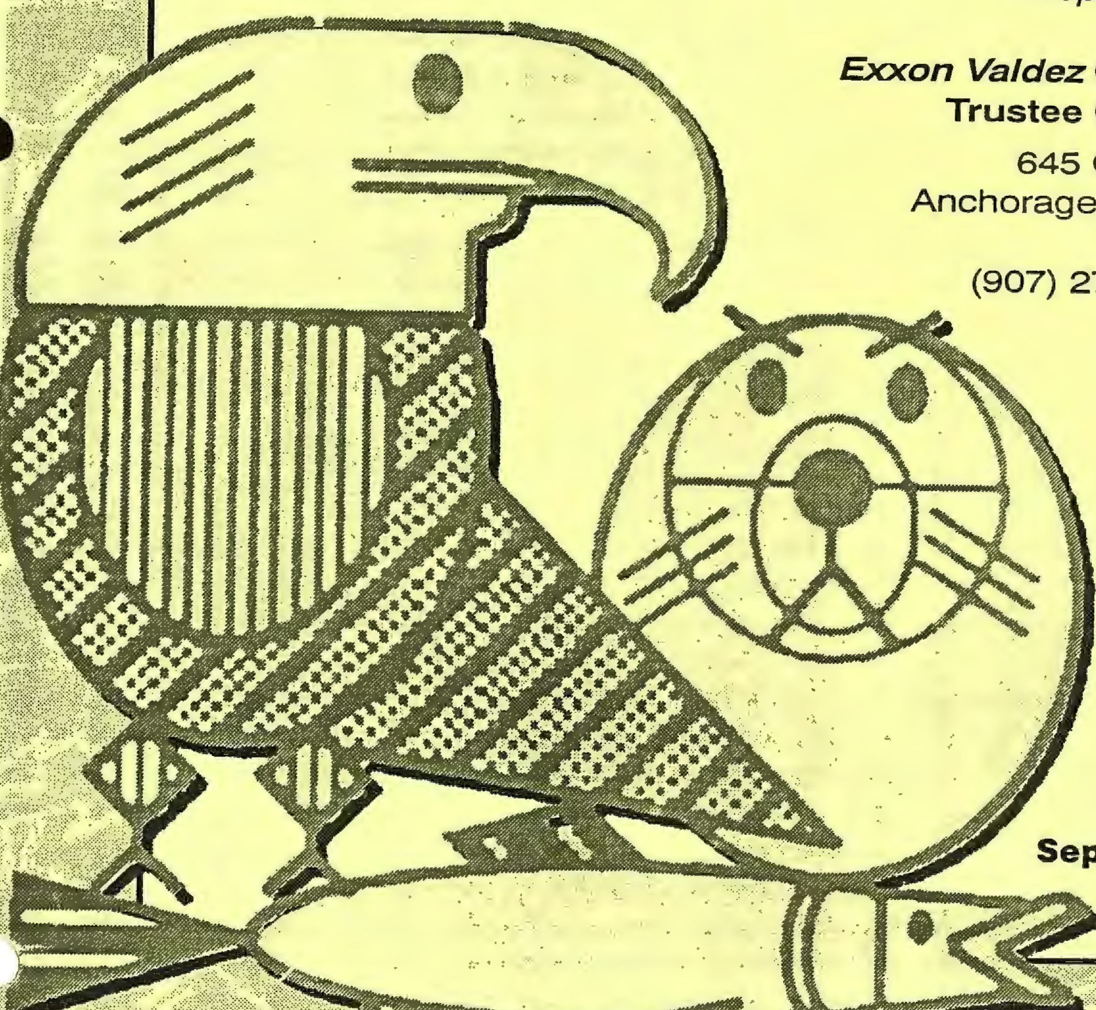

September 1993

Summary of Public Comment on Alternatives
Exxon Valdez Oil Spill Restoration Plan

September 1993

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Summary of Public Comment on Alternatives
Exxon Valdez Oil Spill Restoration Plan
September 1993

EXECUTIVE SUMMARY

In April and May 1993, the Trustee Council asked the public for their views about issues and alternative ways to heal the injuries caused by the 1989 *Exxon Valdez* oil spill. To help gather public comment, the Council distributed 33,000 copies of a newspaper brochure titled "Summary of Alternatives for Public Comment." In addition, Council staff held 22 public meetings throughout the oil spill area, and in Anchorage, Fairbanks, and Juneau. The public comment period on the issues and alternatives extended from April through August 6, 1993. Approximately 2,000 people gave written or verbal comments during that time. This document summarizes what they wrote and said.

The newspaper brochure included a questionnaire, 799 of which were returned: two-thirds from within the spill area, one-quarter from elsewhere in Alaska, and one-tenth from outside Alaska. In addition, 792 letters were received: one-quarter were from Alaska. Most of the letters focused on only one issue, habitat protection and acquisition, though many also mentioned fisheries studies and management programs. Between 500 and 600 people attended the public meetings, and approximately a quarter of them also sent in brochures or letters.

A map of the *Exxon Valdez* oil spill area follows page vi.

Issues and Policies

The newspaper brochure asked five policy questions to guide restoration decisions. We received about 700 written comments on these questions. Few people commented on these issues at public meetings. The questions are below.

Injuries Addressed by Restoration Actions: *Should restoration actions address all injured resources and services, or all except those biological resources whose populations did not measurably decline because of the spill?*

Restoration Actions for Recovered Resources: *Should restoration actions cease when a resource has recovered, or continue in order to enhance the resource?*

Location of Restoration Actions: *Should restoration activities take place in the spill area only, anywhere in Alaska provided there is a link to injured resources or services, or anywhere in the United States provided there is a link to injured resources or services?*

Effectiveness of Restoration Actions: *Should the plan include only those restoration actions that produce substantial improvement over natural recovery, or also those that produce at least some*
improvement?

Opportunities for Human Use: *To what extent should restoration actions be used to create opportunities for human use of the spill area?*

Those who responded to these questions expressed strong preferences on three of the issues. About 60% favored addressing all injured resources and services, and ceasing restoration actions when a resource recovers. Two-thirds favored limiting restoration to the spill area. Views on the two other issues were mixed.

Concerning opportunities for human use, there was no strong preference among the four answers offered in the brochure. However, only 13% of the comments favored creating appropriate new uses. To understand public opinion on this issue, it is important to read the comments themselves. They contain reasons for favoring a certain view, conditions under which new uses would be acceptable, definitions of terms like "appropriate," and concern over how new facilities would be maintained.

Regarding standards of effectiveness for restoration actions, there was no strong preference overall. However, two-thirds of those who commented on this issue from the spill area favored considering restoration actions that produce substantial improvement as well as those likely to produce at least some improvement. Support for this view was strongest in Prince William Sound and Kenai. Responses from outside the spill area were divided on the issue.

Categories of Restoration

The newspaper brochure asked questions about four categories of restoration.

Habitat protection and acquisition. This category received nearly twice as many comments as any other topic. It was discussed in almost every letter, brochure, and public meeting. More than 90% of the people who commented said that habitat protection and acquisition should be part of the plan.

Hundreds of people nominated areas for purchase or protection. About 370 people recommended purchase of inholdings in Kodiak National Wildlife Refuge. The next most popular recommendation was a group of seven purchases that letters titled the "citizen's vision." It consists of land in the Kodiak Refuge and lands at Port Gravina/Orca Bay, Port Fidalgo, Knight Island Passage, Kenai Fjords National Park, Port Chatham, and Shuyak Straits. Forty-five people, mostly Cordovans, recommended the purchase of Eyak Lake, Power Creek and Orca Narrows. However, some people, including 69 people who signed a petition, recommend against purchase of Orca Narrows.

As to what type of habitat should be emphasized for protection and acquisition, views were mixed. About a third of the people favored emphasizing habitat important to injured resources, and a third favored placing an equal emphasis on habitat for injured resources and for human use. In addition, 115 people rejected the choices presented in the newspaper brochure. They preferred protecting habitat for subsistence.

Monitoring and research. About 80% of those who addressed this issue said that in addition to monitoring recovery and project effectiveness, the Trustee Council should undertake other monitoring activities. The most frequent recommendation was for an ecological monitoring program.

General restoration. The newspaper brochure did not ask any questions about general restoration except the proportion of the remaining settlement fund that should be allocated to this category. Nonetheless, many people recommended specific general restoration topics. Some were topics supported by dozens of people (in some cases more than a hundred). The most frequently addressed topics were:

- Cleaning residual oil from beaches and mussel beds;
- Fisheries projects;
- Subsistence projects; and
- Archaeology projects.

In addition, other popular projects included:

- Facilities in individual communities (Kodiak Fisheries Industrial Technology Center, Seward Sea Life Center, Tatitlek Harbor, and Valdez Visitor Center);
- Seabird predator control on the Aleutians.

The support was rarely unanimous, even for those topics singled out for comment by only a few people. In addition, approximately 40% of the people who responded did not favor spending any money on general restoration projects, and others cautioned against unforeseen environmental damage that these projects might cause.

Administration and public information. Few comments addressed administration and public information. However, nearly all that did were concerned about the money presently spent on administration. The 20 individuals who addressed public education and information recommended that information from the restoration process be made available to educate the public.

Endowment

Approximately two-thirds of responses favored an endowment. With the exception of some Native communities that were opposed, the support did not vary much by location. Of those who favored endowment, two-thirds said that the earnings should be used to fund long-term monitoring and research; one-half said that some endowment earnings should be spent on general restoration; and one-half said that some earnings should be spent on habitat protection. (The total exceeds 100% because many people said the earnings should be used for more than one category.)

Spending

The brochure questionnaire presented five alternative ways to use the remaining settlement fund. Each alternative allocated a different percentage of the fund to each of four restoration categories. The allocations were designed to gauge the public views about what emphasis should be placed on each restoration category. People were asked to choose an alternative if one reflected their views about which activities should be emphasized. If none reflected their views, participants could construct their own alternative.

Over half the people designed their own alternative. Thus, no one of the brochure alternatives received a majority of the response. The responses of the individually-designed alternatives varied widely.

The table below shows the average allocations that people gave to each restoration category. It includes the people who chose one of the five brochure alternatives, and those who designed their own.

Average Allocation of the Remaining Settlement Fund

Restoration Category:	Origin of Response			
	Spill Area	Other Alaska	Outside Alaska	All[1] Responses
Habitat Protection and Acquisition	60%	42%	81%	66%
Monitoring and Research	9%	12%	9%	9%
General Restoration	16%	19%	8%	16%
Administration and Public Information	5%	5%	5%	5%
Endowment[2] (Including only those who *favored* endowment)	20%	40%	20%	20%

[1] The columns of the table do *not* total 100%. This is because the endowment allocations reflect the views of only those people who favored an endowment. In addition, 1,028 people provided an allocation to habitat protection and acquisition. Many of them did not specify how the rest of the fund should be allocated. Approximately 650 people responded to the other categories.

[2] All allocations except that for endowment are arithmetic averages. The allocation to endowment shows the median response, because people gave their answer in broad categories, which makes an arithmetic average inaccurate.

Relation to Alternatives

The five alternatives in the newspaper brochure included answers to the five issues and policy questions explained earlier. They also contained spending allocations by restoration category in order to illustrate how different parts of the restoration program might be emphasized. The average choices made by people who responded did not correspond precisely to any one of the five alternatives in the newspaper brochure.

Of all those who submitted comments, the average allocation to habitat protection and acquisition and general restoration fell between Alternatives #3 and #4 of the newspaper brochure. The average allocation to monitoring and research was between Alternatives #4 and #5, and the average allocation to administration and public information was between Alternatives #2 and #3. In addition, the five policies most favored by the people did not correspond to the answers given by any one of the brochure alternatives. Finally, none of the alternatives in the newspaper brochure included an endowment.

Injury

The newspaper brochure did not solicit comments about injury. Nonetheless, many people expressed strong views about the injuries.

Resources. For resources recognized by the Trustee Council as injured, there was concern that specific resources are showing more signs of injury than were acknowledged in the newspaper brochure. This sentiment was most frequently expressed about fish (especially Pacific herring and pink salmon, and sockeye salmon in southern Kodiak and the Alaska Peninsula); and about subtidal and intertidal injuries (especially the continuing damage to clams, and mussels which people cite as the foundation of the marine food chain). It was also expressed, but to a lesser extent, about the many other species listed in the newspaper brochure.

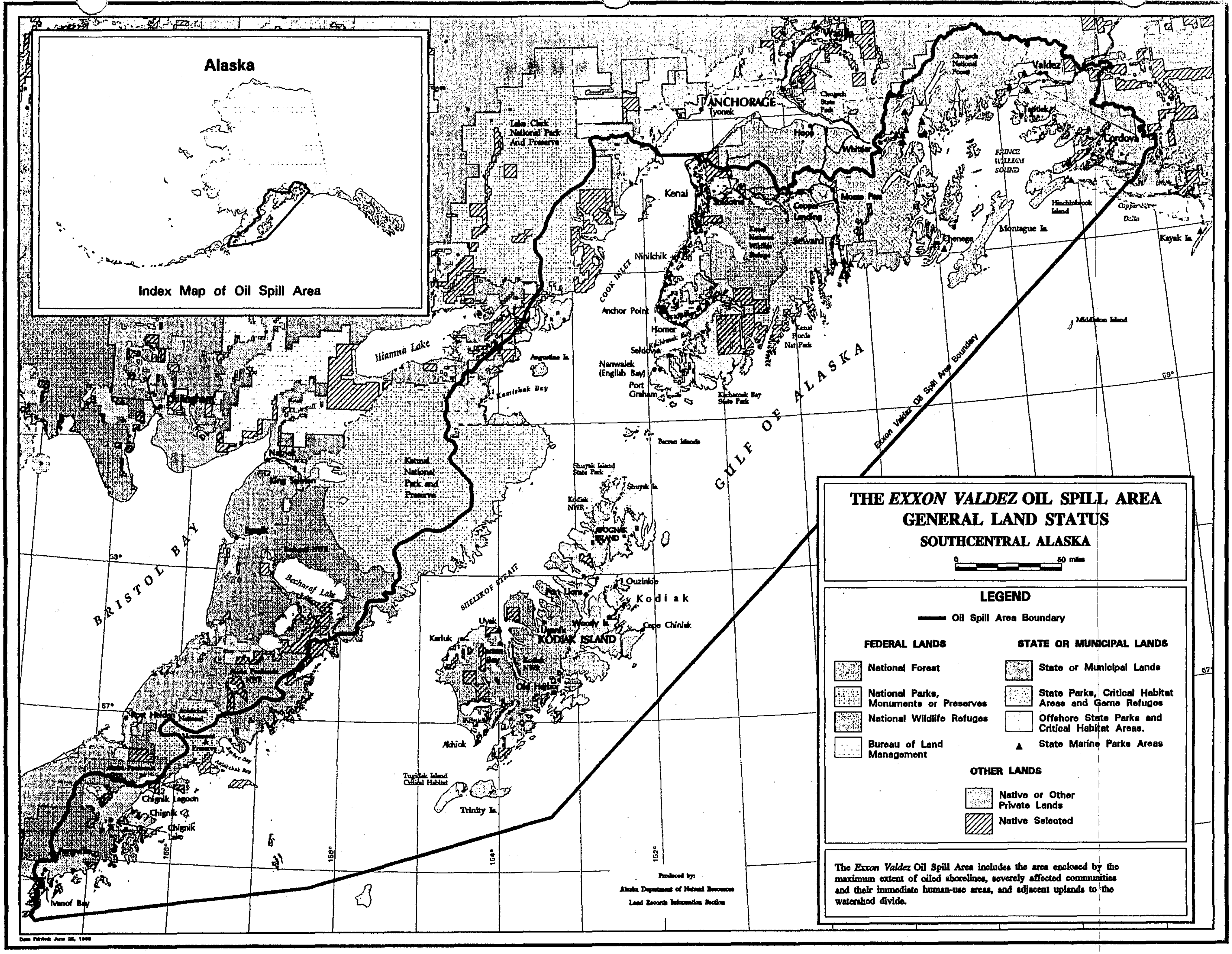
There was substantial comment on many species that were not thoroughly studied for the natural resource damage assessment, but that people said have changed since the oil spill and should be included in a restoration program. Of these resources, Steller (northern) sea lion, ducks (many species, but especially eiders), deer, shrimp, and Dungeness crabs were most commonly identified, but people named over 30 additional species.

Comments throughout the spill area stressed the need for an ecosystem approach in each of the regions within the spill area. Most of the comments focused on marine ecosystems rather than upland ecosystems.

Services. The theme of comments about services (human uses) was that services have not received enough attention in the restoration program. Subsistence was the most frequently cited service followed by commercial fishing. Some people spoke about social damage to people in the spill area and to communities.

Process

A number of people commented on the restoration process. Many people said that they have trouble influencing the restoration process, or understanding when and how to get their ideas considered in annual work plans.


THE EXXON VALDEZ OIL SPILL AREA
GENERAL LAND STATUS
SOUTHCENTRAL ALASKA
0 50 miles
LEGEND
Oil Spill Area Boundary
FEDERAL LANDS
National Forest
National Parks, Monuments or Preserves
National Wildlife Refuges
Bureau of Land Management
STATE OR MUNICIPAL LANDS
State or Municipal Lands
State Parks, Critical Habitat Areas and Game Refuges
Offshore State Parks and Critical Habitat Areas.
State Marine Parks Areas
OTHER LANDS
Native or Other Private Lands
Native Selected
The Exxon Valdez Oil Spill Area includes the area enclosed by the maximum extent of oiled shorelines, severely affected communities and their immediate human-use areas, and adjacent uplands to the watershed divide.
Alaska
Index Map of Oil Spill Area
ANCHORAGE
Tyonek
Valdez
Cordova
Whittier
Hope
Kenai
Seward
Cooper Landing
Moose Pass
Ninilchik
Anchor Point
Homer
Seldovia
Nanwalek (English Bay)
Port Graham
Tatitlek
Chenega
Montague Is.
Hinchinbrook Island
Kayak Is.
Middleton Island
PRINCE WILLIAM SOUND
COOK INLET
GULF OF ALASKA
Exxon Valdez Oil Spill Area Boundary
Lake Clark National Park And Preserve
Iliamna Lake
Augustine Is.
Kamishak Bay
Barren Islands
Katmai National Park and Preserve
Shuyak Island State Park
Shuyak Is.
Kodiak NWR
Ouzinkie
Kodiak
Woody Is.
Cape Chiniak
KODIAK ISLAND
SHELIKOF STRAIT
Uyak
Larsen Bay
Karluk
Old Harbor
Akhiok
Trinity Is.
Tugidak Island Critical Habitat
Naknek
King Salmon
Egegik
Becharof Lake
BRISTOL BAY
Port Heiden
Chignik Lagoon
Chignik
Chignik Lake
Ivanof Bay
Kenai Fjords Nat Park
Kachemak Bay State Park
59°
58°
57°
158°
156°
154°
152°
Produced by:
Alaska Department of Natural Resources
Land Records Information Section

INTRODUCTION

In April 1993, the Trustee Council presented in a newspaper brochure alternatives for restoring resources and services injured in the *Exxon Valdez* oil spill. The brochure was titled, "Summary of Alternatives for Public Comment." Approximately 33,000 brochures were distributed. The deadline for comment was August 6, 1993. This report summarizes all comments postmarked on or before that date. The newspaper brochure contained a questionnaire which is included as Appendix I.

We received responses in the form of completed brochure questionnaires, letters, telephone calls, and comments from 22 public meetings held in April and May 1993. We held meetings in these communities:

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		

In addition, we received comments from throughout Alaska and other states. People sent in 799 brochures and 792 letters. Between 500 and 600 people attended the public meetings. About 75% of the letters came from outside Alaska and generally focused on habitat acquisition. Approximately 90% of the brochures came from within Alaska and expressed opinions on the entire range of issues and policies presented in the newspaper brochure.

In this summary of public comment, we report variations between the spill area and areas outside it. The *Exxon Valdez* oil spill area includes the area enclosed by the maximum extent of oiled shorelines, severely affected communities and their immediate human-use areas, and adjacent uplands to the watershed divide. We also report differences among regions within the spill area. These include Prince William Sound, the Kenai region, the Kodiak region, and a part of the Alaska Peninsula. Occasionally, we report the viewpoints of individual communities where they differ markedly from those of their region.

Appendix II presents, by community and region, the number of brochures and letters received and the number of people who signed the attendance sheets at public meetings. Several organizations also sent letters on behalf of their members. A list of these organizations is included as Appendix III. Appendix IV presents a brief description of the methodologies used to summarize the public's comments.

Who and what do the responses represent? We did not attempt to conduct a scientific survey of public opinion, but instead provided several opportunities for comment to the public. While we can't assume that the results are statistically representative of local, state, or national populations, the large response does suggest that the results are a good guide to the preferences of the highly interested public. Because this is not a statistically valid sample of any of the populations represented, we use statistics only to the extent that they underscore a major trend. For example, "Based on 700 responses received from within the spill area on Question X, a majority (about 60%) preferred Answer Y."

In this report, we used a few quotes from public responses to illustrate major points. The location from which the response originated is indicated in parentheses after each quote.

All comments are on file in the:

Exxon Valdez Oil Spill Public Information Center
645 "G" Street, Anchorage, Alaska 99501
(907) 278-8008
Inside Alaska (800) 478-7745 Outside Alaska (800) 283-7745

Where do we go from here? Summarizing public comment on the alternatives is a critical step in completing the Restoration Plan. The Trustee Council will use the public comments to help choose the policy guidelines that will form the backbone of the Draft Restoration Plan. When the Draft Restoration Plan is completed, the public will have a chance to comment before it is issued in final form. The Final Restoration Plan will provide long-term guidance for restoring resources and services injured by the oil spill.

ISSUES AND POLICIES

The newspaper brochure published in April asked five policy questions to guide restoration decisions. We received about 700 written comments, mostly in the form of returned questionaire. Few people commented on these issues at public meetings.

Those who commented expressed strong preferences on three of the issues. About 60% favored addressing all injured resources and services, and ceasing restoration actions when a resource recovers. Two-thirds favored limiting restoration to the spill area. Views on the two other issues were mixed.

Concerning opportunities for human use, there was no strong preference among the four answers offered in the brochure. However, only 13% of the comments favored creating appropriate new uses. To understand public opinion on this issue, it is important to read the example comments themselves.

Regarding standards of effectiveness for restoration actions, there was no strong preference overall. However, two-thirds of those who commented on this issue from the spill area favored considering restoration actions that produce substantial improvement as well as those likely to produce at least some improvement. Support for this view was strongest in Prince William Sound and Kenai. Responses from outside the spill area were divided on the issue.

A recurring pattern among responses to some of these questions was, "None of the above." A frequently cited reason for this response was that, except for the issue of location of restoration actions, most of these questions seemed more pertinent to general restoration than to habitat protection or monitoring and research.

INJURIES ADDRESSED BY RESTORATION ACTIONS

The newspaper brochure asked the following question:

*Should restoration actions address **all** injured resources and services, or all except those biological resources whose populations did not **measurably decline** because of the spill?...*
and offered the following choices as answers:

- ☐ *Target restoration activities to all injured resources and services.*
- ☐ *Target all injured resources and services except those biological resources whose populations did not measurably decline because of the spill.*
- ☐ *No preference.*

About 60% of those who expressed views on this issue favored addressing all injured resources and services. Responses from the spill area as a whole were similar to the overall response. However, responses from Kodiak Island showed no strong preference.

All Injured Resources and Services

About 60% of the people who commented on this issue answered, "Target restoration activities to all injured resources and services." Typical comments in support of this answer were the following:

<u>Lack of data makes it difficult to measure population decline accurately.</u>

"Since many injured species had no prespill data and only those who had prespill data could be confirmed as population decline..., to only restore those which could be confirmed (in) decline would be bias." (Kodiak)

"I don't feel that enough info is available to confirm that all species did not decline, such as pink salmon and Pacific herring in particular." (Cordova)

"I have a real problem with the identification of what injured resources are out there. Only the top of the food chain is identified." (Kodiak)

<u>Ecological relationships connect all species whether or not their populations declined.</u>

"Even though a species was not directly affected by the oil spill, the food web relationship affected all species." (Seward)

<u>Long-term effects are uncertain.</u>

"No one knows for certain what the long-term consequences of the oil spill might be." (Old Harbor)

"Declines may be subtle, slow to emerge." (Outside Alaska)

Measurable Decline in Population

About a third of the people who commented on this issue answered, "Target all injured resources and services except those biological resources whose populations did not measurably decline because of the spill." Typical comments in support of this answer were the following:

Emphasizing the most severe injuries is cost-effective.

"Focus efforts where injuries were greatest. Let natural recovery tend to marginally affected resources. Save money for habitat protection!" (Anchorage)

If you can't measure improvement, how do you account for prudent use of funds?

"If a species' population has not declined, then there is no way to tell when restoration has been successful. Money could be misspent." (Valdez)

Other Comments

Some of the comments claimed that the questionnaire oversimplified this issue. They argued that the decision may be a matter of priorities rather than a simple choice or that the choices presented in the brochure missed useful options. A recurrent comment was to address subsistence.

Restore injured subsistence resources.

"Subsistence resources must be restored to prespill quality." (77 individuals, including nearly all who responsed from Port Graham, Chenega Bay, and Tatitlek)

Target ecosystems rather than individual species.

"Take the ecosystem view--loss or damage to a part of the system always has some effect on the whole though our science may be too unsophisticated to detect, measure, or understand it." (Kenai)

Address resources most likely to respond to restoration actions.

"Target efforts on those species most apt to respond--not just those most severely damaged." (Cordova)

Set priorities. Some comments suggested different approaches to setting priorities.

"Restoration actions should focus first and foremost on measurable damage to injured resources. ...(T)hen more extensive work could be done." (Seward)

"Emphasize species that are not showing natural recovery..." (Fairbanks)

"Commercially important species that were injured, measurably or not, deserve the greatest restoration effort because of their importance to the people who depend upon them." (Cordova)

None of the above: Rely on natural recovery instead of restoration.

"The more man interjects himself into nature, the more chances there are to foul it up." (Tatitlek)

RESTORATION ACTIONS FOR RECOVERED RESOURCES

The newspaper brochure asked the following question:

Should restoration actions cease when a resource has recovered, or continue in order to enhance the resource?...and offered the following choices as answers:

- ☐ *Cease restoration actions once a resource recovers.*
- ☐ *Continue restoration actions even after a resource has recovered in order to enhance the resource.*
- ☐ *No preference.*

About 60% of those who addressed this issue said that a restoration action should cease when a resource has recovered. Support for this view was slightly weaker within the spill area than outside it. Responses from Prince William Sound and Kenai were comparable to the overall response; those from Kodiak Island showed no strong preference; most of the seven responses from the Alaska Peninsula favored enhancement.

Restore Until Recovery

About 60% of the people who commented on this issue answered, "Cease restoration actions once a resource recovers." Typical comments in support of this answer were the following:

<u>Enhancement may upset the natural balance of the ecosystem.</u>

"Enhanced resources beyond current or natural levels do more damage because of environmental competition for survival, e.g.,(salmon farms, hatcheries vs. wild stock)." (Old Harbor)

"The enhancement of a recovered resource could cause damage to another injured resource which has not yet recovered or to resources not damaged by the spill. It will be important to maintain the delicate balance of the ecosystem as a whole in the restoration process." (Valdez)

"Dangerous concept -- enhancing one resource is often at the cost of another. Also contributes to conflict between resource user groups." (Juneau)

<u>This approach makes the most out of limited funds.</u>

"In order to accomplish the most with limited funds, work with a resource until it shows signs of recovery, then let it go on its own." (Valdez)

"Dollars will soon dwindle! Put resource dollars where they will be most effective. Get the biggest bang per buck. Do not squander this opportunity and resource." (Anchorage)

Enhancement

About a third of the people who commented on this issue answered, "Continue restoration actions even after a resource has recovered in order to enhance the resource." Typical comments in support of this answer were the following:

<u>It is difficult to tell when certain resources or services have recovered.</u>

"Due to the complex nature of a resource such as salmon, it will be difficult to tell when it has recovered." (Cordova)

"Recovery is a subjective term. Those people that depend upon a resource that has been injured may take longer to recover than the resource." (Cordova)

<u>Increased use of the spill area calls for enhancement to restore balance.</u>

"Because the face of the spill areas will never be the same with ever changing conditions, recovered resources is an ambiguous goal to reach. The recreational resources and services in existence at the time of the spill are not suitable for the use now occurring in the spill area. Bringing injured resources and services to appropriate levels would involve some enhancement." (Anchorage)

Other Comments

Many comments supported enhancement only under certain circumstances, such as those listed below.

<u>Enhance only if the resource was in decline before the spill.</u>

"Only if the species was in decline before the spill, then 'enhance' to an acceptable level." (Fairbanks)

<u>Enhance only to replace lost fishing opportunities.</u>

"Return resource to prespill levels and in the case of salmon anadromous streams enhance to offset lost fishing access since the spill." (Cordova)

EFFECTIVENESS OF RESTORATION ACTIONS

The newspaper brochure asked the following question:

Should the plan include only those restoration actions that produce substantial improvement over natural recovery or also those that produce at least some improvement?... and offered the following choices as answers:

- ☐ *Conduct only those restoration actions that provide substantial improvement over natural recovery.*
- ☐ *Conduct restoration actions that provide at least some improvement over natural recovery.*
- ☐ *No preference.*

> Those who responded to this question expressed no strong preference overall. However, two-thirds of those who commented on this issue from the spill area favored considering restoration actions that produce substantial improvement as well as those likely to produce at least some improvement. Support for this view was strongest in Prince William Sound and Kenai. Responses from outside the spill area were divided on this issue.

Substantial Improvement

Nearly half of those who commented on this issue answered, "Conduct only those restoration actions that provide substantial improvement over natural recovery." Typical comments in support of this answer were the following:

<u>Funds are limited. You can't afford to do everything.</u>

"Money would be spread too thin to be effective otherwise." (Valdez)

"Money is very limited and the best use is habitat acquisition. Allocate money only where we will get a substantial return for the investment." (Homer)

<u>Experiments may cause damage.</u>

"Just do the best projects. Experimental projects could do damage. Most resources will recover if left alone." (Cordova)

"Practice minimum intervention, lest restoration efforts cause more damage than the original insult." (Outside Alaska)

At Least Some Improvement

About half of all who commented on this issue, including two-thirds of those within the spill area, answered, "Conduct restoration actions that provide at least some improvement over natural recovery." Typical comments in support of this were the following:

Residual effects, like buried oil, still damage uses like subsistence.

"Following the first rationale (substantial improvement) has already been demonstrated as erroneous because buried oil remains in beaches which still damages subsistence resources by leaking out." (73 individuals, including nearly all who responded from Port Graham, Chenega Bay, and Tatitlek)

Even restoration actions whose effects seem small or uncertain may be significant.

"For although initially an action may seem to be small, it may help considerably later." (Kodiak)

"Hard to predict outcome of any action, especially as it is magnified through the food chain." (Seward)

"Even modest improvements may suffice to enable natural recovery." (Outside Alaska)

Other Comments

Some people questioned how decisions about effectiveness would be made. Others said this issue was a matter of priorities.

How do you define "substantial" or "effective"? Some comments questioned who would make these decisions. Others offered their own definition of what makes a restoration action effective.

"Who defines substantial? You have not even been able to define the parameter of impairment 2 years and 1/3 of the money later." (Cordova)

"Trustees should prefer projects which provide lasting protection for injured resources and services. A project which speeds up recovery of a damaged population by a few years is a far less effective use of settlement funds than a project which helps protect populations in perpetuity." (Anchorage)

"..(R)estoration options should be evaluated from the perspective of whether they benefit more than a single resource. The Pacific Seabird Group's preferred options generally would benefit other seabirds (and often other organisms), not just a single species." (Outside Alaska)

Set priorities. Some comments said that restoration actions that produce substantial improvement should be the top priority and less effective actions should have a lower priority.

"While restoration actions that can produce 'at least some improvement' should not be ruled out as a policy matter, as a practical matter, given limited settlement funds, restoration action with only marginal benefits should be accorded an extremely low priority." (Anchorage)

"Substantial improvement is, of course, ideal, but those that would provide some improvement should not be left out." (Valdez)

LOCATION OF RESTORATION ACTIONS

The newspaper brochure asked the following question:

Should restoration actions take place in the spill area only, anywhere in Alaska provided there is a link to injured resources or services, or anywhere in the United States provided there is a link to injured resources or services?...and offered the following choices as answers:

- ☐ *Limit restoration actions to the spill area only.*
- ☐ *Undertake restoration actions anywhere in Alaska there is a link to injured resources or services.*
- ☐ *Undertake restoration actions anywhere in the United States there is a link to injured resources or services.*
- ☐ *No preference.*

Two-thirds of all who responded to this question favored limiting restoration actions to the spill area. Support for this view was even stronger within the spill area, where three-quarters of those who responded would like to see restoration actions limited to the spill area. Fewer than one-tenth of all who commented on this issue favored restoration actions outside Alaska.

Spill Area

Two-thirds of those who responded to this question, including three-fourths of those within the spill area, answered, "Limit restoration actions to the spill area only." Typical comments in support of this answer were the following:

Link to injury is strongest in the spill area.

"We doubt that a well-founded link to injured resources or services can be justified outside the spill area." (73 individuals, including nearly all who responded from Port Graham, Chenega Bay, and Tatitlek)

"In many instances linkages to injured resources and services may be subtle at best. This will be even more the case as distances from the spill affected areas increase." (Cordova)

"I feel that these funds should be used only within PWS, outer Kenai Coast, and Kodiak Island and in proportion to the extent of damage." (Cordova)

Funds are limited and demands within the spill area are great.

"Even a large sum of money such as this can be diluted pretty quickly by trying to spread it too thin." (Kodiak)

"There is not enough money to fund other areas of state. Plenty to do in spill area." (Port Graham)

Alaska Outside the Spill Area

A small proportion of those who commented on this issue answered, "Undertake restoration actions anywhere in Alaska there is a link to injured resources or services." Typical comments in support of this answer were the following:

Restoration actions outside the spill area can sometimes be more effective than those within the spill area, especially for migrating marine mammals or seabirds.

"Mitigation can occur by benefitting seabirds outside the spill area. Supporting the removal of alien species from islands would benefit seabirds overall far more than any other restoration technique." (Homer)

"Some species especially migrant sea mammals and birds continue to decline not because of one local (event), but from interaction all along their life's travels and instincts." (Old Harbor)

Anywhere in the United States

Fewer than 10% of those who commented on this issue answered, "Undertake restoration actions anywhere in the United States there is a link to injured resources or services." Typical comments in support of this answer were the following:

Migrating marine mammals and seabirds were injured and may be helped outside spill area and outside Alaska.

"Example - protecting migratory bird habitat. Injured species do not recognize state boundaries!" (Outside Alaska)

Other Comments

Some people recommended that the spill area be expanded to include Perryville, Ivanof Bay, and the Susitna drainage. Others recommended that the Trustee Council establish guidelines for considering projects outside the spill area.

Expand the "Spill Area" to include Perryville and Ivanof Bay. At public meetings in Chignik Lagoon and Chignik Lake and in the few letters received from Perryville, people expressed strong support for expanding the spill area to include Perryville and Ivanof Bay. Reasons given for this expansion are that the shorelines of these villages were oiled, local commercial and subsistence resources were damaged, and the sockeye salmon run on which these villages depend in Chignik and Black Lakes were also damaged in the spill. Since the public meetings in April, Perryville and Ivanof Bay have been added to the spill area.

"The boundaries you have outlined I think should include all villages (Chignik Bay, Chignik Lagoon, Chignik Lakes, Perryville and Ivanof). We all depend on this fishery not just the lagoon and lakes." (Chignik Lagoon)

Expand the "Spill Area" to include the Susitna River drainage.

"The spill has had a tremendous effect on the fish in the Susitna Drainage and it should be included." (Anchorage)

Focus on the spill area, but consider restoration actions outside the spill area under certain circumstances. Some people suggest that the Trustee Council adopt guidelines for determining whether to venture beyond the spill area.

"If there is nothing that can be done in the spill-affected area, only then should you look at proposals outside the spill-affected area." (Seldovia)

"The following hierarchy represents the most direct means of achieving this objective (offsetting adverse impacts to fish and wildlife populations and their habitats): 1) Benefit species affected where they were affected, 2) Benefit species affected as close as possible to where they were affected, 3) Benefit other species in the spill area, and 4) Benefit other species as close as possible to the spill area." (Juneau)

"The spill area should be the priority, and anything outside that area should be secondary." (Nanwalek)

"Allow actions outside the spill area for species with continuing population decline (lower priority)." (Anchorage)

OPPORTUNITIES FOR HUMAN USE

The newspaper brochure asked the following question:

To what extent should restoration actions be used to create opportunities for human use of the spill area?...and offered the following choices as answers:
- ☐ *Do not conduct restoration actions that create opportunities for human use.*
- ☐ *Conduct restoration actions to protect existing human use.*
- ☐ *In addition to restoration actions that protect existing human use, also conduct actions that increase existing human use.*
- ☐ *In addition to activities that protect or increase existing human use, also conduct actions that encourage appropriate new uses.*
- ☐ *No preference.*

There was no strong preference among the four answers offered in the newspaper brochure. However, only 13% of the comments favored creating appropriate new uses. To understand public opinion on this issue, it is important to read the comments themselves. We have included typical comments in this section.

No New Opportunities for Human Use

About one-fifth of all those who responded to this question answered, "Do not conduct restoration actions that create opportunities for human use." A typical comment in support of this answer was the following:

<u>Actions that protect or increase existing human use are unrelated to restoration.</u>

"Protection of existing human use is desirable but it is a separate issue from restoration of the natural habitat and wildlife. Use these funds for restoration activities." (Outside Alaska)

Protect Existing Human Use

About one-third of all those who responded to this question, including about half of those from outside Alaska, answered, "Conduct restoration actions to protect existing human use." A typical comment in support of this answer was the following:

Actions that decrease the impact of human use promote restoration.

> "Protecting overused areas is a good idea. Otherwise use NO funds to promote human activities in the spill affected areas as human use is potentially damaging. Let it occur naturally without promoting more." (Homer)

Protect and Increase Existing Human Use

About a quarter of all those who responded to this question, answered, "In addition to restoration actions that protect existing human use, also conduct actions that increase existing human use." Typical comments in support of this answer were the following:

Actions that increase existing human use improve the lifestyle of those affected by the spill.

> "Subsistence, sport and commercial fish runs and an enhanced recreation industry will benefit PWS residents whose lifestyle has been altered by the spill." (76 individuals including nearly all who responded from Port Graham, Chenega Bay, and Tatitlek)

New uses should be near existing communities.

> "New uses are OK, but should exist close to towns and villages that encourage use close by and would not create disturbances in pristine areas of the sound and coast." (Valdez)

Appropriate New Uses

Only 13% of all those who responded to this question answered, "In addition to restoration actions that protect or increase existing human use, also conduct actions that encourage appropriate new uses." Typical comments in support of this answer were the following:

Let people enjoy the spill area.

> "Spend the money to let more people enjoy the Sound. Build more boat harbors! Create new fish runs! Build more cabins! Use the Sound. Don't lock it up!" (Valdez)

Projects are "appropriate" if they divert use away from sensitive areas.

"The key word is appropriate. Existing use should be protected, but use has increased as a result of EVOS publicity. Therefore, appropriate management of human use may entail increasing use in some areas to decrease impact on others. In this event, increasing use projects are appropriate. We should not actively seek to increase use of the spill area in general through projects." (Matanuska-Susitna Borough)

Other Comments

Several comments express concern about how new facilities would be maintained. Others favored increasing certain uses, but not others.

How will new facilities be maintained?

"Oil spill monies should not be spent on infrastructure projects without a clear vision of the future maintenance funding of those projects." (Cordova)

CATEGORIES OF RESTORATION

HABITAT PROTECTION AND ACQUISITION

Habitat Protection and Acquisition received the greatest share of public comment. Its place in the restoration program was discussed in almost every letter, brochure, and public meeting. It received overwhelming support as a part of the plan. The major disagreement about habitat protection was on emphasis: what should be emphasized and how much. In addition, hundreds of people recommended various areas for acquisition and protection -- 50 areas in all.

The newspaper brochure asked four questions:

- Do you agree that habitat protection and acquisition should be a part of the plan?
- What type of habitat should be emphasized: habitat for resources, services, or both?
- Recommendations for specific purchases or protection.
- Spending: What emphasis should the Trustee Council place on habitat protection and acquisition?

Should Habitat Protection and Acquisition be a Part of the Plan?

The newspaper brochure asked the following question:

Do you agree that habitat protection and acquisition should be a part of the plan? The choices were:

☐ *No*
☐ *Yes*

Almost all responses supported including habitat protection and acquisition in the restoration plan. This sentiment was expressed by almost 90% of those who returned a brochure and the overwhelming majority of those who wrote letters. The extent of support varied little depending on location. The only exception was the Alaska Peninsula, where six of the seven brochures returned from Chignik Lagoon and Perryville (the only villages from the Alaska Peninsula that returned brochures) said habitat protection should not be part of the plan.

Comments supporting habitat protection and acquisition. Hundreds of people expressed a strong sentiment without giving detailed reasons. However, many comments contained reasons for supporting habitat protection and acquisition. Recurring reasons are summarized below.

Active restoration is ineffective; recovery will occur without our intervention. Many people said that they came to their conclusion to support habitat protection because they believe that most human action to speed up recovery is ineffective -- that nature will achieve recovery on its own.

"...(I)t is better to just acquire habitat and basically say God knows best. We know a little bit, but we don't know enough...We have to admit that all the queen's horses and all of her men just cannot put it together again. There are some excellent ideas out there, but I believe habitat acquisition is the best way to spend money." (Seward)

"Recovery of species will occur naturally, even without intervention or spending -- (you) should allocate most funds for critical habitat acquisition." (Juneau)

"It seems that there is very little that can be done to cost-effectively restore injured resources and services other than through land and habitat acquisition." (Anchorage)

"We simply cannot fix a broken ecosystem. Therefore, I am recommending that at least 80% of the remaining funds be used for habitat protection." (Outside Alaska)

Either buy habitat or the agencies will squander the money.

"Acquisition would at least be a permanent accomplishment for the E-V Trust Funds as opposed to pumping the respective agencies with funds for a plethora of studies of dubious value." (Kodiak)

"Something good must come out of all this. Habitat acquisition is the only tangible thing that can." (Outside Alaska)

Buying land is the key to the rural way of life.

"We believe that habitat protection and acquisition should be a major component of the Restoration Plan. People want to live, work, and visit these lands because of their natural resources in a wilderness setting. If those resources are conserved, they will be the key to the continuation of the rural Alaska way of life." (Old Harbor)

Habitat is needed for a sustainable economy.

"Simply stated: intact forest lands can and do provide an essential biologic foundation for permanent jobs and strong, sustainable economies. It would be tragic, to say the least, if the ecosystems biological resources and coastal communities of the Exxon Valdez impact region were to finally recover from the spill, only to suffer further devastation as a result of unsustainable, 'boom and bust' development activities, in particular clearcut logging." (Anchorage)

"Tourism will provide more long-term employment than short-term unsustainable logging. Tourists don't want to see stumps." (Cordova)

Stop logging (and other development). Many comments urged the Trustee Council to stop clearcut logging. Others encouraged the Council to prevent habitat loss from other types of development activities as well.

"This (habitat protection) must be done soon, before logging, mining, and recreation developments interfere with the integrity of the ecosystem as a whole." (Cordova)

"I recommend that at least 80% of the remaining funds be used for habitat protection. If this action isn't taken, hundreds of thousands of acres of private forest land will be clearcut. This will only add to the devastating consequences of the Valdez oil spill. Please help!" (Outside Alaska)

Thank you for Kachemak Bay and Seal Bay. Many letters began with a thank you for the Trustee Council action to purchase Kachemak Bay and Seal Bay.

"I am writing to voice my support of the use of Exxon settlement funds for habitat acquisition in the spill affected area. I applaud the designation of funds for purchases in Kachemak Bay and Seal Bay on Afognak Island." (Homer)

Comments opposing habitat protection and acquisition. Between 5% and 10% of the responses opposed the use of habitat protection either in all cases or in the specific instance that was the subject of the comment. Those that did, however, often used strong language to reflect their disbelief in what was happening. The recurring comments are summarized below.

So much land is already publicly owned.

"Too much government land in Alaska. Not enough privately owned." (Homer)

"I can't figure out why we are going to buy land. What is the government doing buying more land when they own 97% of the State of Alaska? (Anchorage)

Buying land is not restoration.

"How many trees were damaged in the spill?" (Seward)

"Owning land will not help prevent other spills or help injured resources by itself." (Seward)

Don't restore the fish by hurting the timber industry.

"The logging industry has truly blessed our family and benefited our community. Please do not buy this timber, we will be losing our jobs, and our own will be due for more hard times. This money should not be used for more hardships for the people of Cordova." (Cordova)

With all the budget cuts coming to the agencies, we're using money to buy land? This sentiment was mostly expressed at the meeting at Chignik Lagoon.

"It doesn't make any sense to me to buy habitat...It doesn't make sense to buy habitat if you're going to cut back the Department of Fish and Game so you can't monitor it...Ifthey want habitat and stuff like that, let the tree huggers buy it." (Chignik Lagoon)

Native ownership is important to Native people. Some Native speakers in many regions expressed concern about losing their ownership.

"Our land was sold once and it took so long for us to get it back again." (Cordova)

"Thanks but no thanks. Our land is all we have left and we'll keep it, thank you." (Chenega Bay)

Other comments about habitat protection and acquisition. We received a few comments that discussed land management, or the way in which habitat should be protected.

Public land, or land purchased by the Trustee Council should be managed for restoration.

"Covenants should contain specific language that these areas (those acquired for habitat and viewsheds areas) must be managed for habitat and viewshed restoration....We would like to see the Restoration Plan include an administrative alternative that allowed a non-profit agency, such as The Nature Conservancy, to manage conservation areas for either private or government landholders." (Valdez)

"I heard that for land acquired under restoration, the state might consider selling it. I would like to see it locked up under some type of sanctuary status." (Homer)

"While there is plenty of talk here about acquiring land, there is nothing about funding for management of these lands once they are acquired from private sources or even who will manage them. If funding goes into acquiring land, then funding needs to go to manage them." (Anchorage)

Type of purchase: easements versus timber rights versus fee simple purchase. Only a handful of people commented about the type of purchase. However, there were not enough to comments to indicate any trends.

What Habitat Types, if Any, Should be Emphasized?

The full text of the brochure question was:

> *Protection and acquisition will include all habitat types, but may emphasize one over another. Please indicate the habitat types, if any, that should be emphasized.* The brochure choices were:
>
> ☐ *Emphasize acquiring and protecting habitat important to injured resources.*
>
> ☐ *Emphasize acquiring and protecting habitat important for human use (important scenic areas and human use areas).*
>
> ☐ *Place equal emphasis on acquiring the most important habitats for injured species and on the most important habitat for human use (scenic and human use areas).*
>
> ☐ *Other.*

Responses were almost evenly split between emphasis on habitat for injured resources and equal emphasis on habitat for injured resources and human use. Very few favored emphasis on habitat important for human use alone. There were some differences among the regions within the spill area. Four-fifths of responses from Kodiak Island (and over 90% of those in Old Harbor) chose "equal emphasis." The brochure questionnaires returned from the Native villages of Prince William Sound and Kenai almost unanimously chose "other" and wrote in their preference for protecting habitat for subsistence. Very few comments were made on this subject other than through the brochure response form.

Below are some common reasons people gave for making their choice. (No reasons are given for choosing *emphasize habitat important for human use* because few people made that choice.)

Reasons for selecting *emphasize habitat important to injured resources*. Below are some reasons given for selecting this choice.

Species first, humans second.

> "After critical habitat needs are met, then consider human uses. When choosing between similar habitat acquisitions, factor in the human use value to help make the choice." (Anchorage)
>
> "Concentrate on natural habitats for all forms of wildlife. The human uses are secondary and will succeed if the natural habitats are secure." (Outside Alaska)

Resources only.

> "I think it's more important to help the animals than having a scenic area for people." (Anchorage)

"Habitat for increased human use does not need to be acquired. Forest Service and state parks land offer ample opportunity for human recreation. (Some may need additional development.) Money should be for species injured." (Location unknown)

Reasons for selecting ***place <u>equal emphasis</u> on the most important habitats for injured species and on the most important habitats for human use.***

<u>Humans were injured too</u>.

"Humans are an injured resource, especially in 'oil spill' communities like Cordova." (Cordova)

"Since human recreation was a highly injured service, there is no real contradiction to be resolved here." (Anchorage)

<u>Place equal emphasis on humans and species</u>.

"In our experience, many areas which have high value as habitat also are highly valued by the user seeking wilderness values. Thus, many parcels could meet both criteria. There should be stipulations to preserve wilderness values (i.e., timber) and allow recreation access." (Matanuska-Susitna Borough)

Reasons for selecting "Other." One hundred and fifteen people did not choose any of the choices the brochure offered. Instead, they chose "other" and wrote in their own choice. Eighty of these people said we should protect habitat for subsistence. The other 35 people offered various ideas but there were no strong patterns in their comments.

<u>Subsistence.</u>

"We agree to land purchase only from willing sellers and absolutely oppose land condemnation. We recommend protecting habitat for subsistence." (80 people from Chenega Bay, Tatitlek, Port Graham, Cordova, Anchorage, other areas of Alaska, and from outside Alaska, including nearly all who responded from the Native villages of Prince William Sound and Kenai)

Where Should the Trustee Council Purchase Habitat?

The brochure asked people to describe "an area you would like the Trustee Council to acquire or protect." Many people did.

The "Citizen's Vision." The largest number of comments (271 letters) recommended purchase of seven areas called the "citizen's vision." Almost two-thirds originated outside of Alaska, and few came from the spill area. Below is a typical letter showing justification for each area.

"**1. Port Gravina/Orca Bay:** The old growth forests of eastern Prince William Sound near Cordova provide exceptional habitat for spill-injured species and support high value wilderness recreation and tourism. **2. Port Fidalgo:** On-going logging activities here threaten the densely forested habitat along sheltered bays near Tatitlek and Valdez. **3. Knight Island Passage:** Rugged mountainous islands with intimate bays provide habitat for spill-impacted species such as killer whales, harbor seals, bald eagles and salmon. **4. Kenai Fjords National Park:** One of Alaska's crown jewels, the heart is threatened by logging and development on private lands within the park. **5. Port Chatham:** This is the last stretch of intact forest habitat along the tip of the outer Kenai Coast. **6. Shuyak Straits:** The Sitka spruce forest on northern Afognak is home to marbled murrelets, salmon, brown bear, elk and deer. **7. Kodiak National Wildlife Refuge**: Although logging is not a threat here, other development activities would jeopardize prime brown bear habitat and other wildlife values."

Many of the letters supporting the "citizen's vision" went on to say:

"Purchasing these habitats would be the best way to guarantee recovery of the areas affected by the spill and would protect them from further injury. It would also preserve valuable tourist attractions and, most important, our unique and priceless Alaskan heritage. Buying wildlife habitat should in fact be the central focus of the restoration plan and should cover broad areas, including entire watersheds."

Kodiak National Wildlife Refuge. In addition to the 271 letters advocating the "citizen's vision" outlined above, 106 other letters advocated purchase of private inholdings from willing sellers in the Kodiak National Wildlife Refuge. This was the largest number of comments received for a single area.

Seventy letters from outside Alaska came on a form supplied by the Great Bear Foundation of Montana.

"Please register my vote for Alternative 2 among the restoration plans you are considering. As someone interested in the best form of environmental recovery from the Exxon oil spill, I wish to see the greatest amount of threatened wildlife habitat in the spill zone acquired. Alternative 2 dedicates 91% of the remaining $600 million in the fund to habitat acquisition. In addition, my highest priority for lands to be acquired are Native inholdings and other private parcels from willing sellers in the Kodiak National Wildlife Refuge."

Other letters, from the City of Kodiak, Kodiak Villages, other areas in Alaska, and from outside Alaska advocated purchase of the refuge inholdings for a variety of reasons:

> "Koniag (Corporation) has long maintained that its Karluk and Sturgeon River former wildlife refuge lands on the west side of Kodiak must be reacquired to have a bear refuge worthy of the name." (Kodiak)

An unusually large number of letters advocating purchase of the refuge inholdings came from organizations: Akhiok-Kaguyak, Inc.; Boone and Crockett Club; Game Conservation International; Great Bear Foundation; International Association for Bear Research and Management; International Wild Waterfowl Association; Kodiak Audubon Society; Koniag Inc.; National Audubon Society; National Rifle Association (co-signed by Wildlife Legislative Fund of America, and Safari Club International); National Wildlife Refuge Association; and Old Harbor Native Corporation.

The purchase of private inholdings within the Kodiak National Wildlife Refuge was also strongly supported at public meetings in Old Harbor and Akhiok.

> "To whom it may concern I would like to see the lands on the south end of Kodiak Island bouth to protect the land for the bears and animals. Seems every year there is getting more and more building going up around here. We would like the lands to remain the same. If sold to the wrong hands it could be strongly developed." (Akhiok)

Areas near Cordova. In addition to comments advocating purchase of the "citizen's vision" areas, many comments focused on the potential purchase of Eyak lands at Power Creek, Eyak Lake, Orca Narrows, and nearby areas.

Supporting purchases. Forty-one letters, mostly from Cordova, supported purchases around Eyak Lake. Reasons cited include effect on wildlife, tourist industry, views, drinking water, and "atrocious logging practices."

> "Support the Trustee Council buying timber rights for Power Creek, Eyak Lake, and other areas in Prince William Sound. Most important thing to protect is the highly visible areas along main PWS traffic routes so tourists won't get bad impressions. It's also important to protect salmon streams since they are important to commercial fishing." (Cordova)

> "I urge the Trustee Council to support the agreement now being negotiated with the Eyak Corporation to acquire and protect Power Creek and Eyak Lake and Nelson Bay lands. I am disgruntled about the clear-cutting and the effects this has on wildlife habitat." (Cordova)

Letters advocating *some* purchases, but against purchase of Orca Narrows. Three letters and one petition advocated purchase of Eyak Lake and Power Creek, but not Orca Narrows.

"We the residents of Cordova, Alaska are against any purchases of timber other than Eyak River, Eyak Lake, and Power Creek areas. By including Orca Narrows in the timber buy out it would eliminate logging in the Cordova area." (petition from Cordova signed by 69 people)

"My husband...began fishing in 1975...in1990, he had to find another career. Indirectly the 1989 oil spill ruined his job....Fortunately he got a full-time job with the local logging company...it has allowed lifelong Cordova residents, such as us, to remain in our town that we love. Spending allocated funds to buy back timber in PWS is senseless...Should the same money be used to help restore what damage was done to our community destroy my families livelihood once more....I am not against the buying of the lands near Eyak Lake and Power Creek in order to protect Cordova's fishing streams, but the Orca Narrows do not pose any threat to the fisheries." (Cordova)

Afognak Island. In addition to the letters recommending purchase of "citizen's vision" areas, approximately a dozen people (approximately half from the spill area and half from elsewhere in Alaska) suggested further purchases on Afognak Island. Many of these also thanked the Trustee Council for their recent purchase at Seal Bay.

"(Priorities for habitat protection): #1 Seal Bay lands, #2 Pauls and Laura Lake Chain, #3 Shuyak Straits conservation unit, #4 Long Lagoon area." (Kodiak)

"The Shuyak Straits/Northern Afognak lands are also of special interest to our members (the Kodiak Audubon Society). Not only are these lands and coastal habitat home to many species that suffered substantial injury to the spill, this wilderness also offers magnificent scenic and recreation values. Acquisition of these ecosystems would insure recovery and protect many resources and services from further degradation." (Kodiak)

Kachemak Bay. Like Afognak, many letters thanked the Trustee Council for their purchase of Kachemak Bay. One other recommended additional purchases adjacent to the park, and two recommended purchase of Gull Island.

Kenai Fjords National Park. In addition to people recommending purchase of the seven "citizen's vision" areas, almost two dozen people recommended purchase of inholdings in Kenai Fjords National Park. The comments were received primarily from Seward but also from Anchorage and around Alaska.

"I would like to see oil spill money used to purchase Native land. English Bay or Port Graham is willing to sell back to Kenai Fjords National Park. The coastal parcels in question are vital components of the park ecosystem for resource protection and visitor use." (Seward)

There was also extensive discussion of Kenai Fjords National Park inholdings at the Seward public meeting.

Other areas. Hundreds of people recommended areas for purchase. Table 1 shows the areas recommended, and the number of times those areas were mentioned. With the exception of Orca Narrows, virtually all comments are recommendations for purchase or protection. As described earlier, Orca Narrows had mixed response. The numbers beside each parcel *do not* include recommendations made as part of the "citizen's vision" package.

Also, the Pacific Seabird Group recommended 51 seabird colonies for acquisition. They are not included in the table. Their recommendations include 34 seabird colonies outside the spill area and 17 colonies in the vicinity of Kodiak Island and Gull Island in Kachemak Bay.

Table 1. Areas Recommended for Purchase or Protection

# of cmts	Prince William Sound
2	Bainbridge Island
3	Chenega Island
1	Chugach National Forest
113	Cordova area private lands (excluding Orca Narrows -- see Orca Bay)
5	Dangerous Passage
6	Eshamy/Jackpot Bay
2	Evans Bay
4	Fish Bay
2	Hawkins Island
1	Hinchinbrook Island
1	Icy Bay
278	Knight Island (271 from "Citizens Vision", 7 other)
1	Knowles Head
3	Latouche Island
3	Montague Island
2	Naked Island
7	Nelson Bay
3	Olsen Bay
312[1]	Orca Bay/Narrows (271 from "Citizens Vision, 41 other. *In addition, 3 letters and a 69 person petition opposed acquiring this area*)
1	Patton Bay
275	Port Fidalgo (271 from "Citizens Vision", 4 other)
275	Port Gravina (including Bear Trap Bay; 271 from "Citizens Vision", 4 other)
1	Red Head
3	Rude River

# of cmts	Prince William Sound (cont'd)
5	Sheep Bay
5	Simpson Bay
2	Two Moon Bay
1	Windy Bay
	Kenai Area
1	Chrome Bay
2	Gull Island
1	Kamishak Bay
300	Kenai Fjords National Park (271 from "Citizens Vision", 106 other)
2	Kenai Peninsula
271	Port Chatham (all from "Citizens Vision")
1	Rocky Bay
	Kodiak Area
11	Afognak Island
2	Fox/Red Fox Bay
2	Karluk River
8	Kodiak Island
378	Kodiak National Wildlife Refuge (271 from "Citizens Vision", 106 other comments)
2	Long Lagoon
2	Pauls & Laura Lake Chain
277	Shuyak Island/Strait (271 from "Citizens Vision", 6 other)
2	Sitkalidak Island
1	Sturgeon River
	General
1	Tongass National Forest

[1] Orca Narrows/Orca Bay was the only area that people specifically stated that they were opposed to acquiring.

NOTE: Comments in support of the Citizen's Vision (Port Gravina/Orca Bay; Port Fidalgo; Knight Island Passage, Kenai Fjords National Park, Port Chatham and Shuyak Straits) are reported by individual area. We received 271 responses in support of the Citizen's Vision.

Questions About Spending

The question about spending asked, *What emphasis should be placed on Habitat Protection and Acquisition?* People were asked what percentage of the remaining civil settlement fund should be allocated to habitat protection acquisition. They answered by choosing one of the five alternatives that contained a percentage that fit their views, or by writing in a percentage of their own.

People's answers differed significantly by location: the average of spill-area responses differed from those of other Alaskan residents and from those outside Alaska. There was also some difference by region of the spill area. The largest average allocation to habitat protection from within the spill area were from people living in Old Harbor and Akhiok.

This question received more comment than any other. More than 1,000 people gave specific percentages that reflected their emphasis. This was much larger than the 650 responses typical of other brochure questions. Most of the additional responses were from outside of Alaska. Many others wrote in giving their support without specifying numbers.

Table 2. Average Allocation of the Remaining Civil Settlement Fund to Habitat Protection and Acquisition

	Origin of Response			
	Spill Area	Other Alaska	Outside Alaska	All[1] Responses
No. of Responses (%)	414 (40%)	164 (16%)	436 (42%)	1,028 (100%)
Average Allocation	60%	42%	81%	66%

[1] Total includes 14 responses from unknown origin.

Spill area. People from the spill area allocated an average of about 60% of the remaining settlement funds to habitat protection. Allocations varied from 0% to 92%. As many people picked between 40%-50% as picked 91% (Alternative #2).

An exception was the Kodiak Region. The average allocation for this region was approximately 80% -- the highest in the spill area. About three-fourths of the responses from Kodiak were from Old Harbor and Akhiok. Most of them picked Alternative #2 which allocates 91% of the remaining settlement to habitat protection.

The only areas where people allocated an average of less than 40% to habitat protection were the City of Kenai (15 people, averaging approximately 25%), and Valdez (17 people, approximately 35%). In addition, six of the seven brochures returned from Chignik

Lagoon and Perryville (the only villages on the Alaska Peninsula that returned brochures) said habitat protection should <u>not</u> be part of the restoration plan.

Alaska, outside the spill area. We received about 160 responses from places in Alaska outside the spill area. They allocated an average of about 40% of the remaining settlement funds to habitat protection. Allocations varied from 0% to 91%.

Outside Alaska. Responses from outside of Alaska were not widely dispersed. Most specified 80% or Alternative #2. A few specified less; a very few specified nothing.

Of the 436 responses received from outside Alaska, 154 individuals did not fill out the brochure but wrote letters requesting that 80% be allocated to habitat protection. Another 102 advocated Alternative #2. Many others wrote in favoring habitat protection without specifying a percentage. Considering those that answered the brochure, and the letters that specified a percentage, the average amount recommended for habitat protection was approximately 81%.

The overall average. The average amount that was allocated to habitat protection and acquisition, considering all responses that either answered the brochure question or wrote in specifying a percentage, was approximately 66%.

MONITORING AND RESEARCH

The brochure asked three questions about monitoring and research.

- In addition to Recovery and Restoration monitoring, should the Trustee Council also conduct other monitoring activities?
- If "Yes," what activities?
- What emphasis should be placed on research and monitoring?

These questions received significant discussion at the public meetings, in letters, and brochure comments. The greatest interest was in Ecological Monitoring. A commonly expressed view was that something was wrong with the ecosystem, but that exactly what was wrong was not understood. They also said that this concept was not captured by the Trustee Council's list of injured species. Ecological monitoring and research was often supported as a way to determine what was wrong, and to understand the natural variation of many species.

Some of the people who supported ecological monitoring also said that monitoring and research will be required for more than ten years. Some of these people also said they supported an endowment to fund the continuing research. The comments concerning endowments are summarized in the Endowment section of this report, pages 45-50.

Should the Trustee Council Conduct Additional Monitoring?

The full text of the newspaper brochure question concerning monitoring is below:

To effectively conduct restoration, it is necessary to monitor recovery and to monitor the effectiveness of individual restoration activities. It is also possible to conduct other monitoring activities: Ecological monitoring and restoration research. In addition to Recovery and Restoration monitoring, should the Trustee Council also conduct other monitoring activities? The brochure choices were:

☐ *No*
☐ *Yes*

There was strong support for additional monitoring activities; approximately 80% of all people responding favored additional monitoring. The extent of support was similar within the spill area, elsewhere in Alaska, and outside Alaska. Akhiok was the only community where people opposed additional monitoring and research (9 responses, 6 opposed). Mixed responses were received from the City of Kenai (17 responses). All other communities showed strong support.

If Yes, What Activities?

The newspaper brochure asked:

Please indicate which monitoring and research activities you believe are appropriate. The choices were:

☐ *Ecological Monitoring*
☐ *Restoration Research*
☐ *Other*

The newspaper brochure defined Ecological Monitoring as "monitor the general ecosystem health to identify problems and prepare for future spills." Restoration Research was defined as "basic and applied research to benefit injured resources and services." It used the term to mean research into new restoration techniques. However, the comments indicate that many people understood the term "research" to mean using science to figure out what's wrong. The comments people wrote on this topic were similar regardless of whether they supported ecological monitoring or restoration research.

Because of the confusion in terminology, the answers to this question are difficult to interpret. However, of those who answered "Yes" to the question concerning additional research and monitoring, ecological monitoring received the greatest support. This was true within the spill area, elsewhere in Alaska, and outside Alaska. Exceptions were Valdez where research was more strongly favored, and Seward where opiinions were mixed.

Some Native communities were also an exception to the trend. In Tatitlek, Chenega Bay, and Port Graham, the most popular choice was "Other."

Comments favoring ecological monitoring and restoration research. People who favored ecological monitoring and those who favored restoration research often gave similar reasons. Frequently cited reasons are summarized below.

Knowledge of ecosystems is important. Many of the people who commented said that basic ecosystem information is needed and indicated that long-term comprehensive monitoring may be a way of obtaining that information.

> "The ecosystem of PWS and the Gulf of Alaska are poorly understood. Ecological monitoring at the ecosystem level would be very valuable." (Cordova)

> "This would provide needed information to aid in direction of efforts to restore and maintain the resources at optimum levels." (Old Harbor)

Baseline research. People who commented expressed their support of scientific research to help understand the ecosystem and to gather baseline information to prepare for the next oil spill.

> "Baseline research about the marine and coastal environments will benefit the whole state for years to come. Focus on ecosystem relationships and also wildlife population censuses." (Anchorage)

> "What we all need is the research to devise the strategy for the inevitable next spill." (Juneau)

Fisheries research.

> "...(C)ontinued support for scientific monitoring and research is essential, particularly fisheries research. Continued monitoring and research is especially important to ensure proper understanding of ecosystem impacts. Monitoring and research should be focused narrowly on single species or populations but include degradation of habitats, chronic and sublethal effects, including changes in physiological or biochemical changes in productivity." (Anchorage)

Monitoring and research programs should be long-term. People who supported ecosystem monitoring sometimes stated that a monitoring and research program should not be limited to the 10-year settlement period. Many of these people also recommended establishing an endowment that would guarantee long-term funding for monitoring and research.

> "Only long-term research and monitoring studies will provide the kind of information needed to assess future spills. Most studies that only last a few years do not provide very useful information because of natural variability!" (Anchorage)

> "Because good, reliable monitoring takes years, (fish cycles are 4-6 yrs.) the benefits from an endowment will allow those type time frames which don't fit as well in the 8 years remaining of the current funds. There's a strong lack of good baseline data on most species and it's a guess to figure impacts without good baselines. An endowment will help establish those baselines." (Valdez)

Comments favoring "Other." In Tatitlek, Chenega Bay, and Port Graham, the most popular choice was "Other" and the vast majority of these people wrote "Archaeological Monitoring," or they wrote "Restoration research is an invitation to overspending in this area, particularly basic research." Many wrote both. The comment concerning archaeological monitoring was received 75 times, and the comment concerning overspending was received 69 times. While most of these comments were from Chenega Bay and Port Graham, they also came from Tatitlek, Alaskans from outside the spill area, and from outside Alaska.

Comments opposed to additional monitoring. Most comments opposed to additional research and monitoring focused on the cost and on "wasteful and endless studies."

"Please do not allow spill funds to be frittered away on bureaucracy. Studies sound like they make sense, when they usually just spend dollars." (Anchorage)

"Do not piss money away on scientists." (Anchorage)

"Too much monitoring in the affected areas might do more harm than good." (Seward)

Questions About Spending

The newspaper brochure also asked, *What emphasis should be placed on Research and Monitoring?* People could select one of the five brochure alternatives (which allocated from 0% to 10% of the remaining settlement fund to monitoring and research), or they could write in a percentage.

The range of responses was relatively narrow. Few people wrote 0%, and less than a fifth wrote a percentage greater than 10%. Table 3 shows that the average allocations are also within a narrow range: 9% - 12%. However, a few communities did depart from this range. The highest community averages were found in responses from the City of Kodiak (27 responses, 12%) and Seward (23 responses, 14%). The lowest was from Old Harbor (120 responses, 5%) and Akhiok (7 responses, 5%).

Table 3. Average Allocation of the Remaining Civil Settlement Fund to Monitoring and Research

	Origin of Response			
	Spill Area	Other Alaska	Outside Alaska	All[1] Responses
No. of Responses (%)	413 (62%)	162 (24%)	78 (12%)	665 (100%)
Average Allocation	9%	12%	9%	9%

[1] Total includes 12 responses from unknown origin.

The numbers in Table 3 *do not* include 103 responses, all but one from outside Alaska, that requested 80% for habitat acquisition and protection and "20% of the funds for fisheries studies and management programs." Because this 20% could arguably be intended for a variety of fishery-related activities, only one of which is research and monitoring, it is not included in the averages cited above. If the individuals had intended the 20% to be used for monitoring and research, the average percentage for all responses would rise from 9% to 11%.

GENERAL RESTORATION

General Restoration actions restore injured resources and services by directly manipulating resources and human uses. This can include management changes, manipulation of habitats, or construction projects. Examples include creating salmon spawning channels, removing predators from seabird colonies, building recreational facilities, and removing oil from mussel beds. General Restoration does not include habitat protection and acquisition, research or monitoring.

Questions About Spending

The newspaper brochure asked only one question about general restoration. It asked what emphasis should be placed upon it, and gave people the opportunity to select an alternative that fit their views or write percentage allocations of their own. Responses are summarized by region in Table 4.

Table 4. Average Allocation of the Remaining Civil Settlement Fund to General Restoration

	Origin of Response			
	Spill Area	**Other Alaska**	**Outside Alaska**	**All Responses**
No. of Responses (%)	410 (62%)	162 (26%)	76 (12%)	648 (100%)
Average Allocation	16%	19%	8%	16%

We received 648 responses that allocated funding for General Restoration. General Restoration contains a wide variety of activities, and comments gave a variety of allocations. The average emphasis was 16% of the remaining civil settlement funds.

Alternatives #1 and #2 allocated no money to general restoration, and fully 42% of all responses allocated no money to this category, usually by choosing alternative #2 or writing in 0%. About 60% of responses from the spill area allocated some funding to general restoration as compared to about three-quarters of people from elsewhere in Alaska, and about 40% of those from outside Alaska. Few comments from any location advocated more than 50% for this category.

The numbers in Table 4 *do not* include 58 responses, primarily from Chenega Bay and

Cordova but also from Anchorage and outside of Alaska, that stated: "With respect to the...(list of General Restoration options in the newspaper brochure) specific services and resources listed would best be restored under alternative five (5)." The newspaper brochure allocated 48% for General Restoration in Alternative 5. Because the people who wrote this comment did not necessarily support the presentation of Alternative 5 for other restoration categories (i.e., Habitat Protection or Monitoring and Research) these percentages are not included in Table 4. If the individuals intended that 48% be allocated to general restoration activities, the average percentage for all responses would rise from 16% to 19%.

Kodiak Island responses allocated the lowest average figure, advocating that approximately 7% of funds be spent on General Restoration. This is largely due to 120 responses from Old Harbor indicating a strong preference for a smaller percentage. Conversely, responses from other spill area communities allocated significantly more than the average. Allocations to general restoration from the communities of Kenai, Seward, and Nanwalek averaged approximately 30%, and Valdez and the City of Kodiak averaged approximately 20%.

Reasons for opposing General Restoration. Most of the comments that favored General Restoration focused on specific projects rather than the category as a whole. However, there were many comments that opposed all General Restoration activities. Two recurring reasons are summarized below.

> "We (Wilderness Society, Alaska Region) oppose virtually all enhancement and manipulation forms of restoration (i.e., "general restoration") because there is little evidence that they would be effective, and these kinds of restoration generally address only one single species....We also oppose funding for projects, such as roads, ports, "Sealife Centers," trails, cabins, visitor centers, mariculture, or other infrastructure development as these are regular agency programs or are inappropriate under the restoration goals of the civil or criminal settlement." (Anchorage)

> "In general, let Mother Nature handle re-populating the critters." (Seward)

General Restoration could cause damage. Other comments urged the Trustee Council to carefully consider whether General Restoration projects could cause additional environmental harm.

> "...(R)estoration activities may actually be detrimental to a second population if there is not adequate observation and research." (Fairbanks)

> "Trustees should not fund projects which harm a damaged resource or service. For example, a hatchery project which increases the numbers of a certain species but reduces genetic diversity by damaging wild stocks should not be funded. Projects which

increase human use at the expense of damaged resources must not be funded." (Anchorage)

Frequently Addressed General Restoration Topics

Over 350 comments suggested specific General Restoration actions. Removal of residual oil, archaeological resources and restoration of subsistence and fisheries received particularly strong support. We also received comments on recreation, facilities in individual communities, predator removal on seabird colonies, and projects for birds, fish, and marine mammals.

Clean oiled beaches and mussel beds. Many people were concerned about continued oiling and over 100 comments urged additional cleanup. Cleaning oiled beaches and mussel beds received strong support from many areas, particularly Chenega Bay, Port Graham, and Cordova. Most of the comments indicated that oiling continued to impact both subsistence and recreation.

> "While the Trustees are considering mussel bed decontamination, they should also plan to restore gravel beaches which periodically release oil in subsistence and recreation areas, by removing the contamination." (54 individuals from Chenega Bay, Tatitlek, Cordova, Fairbanks, Anchorage, Matanuska-Susitna Borough, and outside Alaska)

> "Oil ought to be removed because persistence continues a major threat to the environment....We (Pacific Rim Villages Coalition, Ltd.) have recommended immediate implementation of appropriate technology to remove oil, which we assert needs no further study as the cause of 'poor or slow development.'" (Anchorage)

> "Residual oil in the substrate appears to have a continuing effect on some recreation activities." (Anchorage)

However, a few comments stated that enough had been spent on cleaning beaches and additional cleanup should not be funded.

> "Spend no more on "cleanup" of the spill. Nature will take care of that from here on." (Anchorage)

Archaeology. Strong support for restoring archaeological resources came from Prince William Sound and Kodiak Island villages, Anchorage, Cordova, Valdez, and outside Alaska. Over 80 comments suggested funding site stewardship programs, monitoring, and museums. Eighteen comments from Valdez supported archaeological restoration in the context of funding an archaeological museum in Valdez.

"Increase emphasis on archaeological site stewardship and monitoring using local residents." (Repeated 55 times, from Tatitlek, Anchorage, Fairbanks, Matanuska-Susitna Borough, outside Alaska, Cordova, Chenega Bay)

"...(I)f we had a museum we could save that history for the young ones coming up. If subsistence never comes back they could at least know what it used to be. They could have information about the artifacts, the history, the subsistence, and all that." (Larsen Bay)

"In order to promote the work of both salvaging damaged artifacts and to better inform the world about the Sound and its recovery, what better way than to have this cultural/archaeological/visitor center in Valdez." (Valdez)

Subsistence. Over 70 comments from subsistence communities throughout the spill area, other parts of Alaska and areas outside Alaska urged that attention be paid to restoring subsistence. Comments emphasized funding food sharing programs, testing the safety of subsistence foods, and restoring scarce subsistence species such as harbor seals, waterfowl and clams. Many comments emphasized that the input and concerns of subsistence communities were being ignored. Several people mentioned that they still do not believe that it is safe to eat traditional foods because of possible oil contamination.

"I hope to see our subsistence foods restored and protected from future spills. I feel the villages always get left out and the cities get all the dollars that should go to villages whose lifestyle and food were affected." (Port Graham)

"Consider reestablishing the subsistence food sharing program." (Repeated 56 times, from Chenega Bay, Tatitlek, Anchorage, outside Alaska, Fairbanks, Cordova, Matanuska-Susitna Borough)

"The testing should be done right away because people are going out harvesting thinking things are okay. I don't think it is." (Nanwalek)

"It's been proposed several times that the Trustees provide funds for villagers to hunt elsewhere until the injured species recover. Those requests have gone unheard..." (Tatitlek)

Fisheries. Over 60 comments urging restoration of fisheries and commercial fish species came from Alaska and throughout the spill area, largely from Cordova and other Prince William Sound communities. Pink and sockeye salmon and herring were the species most frequently mentioned. Comments from Kodiak Island and the Alaska Peninsula focused largely on restoring sockeye. In addition, over 100 responses from outside Alaska expressed support for an alternative allocating 20% of remaining funds for "fisheries research and management programs". Most comments on fisheries urged funding management research, unspecified fisheries restoration projects, funding hatchery operations, or financing hatchery debt.

> "We don't feel that fisheries projects are getting a fair shake." (Cordova)

> "One of the things I'm interested in seeing is Kodiak Island being back into the top ten in the fishing industry by restoring the fish runs." (Akhiok)

> "I could see a potential use for some of these funds in our regional aquaculture association. It definitely goes back to the injury. We're trying to build up the fish runs." (Chignik Lagoon)

> "The oil has obviously damaged future fisheries resources of PWS, therefore making it difficult for PWSAC to fulfill its financial commitment. So I feel that part of this fund should be used to pay off PWSAC indebtedness." (Cordova)

Some comments, however, expressed concerned that continued or increased hatchery production could harm wild salmon stocks. Other comments emphasized the need for further research before general restoration projects for fisheries could be initiated.

> "I would steer clear of all options which involve hatcheries, spawning channels, 'creating' new salmon runs, shellfish hatcheries, and the like. These are seldom solutions, rather they bring with them additional problems." (Anchorage)

> "There are gaping holes in our knowledge about spill damage and natural fluctuation in the environment. Restoration activities are questionable. Why do restoration on a species that is naturally recovering if we can't even distinguish the natural cycles from the recovery? Why even monitor the recovery if we don't also try to understand the natural processes? Why do restoration when we can't understand what's driving the process?" (Cordova)

Facilities in individual communities. Many comments advocated particular construction projects within a specific community. These include 17 comments favoring the Seward Sea Life Center, 18 comments for the Valdez Visitor Center, 6 comments for the Tatitlek Harbor, and 4 comments in favor of the Kodiak Fisheries Industrial Technology Center. These projects were often a focus of the community's comments and generally received the majority, if not all, their support from the community in which the project would be developed.

> "...(T)he Sea Life Center will provide research and rehabilitation, but it will also provide education for the public. If we don't keep the public involved in our environment, then we won't build for the future." (Seward)

"This (Tatitlek) harbor project would be one of the most important things anyone could do for this community..." (Tatitlek)

"We want the Fisheries Technology Center ...so we can get a handle on being able to study these resources." (Kodiak)

A few comments opposed the Seward Sea Life Center as an example of inappropriate use of restoration funds. This was the only specific facility that received negative comments.

"The Trustee Council should be stricter in its acceptance of projects supposed to restore the Sound and/or the "resource." I am most familiar with the push for a Seward Sealife Center. Projects such as this which will end up more as a zoo and gift shop are not appropriate use of money supposedly to correct a major human blunder." (Seward)

Recreational and tourist facilities. The over 60 comments on funding restoration of recreation and commercial tourism were mixed. While the facilities mentioned above received strong local support, there was little support for construction projects in undeveloped areas. Some comments supported limited restoration for recreation and tourism, including increasing access to recreational areas.

"Purchase recreational access sites but build NO cabins; boat launches are OK." (Kodiak)

"General restoration funds could be appropriately used in urban/village communities to restore lost tourism and recreation opportunities." (Valdez)

"Spend the money to let more people enjoy the Sound. Build more boat harbors! Create new fish runs! Build more cabins! Use the Sound, don't lock it up!" (Valdez)

Several comments specifically criticized general restoration projects involving the construction of facilities for recreation or tourism.

"I do not understand what recreation facilities, outhouses, trails, and visitor centers have to do with restoration of an oil-injured area." (Cordova)

"I see a lot up there about commercial tourism and recreation. In my opinion the more people you have going into an area means they're going to damage the area. You have to limit the people and how they enjoy the area." (Old Harbor)

Seabird predator control. Eight of the nine comments received on seabird predator control were strongly in favor of eliminating seabird predators in the Aleutians and stated that it was the most effective means of aiding seabird populations in the Gulf of Alaska.

"The only thing we can do as a community of scientists to replace the bird species which have been lost is to exterminate the rats and foxes throughout the Aleutian Chain." (Juneau)

ADMINISTRATION AND PUBLIC INFORMATION

The only question that the newspaper brochure asked about administration and public information is the emphasis that should be placed upon it:

What percentage of the remaining funds should go towards administration and public information?

> The vast majority of responses allocated an average of 5% of remaining settlement funds to administration and public information. Allocations ranged from 3% to 8%. There was little significant difference by location.

Table 5 shows that the average allocation to Administration and Public Information was the same for responses from the spill area, from elsewhere in Alaska, and from outside Alaska: 5% of remaining settlement funds.

Table 5. Average Allocation of the Remaining Civil Settlement Fund to Administration and Public Information

	Origin of Response			
	Spill Area	**Other Alaska**	**Outside Alaska**	**All[1] Responses**
No. of Responses (%)	408 (63%)	159 (24%)	72 (11%)	651 (100%)
Average Allocation	5%	5%	5%	5%

[1] Total includes 12 responses from unknown origin.

Administration. Nearly all of the approximately one dozen people who wrote or spoke about this issue were concerned about the amount of money being spent on administration. Typical examples are below.

> "My #1 concern is that bureaucratic and administrative costs will eat up the fund. Do not let this happen." (Anchorage)

> "I hope a lot of money doesn't go to pay management staff." (Seldovia)

Public Information. Nearly twenty comments specifically expressed concern that information gathered from the restoration program be made available, that we use this information to educate everyone on all aspects of the spill environment and its restoration.

"One of the problems is that when the agencies say they're trying to involve the local people to help, they mean leasing a boat. When I say involve, I mean we want to know what the results are. They spend millions and millions of dollars on research and we don't see the results." (Ouzinkie)

"I think emphasis should be applied to general restoration; for example, by educating the people. We as a people would benefit, for we would all comprehend how our environment works and in return would be able to apply our knowledge to restore our damaged lands and resources." (Juneau)

SPILL PREVENTION AND PREPAREDNESS

Although no specific request was made for the public to comment on spill prevention and preparedness, the subject came up in at least 17 public meetings and was addressed in written comments by 30 people. Frequently occurring viewpoints are summarized below.

Spill prevention is more effective than restoration. Many of the comments expressed this sentiment. A few said that preventing future oil spills is like habitat acquisition -- it prevents further stress on the environment -- but that it is more effective.

> "...(N)atural recovery is possible and will take time, but it is happening and will continue to do so. Protection of habitat area, prevention of future spills, that is where our focus should be." (Seward)

> "If there is oil development, there's going to be more oil spills in the future. Start getting ready for the next one." (Old Harbor)

In favor of more local prevention and response capabilities. In the public meetings, many people in the communities said they felt unprepared for the next spill. Some said they expected one, and wanted to increase the ability of their community to respond.

> "We need a building just for the material, a cache of spill response equipment. If they can spend money on trees, they can spend money to be ready for the next spill." (Ouzinkie)

> "I asked what kind of boom material we had left, and we don't have any to protect streams." (Port Graham)

> "Establish a grant program for rural communities to participate in oil spill conference or attend 'oil spill' schools." (Chenega Bay)

Prevention is good, but don't use settlement funds. A half-dozen people said that spill prevention and preparedness was not the responsibility of the Trustee Council. Although they were not opposed to it, they advised the Trustee Council to use civil settlement funds for other tasks.

> "I think the oil companies should be forced now to pay for prevention stuff. To say that you're going to take your own settlement and use the money to pay for an advantage to the person that just hurt you is nuts." (Kodiak)

> "We strongly oppose any use of criminal or civil funds for spill contingency planning and response efforts or research, as we believe there are many other programs where such activities--albeit important-- are already mandated and these types of activities do not fall within the parameters of the settlement." (Anchorage)

ENDOWMENT

An endowment is a savings program to fund restoration after Exxon's payments end. The topic generated significant discussion at most public meetings. In addition to the answers people gave to the brochure questions, it was the subject of approximately 50 written comments.

The newspaper brochure asked three questions:
- Are you in favor of an endowment or savings account of some kind?
- If so, what should the annual earnings be spent on?
- If you favor the idea, how much should be placed into an endowment?

In addition, a related concept was brought up by about four dozen people in letters and at a few public meetings: permanent funding for university professors at the University of Alaska. Some people considered this a form of endowment; others did not. It is discussed at the end of this section.

Are You in Favor of an Endowment or Savings Account of Some Kind?

The newspaper brochure asked:

Are You in Favor of an Endowment or Savings Account of Some Kind? The choices were:

☐ *No*
☐ *Yes*

Approximately two-thirds of responses favored establishing an endowment or savings account of some kind. This proportion was true of people responding from the spill area, from elsewhere in Alaska, and from outside Alaska. With the exception of four Native communities, the proportion did not vary much by location.

Two-thirds or more of those who commented from Chenega Bay, Port Graham, Akhiok, and Ouzinkie opposed endowments. In addition, responses from Seward were evenly split. Those were the exceptions. The average response from all other communities and regions favored endowments.

Six hundred and ninety-nine individuals responded to the brochure question concerning endowment. These were 60% from the spill area, 20% from elsewhere in Alaska, and 10% from outside the state.

Comments supporting an endowment. These comments showed recurring sentiments expressed at public meetings, in brochure comments, or through letters.

Monitoring and Research will take longer than ten years.

"Because good, reliable monitoring takes years (fish cycles are 4-6 years), the benefits from an endowment will allow those type time frames which don't fit as well in the 8 years remaining of the current funds. There's a strong lack of good baseline data on most species and it's a guess to figure impacts without good baselines." (Valdez)

"There should be money for monitoring activities beyond 2001." (Cordova)

Recovery will take longer than ten years.

"Do we really know how long restoration will take? The endowment ensures we can continue efforts beyond 10 years, a very short period of time in biological terms." (Outside Alaska)

"I think an endowment is a good idea, and 20% sounds all right. You have got to plan for the future, a lot of these things will become apparent later, and at this point the scientists are undoubtedly scientifically guessing." (Port Lions)

Comments opposing an endowment. Frequently expressed comments are:

Habitat protection (or other needs) now! Many people said that they thought the money should be used now to address pressing problems. While the most common recommendation for immediate spending was habitat protection, other needs were also cited.

"Habitat acquisition is extremely important and should not wait for money in the bank." (Anchorage)

"We oppose endowments due to the need for maximum leeway in negotiations for habitat that must occur as soon as possible." (Anchorage)

"The settlement was done so quickly so the money could be made available immediately." (Cordova)

Administration and agencies will eat it up if we save it.

"Without fail, the majority would be eaten up by administration and lawyer yearly taps." (Seward)

"If you're talking about a return from an endowment, it could take a long time and in the meantime only support administration. Endowments aren't all like the permanent fund." (Homer)

What Should the Annual Earnings from an Endowment or Savings Account be Spent On?

The full text of the brochure question asked only those who favored an endowment or savings account to:

Please indicate what the annual endowment earnings should be spent on (you may mark more than one answer). The answers were:

- ☐ *Monitoring and Research*
- ☐ *General Restoration*
- ☐ *Habitat Protection and Acquisition*
- ☐ *No Preference*

It is possible to spend the earnings for more than one purpose, and half the people marked more than one answer. Approximately two-thirds of all people who favored an endowment thought the earnings should be used for monitoring and research. About half thought it should be spent on general restoration, and about half thought it should be spent on habitat protection. There were some differences throughout the spill area, but in most locations in Alaska, monitoring and research was the first priority. The exceptions were Port Graham and Old Harbor where people favored all three uses approximately equally. The first priority for responses from outside Alaska was habitat protection (85% favor), with each of the other two purposes receiving 50%.

Possible endowment purposes. People wrote in comments below this question on the brochure and in letters. In addition, endowments were a common public meeting topic. Below is a list of purposes suggested by the comments. We have included those purposes that received more than one comment.

<u>Monitoring and Research</u>. This purpose received the most comments at the meetings, and in written comments.

> "I believe at least some of the (endowment funds) must be spent on monitoring and research. Some could be spent on restoration and habitat acquisition on a case-by-case basis." (Anchorage)

> "The only reason a long-term mechanism is needed to provide long-term money is long-term monitoring of the environment." (Cordova)

A related topic: Arliss Sturgulewski Endowment. Approximately one-half dozen comments specifically referred to an endowment proposed by Arliss Sturgulewski. The organizations endorsing this proposal include the University of Alaska Fairbanks School of Fisheries and Ocean Sciences, North Gulf Oceanic Society, the Area K Seiners Association, and the Arctic Research Commission.

> "...I urge you to establish the Marine Research Endowment crafted by Ken Adams, Ron Dearborn, Bill Hall, Theo Matthews, Jerome Komisar, and Arliss Sturgulewski...An endowment of this magnitude could successfully fund the kind of long-term research needed to understand how the coastal ocean community...functions normally..."(UAF, School of Fisheries and Ocean Sciences.)

Marine resources or fisheries problems. Over a dozen comments recommended this use.

> "Endowment should be directed to marine resources." (Cordova, 10 responses)

> "Fisheries" (Cordova)

Research facility. A few comments recommended this use.

> "Ongoing funding of marine studies center in the spill impact zone." (Anchorage)

> "A research facility in the state is needed and these funds are an opportunity to build such a facility for Alaska's future and to assure the proliferation of the sealife affected by the spill." (Seward)

Baseline studies. A frequent theme was the need for baseline information for use in responding to future disturbances.

> "There will probably be another shipwreck. There needs to be baseline data to compare from damaged areas." (Seward)

Stewardship -- of the land, of built facilities. A few comments recommended this use.

> "(Endowment earnings for) Funding for maintenance of acquired lands and built facilities." (Anchorage)

> "Maintenance and operation of new and existing marine facilities, stewardship of the affected areas, prevention of future spills." (Anchorage)

> "A small endowment for beach cleanup of garbage." (Matanuska-Susitna Borough)

What is the money used for?

"Where are the funds invested now? Is the interest/revenues accruing to the benefit of restoration? If it is not, the monies must be invested prior to spending in a conservative, but productive manner." (36 people from Tatitlek, Chenega Bay, Anchorage, Cordova, and the outside Alaska)

Questions About Spending: How Much Should be Placed into an Endowment?

The newspaper brochure asked the following question of those who favored an endowment or savings account:

Please indicate the amount that you believe should be placed into an endowment?

The brochure gave readers a choice of answers:

- ☐ *Less than 20%*
- ☐ *20%*
- ☐ *40%*
- ☐ *More than 40%*
- ☐ *Other Amount. If you know the amount, please indicate ______%.*

Answers to this question ranged from nothing to all of the remaining settlement. However, the median amount varied little by location. Also, the answers represent only the two-thirds who favored an endowment -- 465 people. Almost all responses came from returned brochure questionnaires. Very few of the letters addressed this question.

The table shows that the median of responses from the spill area, and from outside Alaska favored allocating 20% of the remaining settlement funds to an endowment or savings account of some type. The median of responses from Alaska outside the spill area favored using 40% of the funds.

Table 6. Average Allocation of the Remaining Civil Settlement Fund to An Endowment or Savings Account

	Origin of the Response			
	Spill Area	Other Alaska	Outside Alaska	All[1] Responses
No. of Responses (%)	258 (55%)	153 (33%)	48 (10%)	465 (100%)
Median allocation of remaining settlement funds to an endowment	20%	40%	20%	20%

[1] All area total includes six responses of unknown origin. The percentage is that of the median response rather than the arithmetic average because people answered the question in categories such as less than 20%, 20%, 40%, greater than 40%, etc. These large categories make an arithmetic average inaccurate.

University Professors; Endowed Chairs

Approximately four dozen people, mostly from Fairbanks or Juneau, recommended that part of the civil settlement be used to provide permanent funding for professors at the University of Alaska. Sometimes the people said that an endowment should provide permanent funding; other times they requested a sum be given to the University. They also advocated a research endowment. Ten people proposed an amount; they requested an average allocation of $30 million dollars. Others made their request in numbers of professors which ranged from one to 20. Some linked the proposed professorships with biological research in the spill area, others did not.

> "Long-term monitoring and research requires a long-lasting, nonpolitical organizational base. Use of endowment income should be to fund professional chairs within the University of Alaska with 50% for PWS research." (Fairbanks)

> "I strongly urge the Trustee Council to give serious consideration to the long term benefits of endowing research and teaching chairs related to ecology, conservation and biology at the UA campuses throughout Alaska. Every dollar that is used in that will provide a return investment that is beyond measure for many years to come." (Juneau)

INJURIES

The overwhelming majority of comments on injuries caused by the *Exxon Valdez* Oil Spill came from people within the oil spill communities, especially from those who attended the public meetings. Fewer than 10% of the comments came from people outside of Alaska. The comments show how passionately people feel about the oil spill and how the injuries are still apparent to people throughout the affected area.

Comments on resource injuries spanned a wide variety of topics but there were three areas that recurred: 1) comments about resources that are currently recognized by the Trustee Council as having been injured by the oil spill; 2) recommendations that the injured resources list should be expanded to include other resources -- resources that were not studied (or not thoroughly studied) during litigation; and 3) concern for restoring the injured ecosystems, especially the marine ecosystems. Except for the ecosystem comments, most comments were about resources with subsistence or commercial value.

For services, the primary theme of the comments was that services (human uses) have not received enough attention in the restoration program. The majority of the comments were about those services which are closely linked to an injured resource for social, economic or subsistence uses. Many people said that the restoration of those resources is extremely important and that those resources should receive the greatest emphasis. There were also many people who wanted to see the restoration program expanded to include social injuries suffered by residents within the oil spill area.

INJURED RESOURCES

Resources Listed as Injured in the Summary of Alternatives

Fish. Of all the injured resources identified by the Trustee Council, Pacific herring and pink salmon were the most often addressed in the public comments. In general, people commented that these resources were showing more signs of injury than were acknowledged in the brochure, and they expressed their anger that the Trustee Council had not adequately addressed the problems. Similarly, there was a great deal of concern from the Alaska Peninsula, and southern Kodiak Island communities about the consequences of the 1989 overescapements of sockeye salmon runs in these areas. In fact, most of the Chignik Lake and Chignik Lagoon meetings discussed injuries to the red salmon run that were not acknowledged in the newspaper brochure.

> "Very little attention has been given to Pacific herring, a resource that is of utmost importance to the survival of all the other resources that prey on herring for

sustenance. More in-depth studies of this resource must be undertaken. I think the impact of oil on herring is much greater than what has been realized by the council and that the impact on herring has had a detrimental effect on the recovery of all other resources." (Tatitlek)

"It seems irresponsible to me. The Pacific herring are the bottom of the food chain. A lot of the birds and other species in the sound rely on herring for food. We were funded for three years, and everyone knew that 1993 would be the important year." (Cordova)

"You only have sockeye salmon on the population decline list. I've fished here all my life, and since 1989 my catch on pinks has gone down 80 to 90%. And you're saying there's no population decline?" (Larsen Bay)

"The thing I was most concerned about was when we were fishing that year, I kept seeing yellow fish. I've never seen red salmon that were completely yellow. I've never seen fish that way before. I was catching one or two of those a week...If those fish are diseased because of that oil, we'll be seeing all kinds of damages." (Chignik Lagoon; similar comments on discolored or spotted fish were made from Akhiok and Chignik Lake)

Subtidal and intertidal. Comments on injuries to subtidal and intertidal areas and organisms formed the second largest group of responses. People who wrote or spoke about these areas were concerned that the importance of these areas as the foundation of the marine food chains were not adequately recognized. They also talked about continuing signs of injury in clams and mussels and wanted a greater emphasis placed on these resources in the restoration program to protect humans as well as other resources that feed on shellfish.

"Studies of impact of oil on ocean bottom environment and resources is greatly under emphasized -- it makes no sense at all not to study the ocean bottom. The effects that it may have on people that use the resources from it could be harmful, and we'd like to know if this is a potential problem." (Tatitlek)

"This was the time of year when entire families would walk the beach digging clams, and it was a yearly, seasonal thing. Since the spill, those clam beds were contaminated. These beds have not been tested, and so we have not used them. Every time they have gone to gather seaweed, they have come up with oil." (Port Graham)

"How come you don't have anything in the brochure about shellfish, like clams? That's a pretty wide field to lump it into intertidal. That includes a lot of other organisms, too. We know the clams have declined on beaches here." (Larsen Bay)

Mammals and birds. Approximately 10% of all comments on injuries were on the mammals and birds listed in the Summary of Alternatives as injured. The majority of these comments focused on harbor seals and murres, but concern was expressed for marbled murrelets and harlequin ducks. Some people within the oil spill area disagreed with the statement in the Summary of Alternatives that said the harbor seal population may be stabilizing in the affected area. Others were concerned that the recent die-off of murres was also related to the oil spill.

> "Seals are definitely in decline, you used to see them in the narrows all the time and you just don't see them any more." (Old Harbor)

> "I don't think it's right you should say that the murres that are dying now are not dying because of the spill. These birds feed on the little fish, if you kill that feed off it could affect the birds, all the little things that grow up in the ocean..." (Chignik Lagoon)

Archaeological resources. There were over 70 comments received from throughout the affected area as well as outside of Alaska that discussed injuries and restoration of archaeological resources. While a few were opposed to using settlement funds for archaeological resources, the vast majority emphasized the importance of these resources and wanted to be certain that they were considered in the restoration process.

> "During the oil spill, our old village site was vandalized by some oil spill workers. That hit very near and dear to a lot of people here. There must be some mechanism to restore, monitor and protect the old village site." (Chenega Bay)

> "The people that are out on the beaches have uncovered artifacts. Some artifacts have been stolen. What about setting up mini museums in the villages and hiring some archaeologists to go out and do those digs and bring that stuff back?" (Larsen Bay)

Additional Resources That Should Be Restored

There was concern about many species that were not thoroughly studied during litigation. Table 7 includes a list of resources that were commented upon that are not currently included in the Trustee Council's list of injured resources. These resources were all mentioned as having changed since the oil spill and should be included in the restoration program.

Table 7. Additional Resources (Not Listed in the Summary of Alternatives) Mentioned as Injured by the Oil Spill

MAMMALS	BIRDS	FISH and SHELLFISH
bear	eider duck	tom cod
mountain goat	other ducks	silver salmon
deer	swan	northern smooth tongue
mink	brant	dog salmon
Dall porpoise	Canada geese	king salmon
sea lion	loon	bottomfish
	cormorant	candle fish
SUBTIDAL/INTERTIDAL	grebe	king crab
seaweed	Bonaparte's gull	tanner crab
snail	Arctic tern	Dungeness crab
barnacle	black-legged kittiwake	shrimp
sea urchin	tufted puffin	

Of the resources in Table 7, Steller (northern) sea lion, ducks (many species, but especially eiders), deer, shrimp and dungeness crabs were the most commonly identified. Below are examples of comments about the resources people identified as being injured.

> "I have been watching the sea lions. Their haulout wasn't hit; they were hit when they were having pups. The oil was six inches thick when it came through the passages. There are 200 animals where there should be 700. There is a significant change since 1989." (Chenega Bay)

> "About two years ago there were dead deer all along this whole area. These last two winter we have had cold snaps but not too much. In this one little island one guy counted 80 dead deer. There were dead deer everywhere, I never saw so many dead deer. It was about two years ago." (Akhiok)

> "Some of the message you should get across is that some of the population decline we see isn't showing up on the brochure. There's a lot of species that aren't on there. Like the sea ducks. Last winter certain ducks didn't come back, Steller's eider and king eider for example. There are plenty of harlequin ducks in certain places but some of the other ducks are missing." (Old Harbor)

> "I noticed that you don't have spot shrimp on your list. Aside from one small opener, fishing for spot shrimp has been closed since the spill. A lot of fishermen think the decline in spot shrimp is from the spill." (Valdez)

"I also would like to see research on crab impacts. When he said that crab were not mentioned it reminded me of when the spill hit Shelikof side of Shuyak in the area of Nikita Bay...Afterwards there were a thousand, maybe more, dollar sized Dungeness crabs dead on the beach in that area. I don't know for sure if they were related to the spill at the time but it was in the summer of 1989." (Kodiak)

Injured Ecosystems

An important topic of conversation at many of the public meetings was injuries to the ecosystem and our limited understanding of how ecosystems function. In each of the regions, many of these comments stressed the need for an ecosystem approach to restoration. Most of the comments also focused on marine ecosystems rather than upland ecosystems. The comments pointed out that without an understanding of how the ecosystems function, we cannot restore an injured resource.

"If we don't really know what the injuries were, we can't really say much with certainty. So we really need to be looking at the overview of the whole ecosystem, not just targeting maybe a commercially important species." (Kodiak)

"The species are interlinked to the food chain, and we can't say it doesn't have any relationship to the species above and below it in the food chain. By addressing all the injured species, you leave the possibility that new data may arise." (Seldovia)

"...There is strong evidence that whole ecosystems were damaged. For example, they found deformities in the northern smooth tongue and that is the single largest feeder fish...How do we get the focus back on the ecosystem and off the politics?" (Cordova)

INJURED SERVICES

For services, the primary theme of the comments was that services (human uses) have not received enough attention in the restoration program. Many of the comments in the previous section on injured resources relate to the services discussed in this section. The restoration of those resources is extremely important and people said that those resources should receive the greatest emphasis. Some people wanted to see the restoration program expanded to include social injuries suffered by residents in the spill area.

General comments. People often said that services, including human uses, have not received enough attention. Many concerns expressed about injured resources (that have economic, subsistence or social uses) were directly related to services.

Services do not get enough attention.

"The services or human uses I don't think get enough attention..." (Larsen Bay)

Some services can be addressed by dealing with injured resources.

"I don't think the human impacts are getting enough priority. For us, the human impact can be best addressed by dealing with the commercial fish species, it is one of the only things we can do to help the human impact." (Cordova)

Subsistence. People mentioned subsistence more frequently than they mentioned any other service. Most who commented, especially those from Native communities, said it was underemphasized in the restoration program. Other common comments were that people were still afraid to eat some foods, and some resources were still unavailable or contaminated.

Subsistence is underemphasized.

"Subsistence service restoration is vastly under emphasized." This same comment was made 58 times. (Fairbanks, Mat-Su Borough, Anchorage, Lower 48, Cordova, Chenega Bay, Tatitlek)

"I can remember when the head guy from Exxon was sitting in this room with the head guy from the state. The state guy said eat them, they're clean. I told them I'll make you a deal. You eat our foods for 30 days and then we'll have YOU analyzed." (Ouzinkie)

It is not safe to eat subsistence foods. In addition to saying foods are not safe, many people described the psychological damage and said that by the time the foods recover, their children will no longer be used to eating them. Frequently clams were mentioned as an example.

"You have a bowl of clams and when you look at them, all you can think about is a bowl of oily goop. How is the younger generation going to learn about the oil spill. How do I know, does it turn that color every year? (Larsen Bay)

"I would hope that when my three children are grown, there would be food for them to subsist on." (Port Graham)

Subsistence foods are still unavailable.

"Subsistence has come back a little bit but it's not like it used to be. I'm surprised they don't talk about it here, in the brochure." (Larsen Bay)

"Port Graham residents continue to have serious concerns about many local species and therefore ask you to fund subsistence studies and restoration projects...There has been a serious decline in the populations of all of these species and we must travel quite far to find equivalent resources." (Port Graham)

Commercial fishing. Fishermen were extremely concerned about the injuries to fish. Fishing is a way of life. People said this lifestyle has been disrupted.

"The commercial fisheries were the single most damaged user group. Too much emphasis is being placed on 'lock-up and view' rather than 'restore!'" (Cordova)

"Probably one of the most important things you could spend money on is something directly related to improve the commercial fishing and provide recreation opportunities for the village...And help out commercial fishing in each community." (Old Harbor)

Passive use. Comments pointed out that there was a significant monetary value associated with this injury and that it is related to aesthetics, cultural and spiritual resources, and wildlife. Although only a handful of comments specifically discussed passive uses, many of the hundreds of letters that addressed habitat protection and acquisition expressed this concern.

"I would like to see the emphasis off tourism potential and placed on the value of the land, sea and wildlife simply because they exist and are part of the planet." (Homer)

"...theTrustees would be wise to recognize that the overwhelming loss was loss of passive use of wildlife generally." (Anchorage)

Social injuries. A handful of people spoke to the various social damage to people in the spill area and to communities. Smaller communities seemed to be more affected by this problem than larger cities like Anchorage.

"The governmental process in our community broke down because of the spill. The whole leadership of our community fell apart. How do we get to restoring that?" (Ouzinkie)

PROCESS

Although no specific request was made for the public to comment on the restoration process, people offered many comments on the subject. Their comments discussed the civil and criminal settlements and the work of the Trustee Council, the restoration process, local influence on the process, projects for the annual work plans, and the restoration plan. (The comments about these restoration issues came from 22 public meetings and from written response to the newspaper brochure.)

Civil and criminal settlements. Most of the comments on these issues came from public meetings. People said they have no influence in how the criminal settlement money is spent and want to be sure they can influence how the civil money is spent.

> "...These two processes [civil settlement and criminal settlement] should be concurrent with a synchronization of ideas. The end result would be a cohesive restoration of injured recreation resources. Cooperation and information sharing would be beneficial to both parties." (Anchorage)

> "Some of the damage sustained as the result of the spill is irrevocable and Exxon should not be allowed to escape their responsibility to continue payment beyond the extremely minor payment of $900,000,000. The actual damage will run into many billions of dollars that we and future taxpayers will be burdened with, for many decades ahead. Both the State of Alaska and the Federal Government have been overgenerous in giving away our property and our rights to a proper settlement for present and ongoing damages that will extend into the distant future." (Outside Alaska)

> "We had absolutely no say on the spending of the criminal fine. Look where the money from the criminal fine went. This money [civil] is going to go the same way." (Cordova)

Trustee Council. Most comments about the Trustee Council, their appointment and operating procedures were received at meetings.

<u>Some people cite the difficult task of the Trustee Council and applaud their hard work.</u>

> "I would like to thank the Trustee Council for their efforts to involve the public in this process." (Cordova)

> "As we have all seen, the process of defining damage (beyond the obvious losses of birds, mammals, and some fishes) was difficult enough. Attempting to decide how to restore and enhance injured resources appears to be a problem of similar or even greater magnitude. While I may not agree completely about how restoration funding has been allocated in the past, I nevertheless compliment the Council for attempting to

do something." (Fairbanks)

Many said that they can't reach the Trustees with their concerns.

"We better get to know the Trustees pretty good if they are making the decisions." (Homer)

"How much does the Trustee Council listen to us on these things? It seems like they still have a lot of questions but they want answers that we have already given. Should we beg them, is that what will work? What should we do to make sure they hear us? These Trustee Council members, they have other jobs, too. Where do they find time to pay attention to the important things in this process that they should? (Tatitlek)

"I have heard you say the Trustees are going to want public input. We've already had public input on behalf of fisheries. We've stressed this coding wire tagging business several times. The point still stands that the Trustees receive public input but never do anything with it." (Cordova)

Local Influence on the Restoration Process. Nearly all of the comments on local, or even regional, influence on the restoration process came from the public meetings. There were 78 comments overall. Notes from the meetings showed that almost all of the communities, and particularly the smaller villages, within the spill area commented on their inability to influence the process. Communities expressed concern about not being heard. The smaller villages were especially concerned that their needs will not be addressed, because there are too few people to influence the process. There were also opposing views between regions on how the funds have been allocated so far. Prince William Sound residents said they were being ignored, and Kodiak Island residents said that without the same damage assessment studies that were conducted in Prince William Sound they would not be able to prove injuries in their area. The comments from the public meetings also contained a couple of suggestions - have an occasional Trustee Council meeting in Cordova and Kodiak where they are more accessible to people directly affected by the oil spill; and emphasize local hire especially for monitoring studies.

Influencing the process should be greatest from the spill area communities - regardless of their population size.

"We appreciate you people coming down here, but we know that with the amount of folks we have here, we're not going to get any help out of this money at all. I see it time and time again." (Chignik Lagoon)

"Is there any way to make the Trustees aware we don't have the resources of the environmental groups or whatever, but we do have strong concerns about these issues and we need to be heard too." (Tatitlek)

People said that their community has not received the attention that it deserves.

"...Kodiakis Kodiak and Larsen Bay is Larsen Bay and they are two different places. When these plans are made up, they should reflect that. This village was affected differently from Karluk. And if you include us in the borough we won't see any benefit from this money." (Larsen Bay)

"Like you said, they spent $100 million in research in Prince William Sound. How many miles of beaches were damaged in Prince William Sound, and how many miles were damaged on Kodiak? It seems to me the most of the damage was done here. Here the oil busted into little pieces and everything ate it. I don't think there was any species of bird or animal that didn't eat it. Some of them got away, but every beach on Kodiak Island has been damaged and the ocean bottom was damaged, and yet you say they didn't do any research here?" (Old Harbor)

"...PrinceWilliam Sound is not significantly represented in the work projects...Here in Prince William Sound it was the hottest and most toxic, but they didn't get that kind of contamination in the other regions. We're not getting the right amount of attention." (Cordova)

Some suggestions to the Trustee Council on how to empower the oil spill communities to influence the restoration process.

"It would also be important to use local people and knowledge (to do the work) because you won't get a good picture unless you consult with us." (Chenega Bay with similar comments from Nanwalek, Ouzinkie, Cordova, Seward, and Kodiak)

"You must include the local villages and towns and empower them to understand the research and involve them in the activities. They will feel cheated if you don't. I hope they will be involved throughout the ten years and beyond." (Anchorage)

"Can we invite the Trustees to come to the villages? They really should have a meeting either in Valdez or Cordova or somewhere where the ordinary people could attend" (Tatitlek)

Restoration Process. Many comments addressed the restoration process in general. People were concerned that they are not being heard, but a minority also said the design for public participation is okay. They cited the formation of the Public Advisory Group as an example of positive direction.

"Were we to be in Chenega we'd be hearing the same thing, in Kodiak we'd hear how badly they were hit. I'm concerned as we go through this process that we don't pit each other against ourselves. We need to have a healing process going on to make sure this process works successfully for all of us...Ifwe are going to be repairing damage we have to look at what is damaged by doing research and then restoration work. ...The Trustees need to put the money into programs where it will help all of the areas affected by the spill." (Valdez)

"Please LISTEN, LISTEN, LISTEN damn it." (Cordova)

"Despite this excellent publication, your commendable efforts toward gathering public comment and the theoretical democratic process of the Trustee Council, I fear that politics, bad science, undisclosed pressures will guide the Council's decisions. I fear that public comments won't be considered seriously or given substantial weight." (Seward)

Restoration Plan. General concerns focused on usefulness and flexibility of the restoration plan. People were concerned about what will be in the plan and want their concerns reflected. Several of the seven comments on this issue state the plan needs to provide process, guidelines and policies to which all restoration activities comply.

"My suggestion is to be sure to make the plan very simple, clear, and black and white." (Cordova)

"I am not inclined to sticking with rigid allocation formats...The division between habitat protection and acquisition and restoration I would not like to see prescribed rigidly." (Juneau)

"We also believe that a process based upon the long-term Restoration Plan needs to be established to allocate such funds on an annual basis." (Anchorage)

Work Plan. Twenty-five people from Alaska commented on the annual work plan process. People were generally unsure of the process used to fund proposals. They were also unsure of what was in the 1992, 1993, and 1994 annual work plans. The source of funding for the annual plans was an underlying concern about the annual process.

"Regarding the 1994 Work Plan, I feel awkward voting on something based on just a title. Having looked at the 1993 Work Plan, some titles sounded crazy but when you reviewed it, you got a better understanding." (Seldovia)

"Do all the projects have to go through an agency? If a committee approached the Trustee Council with a proposal, could the funds be directed through our SOS, city government or chamber of commerce?" (Seldovia)

"When the Trustee Council gives a yea or nay on the 1994 projects, will we have an opportunity to give input?" (Whittier)

"Should not squander funds on state/federal agency projects that will be funded from other sources anyway." (Juneau)

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Chapter I: Purpose and Need for Action

Introduction

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 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 I-1 shows the extent of surface oiling as recorded by satellite observation at the time of the spill.

The weather for the first 3 days following the spill was calm and did not move the oil 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 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. Seventy-two studies were 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.

Litigation and Settlement

After the spill, both President George Bush and Alaska Governor Steve Cowper declared their intent to restore both the affected ecosystem and 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 were also filed. The Federal Government brought

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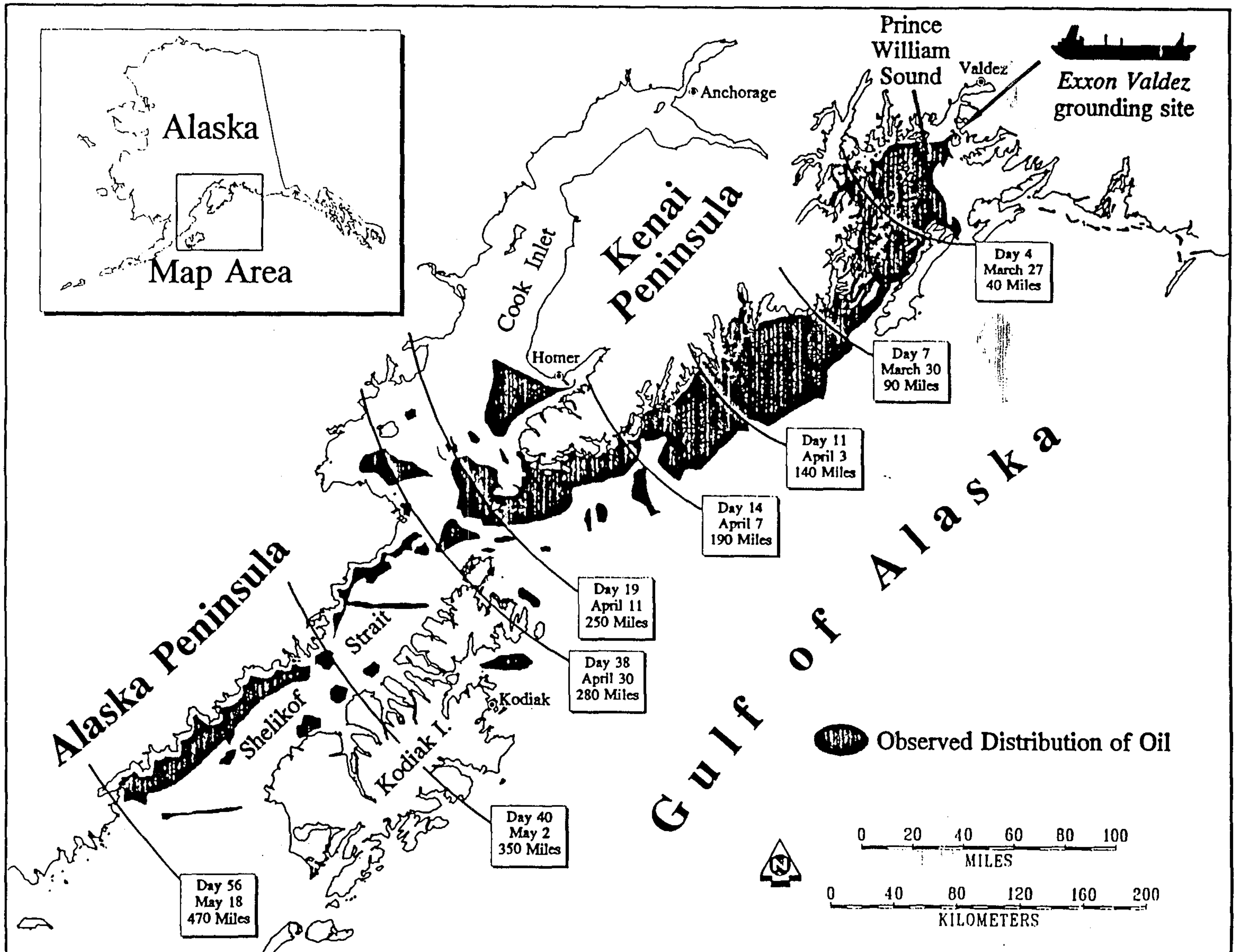

Figure I-1. Extent of surface oiling

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criminal charges under the Clean Water Act (33 U.S.C. 1251 *et seq.*), the Migratory Bird Treaty Act (16 U.S.C. § 703 *et seq.*). Private citizens also made claims for damages against Exxon, many of which are still pending.

Terms for a settlement between the Exxon companies and the United States and the State of Alaska were approved 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 Federal Court Registry Investment System. As funding needs for restoration projects are identified, the Trustees apply 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 this agreement, 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 Memorandum of Agreement (MOA) also provides for the reimbursement of certain spill-related expenses such as litigation costs, cleanup, and damage assessment.

To date, the Trustees have authorized approximately $200.2 million in expenditures from the restoration fund. The Trustees released $107.5 million to reimburse the Federal and State governments for the cost of past damage assessment, cleanup, litigation, response, and restoration expenses. A total of $39.9 million was credited to Exxon for cleanup costs incurred after January 1, 1991. A total of approximately $19.5 million was spent on developing and implementing the 1992 Annual Work Plan. The 1993 Annual Work Plan was allocated $33.3 million, including $7.5 million for the purchase of inholdings within the Kachemak Bay State Park. In May 1993, the Trustees entered negotiations to buy property at Seal Bay for approximately $38 million. Final negotiations were pending at the time of writing. It is estimated that an additional $70–$90 million will be required to reimburse the Federal and State governments for past expenditures on cleanup and litigation.

The MOA provides that the Trustees are responsible for making all decisions regarding funding, injury assessment, and restoration. Six organizations have been designated to serve as Trustees, three representing the State of Alaska and three representing 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 (DOI), 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 Special Assistant to the Secretary of the Interior represents DOI, and the Regional Director of the National Marine Fisheries Service represents NOAA. The planning, evaluation, and conduct of restoration activities must be made by the unanimous agreement of the Trustees.

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 regulations. 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, had already 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 are therefore 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. These funds are not controlled by the Trustees, but 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.

Proposed Action

The proposed action is to restore the injured natural resources and services through implemention of Restoration Plan. The Draft Restoration Plan issued in conjunction with this Draft Environmental Impact Statement (DEIS) presents five general approaches to restoration. The final restoration approach will be decided by the Trustees, and the effects analysis in the DEIS will be considered in their decision. The Final Restoration Plan will provide broad, long-term guidance for implementation of restoration activities to restore injured resources and services in the Exxon Valdez oil spill area shown in figure I-2. The EVOS area includes the area enclosed by the maximum extent of oiled shorelines, severely affected communities and their immediate human-use areas, and adjacent uplands to the watershed divide.

A Draft Restoration Plan has been prepared for public review and comment. As indicated above, it presents five alternative approaches to restoring the injured resources and human uses those resources support. Each of the alternatives addresses policies for selection of possible restoration activities. Each of the alternatives is made up of varying proportions of the four restoration categories of administration, monitoring, habitat protection, and general restoration. Within the category of general restoration there are 25 options. The term "option" refers to a general category of actions designed to achieve a particular objective.

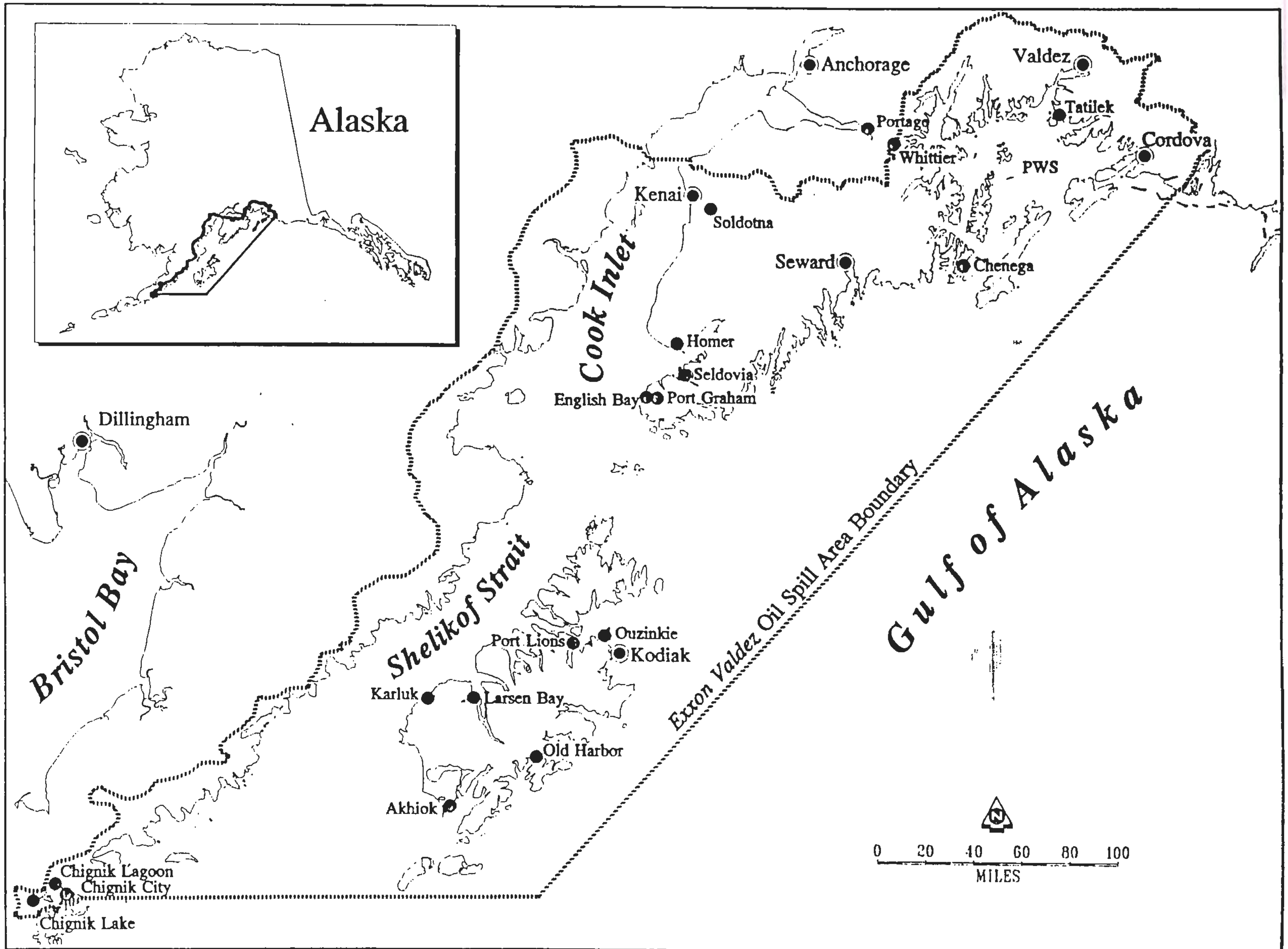

Figure I-2 Location Map.

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Actions is the term used to refer to site-specific projects to be implemented to achieve the option goals. The analysis contained in this DEIS pertains to the alternatives and the options, but does not consider individual actions. Appropriate site-specific environmental documents will be written by the appropriate agencies for all future actions that require additional analysis.

Purpose and Need for Action

The Trustee Council began work on 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 the Trustee Council decided to continue development of a restoration plan to allow for meaningful public participation. Following public review and comment on the Draft Restoration Plan, the Trustees will select a preferred alternative for implementation. This alternative will be the focus of the Final Restoration Plan. The Final Restoration Plan will assist the decisionmaking process by establishing management direction for the identification and selection of activities for restoring injured resources and services. Program-level guidelines will assist in the evaluation and implementation of future proposed restoration activities. These activities will be developed as part of an Annual Work Program and will be evaluated by the criteria 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 Draft Restoration Plan describes the five alternative courses of action, including the no action alternative, explains the evaluation criteria used, and outlines the differences among each of the alternatives. It discusses an approach to implementing the alternatives. The Restoration Plan also covers administration, funding allocation guidelines and mechanisms, monitoring, and public participation. 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.

Each restoration alternative is made up of four types of activities, and thc alternatives place different emphasis on each category:

- 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 rights to privately held land, or changing the management of publicly held land.

- General restoration.

  This activity includes options that manipulate resources directly, such as building new fish passes. It also includes options 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 design, develop, and implement new technologies and approaches to help restore resources and services not recovering or recovering at lower than expected rates.

- Administration and public information activities.

  Funding levels for these 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. This category also includes providing information to the public about restoration activities and the progress of recovery.

Public Participation Process

Roles of the Agencies

The Trustees selected the USDA Forest Service to act as the lead agency in developing the Environmental Impact Statement for the Restoration Plan (see 40 CFR 1501.5-7, 1503.1, and 1508.16). In this capacity, the Forest Service has used its implementing regulations, policies, and procedures for ensuring compliance with NEPA regulations. The Forest Service selected and supervised third-party contractors to produce the analyses and public scoping documents, including this DEIS. Contractors provided impartial analysis and input, as well as an independent evaluation of the Draft Restoration Plan. The Department of Interior, the National Marine Fisheries Service, the Alaska Department of Natural Resources, the Alaska Department of Environmental Conservation, and the Alaska Department of Fish and Game are cooperative agencies with the Forest Service in the NEPA process and scoping of the action.

The lead agency is responsible for coordinating the public scoping process, which is required by 40 CFR 1501.7. The scoping process is defined as "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action." During the scoping process, the Forest Service coordinated with affected Federal, State, 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 EIS. As required by Forest Service policy, the planning record for the Restoration Plan EIS 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 Memorandum of Agreement 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 were also 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 opportunity to provide identify issues to be addressed related to the proposed action, the Trustee Council held four sets of public meetings. The first set, held in January - February 1992, was 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 as input 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 Draft EIS. A third round of meetings was held in April 1993 to collect public comments on the Summary of Alternatives for Public Comment, released in April 1993. 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. 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 Trustee Council on all matters relating to the planning, evaluation, and allocation of funds, as well as the planning, evaluation, and conduct of 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 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?

- For 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 pre-spill 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 action be limited to the spill area, or should actions 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 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. The public also raised many issues that are relevant to developing the Restoration Plan, but not relevant to analyzing the effects of the alternatives. Those issues are identified in the Restoration Framework document published in April 1992 and in the Draft Restoration Plan.

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 has expressed interest 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, acreage or sites protected from development or other physical encroachment, changes in human use or management, or changes in aesthetic quality could also affect the rate and degree of recovery.

Issue 2: How would activities directed at injured resources and services affect non-target 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 could also indirectly affect non-target resources and services. Potential impacts include changes in the number or structure of non-target species populations as a result of restoration-associated changes in the amount or quality of available habitat or food sources.

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

Ecological change 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 prespill conditions and overall biodiversity levels. Many of the proposed activities aim to change ecosystem diversity and species abundance. Specific ecological changes include structural changes in habitat and changes in species populations.

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. The number and kinds of new jobs, as well as the income associated with them, are of interest to the public. There is also concern that employment could be reduced in some resource development industries that may be adversely affected by some restoration options. Additionally, the effect of increased or decreased employment on the economy and services of the local communities 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 or enhancement 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 land management 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 will be considered in this analysis.

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 used for subsistence in the area or increasing access to resources not previously available for subsistence harvest. Subsistence use may also 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 and publicizing research to determine the level of persistent contamination, if any, in harvested resources.

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.

Draft Environmental Impact Statement Organization

An Environmental Impact Statement serves as a decision-aiding tool to ensure that Federal agency actions take into consideration the policies and goals of NEPA. An EIS is prepared by integrating as many of the natural and social sciences as may be warranted based on the potential effects of the proposed action. The direct, indirect, and cumulative impacts of the proposed action are analyzed. This document is a program-level EIS; it addresses only the alternatives proposed for the Restoration Plan. Specific actions and/or projects to be implemented in the future would require additional environmental assessment.

Chapter I of this Draft EIS document has presented the purpose and need for action by describing the background circumstances, the proposed action, and the management process involved. Chapter II presents the five alternatives being considered for implementation as the final Restoration Plan. It briefly describes each of the alternatives and highlights the differences among them. In Chapter III, an overview of the affected environment is presented. This chapter describes the physical, biological, and socioeconomic environment and conditions of the EVOS area. Chapter IV contains the results of the environmental impact analysis and presents the projected effects of each of the proposed alternatives. Supplementary information, including a glossary, list of preparers, species list, and reference list, is included in the latter portions of this document.

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Chapter II: Alternatives Considered

Introduction

The *Exxon Valdez* Restoration Plan contains five potential alternatives for restoration. These alternatives, including the required "no action" alternative, are briefly described in this chapter. 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. For more detailed information about the alternatives, please refer to the Restoration Plan.

Each of the alternatives is made up of several 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 25 options, i.e., general types of actions designed to achieve a particular objective in relation to an injured resource or service. The Trustees are seeking public input on five policy questions in regard to the Draft Restoration Plan:

- Which resources and services should be targeted?
- How long should restoration actions last?
- Which restoration actions should be undertaken?
- In what geographic area should actions be taken?
- To what extent, if any, should restoration actions create or enhance opportunities for human use?

Alternative 1: No Action

The "no action" alternative required by 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 their responsibilities would remain unchanged. None of the funds from the civil settlement would be spent if this alternative were implemented.

The following paragraphs briefly summarize 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 primary 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 maintaining wild stock habitat.

The *National Oceanic and Atmospheric Administration*'s 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 whales and pinnipeds in Alaska; 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* manages the national wildlife refuges to accomplish the following purposes:

- To conserve fish and wildlife populations and habitats in their natural diversity includin but not limited to, marine mammals, marine birds and other migratory birds, the marine resources upon which they rely, 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* 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 Department of Environmental Conservation is involved in education efforts and technology transfer directed at reducing pollution.

The *Alaska Department of Natural Resources* 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 Department of Natural Resources 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* is charged with managing and protecting the fish, game, and aquatic plant resources of the State. Functions include managing harvests to ensure sustained yields of fish and game, granting permits for activities in fish-bearing and anadromous streams, administering ADF&G Special Areas, overseeing 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. ADF&G also makes management recommendations to the State Board of Fisheries and Game, which are responsible for establishing harvest regulations. ADF&G has the authority to order emergency harvest openings and closures.

Alternative 2: Habitat Protection

The goal of Alternative 2 is to protect strategic lands and habitats important to the long-term recovery of injured resources and services from further damage. 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.

Figure II-2 displays the potential allocation of funds for this alternative. The majority of the funds would be used to acquire and protect lands within the spill area. The potential allocations are illustrative only and do not represent a commitment of actual resources.

Alternative 3: Limited Restoration

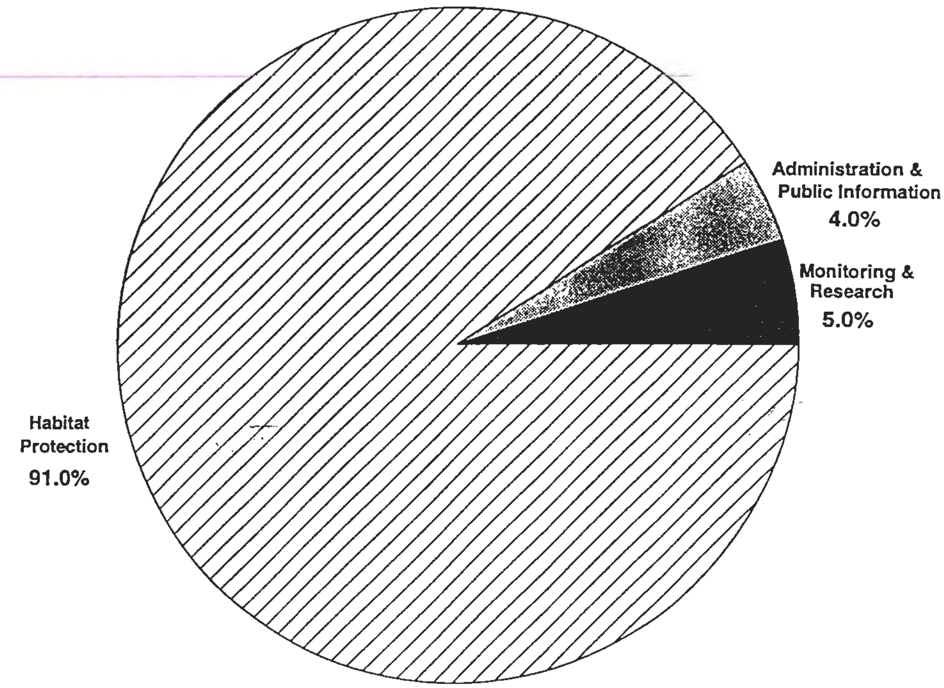

Figure II–2. Potential Allocation of Funding for Alternative 2: Habitat Protection

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 would 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.

Figure II–3 displays the potential allocation of funds for Alternative 3. Although the majority of the funds would be used to acquire and protect lands within the spill area, this alternative also includes funding for general restoration activities. The potential allocations are illustrative only and do not represent a commitment of actual expenditures.

Alternative 4: Moderate Restoration

This alternative is broader than Alternative 3 in that it aims to aid recovery of all injured resources and services, not only the most injured. 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 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 would increase opportunities for human use to a limited extent. Monitoring and research would be conducted.

Figure II–4 displays the potential allocation of funds for Alternative 4. 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. The potential allocations are illustrative only and do not represent a commitment of actual expenditures.

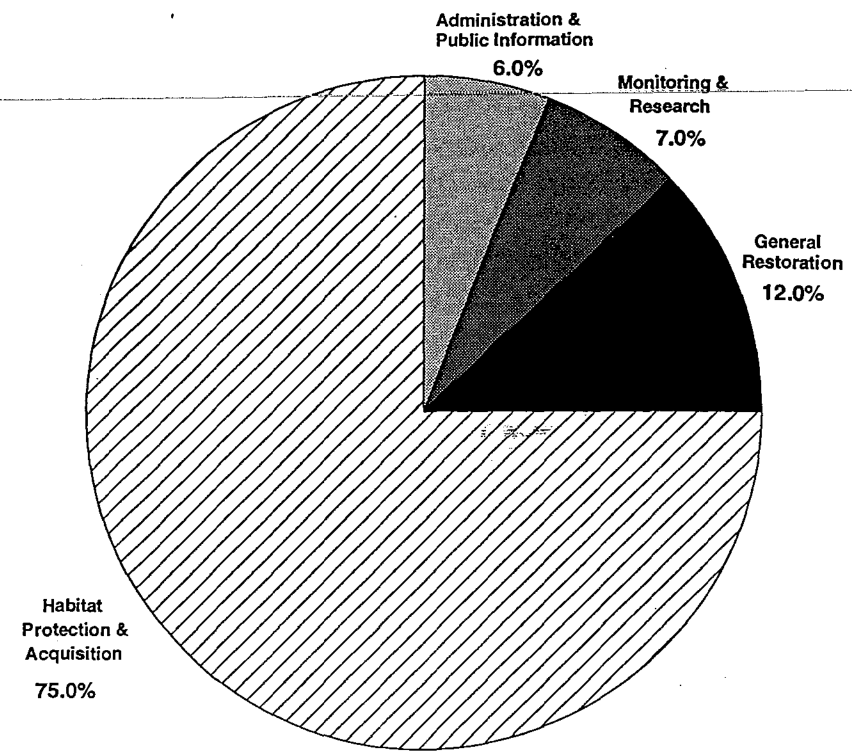

Figure II-3. Potential Allocation of Funding for Alternative 3: Limited Restoration

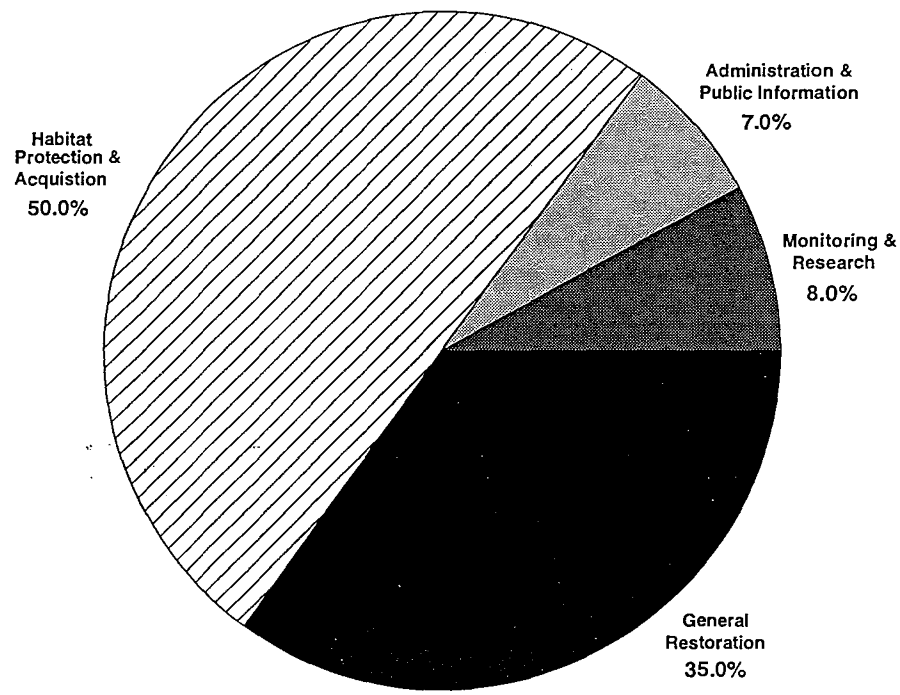

Figure II-4. Potential Allocation of Funding for Alternative 4: Moderate Restoration

Alternative 5: Comprehensive Restoration

Alternative 5 is the broadest in scope of the proposed alternatives. It would help all injured resources and services, both within the spill area and in other parts of Alaska. Unlike Alternatives 3 and 4, this alternative includes actions to aid resources and services that have already recovered, as well as those that have not. Actions likely to produce some improvement over unaided recovery would be allowable under this alternative. Habitat protection is a smaller part of this alternative. Alternative 5 also allows for expansion of current human use and encourages appropriate new uses. Monitoring and research would also be included.

Figure II–5 displays the potential allocation of funds for Alternative 5. As the pie chart shows, funding percentages under this alternative are projected to be more evenly distributed among the action categories. The potential allocations are illustrative only and do not represent a commitment of actual expenditures. In this alternative, the majority of funds would be used for general restoration activities. The percentage allotted to habitat protection and acquisition is the least of all the alternatives except the .no action. alternative.

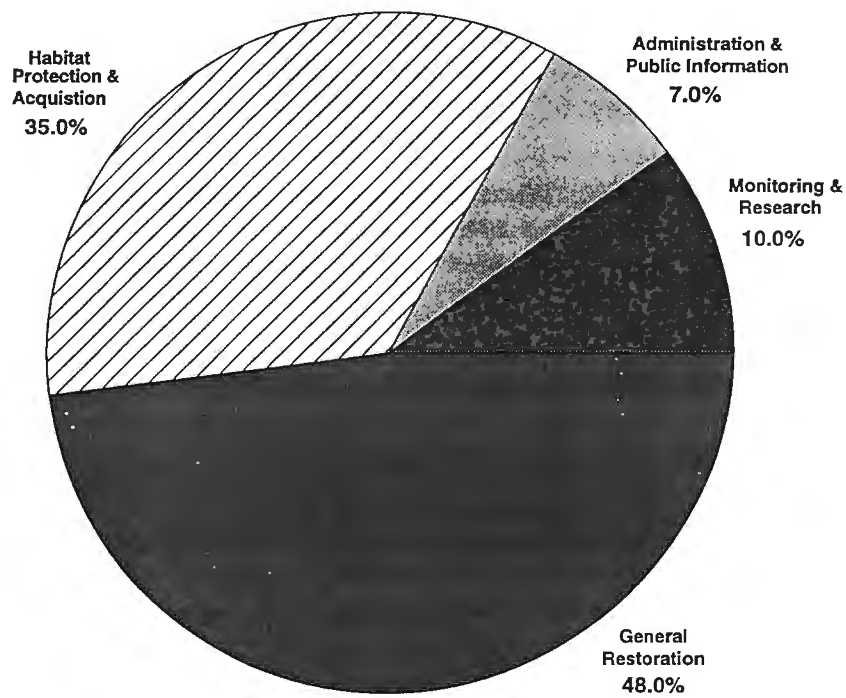

Figure II–5. Potential Allocation of *Funding for Alternative 5: Comprehensive Restoration*

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 the settlement funds would be spent on monitoring the recovery of the resources. This aspect of the alternative is contained in the other alternatives.

An alternative was developed with a theme and policy direction that fell between Alternatives 4 and 5. However, this alternative was dropped from detailed consideration because it was not significantly different from the other alternatives.

Comparison of the Alternatives

Each alternative in the Draft Restoration Plan is structured to give varying degrees of emphasis among the four categories of habitat protection and acquisition, general restoration, monitoring and research, and administration and public information. The no action alternative, (Alternative 1) does not contemplate any activities in these categories above and beyond normal agency management actions.

The comparative emphasis on categories of actions for Alternatives 2 through 5 is illustrated in Figure II-6. The essential variation among the alternatives has to do with the balance between habitat protection and restoration activities. Alternative 2 is principally habitat protection with no restoration activities, whereas Alternative 5 proposes roughly identical emphasis for these two categories.

The restoration category of actions includes 25 options. Table II-1 provides a brief description of these, indicates which alternative(s) contain each option, and identifies what the targeted resource or service is for each alternative/option combination. As noted under the alternative descriptions above, Alternatives 3, 4, and 5 vary in terms of the scope of restoration activities proposed. Alternative 3 restoration 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. As shown in the table, only the most severely injured species and services are targeted.

Alternative 4 envisions actions that would aid recovery of all injured resources and services, not just the most injured as summarized in Table II-1. 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 encourage new uses would be taken. Accordingly, Table II-1 shows the most extensive list of targets for this alternative than for any of the others.

The focus of this DEIS is to identify and compare how each of the proposed alternatives addresses the five restoration issues posed in Chapter I. Table II-2 summarizes the impacts of Alternatives 2 through 5 on each of the issues. Alternative I is not included because it would have 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. Public input is needed to inform the Trustee Council as to what these values should be.

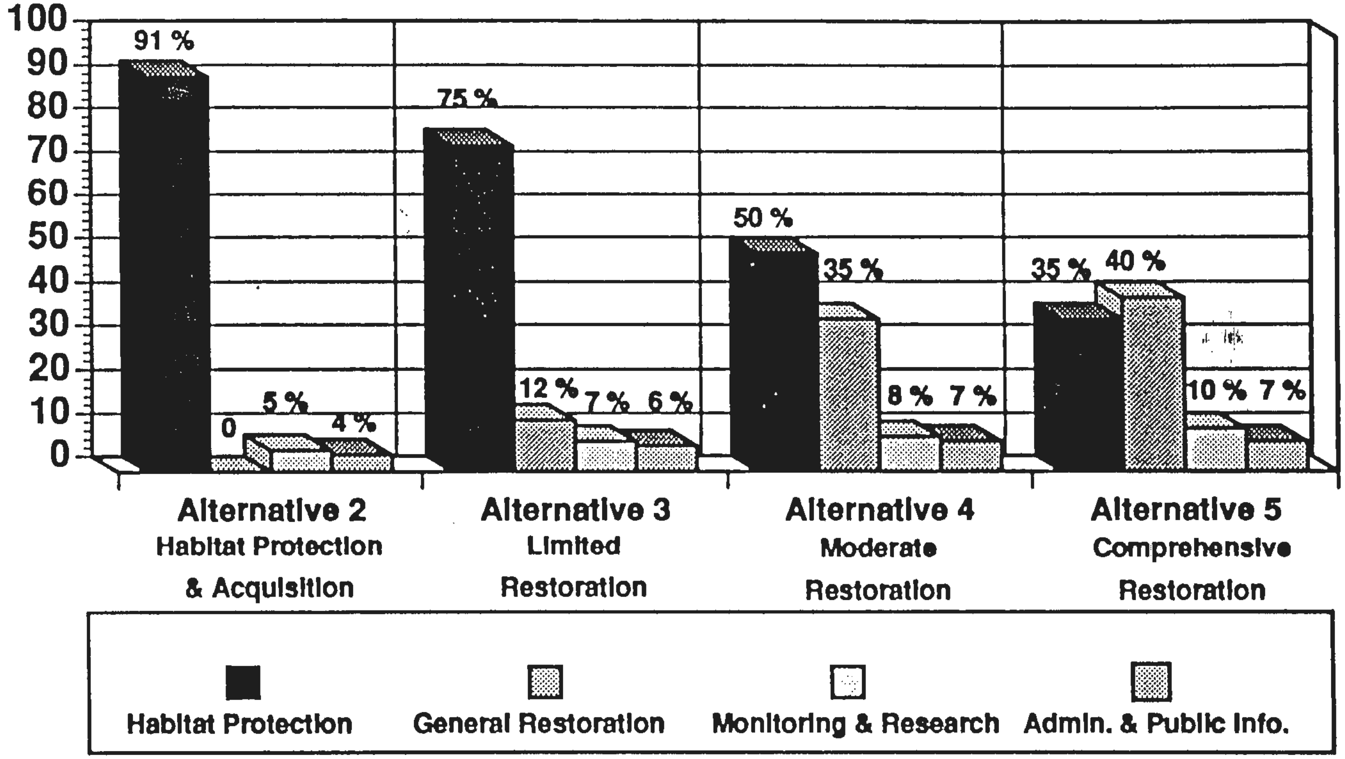

Figure II- 6
Comparative Emphasis on Categories of Actions Among Alternatives

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Table II-1. List of alternatives and associated options.

Option	Alternative 3 Targets	Alternative 4 Targets	Alternative 5 Targets
Option 1: Implement cooperative programs between fishermen and agencies to reduce incidental take of harbor seals.	harbor seals	harbor seals	harbor seals
Option 2: Implement cooperative programs between subsistence users and agencies to assess the effects of subsistence harvest on sea otters and harbor seals.	harbor seals, sea otters	harbor seals, sea otters	harbor seals, sea otters
Option 3: Study techniques for changing black cod fishery gear to avoid conflicts between fishermen and killer whales.		killer whales	killer whales
Option 4: Intensify fisheries management to protect injured stocks.	sockeye salmon	cutthroat trout, Dolly Varden, pink salmon, rockfish, pacific herring, sockeye salmon	cutthroat trout, Dolly Varden, pink salmon, rockfish, pacific herring, sockeye salmon
Option 5: Improve freshwater wild salmon spawning and rearing habitats.			pink salmon, sockeye salmon
Option 6: Improve survival rates of salmon eggs to fry by using egg boxes, net pens, or hatchery rearing.	sockeye salmon	sockeye salmon	pink salmon, sockeye salmon
Option 7: Relocate hatchery runs of pink salmon to reduce the interception rate of wild stocks of pink salmon.		pink salmon	pink salmon
Option 8: Update the Alaska Anadromous Streams Catalog to ensure that the necessary protection and regulation is provided for all listed salmon streams in the spill area.			pink salmon, cutthroat trout
Option 9: Remove predators at injured colonies or remove predators from islands that supported murres, black oystercatchers, or pigeon guillemots before the spill.	common murre, pigeon guillemot	common murre, pigeon guillemot, black oystercatcher	common murre, pigeon guillemot, black oystercatcher
Option 10: Study use of artificial stimuli (decoys, vocalizations) to encourage recovery at affected murre colonies and accelerate recolonization of historic colonies.	common murre	common murre	common murre
Option 11: Study changes in fishing gear or timing as a way of minimizing incidental capture of marbled murrelets.	marbled murrelet	marbled murrelet	marbled murrelet

Option	Alternative 3 Targets	Alternative 4 Targets	Alternative 5 Targets
Option 12: Accelerate recovery of upper intertidal zone.	intertidal organisms	intertidal organisms	intertidal organisms, black oystercatcher
Option 13: Study the effects of disturbance in marine birds and mammals.	sea otter	sea otter, common murre, harbor seal	sea otter, common murre, harbor seal
Option 14: Study extent of oiling of mussel beds and techniques for removing oil from mussel beds.	harlequin duck, sea otter	harlequin duck, sea otter	harlequin duck, sea otter
Option 15: Propose modifications of sport and trapping harvest guidelines of injured river otter and harlequin duck populations to speed the rate of recovery.			river otter, harlequin duck
Option 16: Develop a site stewardship program to monitor archaeological sites.	archaeological sites	archaeological sites	archaeological sites
Option 17: Preserve archaeological sites and artifacts within the spill area.	archaeological sites	archaeological sites	archaeological sites
Option 18: Acquire replacements for artifacts removed from the oil spill area.	archaeological artifacts	archaeological artifacts	archaeological artifacts
Option 19: Develop new public recreation activities.	protect existing recreation opportunities	protect or increase existing recreation opportunities	protect or increase existing recreation opportunities, encourage new use
Option 20: Test subsistence foods for continued contamination.	subsistence foods	subsistence foods	subsistence foods
Option 21: Provide new access to traditional subsistence foods in areas outside the spill area to replace lost use.	subsistence foods	subsistence foods	subsistence foods
Option 22: Develop subsistence mariculture sites, shellfish hatcheries, and a technical research center.			subsistence foods
Option 23: Replace lost sport, commercial, and subsistence fishing opportunities by creating new fisheries for salmon or trout.	commercial and sport fishing, commercial tourism	commercial and sport fishing, commercial tourism	commercial and sport fishing, commercial tourism, subsistence fishing
Option 24: Develop and conduct public information programs through visitors' centers.			recreation and commercial tourism

Option	Alternative 3 Targets	Alternative 4 Targets	Alternative 5 Targets
Option 25: Establish a marine environmental institute and research foundation.			education

Table II-2. 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 and acquisition of all alternatives, could enhance natural rate of recovery.	Second highest allocation of restoration funding for habitat protection and acquisition. Only high rate of recovery options selected under this alternative.	Third highest allocation of restoration funding for habitat protection and acquisition. Would include options that address only those resources and services that have not recovered from *EVOS* are included.	Least amount allocated to habitat protection and acquisition. Would include all injured resources and services. Largest amount allocated to general restoration.
2. How would activities directed at injured resources and services affect non-target resources and services?	Habitat acquisition could greatly enhance ecosystem management and the consideration nontarget species.	Habitat acquisition could greatly enhance ecosystem management and the consideration nontarget species.	Habitat acquisition could moderately enhance ecosystem management and the consideration nontarget species.	Habitat acquisition could moderately enhance consideration nontarget species. Intensive stocking may reduce natural populations.
3. What ecological change would occur in the spill area as a result of restoration activities?	Habitat protection could greatly enhance the ecological integrity of the *EVOS* area and therefore promote only beneficial ecological change.	Habitat protection could greatly enhance the ecological integrity of the *EVOS* area and general restoration could enhance recovery of natural ecological conditions for selected species.	Habitat protection could enhance the ecological integrity of the *EVOS* area and general restoration could enhance recovery of natural ecological conditions for selected species.	Habitat protection could enhance the ecological integrity of the *EVOS* area and general restoration could enhance recovery of natural ecological conditions for selected species.
4. How would restoration activities affect land uses, local economies, and communities?	Habitat acquisition could preclude areas from resource exploitation, principally logging. Tourism and fishing economies may benefit.	Habitat acquisition may preclude areas from resource exploitation, principally logging. Tourism and fishing economies could benefit. Short-term disruption of fishing.	Habitat acquisition may preclude areas from resource exploitation, principally logging. Tourism and fishing economies could benefit. Short-term disruption of fishing.	Habitat acquisition may preclude areas from resource exploitation, principally logging. 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 might restrict subsistence uses on certain lands, or increase competition for resources.	Habitat protection might restrict subsistence uses on certain lands. General restoration could enhance opportunities for subsistence use.	Habitat protection might restrict subsistence uses on certain lands. General restoration could substantially enhance opportunities for subsistence use.	Habitat protection might restrict subsistence uses on certain lands. General restoration could substantially enhance opportunities for subsistence use.

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Chapter III. Affected Environment

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 section of this chapter covers the physical and biological environment including the physical setting, marine, coastal, and terrestrial ecosystems, and individual biological resources. In addition to describing the fish and wildlife of the EVOS area, this section summarizes injury to the biota including results of the natural resource damage assessment studies. The second part of the chapter covers the social and economic environment in the affected area before and after the spill. This section 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 and Biological Environment

Figure III-A shows the location of the area oiled by the *Exxon Valdez* spill in relation to the rest of the State of Alaska. Within this area, Prince William Sound and the Gulf of Alaska were the areas most severely affected.

Physical Setting

The *Exxon Valdez* Oil Spill (EVOS) area is located in southcentral Alaska, north of the Gulf of Alaska, encompassing a surface area of approximately 75,000 square miles. At the northeastern edge of the EVOS region is Prince William Sound, an area about the size of Maryland's Chesapeake Bay or Washington State's Puget Sound (Mickelson, 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, including Montague, Kodiak, and Afognak; 19 minor islands; and 150 lesser islands.

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 destroying the towns of Valdez, Kodiak, Seward, and Chenega. Winter winds in the Gulf of Alaska are generally easterly or southeasterly and interact with currents to push waters into Prince William Sound. This produces complex flow patterns resulting in strong downwelling and an outflow of surface waters to the southwest. The majority of the EVOS area has a maritime climate with heavy precipitation, averaging 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 EVOS region contains diverse marine, coastal, and terrestrial ecosystems that together constitute one of the largest and least developed regional ecosystems in the United States.

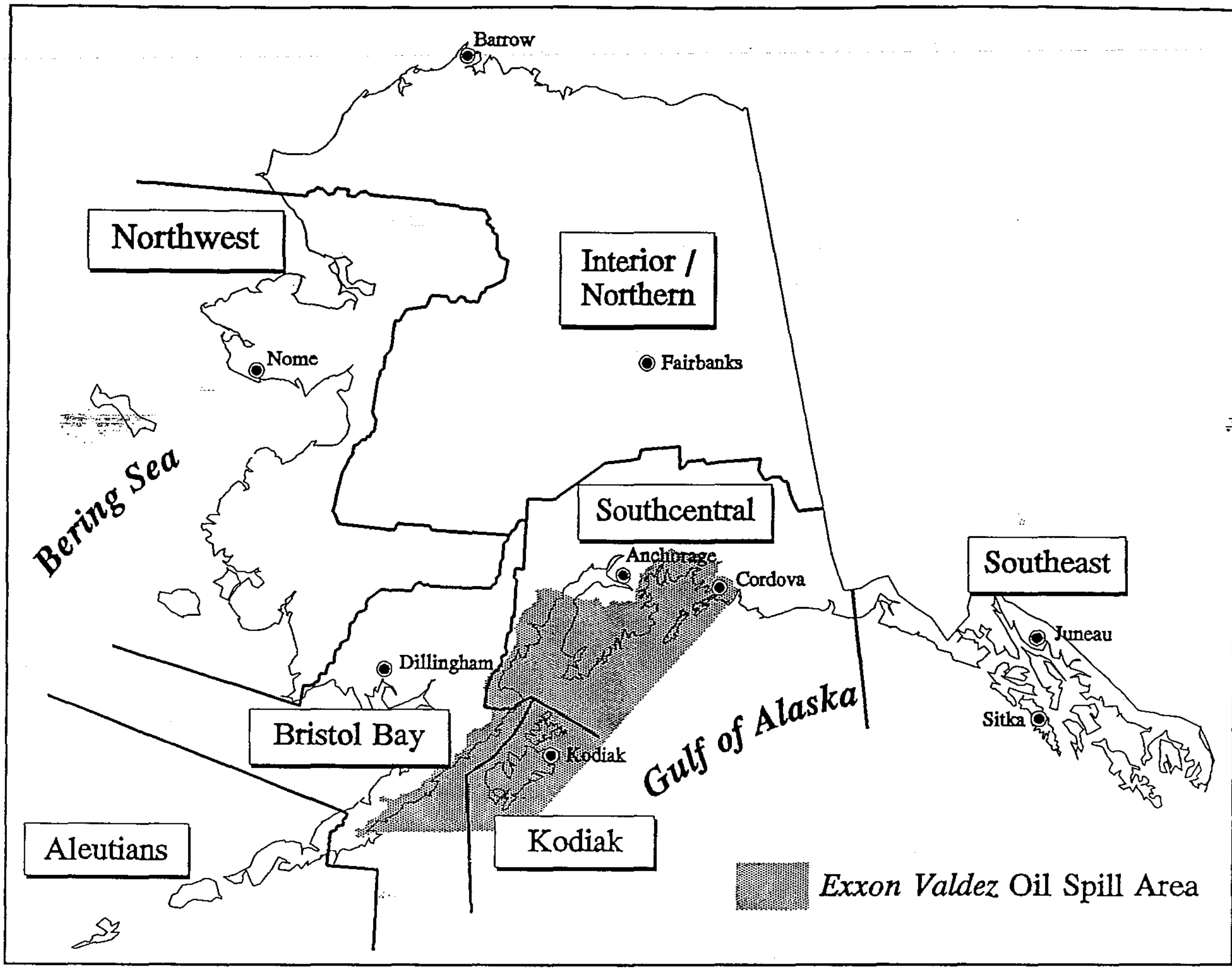

Figure III-A. *Exxon Valdez* oil spill in relation to Alaskan Census Regions.

Marine Ecosystem

The marine ecosystem in the EVOS area is characterized by deep water (hundreds of meters) and cold temperatures. High winds and strong currents provide mixing of waters and can produce 20-meter waves. Prior to the oil spill, water quality in the region was considered pristine. Phytoplankton (usually dominated by diatoms) are patchily distributed both horizontally and vertically depending on hydrographic and chemical conditions. In highly productive areas, such as Prince William Sound, a large phytoplankton bloom occurs in the spring and declines during the summer. Zooplankton follow the distribution of phytoplankton and peak 1 to 2 months later. Euphausiids, copepods, and other zooplankton are the major food source for many marine species, including whales and salmon. Polychaete annelids and mollusks dominate a diverse benthic community of more than 200 species to depths of 200 m. Soft corals also occur throughout the region (Bureau of Land Management, 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 move to shallower water in summer months for spawning. Shrimp, clams, and scallops are also important shellfish in the region.

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 EVOS area contain unusually 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 supratidal zone is important for marine mammal haulout areas and many terrestrial species. The intertidal and subtidal zones contain diverse communities of their own and are critically important for maintaining a food source for both marine and terrestrial organisms.

The intertidal zone is reaches from low to high tide and is intermittently inundated. Inhabitants of the intertidal zone include algae (e.g., *Fucus*), mussels, clams, barnacles, limpets, amphipods, isopods, marine worms, and fish. The intertidal zone is used as a spawning area by many species of fish and as a feeding ground for a variety of marine organisms (e.g., sea otters, Dungeness crabs, juvenile shrimps, rockfish, cod, and juvenile fishes), terrestrial organisms (e.g., bears and river otters), 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 (*Exxon Valdez* Oil Spill Trustees, 1992).

The subtidal zone extends from the low tide boundary of the intertidal zone into the open water area. Because the near coastal subtidal community is similar in many respects to the intertidal community, it is considered separately from the marine ecosystem. Inhabitants of the shallow subtidal zone include amphipods, clams, eelgrass, crabs, juvenile cod, *Laminaria* plants, spot shrimp, and many other organisms. Like the intertidal zone, the subtidal zone is especially vulnerable to oil spills.

Terrestrial Ecosystem

The *Exxon Valdez* Oil Spill area falls almost entirely within the Oceanic Forest-Tundra Province of Bailey's (1989) ecoregional classification. This Province is part of the Marine Regime Mountains Division and Humid Temperate Domain. Within the EVOS area, three more specific biogeographic regions can be identified—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 are still present at high elevations in all three regions.

At lower elevations, ecological conditions vary between 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, devilsclub, 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 yrs plus), mature forest (70-200 years), intermediate stage forest (40-70 years), early stage forest (0-20 years), lowland shrub, mud flats/gravel/rock, subalpine shrub, alpine shrub-lichen tundra, cliffs, islands in lakes, and snow/ice/glaciers (USFWS, 1983). Inland aquatic habitats include anadromous fish streams, anadromous fish lakes, resident fish streams, and resident fish lakes.

A wide range of bird and mammal species inhabit the terrestrial ecosystem of the EVOS area and many are more abundant there than anywhere else throughout their range. More than 200 species of birds occur in the EVOS area, including more than 100 shorebirds and seabirds. Approximately 100 species of these birds are year-round residents. Important nesting and breeding areas include the Copper River Delta, Kenai Peninsula, lower Cook Inlet, and the Kodiak and Afognak Island coasts. Moderate populations of bald eagle and peregrine falcon occur and the endangered Aleutian Canada goose and short-tailed albatross may be seasonal visitors to the area. The EVOS region contains 33 species of terrestrial mammals including brown and black bear, moose, Sitka blacktail deer, mink, and river otter. In addition to the five species of anadromous Pacific salmon (chinook, coho, pink, chum, and sockeye), many other fish contribute to the area's diverse inland aquatic communities including Dolly Varden char, rainbow and cutthroat trouts, lake trout, arctic grayling, whitefish, and turbot.

Of the 15 million acres within the oil spill area, 1.8 million are private lands (Figure III-B). 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 (ANSCA). Lands chosen for conversion to private uses were primarily 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 1970s, and no harvests are currently planned. Nine other large Federal land management areas are contained wholly or partially within the EVOS area. The National Park Service 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 and Katmai 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, Becharof NWR, Alaska Peninsula NWR, and Alaska Maritime NWR. 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 degradation of the ecosystem, but they also preclude enhancement activities within their boundaries.

Land management activities, especially those that involve timber harvesting (either clear-cut logging or selective cutting), have important consequences for the recovery of injured resources in the EVOS area. Although timber harvesting is allowed on some Federal and State lands, it is the primary activity planned for the majority of forested private lands. Therefore, the proportion of sensitive EVOS area lands in private ownership can be used to estimate future adverse impacts to the ecosystem that may slow the natural recovery of injured resources.

Another issue in forest land management 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 100-150 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 may also 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. Some species (e.g., invertebrates such as clams and barnacles) have never been inventoried, while others, such as the brown bear and the bald eagle, are counted annually for management purposes. Much 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 the oil spill area. It will be used in evaluating the potential impacts, either direct or indirect, of the various restoration options.

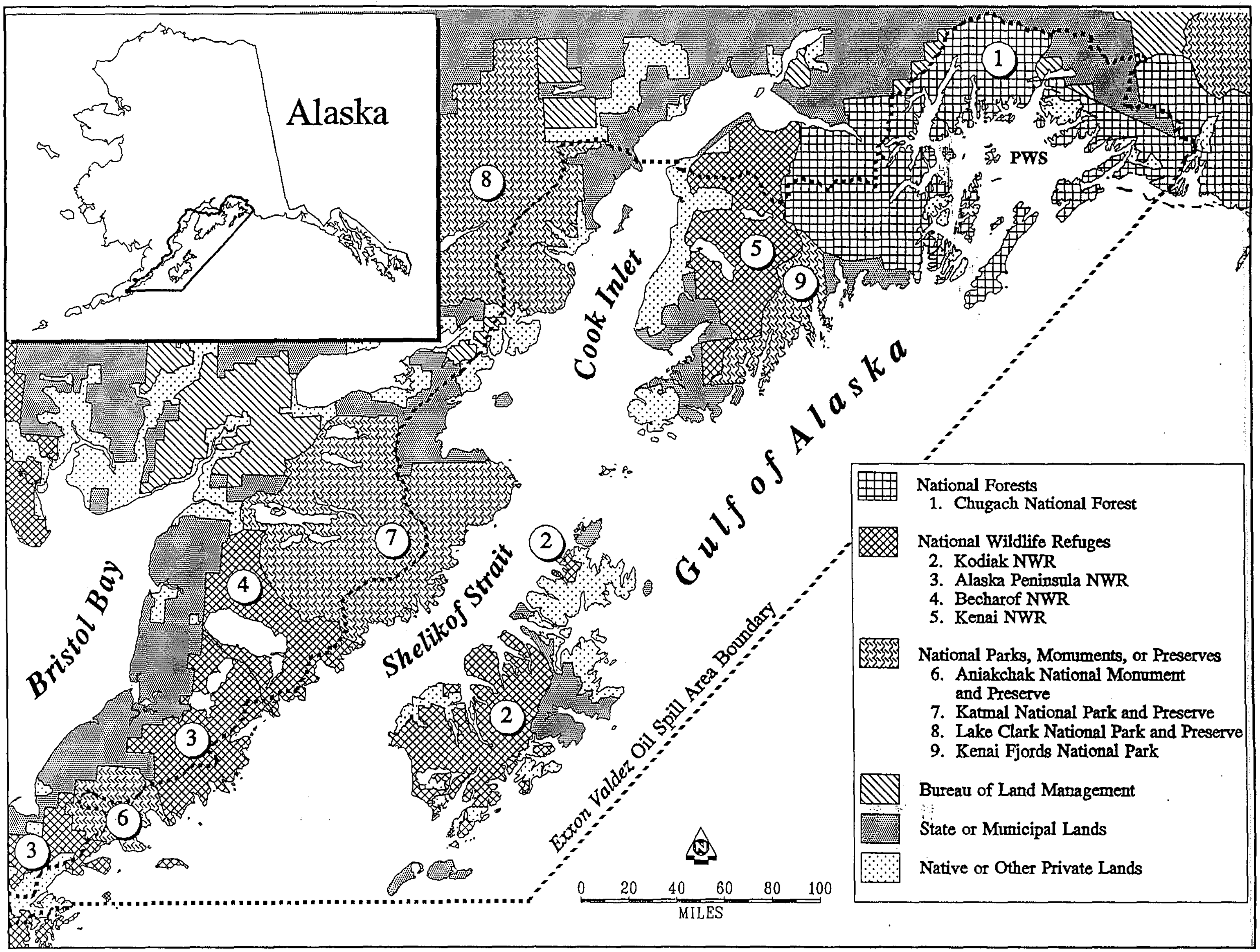

Figure III-B. General land status in the *Exxon Valdez* oil spill area.

Marine Mammals

The following section discusses the relevant population status, life cycle requirements, and oil spill injuries including relevant information for harbor seals, sea lions, sea otters, and killer whales.

Harbor Seals

The harbor seal (*Phoca vitulina richardsi*) is a protected species under the Marine Mammal Protection Act of 1972, which placed a moratorium on the taking of harbor seals except for subsistence use by Native Alaskans. The harbor seal is under the management of the National Marine Fisheries Service.

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

Life cycle requirements of the harbor seal include sources of fish, octopus, squid and shrimp for food, and protected haulout sites for pupping and molting. 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). Factors influencing the population recovery for harbor seals include high mortality in the first year of life; the seal's annual reproductive rate (1 pup); and age to reproductive maturity (2-6 years).

The oil spill caused population declines and sublethal injuries to harbor seals in Prince William Sound. While some dead seals were recovered from the Kenai Peninsula, the extent of injury outside Prince William Sound is unknown. Many were directly oiled and an estimated 345 seals died. The pre-spill population of harbor seals in Prince William Sound was estimated to be between 2,000 to 5,000 animals.

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 post-spill spring (April) survey were extensively oiled and 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.

Steller Sea Lions

The Steller sea lion (*Eumetopias jubatus*) has been classified as "threatened" under the Endangered Species Act of 1973. The sea lion is a protected species under the Marine Mammal Protection Act of

1972, which placed a moratorium on the taking of sea lions except for subsistence use by Native Alaskans. ~~The sea lion is under the management of the National Marine Fisheries Service.~~

Pre-spill sea lion populations for the Gulf of Alaska have been estimated at 136,000 (Calkins and Pitcher, 1982). Approximately 70 percent of the world population of sea lions is located in Alaska (Johnson et al., 1989). The sea lion population has been in decline since 1980 (Johnson et al., 1989). In Alaska, the sea lion population declined 56 percent from 1985 to 1990 (Alaska Fisheries Science Center, 1991). The sea lion is in direct competition with human subsistence, recreational, and commercial resource users for fish. Natural predators of sea lions include killer whales and sharks.

Life cycle requirements for the sea lion include their age to reproductive maturity (4-7 years) and their annual reproductive rate (1 pup). Other causes of mortality are disturbance and stampeding during breeding season (August being the most critical period), and deaths incidental to commercial fishing (Johnson et al., 1989).

Results from sea lion studies were inconclusive about the effects of the spill. Several sea lions were observed with oiled pelts, and oil was found in some tissues. Sea lions have experienced a severe decline over the past 30 years in the north Pacific Ocean--as great as 93 percent. This decline combined with seasonal movements, which are significant but not well understood, hindered determining if the seal lion population in the Gulf of Alaska had been affected by the spill. Sea lions were counted at eight haulout sites, located mainly in the Gulf of Alaska. Some of these sites were oiled, although oiling was patchy and generally short-lived, but away from these sites, sea lions were observed swimming through oil. Ten sea lions were found dead in oiled areas, mainly on rocky beaches, but it is not known how many of these deaths were attributable to natural mortality, or if any were due to oiling.

Sea Otters

The sea otter (*Enhydra lutris*) has been classified as "threatened" under the Endangered Species Act of 1973. The sea otter is a protected species under the Marine Mammal Protection Act of 1972, which placed a moratorium on the taking of sea otters except for subsistence use by Native Alaskans. The sea otter is under the management of the State of Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service. Pre-spill and post-spill management of sea otters by these agencies has focused on population monitoring through surveys and monitoring of Native harvest.

Sea otter pre-spill population for the entire State of Alaska was estimated at 150,000 animals (*Exxon Valdez* Oil Spill Trustees, 1992). The population in Prince William Sound prior to the oil spill was estimated at 10,000 animals (*Exxon Valdez* Oil Spill Trustees, 1992). The sea otter population within the oil spill zone 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 was and is now in direct competition with human subsistence, recreational, and commercial resource users for crabs, clams, and other benthic organisms. Natural predation of sea otters is limited.

Life cycle requirements of the sea otter appear to be intertidal and subtidal invertebrates as food sources and protected areas for use as haulouts. An adequate food supply is critical for sea otters because they must eat large quantities in order to maintain the high metabolic rate necessary to survive in cold waters (Chapman, 1981). The importance of haulouts for sea otters is not fully understood. Sea otters appear to need haulouts for grooming to maintain their fur's insulating capabilities (Van Gelder, 1982) and also may use haulouts for pup rearing and weaning. Factors influencing the population recovery for sea otters are age to reproductive maturity (3-5 years); annual reproductive rate (1 pup); and low juvenile survivorship (Calkins and Pitcher, 1979). Adult sea otter survivorship is generally high in absence of outside mortality events (e.g., oil spills, disease, or harvest). There are limited management opportunities to increase sea otter populations. Population management is restricted to protecting habitat and monitoring Native harvest.

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 were still 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.

One possible cause of the relatively higher mortalities of weaning and prime-age animals is the ingestion of oil-contaminated prey. During 1992 surveys, fresh (unweathered) oil was found in beds of mussels on protected (low energy) beaches. Sea otters, particularly young sea otters, feed on mussels and other invertebrates and may still be exposed to oil persisting in intertidal habitats.

Killer Whales

The killer whale (*Orcinus orca*) is protected under the Marine Mammal Protection Act of 1972, under which a moratorium was placed on harvesting killer whales. Killer whales are managed by the National Marine Fisheries Service (NMFS).

The largest members of the dolphin family, killer whales live and migrate in groups of up to 50 individuals. There are two types of these groups, called pods: resident pods and transient pods. Because transient pods travel great distances throughout the year, resident pods were more likely to have suffered injuries from the EVOS. Resident pods have a more defined social structure, including a home range that may cover an area up to several hundred square miles (Matkin et al., 1993). Another factor that may affect the ability of killer whales to recover is their low reproduction rate. The birthing rate of killer whales varies, with 5 years being the average time between calves. The gestation period is about 16 to 17 months and the cow gives birth to a single calf. Killer whales reach sexual maturity at approximately 7 years and have a life span of approximately 25 years. Analysts estimate that recovery of the AB pod to pre-spill numbers could take one to two decades.

Thirteen killer whales disappeared from one pod (extended family group) between 1988 and 1990, and are presumed to have died. Approximately 140 killer whales forming nine distinct pods regularly use Prince William Sound, and are considered resident pods. There are also transient pods and other resident pods with wider ranges that enter the Sound occasionally. The rate of natural mortality in killer whales in the North Pacific is about 2 percent per year, so it would be unusual for more than 3 to 4 individuals to be missing annually from Prince William Sound's resident pods.

In the summer of 1989, there were more than nine whales missing from resident pods. The AB pod, which had 36 individuals, when last seen in the Sound in the fall of 1988, was missing 7 animals, for an unprecedented 19.4 percent mortality rate. In 1990, an additional 6 individuals were found missing from AB pod, resulting in an annual mortality rate of 20.7 percent (prespill mortality for the resident AB pod typically ranged from 3.1 to 9.1 percent from 1984 to 1988). All of the missing whales were either females or immature animals, and in several cases calves were orphaned. No births were recorded in 1989 or 1990. Due to the fidelity of killer whales to the pod, and the bonds observed between mothers and calves, the missing whales are presumed to have died. However, no dead individuals were ever recovered.

The cause of death is uncertain. Some experts think that the circumstantial evidence points to the spill. Other experts acknowledge that something very unusual happened to AB pod in 1989 and 1990, but that based on current knowledge of the spill and the toxicity of crude oil, it is unlikely that these deaths were due to contact with oil spilled by the *Exxon Valdez*.

Humpback Whales

Humpback whales (*Megaptera novaeangliae*) are currently listed under the U.S. Endangered Species Act of 1973. They are also protected under the Marine Mammal Protection Act of 1972. Humpback whales are managed by the National Marine Fisheries Service (NMFS).

The estimated worldwide population of humpback whales is 10,000, with approximately 1,500 occurring in the North Pacific (Ziegesar and Dahlheim 1993). The humpback whale is a large whale (up to 48 feet and 50 tons) and eats vast amounts of krill and schooling fishes such as herring, anchovies, and sardines (Grzimek, 1990). Their preferred habitat is along shallow shelves and bank areas, rather than deeper ocean waters. During spring migration, the humpback whale travels well defined routes along the continental coastline to high latitude waters for feeding. In the Northern Hemisphere, the mating and calving season is October to March (Walker, 1983). During the breeding season, humpback whales migrate to tropical waters. Like the killer whale, humpback whales have a low reproduction rate, reaching sexual maturity in 7 to 10 years and giving birth every 1 to 3 years.

The only apparent effect of the spill on humpback whales was a temporary displacement from preferred habitat in Lower Knight Island Passage during the summer of 1989. There is no evidence that any humpbacks were killed by the spill, nor has the reproduction been affected. Photodocumentation studies confirmed that normal use of lower Knight Island Passage was resumed in late 1989.

Terrestrial Mammals

Sitka Black-tailed Deer

The Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) is an introduced game species under the management of the State of Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service.

Sitka black-tailed deer were introduced into Prince William Sound and the Kodiak Archipelago in the 1930s (Wallmo, 1978). The present population of deer in Alaska is approximately 350,000 to 400,000. Deer are hunted for sport and for subsistence use by Native Alaskans. Life cycle requirements of the Sitka black-tailed deer include old-forest habitat, herbaceous vegetation in the forest understory as food, and coastal vegetation during winter when uplands are snow covered.

Deer often forage in the intertidal zone on seaweed. Since seaweeds were extensively contaminated on oiled shores, deer were probably exposed to oil. In fact, tissues from deer taken by subsistence hunters and chemically analyzed were found in some cases to contain slightly elevated concentrations of hydrocarbons. The deer were, however, determined to be safe to eat. No evidence was found that populations of Sitka black-tailed deer were injured by the spill. Most deer carcasses found in 1989 on islands in Prince William Sound were probably the result of winter kill.

Black Bear

The black bear (*Ursus americanus*) has been classified as threatened under the Endangered Species Act of 1973 in the states of Mississippi, Louisiana, and Texas. The black bear is under the management of the State of Alaska Department of Fish and Game. Life cycle requirements of the black bear include use of foraging habitat in coastline intertidal regions, riparian regions, and upland areas. Black bears are omnivorous; their main diet consists of grasses, berries, and assorted plant foods, but they also eat fish during salmon runs in Alaska. Factors influencing population growth of black bears include age to reproductive maturity (3-5 years) (Pelton, 1982); 2-year intervals between offspring production (Jonkel, 1978); and availability of large habitat as range areas.

There was an initial attempt to study the potential effects of the spill on black bears, but due to the difficulty of finding, tagging, or observing this species in dense vegetation, the effort was quickly abandoned. No carcasses or other indications of oil spill-related injuries were ever reported.

Brown Bear

The brown bear (*Ursus arctos*) has been classified as "threatened" in the lower 48 states under the Endangered Species Act of 1973. The brown bear is a subsistence and recreational hunting species under the management of the State of Alaska Department of Fish and Game.

The population of brown bears in Alaska is approximately 32,000 to 43,000. The opportunity to observe and photograph brown bears draws thousands of tourists to Katmai National Park and McNeil River State Park annually.

Life cycle requirements of the brown bear include use of foraging habitat in coastline regions in the spring, riparian regions in the summer, and upland areas in the fall and winter (*Exxon Valdez* Oil Spill Trustees, 1992). Black bears are omnivorous. Their main diet consists of grasses, berries, and assorted plant foods. They also eat fish during salmon runs in Alaska. Factors influencing population growth of brown bears include high cub mortality; 2- to 3-year intervals between offspring production (Craighead and Mitchell, 1982); and availability of large range areas.

In the Kodiak Archipelago and in the Alaska Peninsula, brown bears forage in the intertidal zone, where clams are a favorite food. Brown bears also apparently scavenged the carcasses of sea otters and birds that washed ashore after the spill. Analyses of fecal material and samples of bile indicated that some brown bears had been exposed to oil. High concentrations of oil were found in the bile of one yearling brown bear dead in 1989. Since the mortality rate for cubs is close to 50 percent for the first two years, it is uncertain whether this death was associated with oil exposure.

River Otters

The river otter (*Lutra canadensis*) has been found throughout North America except in the extreme southwest (Trustee, 1992). The river otter is one of the largest members of the weasel family. Found in marshes, wooded stream banks, and all types of inland waterways, river otters are almost completely aquatic, although they sometimes travel overland great distances to reach another stream (Forsyth, 1985).

The primary diet of the river otter is fish. They also eat crabs, mussels, clams, snails, and aquatic invertebrates (Walker, 1983), and occasionally birds and small land mammals such as rodents and rabbits. River otters are more prolific reproducers than bears, with a gestation period of 60 to 63 days (Toweill and Tabor, 1982) and females breeding more than once a year at age 2. Predators include bobcat, lynx, coyote, wolves, bald eagle and great horned owl when they are young.

Following the oil spill, eleven river otter carcasses were found on beaches. It is estimated that as many as 50 animals could have been killed if it is assumed that the recovery rate of carcasses is similar to that for sea otters. The bile from two river otters collected from oiled areas in 1989 was analyzed and found to contain elevated concentrations of hydrocarbons. This indicates that surviving river otters could have ingested contaminated food.

There are indications that chronic oil exposure may affect river otters in Prince William Sound, although there is uncertainty about the evidence. First, river otters captured in oiled areas after the winter of 1989-1990 weighed less than those captured in oiled areas, while they were of the same overall length. Since the oiled population is an island population (Knight Island) and the unoiled population is from a mainland location (Ester Passage), and there are no comparative prespill length and weight data from the two areas, it is difficult to determine whether this represents an effect of the spill. Second, chemical factors in the blood show slight differences between study areas: in the oiled population, haptoglobin concentrations and some amino transferase enzyme activities are slightly elevated. These differences could be caused by oil exposure, but they could also be cause by disease, handling stress, and parasitism.

A reduction in the number of prey species was noted in the diets of river otters in the oiled areas between 1989 and 1990; this reduction was not seen in the unoiled study areas. This reduction was probably due to the severe impact of the spill on the intertidal and shallow subtidal fauna in the oiled portions of Knight Island. Also, on Knight Island the average size of territories of river otters were larger than on the mainland, potentially a result of having to forage over a larger area to find sufficient food. Because of the lack of pre-spill data and follow-up study, however, there again is uncertainty.

Finally, data from an analysis of river otter droppings in latrine sites suggested that estimated populations sizes were not different between the study areas, although this conclusion also can be questioned because of the relatively small sample sizes employed.

Birds

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) lives only in North America, ranging from south of the arctic tundra in Alaska and Canada to the southern United States and Baja California in Mexico. In all States where it occurs, except Alaska, the bald eagle is classified as an endangered or threatened species and receives Federal protection under the Endangered Species Act (16 U.S.C. §1543 [1976 & Supp. V 1981]). Although the bald eagle in Alaska is classified as neither threatened nor endangered, the species is protected under the Bald Eagle Protection Act of 1940 (16 U.S.C. §§668-668d [1976 & Supp. V 1981]) and the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

Water is the feature common to bald eagle nesting habitat. Nearly all bald eagle nests are within two miles, and the vast majority are within a half mile, of a coastal area, bay, river, lake, or other body of water (Grubb, 1976; Lehman, 1979). Proximity to water reflects the dependence of bald eagles on fish, waterfowl, and seabirds as primary food sources. On National Forests in Alaska, protection measures for bald eagles and their nesting habitats are prescribed in the Memorandum of Understanding between the USDA Forest Service and the U.S. Fish and Wildlife Service. The Memorandum provides for the exclusion of all land-use activities within a buffer zone of 100 meters around all active and inactive bald eagle nests.

Abundant, readily available food resources are a primary characteristic of bald eagle wintering habitat. Most wintering areas are associated with open water, where eagles feed on fish or waterfowl, often taking dead or injured animals that are easy to find. Wintering bald eagles also use habitats with little or no open water if other food resources, such as carrion, are regularly present (Spencer, 1976).

There are estimated to be 27,000 adult bald eagles in Alaska. About 2,000 of these are in Prince William Sound and about 6,000 are found along the northern coast of the Gulf of Alaska. Bald eagles encountered floating oil while preying on fish and oil- contaminated carcasses, and heavy oiling of the plumage led to loss of flight and probably also loss of body heat. Preening also exposed eagles to oil by ingestion. While 151 eagles were found dead after the spill, an estimated 200 to 300 may have been killed.

There is considerable uncertainty as to the total number of eagles killed by the spill. Seventy-four percent of radio-tagged eagles that died of natural causes in a post-spill study were found in forest and other inland areas. If this carcass deposition pattern is representative of eagles dying from acute oil exposure, then total mortality based mainly on the recovery of carcasses during beach searches would be about 430 individuals. However, it seems unlikely that acutely oiled birds would die in similar locations as those that died of natural causes.

Most aerial surveys to estimate population size and productivity were conducted in Prince William Sound. Population estimates made in 1989, 1990 and 1991 indicate that there may have been an increase in the bald eagle population since the previous survey conducted in 1984, although considerable variability was associated with this data. Estimates for the three post-spill years were not significantly different.

Estimates of productivity indicate that in 1989, 85% of nests in moderately and heavily oiled areas failed, compared to 55% in lightly oiled and unoiled areas. In 1990, there were no differences between these areas. It is estimated that the loss of production in 1989 was equivalent to 133 chicks.

Peale's Peregrine Falcon

Peale's peregrine falcon (*Falco peregrinus pealei*) is a very large, dark western form, or subspecies, of the peregrine falcon. In North America it nests from the Aleutians, occasionally the Pribilofs, south to Queen Charlotte Island. In winter it migrates to California (Brown and Amadon, 1968). Though some of the subspecies of peregrine falcon are on the Endangered Species List, the race *pealei* has been considered stable and is apparently maintaining its population. This species is protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

During the breeding season, peregrines frequently inhabit offshore islands where bluffs provide suitable undisturbed nest sites and an abundance of food from nearby colonies of nesting seabirds. At all seasons, open country is preferred, particularly shores and marshes frequented by shorebirds and waterfowl.

Common Murre

The subspecies of common murre found in Alaska (*Uria aalge inornata* Salomonsen) breeds from the Commander Islands, Saint Matthew Island, and northwestern Alaska to Kamchatka, the Kurile Islands, southern Sakhalin, eastern Korea, and Hokkaido, and through the Aleutian and Pribilof Islands to southern British Columbia (Johnsgard, 1987). This species is protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

Breeding colonies of common murres are largely restricted to subarctic and temperate coastlines on rocky coasts that usually have steep seaward cliffs, though low-lying coasts may also be used if they are remote and predator-free. Stratified rock layers providing nesting ledges, or weathered pinnacles and similar promontories, are important habitat components (Tuck, 1961). Murres normally nest in dense colonies and breeding is synchronized so that all young hatch at the same time. Synchronized breeding helps satiate predators such as gulls and ravens. Murres are highly social birds on the breeding areas, with maximum densities of 28 to 34 birds per square meter reported by Tuck (1960), with some birds occupying no more than 500 cm^2 (about 0.5 square feet) of ledge. No nest is built, though a few pebbles or other materials may be dropped at the nest site, perhaps to reduce rolling of eggs early in incubation before the egg has become cemented to the substrate by excrement and sediment (Johnsgard, 1987). Only one large pyriform (pear-shaped) egg is laid. If disturbed, the egg usually rolls in a small circle around its pointed end. There is often a fairly high loss of chicks to exposure or falls during the first 6 days after hatching, after which their clinging, hiding, and thermoregulation abilities have become better developed (Johnsgard, 1987).

Breeding success has been reported to be between 70 to 80 percent of young fledged per breeding pair (Birkhead, 1977; Hedgren, 1980). Birkhead (1974) estimated a 6 percent annual adult mortality rate and stated that most birds probably do not begin breeding until their fifth year. A 6 percent mortality rate results in an average life expectancy for adults of 16 years. Banded birds have been known to survive as long as 32 years, however.

Non-breeding habitats are coastal and pelagic areas. Typically, they are found in the offshore zone (at least 8 kilometers out to sea), and no more than a few hundred kilometers offshore at their southernmost breeding limits (Tuck, 1961). The common murre feeds predominantly on fish throughout the year. Prey are captured by extended dives, mostly at depths of 4-5 meters, but sometimes by bottom feeding at 8 meters (Madsen, 1957). Foraging tends to occur in flocks early in the breeding season, but as the year progresses, murres begin to forage individually.

The oil spill caused population declines and sublethal injuries at murre colonies in the Gulf of Alaska. Including both common murres and thick-billed murres, there are about 12 million murres in Alaska, and 1.4 million in the Gulf of Alaska region. About 1.2 million of the total population in the Gulf of Alaska nest on the Semidi Islands, which were not directly impacted by the oil. Murres are particularly vulnerable to floating oil and have been killed in large numbers by oil spills elsewhere in the world.

At the major breeding colonies studied (Chiswell Islands, Barren Islands, Puale Bay, and the Triplets), an estimated 120,000 - 134,000 adult breeders were killed by contact with oil. The oil arrived in early April just as birds were beginning to congregate at the colonies in anticipation of breeding. If the rate of mortality is adjusted for birds not counted on the colonies, but feeding at sea, it is estimated that 170,000 to 190,000 breeding birds were killed. In general, it is estimated that between 35 percent and 70 percent of the breeding adults at the above colonies were killed by the spill. It is not known where pre-breeding juveniles were at the time of the spill, or if many were killed.

The timing of reproduction also changed at oil-impacted colonies following the spill. At the Barren Islands and at Puale Bay, egg laying was about a month late in 1989, 1990 and 1991. In 1992 there were some indications that breeding was returning to normal at places in the Barren Islands colony. At the Chiswell Islands, laying was not observed in 1989, and laying was late in 1990. Due also to fewer birds occupying these colonies, it is likely that the rate of predation was much greater than normal, since these colonies rely on sheer numbers of birds to discourage predation by gulls and eagles. Furthermore, the delay in egg-laying (estimated to be one month) that has been seen in the Barren Islands, at Puale Bay and in the Chiswell Islands since the spill, may produce chicks that cannot survive the first autumn storms in the Gulf of Alaska. Conservatively, the estimate of lost production associated with delayed reproduction could exceed 300,000 chicks.

Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratum marmoratum*) breeds on islands and in coastal areas from southeastern Alaska to northwestern California. In Alaska, it is probably a common to abundant breeder in southeastern and south-coastal areas, a resident and probable local breeder in the Alaska Peninsula and also the Aleutians, and a casual summer visitor in western areas (Kessel and Gibson, 1976). The marbled murrelet is a species of concern in Alaska and is listed as threatened under the Endangered Species Act (16 U.S.C. §1543 [1976 & Supp. V 1981]) in Washington, Oregon, and California. This species is also protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

The total breeding distribution of this species is poorly understood, but it apparently is limited to fairly warm waters of the west coast of North America. It is most closely associated with the humid coastal areas supporting wet-temperate coniferous forests with redwood, Douglas fir, and other ecologically similar species, but it also inhabits coastlines along tundra-covered uplands along the Alaska Peninsula and in the Aleutian Islands. In winter the birds move farther south, sometimes as far as southern California, but some wintering occurs on protected waters as far north as the Kodiak area of Alaska and as far west as the Aleutians (Forsell and Gould, 1981). For most of the year the birds seem to prefer semiprotected waters of bays and inlets, making only limited use of rock coastlines (Hatler, Campbell, and Dorst, 1978).

The murrelet eats small fishes it catches by diving in tide rips and other places where small fishes swim in schools. The major fish prey, sand lance (*Ammodytes*), belongs to a group of fish in which the young of the previous fall and winter tend to migrate to surface waters and move inshore in late spring, when they would become available to the murrelets. The murrelet's fall and winter diet is essentially unknown, but samples from a few birds suggest that sea perch (*Cymatogaster*) may be an important food item, and possibly also ~~mysid and~~ schizopod crustaceans (Sealy, 1975). Nearly all foraging is done in fairly shallow water close to shorelines. During the course of a study involving fishermen who salvaged dead birds for inspection, Carter and Sealy (1984) found that the marbled murrelet was the most frequently killed alcid. Marbled murrelets were killed almost exclusively at night and within 2 meters of the surface. They estimated that this accounted for 7.8 percent of the potential fall population, or 6.2 percent of the breeding birds. They also reported 600 to 800 murrelets killed annually in Prince William Sound.

Approximately 612 marbled murrelets were recovered from beaches following the spill. Based on other carcass recovery studies, this suggested that between 8,000 and 12,000 birds may have been killed by the oil spill, which appears to be about 5 - 10% of the current population in the affected area. The available post-spill data indicated that marbled murrelets population have declined since the last census conducted in the middle 1980s. The oil spill probably increased the rate of decline for this species in the spill area, although the magnitude of incremental injury is difficult to estimate.

Storm Petrels

Storm petrels are among the smallest of the seabirds, measuring between 7½ and 9 inches in length and having a wingspan of 18 to 19 inches. With the exception of the breeding and nesting period, these birds spend their entire lives on the ocean. Two species of storm petrels are known to occur in Alaska. Those species are the fork-tailed storm petrel (*Oceanodroma furcata*), and Leach's storm petrel (*Oceanodroma leucorhoa*). The fork-tailed storm petrel occurs in the northern Pacific from the Bering Sea to southern California (Terres, 1980). The breeding range includes the Kurile, Komandorskie, and Aleutian Islands, southward along the North American Pacific coast to northern California. Leach's storm petrel occurs throughout the oceanic portion of the northern hemisphere. This species' breeding and nesting range includes coastal islands in the northern Pacific and northern Atlantic. In the Pacific, breeding occurs on the Kurile and Aleutian Islands, Alaska, and southeast along the Pacific Coast to Baja California (Godfrey, 1979; Terres, 1980). Storm petrels are protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

The petrel's primary food sources are small fishes, crustaceans, mollusks, small squids, and oily materials gleaned from the ocean (Terres, 1980). Habitat requirements for storm petrels include the open ocean and coastal islands for nesting purposes. For breeding purposes, storm petrels prefer offshore islands. The preferred breeding and nesting habitats are burrows or rock crevices on marine islands and islets, although they have been known to nest up to 1 mile inland (Terres, 1980). The burrow is usually approximately 3 feet long, somewhat angled, and is excavated by the petrel. Some plant debris may accumulate at the nest site. Banding has shown that older breeding birds are the first to return to the nesting site in spring, and that pairs often return to the same nest burrow each year. It is thought that the species mates for life (Terres, 1980). As this species nests in burrows, primary predators in the oil-spill area included foxes that have been introduced to the islands.

The breeding season begins in late May for Leach's storm petrel and in June for the fork-tailed storm petrel. A single clutch consisting of one egg is produced. If that clutch is destroyed, storm petrels do not produce a second egg (Harrison, 1978). Incubation begins when the first egg is laid, usually in late May or early June for Leach's storm petrel and June to July for the fork-tailed storm petrel. Incubation lasts from 5½ to 7 weeks (Terres, 1980). The fledglings are usually deserted by the parents after 40 days. The young remain in the nest, living on fat reserves, and emerge at night to exercise as their feathers grow. The fledglings leave the nest for the sea 63 to 70 days after hatching (Harrison, 1978).

Data from the U.S. Fish and Wildlife Service's seabird colony catalog (Sowls *et al*, 1978) indicate that approximately 150,000 storm petrels colonized the Barren Islands for breeding and nesting prior to the oil spill. Post oil spill studies (Fry, 1993) indicated that storm petrels were not directly impacted by the oil spill because they did not return to their breeding colonies until most of the oil had drifted away from the Barren Islands. However, 363 storm petrel carcasses were recovered after the spill, indicating that a number of individuals of this species were killed at sea. Injury assessments indicated that storm petrel reproduction was normal in 1989, although petrels had reportedly ingested oil and transferred that oil to their eggs. There has been no documented change in the current storm petrel population status, and no decline in population following the oil spill.

Black-legged Kittiwake

The black-legged kittiwake (*Rissa tridactyla*) is a marine bird occurring throughout the northern part of the northern hemisphere. With the exception of the breeding season, this species occurs almost exclusively in offshore waters. The nesting range includes islands and shores of the Arctic Ocean south to the Aleutian Islands and southern Alaska, southern Newfoundland, France, the Kurile Islands, and Sakhalin. The winter habitat range extends south to Baja California, southern New Jersey, northwestern Africa, and Japan (Godfrey, 1979). This species is protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]). The kittiwake's primary food sources are small fishes and small mollusks, crustaceans, and other plankton (Terres, 1980).

Black-legged kittiwakes were among the most abundant colonially nesting seabirds in Prince William Sound (Irons, 1993). Additionally, the U.S. Fish and Wildlife Service's seabird colony catalog (Sowls *et al*, 1978) documented 46,600 kittiwakes utilizing the Barren Islands for breeding and nesting. Ten of the 27 colonies within Prince William Sound were subjected to the oil spill. In 1989, 1,225 carcasses were recovered from beaches after the oil spill. Post-spill monitoring has shown that overall, the number of breeding pairs did not substantially decline subsequent to the oil spill. However, the reproductive success of the kittiwakes at the oiled colonies was lower than expected in 1990, 1991, and 1992 when compared to previous years reproductive success (Irons, 1993). In 1989, kittiwakes built their nests using contaminated seaweed (i.e., *Fucus*). It is possible that reproductive failure of some kittiwake colonies may have been related to this oil exposure (Fry, 1993). Additionally, the brood size of fledglings decreased, suggesting less available food (Irons, 1993).

In 1989, contaminant analyses indicated that one out of 10 kittiwakes from oiled colonies contained hydrocarbon contaminated tissues. A follow-on study carried out in 1990 indicated that none of the birds collected in the oil spill area had contaminated tissues, but two out of five kittiwakes examined had ingested hydrocarbon contaminated material suggesting that oil may have persisted in the food chain (Irons, 1993).

Black-legged kittiwakes often nest in dense colonies, usually on high cliffs overlooking the sea, and in sea caves. Their nest sites may be associated with murres and other seabirds. Their breeding season begins in May. Nests are deeply cupped and constructed of grass, mud, moss, and seaweed (Terres, 1980). Nests are often built on small projections or irregularities in the rock face. On the average, a single clutch consisting of two eggs is produced. Incubation lasts from 25 to 30 days (Harrison, 1978). Although black-legged kittiwakes are a single-brooded species, lost clutches are often replaced. The nestlings are tended by both adults, and are fledged between 38 and 48 days of hatching (Terres, 1980).

Pigeon Guillemot

Pigeon guillemots (*Cepphus columba*) have been documented as year-round residents of the Gulf of Alaska and the Aleutians. They are generally dispersed as single birds or small colonies of fewer than 1,000 individuals. In the winter, they move from exposed coastlines to sheltered bays and inlets. The winter range encompasses the Pribilof and Aleutian islands to the Kamchatka and the Kurile Islands, and south to California. During the nonbreeding season, the birds are nonpelagic and fairly sedentary. They rarely move into water more than 50 meters deep, and they tend to spread out thinly along coastlines in winter. Their breeding range extends from Chukotski Peninsula and Diomede Islands to southern Kamchatka, and from Saint Lawrence and Saint Matthew islands and the Aleutians west to the Attu, Bogoslof, and Shumagin Islands, Kodiak, and southeastern Alaska south to Santa Barbara Island, California. The pigeon guillemot is protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

The pigeon guillemot is a diving bird that feeds on bottom dwelling small fishes (e.g., blennies, sculpins, cods), schooling fish (e.g., sand lance, herring), mollusks, crustaceans, and marine worms (Oakley and Kuletz, 1993; Terres, 1980). This species is heavily dependent upon the nearshore and intertidal environments. Most of the guillemot's prey are found on or over rocky bottoms within the subtidal zone (Johnsgard, 1987). Dietary preferences may vary between individuals of this species.

The pigeon guillemot breeding season begins in mid-May to mid-June, depending on latitude. The pigeon guillemot nests either solitarily or in small colonies (Terres, 1980). Nesting distribution may be dictated by the availability of nesting sites rather than by any colonial tendency, and is thought to be related to the use of inshore feeding areas. Breeding densities have been documented to range from 5 to 110 pair per colony (Johnsgard, 1987). Nests are often located in crevices or cavities under rocks, in crevices, or in similar cavity sites (Harrison, 1978). This species is also known to nest under railroad ties, use abandoned puffin and rabbit burrows, and nest on bridges and beneath wooden piers (Terres, 1980). In rocky habitats, the nests are usually close to water, often near the high-tide line. Throughout the breeding season, pigeon guillemots use the supratidal and intertidal areas in front of the nest sites for feeding and social activities (Johnsgard, 1987). Eggs are typically deposited on the bare cavity floor of the nest site, as no nest-lining materials are ever brought into the cavity. The female produces one clutch consisting of two eggs. This species is thought to be single-brooded, as the incidence of renesting after the loss of the initial clutch is still unproven (Johnsgard, 1987). Both sexes incubate, with incubation lasting from 30 to 32 days (Terres, 1980). Losses of eggs before hatching are sometimes fairly high. Causes of egg failure are diverse and include human disturbance, heavy rainfall causing nest desertion or chilling, and predation (Johnsgard, 1987). Egg survival may be affected by crow and gull predators. The northwestern crow (*Corvus caurinus*) has been identified as a serious guillemot egg predator (Bent, 1919).

The young are able to fly 29 to 39 days after hatching (Terres, 1980). At fledging time, the chicks are led from the nest to the water or, if necessary, fly or glide down from higher sites. The adults then either cease to tend the chicks, leaving them to feed in nearby kelp beds (Thoreson and Booth, 1958), or convoy the chicks to deeper water where they are tended by adults for about a month after leaving the nest (Johnsgard, 1987). It is thought that pigeon guillemots do not begin breeding until they are 3 to 5 years of age.

Because these birds forage nearshore and often congregate on rocky beaches, they were vulnerable to the spilled oil. Five hundred and sixteen guillemot carcasses were recovered after the spill. Total mortality is estimated to be between 1,500 to 3,000 individuals, and may be as much as 10 - 15% of the pigeon guillemot population in the Gulf of Alaska. The results of boat surveys in Prince William Sound indicate that the population of this species was 14,600 in 1973. After the spill, the populations were 4,000 in 1989; 3,000 in 1990; and 6,600 in 1991. The population in Prince William Sound was probably declining prior to the spill, but the survey data indicate that the decline in oiled areas was greater than in unoiled areas. For the Naked Island group, results of post-spill surveys indicated a 40% decline in abundance compared to the latest pre-spill surveys in the mid-1980s. The decline showed a correlation with degree of shoreline oiling. The oil spill probably increased the rate of decline for this species in the spill area, although the magnitude of incremental injury is difficult to estimate.

There are limited management opportunities to increase pigeon guillemot populations. Identification, restoration, and protection of important nesting and feeding areas would facilitate population restoration.

Glaucous-winged Gull

The glaucous-winged gull (*Larus glaucescens*) occurs primarily along the Pacific coast of North America. The summer range extends from Alaska and St. Lawrence Island, the Pribilofs, and the Aleutians south to northwestern Washington. The winter range extends from southeastern Alaska along the Pacific coast to Baja California (Terres, 1980). This species is protected under the Migratory Bird Treaty Act (U.S.C. §§703-711 [1976 & Supp. V 1981]).

The glaucous-winged gull is oceanic in its habits, is most often found in the vicinity of salt and brackish water along the northern Pacific coast, and is rarely found more than a few miles offshore. This species is omnivorous, scavenging for garbage on docks, dumps, and shores near coastal cities. Glaucous-winged gulls follow boats and ships up and down the coast in search of food, and will eat carrion and fishes at sea. From the nearshore areas, this species gathers barnacles, mollusks, and sea urchins for food (Terres, 1980; Godfrey, 1979).

Glaucous-winged gulls breed on steep coastal cliffs and rocky islands offshore. They often nest colonially, usually on flat, low islands, rock ledges of higher islands, or on rock outcroppings. Nests are well-made bulky cups of grasses, seaweeds, feathers, fish-bones, and other debris built among tufts of plant life or left in the open on rocky ledges. The breeding season begins in late May. The female produces a single clutch of two to three eggs that are incubated for 26 to 28 days. The young are tended by both adults and leave the nest between 35 and 54 days. Glaucous-winged gulls are single-brooded, but usually replace lost clutches (Harrison, 1978; Terres, 1980).

Harlequin Duck

The harlequin duck (*Histrionicus histrionicus*) is a diving duck common to the northern coastal areas of North America, specifically along the coasts of the Aleutian Islands and Alaska. The harlequin duck occupies both an eastern and western range in the Northern Hemisphere. The western range includes northeastern Siberia north to the Arctic Circle, across the Bering Sea to the Aleutian Islands, much of the Alaskan interior, and south to northwest Wyoming and central California. The western population is much more abundant than the eastern population, with the main western stronghold located in Alaska. The greatest abundance of harlequin ducks is in the Alexander Archipelago, the Alaska Peninsula, and the Aleutian Islands (Bellrose, 1980; Johnsgard, 1978; Terres, 1980). This species is protected under the Migratory Bird Treaty Act (U.S.C. §§703-711 [1976 & Supp. V 1981]).

Fall and spring migration patterns consist of lateral movements from interior breeding grounds to coastal habitat. A number of ducks migrate from the Alaskan interior to the Aleutians each fall. Additionally, the harlequin duck population in the oil spill area consists of both resident and migratory birds. The migratory ducks spend the winter in Prince William Sound, leaving for their nesting areas in May. In the late 1960s, the May to August population estimates for the Aleutian Islands National Wildlife Refuge ranged from 100,000 to 150,000. Population estimates for this wildlife refuge peak during the winter season (September to April) and range from 600,000 to 1 million individuals (Bellrose, 1980).

During the summer breeding season, the preferred habitat of the harlequin duck is cold, turbulent mountain streams, or ponds and lakes along rocky arctic shores in remote areas. The species favors forested mountain streams over non-forested streams. Patten and Crowley (1991) found that harlequin duck nesting sites in Prince William Sound were within 25 meters of streams or small tributaries to streams. Cassirer and Groves (1990) observed harlequin broods more often on undisturbed streams, away from human activity. Streams with adjacent logging activity within 50 meters would be unsuitable for harlequin duck breeding activity for more than 20 years after the initial logging cut. This species is sensitive to human disturbance (logging, near shore boating, research activities). Reduced disturbance at breeding and molting sites may increase productivity by allowing paired ducks to maintain their pair-bonds during the pre-nesting and nesting seasons. In winter, the harlequin duck's preferred habitat is heavy surf adjacent to a rocky coastline with shelves, reefs, and sunken rocks in remote areas (Terres, 1980).

Harlequin ducks are not known to breed until their second year. After reaching maturity, adults breed annually. Their breeding season begins in mid-May of each year. Adults congregate at the mouths of anadromous fish streams in spring, and most are paired by the time they leave the coastal wintering area for their interior breeding grounds. Harlequin ducks are primarily surface nesters and may use the same nest site each year. The nests are always well concealed by dense vegetation and are located along the rocky shores of turbulent mountain streams, often adjacent to rapids, in mature forests. Nests are composed of thin layers of grass, twigs, and leaves and are lined with white down (Bellrose, 1980).

The female produces one clutch consisting of three to seven eggs, laid at a rate of one every two days. The male leaves the breeding ground shortly after incubation begins, in preparation for the molt. The incubation period lasts from 27 to 33 days, although the time period has not been firmly established. The ducklings are tended by the female only, and are capable of flying in about 40 days (Johnsgard, 1978; Harrison, 1978; Terres, 1980). The female remains with the brood in the freshwater stream until late summer when they migrate to the coastal habitat.

Harlequin ducks feed by day, usually by themselves, and roost on rocks at night. They prefer water rich in aquatic life. The harlequin is a diving duck, and is well adapted to swimming in torrential currents. They often emerge at their points of entry, indicating an ability to walk along the bottom of the stream against the current. At times they feed by immersing their heads or upending like dabbling ducks (Terres, 1980; Bellrose, 1980).

The harlequin duck feeds primarily on crustaceans, mollusks, insects, echinoderms, and fishes. In the mountain streams during summer, the harlequin will prey on mayfly nymphs, stone flies, caddis fly larvae, and black flies. During the winter months, the duck will feed about sunken wrecks and rock breakwaters, and rocky underwater places. The primary prey in the coastal habitat are crustaceans (crabs, amphipods, isopods) and mollusks (barnacles, limpets, snails, chitons, blue mussels) that are dislodged from rocks (Bellrose, 1980; Johnsgard, 1978; Terres, 1980).

During the fall, harlequin ducks can be legally harvested in Alaska. Management opportunities to increase harlequin duck populations include temporary restrictions on sport and subsistence harvesting of this species. Additionally, restoration of oiled mussel beds and adjacent anadromous streams; and identification, restoration, and protection of important nesting and feeding areas would facilitate population restoration.

The oil spill caused population declines and appears to have caused sublethal injuries in harlequin ducks. Of the six species of sea ducks studied, harlequin ducks feed highest in the intertidal zone where most of the stranded oil was initially deposited and in some cases still persists. An estimated 600 harlequin ducks were killed by the spill. The resident pre-spill population of harlequin ducks in western Prince William Sound was estimated to be approximately 2000. Wintering migrants increase this population in the western Sound annually by 10,000. With few exceptions since 1989, neither breeding adults nor fledglings have been located in the heavily oiled areas of western Prince William Sound. Evidence of breeding activity in the unoiled eastern Prince William Sound appears to be normal.

Elevated concentrations of hydrocarbons and their metabolites were found in the bile of harlequin ducks collected in western Prince William Sound in 1989. If residual oil in the diet is affecting reproduction, then the effect should begin to diminish once the threshold for toxicity is reached and the levels of persistent oil decrease in the environment. Unfortunately, we have no information after 1989 that determined exposure levels in bile for harlequin ducks in western Sound. Also, there is so little known about how oil may affect reproduction and what physiological changes can be induced by feeding on oiled prey. For these reasons, the possible causes of breeding failure have not been established.

Black Oystercatcher

The black oystercatcher (*Haemotapus bachmani*) is a large shorebird easily distinguishable by its long red bill used to open bivalves. The oystercatcher is often seen on rocky ledges along outer beaches where it preys on attached shellfish exposed by retreating tides. The black oystercatcher's range extends along the Pacific coast from Kiska Island, the Aleutians, Alaska, and south to Baja, California. The species is casual in winter on Pribilof Island and Yukon. The black oystercatcher does not migrate, and winter flocks seldom wander more than 30 miles from their nesting places (Terres, 1980). Observations from Alaska, however, indicate that some birds may disperse in the winter. The black oystercatcher prefers a rocky habitat. Outer saltwater shores and islands are most suitable (Godfrey, 1979). This species feeds in the intertidal zone, primarily on limpets, mussels, clams, and chitons (Terres, 1980). The black oystercatcher is protected under the Migratory Bird Treaty Act (U.S.C. §§703-711 [1976 & Supp. V 1981]).

Black oystercatchers may take two to three years to reach sexual maturity. The oystercatcher breeds on coastal sites, preferring rocky shores, promontories, and islands. The highest breeding densities occur on low elevation, gravel shorelines with little wave action. Nests consist of hollows on gravel beaches above the tide line, or hollows of a rocky islet or reef. Nests are often unlined, or lined with a variable amount of small pebbles or bits of stone and shell chips. Nesting begins in late May or early June. This species is single-brooded, but renests to replace lost clutches. The female produces a single clutch of two to three eggs. Both sexes incubate the eggs for a period of 26 to 27 days. The chicks are usually fledged after 30 days but may continue to be fed by the adults. The young are very active, drawing attention to their location, and are thus vulnerable to predation. Known predators include the river otter, mink, and gulls (Terres, 1980; Harrison 1978; Godfrey, 1979).

The spill caused population declines and sublethal injuries to black oystercatchers. Nine black oystercatcher carcasses were recovered from beaches after the spill. It is unknown how many additional oystercatchers were killed by the spill, but were not recovered. Pre-spill (1972-1973, 1984) and post-spill population surveys suggest that within Prince William Sound, an estimated 120 - 150 black oystercatchers representing 12% - 15% of the total estimated population, died as a result of the spill. Mortality outside of Prince William Sound is unknown, but the total spill-area population is thought to be approximately 2,000 birds.

In addition to mortality caused directly by the spill, oiling also affected their reproductive success. Egg volume and the weight of chicks raised in oiled areas were lower compared to those raised in unoiled areas; however, there are no pre-spill data and it is not known if those conditions existed before the spill. Other measures such as hatching success, fledgling success, and chick production were not different between oiled and unoiled areas. It is quite possible that in 1989 and 1990, disturbance associated with clean-up activities of oiled study areas, e.g., Green Island, contributed to these differences.

Fish

Pink Salmon

Pink salmon (Oncorhyncus gorbuscha), both hatchery reared fish and wild stocks are managed by the Alaskan Department of Fish & Game (ADF&G) in freshwaters and within a three mile limit in marine waters. The North Pacific Fishery Management Council 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 (INPFC) provides conservation measures that limit location, time, and number of fishing days beyond the 200 mile limit.

Pink salmon have the simplest and least variable life cycle of all salmon. Adults mature after 2 years and die after their first spawning. Because of this simple life cycle, populations spawning on odd number calendar years are effectively isolated from populations spawning on even number years, therefore, no gene flow occurs between the populations (Bonar et al., 1989). As adults, pink salmon return to their natal spawning grounds in the fall to reproduce, traveling several miles up their natal streams (Scott and Crossman, 1973). However, as much as 75 percent of Prince William Sound populations spawn in the intertidal zone (ADF&G, 1985a). Spawning generally occurs between June and mid-September, and hatching occurs between October and January.

The diet of pink salmon fry consists primarily of invertebrate eggs, amphipods, and copepods. Juveniles feed primarily on larger invertebrates and small fishes, and adults feed mostly on euphausiids, squid, other invertebrates, and small fishes (Bonar et al., 1989 and ADFG, 1985a). Eggs, alevins, and fry are preyed upon by Dolly Varden, cutthroat trout, coho salmon, other fishes, and aquatic birds. During spawning migrations, juveniles and adults are consumed by terrestrial mammals such as bears and otters, and by marine mammals, predatory birds, and other fishes while at sea (ADF&G, 1985a).

The oil spill caused sublethal injuries to wild populations of pink salmon, but there is continuing debate on whether the wild stock population has been affected. Seventy-five percent of the wild pink salmon spawn intertidally at the mouth of streams in Prince William Sound. There was no apparent change in the use of this habitat in the summer of 1989, and many salmon deposited their eggs in the intertidal portion of oiled streams. In the autumn of 1989, egg mortality in oiled streams averaged about 15%, compared to about 9% in unoiled streams. Since 1989, egg mortality has generally increased, until in 1991, there was an approximate 40 - 50% egg mortality in oiled streams, and 18% mortality in unoiled streams.

Although the differences between egg mortality in oiled and unoiled streams over the first two years are likely attributable to the effects of oil, the persistence of these differences three years after the spill was entirely unexpected and is not understood. In this regard, natural factors that vary between oiled and unoiled streams, e.g., the degree of wave exposure, have not been eliminated as possible causes of persistent differences. Also, the studies of pink salmon carried out after the spill have documented that adults released as fry from nearby hatcheries are wandering into streams and spawning with wild stocks. The potential effect of this phenomenon on egg survival has not been investigated. Some scientists suggest that the longer the differences in egg mortality persist, the less likely it will be that oil is the cause or a contributing cause.

Pink salmon fry released from hatcheries as well as wild pink salmon fry leaving their natal streams in the spring of 1989 were also exposed to oil in the open water. Both pink salmon and chum salmon larvae were exposed to sufficient amounts of oil to induce 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 is dependent on conditions during the larval stage; and lower food supply, temperature and growth will result in a lower return of adults the following year.

Despite the differences in egg mortality and larval growth, tagging data do not show that pink salmon populations were affected by the oil spill. For example, fry that were tagged as they left their streams in 1990, and were recaptured as returning adults in 1992, did not show differences in survival between oiled and unoiled streams. Fisheries experts disagree whether or not the increased egg mortality seen in the oiled streams is affecting the adult populations.

Seventy-five percent of the wild pink salmon spawn intertidally at the mouth of streams in Prince William Sound. There was no apparent change in the use of this habitat in the summer of 1989, and many salmon deposited their eggs in the intertidal portion of oiled streams. In the autumn of 1989, egg mortality in oiled streams averaged about 15%, compared to about 9% in unoiled streams. Since 1989, egg mortality has generally increased, until in 1991, there was an approximate 40 - 50% egg mortality in oiled streams, and 18% mortality in unoiled streams.

Sockeye Salmon

Both hatchery reared and wild stocks of sockeye salmon (*Oncorhyncus nerka)* are managed in freshwaters and within a 3-mile limit in marine waters by the Alaska Department of Fish and Game. The North Pacific Fishery Management Council prepares management plans, which become Federal law, and applies them to marine waters from the 3 mile limit to the 200 mile limit. The International North Pacific Fisheries Commission (INPFC) provides conservation measures that limit location, time, and number of fishing days beyond the 200 mile limit.

Spawning usually occurs between July and October. The female builds several redds in sand or graveled areas that will provide sufficient oxygenation for the eggs and alevins. Egg survival is dependent on chemical and physical characteristics of the gravel in which they are laid. One of the most critical life stages of sockeye salmon are the egg to juvenile stages. Several environmental requirements must be met for successful reproduction. The optimum temperature range for spawning is 10.6 to 12.2°C. Lower mortality and faster growth rates during incubation occur when water temperatures are between 8.9 and 10.0°C. Water temperatures higher than 23.0°C and lower than 7.2°C cause increased mortality and poor growth. Sockeye salmon require a minimum of 5.0 mg/l of DO for successful spawning. Low DO can disrupt swimming efficiency during migration and stunt the growth of alevins and juveniles (Pauley et al., 1989; ADFG 1985b). Egg mortality usually results from oxygen deprivation, freezing, flow fluctuations, dewatering, predation, or microbial infestation (Bonar et al., 1989). Changes in velocity can effect developing eggs and alevin through mechanical damage, temperatures changes, or reduced DO concentrations (Pauley et al., 1989; ADFG 1985b). The alevins leave the gravel as fry in April or May (Pauley et al., 1989).

The fry move into their nursery lakes and remain for 1 to 2 years, 3 years in some Alaskan lakes, as smolts. This is a critical stage in their life cycle. Mortality is generally high as a result of predation from Dolly Varden, rainbow trout, and coho salmon. During this time, the sockeye salmon are pelagic schooling fish that feed primarily on zooplankton during the afternoon and avoid predators at other times. Migration as smolts from the nursery lakes to the sea is usually temperature dependent. They migrate to the ocean and remain in the inshore areas for the first few months before moving out to the Gulf of Alaska. Adults generally remain in the marine environment for 2 to 4 years before returning to freshwater to spawn (ADFG, 1985b, Pauley et al., 1989).

Adults feed primarily on euphausiids, amphipods, copepods, and young fishes. When returning to fresh water, the adults generally do not feed. Juveniles in streams feed primarily on small insects and insect larvae, and eat zooplankton in lakes. In the marine environment, they feed on small crustaceans, plankton, and fish larvae. Juveniles are important prey species for birds and other anadromous fish species such as Dolly Varden, coho salmon, cutthroat trout, arctic char, and sculpin. Adults are preyed on by marine mammals and predatory fishes (Pauley et al., 1989; ADFG 1985b).

Kenai River and Red Lake-Kodiak sockeye salmon stocks may have suffered population declines as well as sublethal injuries. This potential injury is unique, since 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 (overescapement) of spawning fish to the Kenai and Red Lake systems in 1989, although this was the third consecutive year of overescapement to the Kenai River system.

For the Kenai system, more than 900,000 spawning fish returned each year from 1987 through 1989, when the system was managed for a return of only 600,000 fish a year. The cumulative effect of too many spawning adults in the Kenai River system has been a decline in smolt production. Although the exact mechanism by which this occurred is not clear, it is believed that concentrations of food (planktonic crustacea) are insufficient to meet the needs of the greater number of fry produced. Fewer fry surviving their first winter in rearing lakes result in fewer outmigrant smolt in the spring. Smolt production in the Kenai River system has declined as follows: 1987, 30 million; 1988, 6 million; 1989, 2.5 million; and 1990, less than 1 million. Outmigrations of smolt from the system have been on the decline since 1990 and the forecasted returns in 1994 are below escapement goals.

Pacific Herring

Pacific herring (*Clupea harengus pallasi*) are managed in freshwaters and within a three mile limit in marine waters by the Alaskan Department of Fish & Game (ADF&G). The North Pacific Fishery Management Council prepares management plans, which become Federal law, and applies them to marine waters from the 3 mile limit to the 200 mile limit. The International North Pacific Fisheries Commission (INPFC) provides conservation measures that limit location, time, and number of fishing days beyond the 200 mile limit.

At the time of the oil spill Pacific herring were spawning in the shallow eelgrass and algal beds. As a result, a large percentage of abnormal embryos and larvae were found in the oiled areas in Prince William Sound. There was also evidence of hydrocarbon metabolites in the bile of adult fish. It is unclear whether or not the adult population was affected by the oil spill; only when the cohorts from 1989 and 1990 return to spawn in 1992 and 1993 will determination of effect be possible.

Pacific herring mature between 2 and 4 years of age and spawn annually. They live offshore, but spawn in nearshore coastal waters. Their greatest mortality occurs during the egg to juvenile stages, when mortality is 99 percent. Adults have a lifespan of approximately 19 years (Pauley et al., 1988). Juvenile herring feed on crustaceans, mollusks, and fish larvae, and adults feed on euphausiids, planktonic crustaceans, and fish larvae (Pauley et al., 1988). Herring eggs are preyed on by shorebirds, diving birds, gulls, invertebrates, and fish. Herring larvae are eaten by jellyfish, amphipods, and fish. Adults are a prey base for large finfish, sharks, and marine mammals and birds (Pauley et al., 1988).

The oil spill caused sublethal injuries to Pacific herring in Prince William Sound, but scientists do not know whether these injuries will result in a population decline. Pacific herring spawned in intertidal and subtidal portions of Prince William Sound shortly after the spill. Although none of the herring spawning areas were heavily oiled, over 40% of areas used by herring to stage, spawn, or deposit eggs and 90% of the areas used for summer rearing and feeding were lightly or moderately oiled. Oiled spawning areas included portions of Naked and Montague islands.

Studies conducted in 1989 and 1990 showed a slight but statistically significant higher rate of egg mortality in oiled areas, compared to unoiled areas. In 1989, rates of larval mortality, lethal and sublethal genetic damage, and physical deformities also were greater in oiled areas. There also is some evidence of differences in histopathological condition and reproductive success in oiled areas in 1989. However, all differences between oiled and unoiled study sites were less pronounced in 1990, and were not observed in 1991.

Three-year-old herring exposed as eggs or larvae in 1989 were under represented in the 1992 spawning migration. In 1993, the 1989 year class represented only 5 - 10% of the spawning migration, and although contributing a relatively low number of potential spawners, this number is within the natural variation for individual year class size. There also was an outbreak of viral hemorrhagic septicemia (VHS) in herring returning to Prince William Sound in 1993 but it is not known if the disease is linked to the oil spill.

Rockfish

The North Pacific Fishery Management Council 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 (INPFC) provides conservation measures that limit location, time, and number of fishing days beyond the 200 mile limit.

There are more than 50 species of rockfish (*Sebastes* spp. and *Sebastolobes* spp.), including yellow 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. Their life histories are variable and not well understood. The following life history information is for the yellow rockfish. Yellow 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.

Yellow rockfish are opportunistic feeders. They feed primarily on a variety of crabs, shrimp, snails, and fish. Small yellow 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 whether or not population declines also occurred. There is little pre-spill 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, although there is some uncertainty associated with causes of these pathological changes. In 1990 and 1991, oil exposure was documented in oiled but also unoiled sites.

An additional unknown is the degree to which post-spill increases in fishing pressure may be impacting rockfish. Partially due to 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. While harvests decreased since 1990, 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.
The yellow rockfish range extends from Cook Inlet in Alaska south to Baja California (Hart, 1973). Rockfish grow very slowly and sexual maturity between 14 and 19 years of age and breeds annually thereafter. They grow slowly and produce few offspring. They can live up to 114 years. If is not known whether or how rockfish migrate, but older fish tend to move to deeper water (Carlson and Straty, 1981).

Dolly Varden

Dolly Varden (*Salvelinus malma*) are managed in freshwaters and within a three mile limit in marine waters by the ADF&G. The Alaska Board of Fisheries develops regulations governing sport harvest of fish in Alaska

Dolly Varden are found in fresh and salt water in western North America and eastern Asia. Their range extends from northern California to the arctic coast of Alaska (Scott and Crossman, 1973). There are both anadromous and nonanadromous populations in Alaska.

Dolly Varden 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 and spawn each year from age 6 to 10 years. The young remain in their natal streams for 3 to 4 years. The average life span of the Dolly Varden is 12 years (Scott and Crossman, 1973; ADF&G, 1985c).

Spawning occurs in the fall between September and December. The female builds the redd and is usually attended by 4 to 5 males during spawning. Fecundity is positively correlated with female size with females generally producing between 1,300 and 3,400 eggs. The eggs hatch in approximately 4 to 5 months. The alevin remain in the redd for approximately 18 days and then emerge as fry. 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 fresh water for 3 to 4 years before moving seaward. They are found near logs and undercut banks, where they seek protection from predation. Post-spawning mortality is usually high in adults (Scott and Crossman, 1973; ADF&G, 1985c).

The primary diet for marine adult Dolly Varden consists of smelt, herring, juvenile salmonids, and other small fishes. In the freshwater habitat, juvenile salmonids, invertebrates, and other small fishes are the main diet. Juvenile Dolly Varden feed near the bottom and prey on aquatic insects, insect larvae, and fish eggs (Scott and Crossman 1973, ADFG 1985c).

Both Dolly Varden char 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. Both species were captured at weirs on five stream 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.

While survival of Dolly Varden returning to oiled streams in 1990 was 32% less than those returning to unoiled streams, and survival appeared to be 57% less for cutthroat trout returning to oiled streams in 1990, these differences are not statistically different. There also are not pre-spill data with which to compare these results. However, it was determined that larger cutthroat trout grew significantly less in oiled areas in 1989, 1990 and 1991.

Cutthroat Trout

Cutthroat trout (*Salmo clarki*) are managed in freshwaters and within a three mile limit in marine waters by the Alaskan Department of Fish & Game (ADF&G). The Alaskan Board of Fisheries develops regulations governing sport harvest of fish in Alaska.

Cutthroat trout range from northern California, Oregon, British Columbia to Prince William Sound, Alaska at the very northern edge of their range (Pauley et al., 1989). There are both anadromous and nonanadromous populations in Alaska.

The oil spill caused some injury to the anadromous populations of cutthroat in Prince William Sound. Large cutthroat trout had a higher mortality rate in oiled areas than in unoiled areas. There was a 57% greater mortality rate in oiled streams in 1989-1990 and a 65% 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.

Male sea-run cutthroat trout mature at 2 to 3 years, and females mature at 3 to 6 years. Unlike salmon they can spawn annually for up to ten years. 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 return to the sea between March and July. They remain in the vicinity of the natal stream to feed along its shores, and they return to freshwater lakes to overwinter. Cutthroat trout have a high survival rate between spawnings (Pauley et al., 1989).

Cutthroat trout are sensitive to high turbidity and its associated problems. They cease migration in streams with turbidity greater than 4,000 mg/l and may stop feeding and move to cover when turbidities exceed 35 mg/l. Excessive silt loads can affect DO concentrations, causing increased egg mortality in the redds, and can disrupt the emerging fry. The preferred water velocity for successful spawning is 11 to 90 cm/s. Fry are generally found in water velocities of less than 30 cm/s, with an optimum velocity of 8 cm/s. Changes in flow can effect developing eggs and alevin in several ways, including mechanical damage, temperature changes, or reduced DO (Pauley et al., 1989).

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, callianassid 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 sculpins, 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).

Coastal Biological Communities

Coastal communities are protected under the Coastal Zone Management Act of 1972 (16 U.S.C. 1451-1464), the Alaska Coastal Management Act of 1977 (A6 46.40), and the Coastal Resource District Management Plans (6AAC 80 and 85). For the purposes of this document, coastal communities include the organisms living in the intertidal and subtidal zones, as described below.

Intertidal Organisms

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 dependent upon 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 area by many species of fish (*Exxon Valdez* Oil Spill Trustees, 1992). The intertidal zone serves as a feeding grounds 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 clean-up operations (Exxon Valdez Oil Spill Trustees, 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 the upper intertidal zone. With tidal action, oil penetrated deeply into cobble and boulder beaches that are relatively common on the rocky islands of the spill area. Cleaning removed much of the oil from the intertidal zone, but subsurface oil persisted in many heavily oiled beaches, and in mussel beds, which were avoided during the cleanup.

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 pre-spill data, these studies have relied on comparisons of oiled and unoiled sites. Because of our ability to measure effects on common organisms, these have been emphasized in the injury studies.

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 seaweed <u>*Fucus gardneri*</u> (rockweed or popweed), barnacles, limpets, periwinkles, clams, amphipods, isopods and marine worms were less abundant at oiled than unoiled sites. Although there were increased densities of mussels in oiled area, they were significantly smaller than mussels in the unoiled areas, and the total biomass was significantly lower. While the percentage of intertidal areas covered by <u>*Fucus*</u> was reduced following the spill, the coverage of opportunistic plants (ephemeral algae) that characteristically flourish in disturbed area was increased. The average size of <u>*Fucus*</u> plants was reduced, as was the reproductive potential of those plants surviving the initial oiling.

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 clam also were significantly affected by the spill. Also, in 1990, comparisons of abundance of intertidal fishes indicated fewer fish in oiled areas, but such differences were not found in 1991.

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

Profiles of the following intertidal inhabitants are presented in subsequent paragraphs: blue mussel (*Mytilus trossulus*), common littleneck clam (*Protothaca staminea*), and Pacific razor clam (*Siliqua patula*). These organisms play important ecological and commercial roles within the EVOS area (e.g., mussels provide a source of food for many other organisms, and clams are harvested both recreationally and commercially).

Blue Mussel. Within the United States, the subspecies of blue mussel called *Mytilus trossulus* is distributed from Oregon to Alaska (Moore, personal communication, 1993). It is found along rocky coastlines, in bays, and in estuaries. Blue mussels are harvested commercially for bait and for food. Blue mussels are suspension feeders and feed on dinoflagellates, organic particles, small diatoms, zoospores, ova and spermatozoa, flagellates, unicellular algae, and detritus. There is limited culturing of these mussels for food. These mussels are preyed upon by sea stars, gastropods, crabs, sea otters, black oystercatchers, and ducks (Shaw *et al.*, 1988).

Blue mussels are subject to pollution and paralytic shellfish poisoning. Commercial harvest of another subspecies of the blue mussel in California has decreased immensely over the years, primarily due to the repercussions of paralytic shellfish poisoning. These mussels can also accumulate hydrocarbons in their tissues by taking hydrocarbons up through the gill tissues. Although oil is only slightly toxic to mussels, it may prevent mussels from being marketed as food, as well as cause them to be toxic to predators (Shaw *et al.*, 1988).

Common Littleneck Clam. The common littleneck clam species is widely distributed along the coast of the Northwest region, but can be found from Mexico to the Aleutian Islands, Alaska. It serves as an important sport and subsistence species. This species is found in both intertidal and subtidal zones. Common littleneck clams are farmed in the intertidal zone in Puget Sound. It is a filter-feeder, feeding primarily on diatoms. Predators of the common littleneck clam in Prince William Sound include the sea star and the sea otter (Chew and Ma, 1987).

Studies show that the quantity of common littleneck clams landed in the U.S. Pacific Northwest have been decreasing yearly (these statistics did not include Alaska). Little recruitment of common littleneck clams occurred in Prince William Sound in 1967 to 1971 due to poor spawning and recruitment conditions. Harvest of abundant clams along the coast of Alaska is limited because of paralytic shellfish poisoning (i.e., toxic phytoplankton is filtered in and accumulated by shellfish and is fatal to humans, but not to the shellfish). It has been shown that common littleneck clams grow at a slower rate in oil-treated sediments, and they tend to burrow to a shallower depth, making them more accessible to predators (Chew and Ma, 1987).

Pacific Razor Clam. The Pacific razor clam species is found on open sandy beaches from Pismo Beach, California to the Aleutian Islands, Alaska. Large razor clams tend to inhabit the lower intertidal zone, and razor clams found in the subtidal zone tend to be juveniles. The razor clam filters its food from the water it inhabits, and serves as prey for seagulls, sea ducks, and Dungeness crabs. This species supports an active sport fishery and limited commercial harvest. It has been suggested in the past that artificial propagation of razor clams is not feasible; however, the State of Washington has maintained a razor clam hatchery since 1980 (Lassuy and Simons, 1989).

The razor clam has been subject to disease in the past. Paralytic shellfish poisoning in razor clams was found in Alaskan razor clam populations between 1985 and 1987 (Lassuy and Simons, 1989).

Subtidal Organisms

The subtidal zone is the environment below the low tide. The shallow subtidal zone differs in community composition from deeper marine habitats and is especially vulnerable to oil spills. Inhabitants of the shallow subtidal zone consist of amphipods, clams, eelgrass, crabs, juvenile cod, *Laminaria* plants, spot shrimp, and many other organisms. As with the intertidal zone, oil-contaminated areas in the subtidal zone suffered declines in the populations of many of the organisms that inhabited them.

The oil spill caused population declines and sublethal injuries in the communities of plants and animals found below low tide. Several kinds of subtidal environments were studied after the spill: eel grass beds, *Laminaria* (kelp) beds, fjords and the deep bottom (40 to 100 meters). All these studies relied on comparisons between oiled and unoiled environments. Study sites also were matched for conditions (sediment grain size, depth., etc.) likely to affect the distribution and abundance of organisms.

The greatest differences were seen for small organisms living in the sandy sea bottom below eelgrass beds--they were less abundant in oiled environments. Among affected groups were amphipods, known from previous studies to be highly sensitive to oil. In addition, there were larger organisms that showed differences in abundance, most notably the crab *Telemesus* was less abundant in oiled areas. Two separate studies found that eelgrass in oiled areas did not bloom as well after the spill as in unoiled areas. Other organisms, however, were more abundant in oiled areas--some small mussels that live on eel grass and juvenile cod. Even greater differences were observed in the abundance of fauna at depths from 6-20 meters below the oiled eelgrass beds, where there were far fewer individuals in oiled areas.

The results of other subtidal studies were more equivocal. Chemical analyses show that Exxon Valdez oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases. Reduced abundances in fauna were encountered in several oiled bays at 100 m, but the causes of these differences are not clear. Some flatfish had elevated amounts of hydrocarbons in their bile in 1989 and 1990, and slightly elevated prevalences of gill damage.

Because of their ability to quickly take up petroleum hydrocarbons, and their inability to quickly metabolize the hydrocarbons, clams accumulate high concentrations of hydrocarbons. Therefore, clams inhabiting the shallow subtidal zone present an ongoing source of contamination to the many organisms that feed upon them (*Exxon Valdez* Oil Spill Trustees, 1992).

Social and Economic Environment

This section describes the social, cultural, and economic conditions of the EVOS region. Included are descriptions of the communities affected by the spill; a discussion of the impact of the spill on traditional Native and non-Native subsistence hunting and fishing; information about spill-related injury to cultural and anthropological resources; and a description of the economic base of the area.

Relevant State History

The Alaska Statehood Act (48 U.S.C.) admitted Alaska to the Union in January 1959. The act allowed the State to select 400,000 acres of National Forest and unreserved land for community use. In addition, the State was also empowered to choose 102.55 million acres of public lands from other unreserved U.S. lands.

The Alaska Native Claims Settlement Act of 1971 (33 U.S.C. § 1601-1624) settled aboriginal rights and established the legal claims for Alaska Natives. It also authorized formation of the Regional Native Corporations. 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.

Oil exploration and development grew after statehood was declared. In 1968, a discovery well at Prudhoe Bay on the North Slope uncovered the largest known oil field in the United States. The North Slope oil lease, completed in 1969, granted oil rights to an oil consortium and brought more than $900 million in bonuses to Alaskans. To provide for transporting the oil from the North Slope to a shipping point, Congress passed the Trans-Alaska Pipeline Authorization Act in 1973. Construction of the pipeline was completed in 1977. Today, the pipeline moves almost 2 million barrels (84,000,000 gallons, or 317,940,000 liters) from Prudhoe Bay to Valdez every day. Since 1977, the Port of Valdez has shipped the bulk of crude oil taken from Prudhoe Bay (*Alaska Blue Book*, 1991).

In 1976, the first of USDOI's Minerals Management Service lease sales for outer continental shelf (OCS) oil and gas were completed in the eastern Gulf of Alaska. Sales followed in Lower Cook Inlet (1977 and 1981), the northeastern Gulf of Alaska (1980), and east of Kodiak Island (1980). Although Valdez and Prince William Sound have little or no known oil or gas potential, the area is part of Lease Sale 88.

The Alaska National Interest Lands and Conservation Act of 1980 (ANILCA, 16 U.S.C. 3111 *et seq.*) in part implemented provisions of the Alaska Native Claims Settlement Act and the Statehood Act. In ANILCA Congress recognized 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 (KPB), the Kodiak Island Borough (KIB), the Lake and Peninsula Borough, and the Valdez–Cordova Census Area. The effects of the spill differ for each region and its communities. In general, the communities that experienced the most disruption were the small villages with larger Native populations, which are mixed cash-subsistence hunting- and fishing-based economies. Figure III- presents a summary of the baseline descriptive socioeconomic data for the *EVOS* communities.

Kenai Peninsula Borough

The Kenai Peninsula Borough, which is located south of Anchorage, 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 holds 99 percent of the borough's population and most of the area's development because it is linked by roads to Anchorage. Sixty-three percent of the borough's population lives in Kenai and Soldotna. The area is economically dependent on the oil and gas industry, as well as fishing and tourism. Communities within the central Kenai Peninsula region are the cities of Kenai, Soldotna, and Seward.

The southern Kenai Peninsula contains the cities of Homer and Seldovia and the Native villages of Port Graham and English Bay. Homer is the economic and population hub of the region, with revenues from commercial fishing, tourism, government and commercial offices, and agriculture. In contrast, the Native villages are largely dependent upon subsistence hunting and fishing. Residents of these communities who relied upon subsistence were adversely affected by actual contamination or perceived contamination of subsistence foods.

Kodiak Island Borough

The Kodiak Island Borough (KIB) includes the city of Kodiak and the six Native villages of Port Lions, Ouzinkie, Larsen Bay, Karluk, Old Harbor, and Akhiok. The KIB population is between 13,000 and 15,000 and includes Natives of Aleutic background and immigrants from the Philippines and from Central and Meso-America. As in other parts of Alaska, Kodiak Island's population grows significantly in the summer. The KIB provides some social, cultural, and economic services to villages, and the Kodiak Area Native Association (KANA) provides medical and social services through the tribal governments in each village.

Nearly two-thirds of the Kodiak Island shoreline was oiled. Oil in varying forms spread from the northern end of the island along the west coast and through the many passages, coves, and small islands that make up the Kodiak Island group. In addition to the physical effects of the oil on these communities' land, social effects were associated with the cleanup activities that followed the spill. Daily life in many Native villages was disrupted by the presence of outsiders and by changes in the local economy caused by the influx of visitors and cash.

Lake and Peninsula Borough

The Lake and Peninsula Borough contains three communities—Chignik Bay, Chignik Lagoon, and Chignik Lake—which were exposed to oil in the form of tar balls and oil sheen. Some remote beaches were also oiled. Residents of all three communities are Aleut, Russian, and Scandinavian. The economies of the communities are mixed cash-subsistence.

Valdez-Cordova Census Area

The Valdez-Cordova Census Area covers an area of about 20,000 square miles of water, ice, and land in Prince William Sound. For the purpose of this study, the region includes five communities: Valdez, Cordova, Whittier, Chenega Bay, and Tatitlek. Each is accessible by air or water, and all have dock or harbor facilities. Only Valdez is accessible by road.

The region has an abundant supply of fish, shellfish, and marine mammals. These and the other natural resources of *EVOS* play an important part in the lives of area residents. In addition, the area offers significant opportunities for outdoor recreation and commercial tourism.

The 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 are also important to the local economy. Whittier residents work as government employees, longshoremen, commercial fishermen, and service providers to tourists. The Alaska Native people of Chenega Bay and Tatitlek, by contrast, rely on subsistence fishing, hunting, and gathering for their livelihood.

Transportation

Transportation resources 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. Road access is available from Anchorage to Homer and Seward on the Kenai Peninsula, and to Valdez and Cordova 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. Figure III-C summarizes the transportation resources in the Exxon Valdez oil spill area.

Cultural and anthropological resources

Sites important to the Alaskan culture were injured by the oil spill and by the cleanup response, mainly by increasing human activity in and around Prince William Sound. At least 24 archaeological sites, including burial grounds and home sites, were injured to various degrees. Injuries included vandalism, erosion of beachfront sites, removal of artifacts, and oiled sites. With regard to the oil spill, the three major sources of potential impact were direct impacts resulting from oil in direct contact with artifacts or features; treatment methods employed to remove oil; and human activities incidental to the response actions.

The types and locations of archaeological and architectural sites made them particularly vulnerable to disturbances related to the oil spill. 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 were 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 physical materials incorporated into these sites includes stone, bone, shell, various metals, wood, textiles, leather, and other organic items.

The major potential physical impact of oiling is the obscuring of intertidal artifacts from observation, with the secondary 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 not known. Some scientists have raised questions about whether contaminated organic items can still be dated using radiocarbon techniques, but others believe that the oil can be removed from crucial samples so that they may be successfully dated. (CRS, 1989:103).

Several of the cleaning methods used on the beaches were particularly damaging to archaeological resources. Archaeological and architectural sites located in the uplands adjacent to treated shorelines were at risk only 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. In addition, a variety of pedestrian upland crossings 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.

Eight methods of treatment were routinely combined and employed to remove oil from shorelines in the EVOS, and affected archaeology sites and artifacts to varying degrees. Four more were developed and applied experimentally. The potential impacts to cultural resources varied depending on the type of application. These treatment methods and their potential impacts are outlined in the table below.

Treatment Methods and Potential Impacts

Method	Where used	Technique	Potential Impacts
Cold-water deluge	Crevices, interstices on rocky shores	Large volumes of ambient seawater at low pressure are used to wash surface oil to the water's edge.	Limited; comparable to normal wave action.
Cold-water, low-pressure washing	Rock surfaces, oil buried in shallow layers in sand and gravel-sized sediments	Low pressure (<50 psi) spray used to remove lightly adhering oil; also used to gently agitate substrate, expose buried oil, and move it downslope to a boomed area.	Limited; comparable to normal wave action. Improper application may drive oil farther into substrate.
Cold-water, high-pressure washing	Rock surfaces, buried oil in substrate, loose oil in tide pools and crevices	High-pressure ambient spray used to remove adhering oil and flush out loose oil.	Potentially destructive; severely agitated near-surface deposits. May drive oil deeper into substrate.
Warm-water, high-pressure washing	Heavily oiled boulder, cobble, and rock shoreline	High-pressure (up to 100 psi), heated seawater spray used to mobilize weathered oil.	As above; warm water may facilitate oil penetration to deeper levels of sediment.
Hot flush with hand wands	Inaccessible locations (e.g., narrow crevices)	Hand wands with pressurized water used to dislodge trapped oil.	Little sediment agitation lessens threat to artifacts; warm water may facilitate oil penetration.
Vacuum system	Shoreline surface	Vacuum pumps used to remove free oil.	Limited if used properly (i.e., little substrate removed).
Hot water injection	Shoreline sediments	Forces hot water below the sediment surface and flushes oil out through well points driven into the substrate.	Well point insertion may damage or displace buried artifacts; warm water may facilitate oil penetration.
Burying of oiled surfaces	Oiled logs and other materials	Used to remove oiled objects from areas of high recreational use.	Digging may damage existing buried artifacts.
Disking (Experimental)	Lightly oiled sand beaches	Used to break up oiled layers and mix throughout the upper sediment profile.	High potential for damaging surface and near-surface artifacts.
Sediment removal (Experimental)	Oiled beaches	Manual or mechanical removal of oiled sediment, then disposal.	All features in the direct work area may be affected; buried features may be compressed or displaced by heavy equipment.
Shoreline removal, cleaning, and replacement (Experimental)	Oiled shoreline	Oiled sediments are removed, treated, and replaced.	Cultural materials in the removed sediment zone may be destroyed or crushed.

Method	Where used	Technique	Potential Impacts
Relocation to surf zone (Experimental)	Shoreline, beach	Manually or mechanically removed sediments and placement in surf zone to allow natural wave action to clean sediments.	As above; potential for severe disturbance of cultural resources in the removal zone.

Subsistence

Subsistence Law

Alaska is the only State in which a significant proportion of the population lives off the land or practices a subsistence life style. Subsistence is critical to supporting the incomes and cultural values of many Alaska residents. While there are a variety of cultural, popular, and sociological definitions and interpretations of subsistence, Congress addressed 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.

ANILCA provides for "the continuation of the opportunity for subsistence uses by rural residents of Alaska, including both Natives and non-Natives, on the public lands." It also legislates that "customary and traditional" subsistence uses of renewable resources "shall be the priority consumptive uses of all such resources on the public lands of Alaska." 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. In July 1990, the State of Alaska initiated action to insure compliance of its fish and game regulations with the Federal Subsistence Board, and implemented Temporary Subsistence Management Regulations for Public Lands in Alaska with institutions of these regulations, all Alaskans residents became eligible for subsistence priority on State public lands.

Subsistence in Practice

The term "subsistence" refers to a particular pattern of harvesting and using of naturally occurring renewable resources. Subsistence hunting, fishing, trapping, and gathering activities represent a major focus of life for many EVOS communities. Individuals 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.

Subsistence systems are characterized by four 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. The form of settlement and the pace of life in Alaskan communities depend upon the season.

- 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, the division of the catch or harvest, and the assignment of responsibilities are determined by tradition. Communities that share the overlapping territories for hunting and fishing occupy their individual niche and adhere to the rights and responsibilities traditionally assigned to them.

- 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.

Historically, government, the socioeconomic environment of the EVOS 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. EVOS residents working in the resource and tourist industries often experience levels of unemployment higher than the national average during periods of recession.

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

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 (Glass, Muth, and Flewelling, in press; Muth and Glass, 1989).

The harvest of fish and game plays important sociocultural roles in nonNative communities as well. It contributes to self-reliance, independence, and ability to provide for oneself; values that social surveys indicate 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.

Prior to the oil spill, the EVOS was considered a relatively pristine wilderness with bountiful environmental resources that made the area particularly valuable to Alaskans, both Native and non-Native. The relatively unpolluted environment enriched individual lives by simply existing. This perspective is some what 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.

Economic Implications

The economic aspects of the subsistence system are dependent upon 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 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 as depicted on the Per Capita Subsistence Harvest chart. For some residents, subsistence is the primary source of food and supplies. For others, subsistence supplements resources available from other sources.

The communities affected by the oil spill are small, relatively isolated, and economically dependent on local fish and wildlife. The noncommercial transfer and exchange of wildlife products are important institutions in Prince William Sound and in Alaska. 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. (The Day the Water Died, 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. Among Alaska Natives, reliance on subsistence foods is greater still, with subsistence resources providing 80 to 100 percent of Natives' total protein intake, at an average of 500 pounds per person per year as depicted on the chart for Post Spill Change. Subsistence foods provide a large portion of the diet—a portion that families can ill afford to replace with imported substitutes.

Valuing Subsistence

There is not standardized formula for establishing the cash value of subsistence harvests (Fall 1991; Pederson 1990; Wolfe 19--). The economies of the EVOS area are mixed cash-subsistence economies (Wolfe 19--). Cash income received from employment is supplemented by subsistence harvesting. The percentage of total income represented by subsistence in the EVOS communities is not known. The dependency on subsistence supplementation varies from community to community throughout the EVOS area. Nevertheless, understanding the contributions made by subsistence resources to EVOS resident incomes is important the impacts of the oil spill and the Restoration Plan. As a result, the following concept has been developed to attempt to identify the portion of overall household income represented by subsistence resource contributions, and is depicted on the Potential Oil Spill Impacts on Subsistence tables.

In an effort to provide insight into the importance of subsistence resources to EVOS households, per capita income data and average household size were drawn from the 1990 Census for EVOS communities. Per capita income figures and average household size numbers were multiplied to produce an average household income. Household sizes ranged from 2.16 to 4.05. A standardized household size value needed to be established to provide a meaningful comparison across EVOS communities. Valdez was selected as the baseline community because it showed more diversity in its economic base, and less dependence on subsistence harvests. All other EVOS communities were compared for their deviation from the Valdez standard. A percentage value relative to Valdez was developed for each community, and adjusted household income values were established for an average household of 3.

Per capita subsistence harvest information was available for selected EVOS communities for recent years prior to the oil spill and the oil spill year (Fall 1990). For purposes of this study, a value for a pound of protein was developed using data from a market survey of Cordova. Based on the Cordova study information values were extrapolated for other EVOS communities to facilitate the development of a cash economy replacement value. Costs for commodities varied from community to community.

The resulting amount (subsistence pound harvest X value/pound) was multiplied by 3 to represent the cash value of subsistence for the 3 person average household. This amount was added to the cash per capita household figure to create the total cash plus subsistence income for households of 3 persons.

The subsistence cash value was divided by the total cash-subsistence income to provide a percent of total household income from subsistence for the years before the oil spill and the year of the oil spill. The percentage difference between the years before the oil spill, and the year of the oil spill was established.

For the purpose of developing a scenario portraying the importance of subsistence resources to EVOS households, many assumptions were made which may not reflect the true value of subsistence harvesting in mixed cash-subsistence incomes. Valdez was selected as the baseline community because of its apparent non-subsistence dependency. Its location within the EVOS area suggested that a more reasonable comparison could be made between Valdez and other EVOS communities, and than between Anchorage and EVOS communities. In addition, it is acknowledged that the average household size identified in the 1990 Census may not reflect the true composition of households, particularly in largely Native communities. Nevertheless, in the absence of a standardized methodology address the value of subsistence in a mixed cash-subsistence economy, the concept suggests a means of suggesting the contribution of subsistence activities to overall household income.

This approach is a concept only, and should not be considered the definitive approach for valuing the portion of total income represented by subsistence harvesting. Degrees of error are introduced by the averaging, extrapolation and ration assumptions which may not be valid or accurate given the current lack of precise information. The concept is offered only as a potential means of identifying the contribution of subsistence harvesting to total incomes of EVOS residents.

Oil Spill Impacts on Subsistence Income

Community	Income per capita	Average persons per household	Income per household of 3 persons	Adjustment factor for household of 3	Adjusted income for family of 3	Difference % from Valdez baseline
Kenai Peninsula						
English Bay	12,615	3.76	47,432.40	0.79	37,471.59	-0.54
Homer	19,182	2.54	48,722.28	1.81	88,187.32	+0.09
Kenai	17,877	2.70	48,267.90	1.11	53,577.36	-0.34
Port Graham	17,265	2.77	47,824.05	1.08	51,649.97	-0.36
Seldovia	14,052	2.45	34,427.40	1.27	41,312.88	-0.49
Seward	16,615	2.47	41,039.05	1.21	49,657.25	-0.39
Soldotna	15,800	2.69	42,502.00	1.11	47,177.22	-0.42
Kodiak Island						
Akhiok	14,793	4.05	59,911.65	0.74	44,334.62	-0.45
Karluk	8,052	3.94	31,724.88	0.76	24,110.90	-0.71
Kodiak	22,951	2.92	67,016.92	1.02	68,357.25	-0.16
Larsen Bay	19,222	3.34	64,201.48	0.89	57,139.31	-0.30
Old Harbor	8,008	3.26	26,106.08	0.92	24,017.59	-0.71
Ouzinkie	16,530	3.07	50,747.10	0.97	49,224.68	-0.39

Community	Income per capita	Average persons per household	Income per household of 3 persons	Adjustment factor for household of 3	Adjusted income for family of 3	Difference % from Valdez baseline
Port Lions	14,960	3.04	45,478.40	0.98	44,568.83	-0.45
Lake and Peninsula Borough						
Chignik	13,188	3.48	45,894.24	0.86	39,469.04	-0.52
Chignik Lagoon	19,604	3.12	61,164.48	0.96	58,717.90	-0.28
Chignik Lake	7,765	3.91	30,361.15	0.76	23,074.47	-0.72

Community	Income per capita	Average persons per household	Income per household of 3 persons	Adjustment factor for household of 3	Adjusted income for family of 3	Difference % from Valdez baseline
Valdez-Cordova Census Area						
Chenega Bay	9,211	3.03	27,909.33	0.99	27,630.23	-0.66
Cordova	23,408	2.61	61,094.88	1.49	91,103.37	+0.13
Tatitlek	8,674	3.61	31,313.14	0.83	25,989.90	-0.68
Valdez	26,968	2.90	78,207.20	1.03	80,553.41	n/a
Whittier	17,032	2.16	36,789.12	1.38	50,768.98	-0.37

Per capita income and average household data from 1990 Census.
Subsistence harvest figures are drawn from Fall 1990.
Protein cost information from Stratton 1992, Cordova Market Survey, February 1989.
Protein consumption factors were based on the USDA consumption estimates of 222 pounds of protein per capita (Wolfe 1990).

Community	Adjusted income for family of 3	Per capita subsistence harvest/year (in lbs.)	Per capita cash equivalent	Subsistence cash value for family of 3	Total income for family of 3 (cash + subsistence)
Kenai Peninsula					
English Bay	12,615	288.8 [3.93]	$1,134.98	$3,404.95	$40,876.54

Community	Adjusted income for family of 3	Per capita subsistence harvest/year (in lbs.)	Per capita cash equivalent	Subsistence cash value for family of 3	Total income for family of 3 (cash + subsistence)
Homer	19,182				
Kenai	17,877				
Port Graham	17,265	227.2 [3.93]	$842.89	$2,678.68	$54,328.65
Seldovia	14,052				
Seward	16,615				
Soldotna	15,800				
Kodiak Island					
Akhiok	14,793	519.50 [3.93]	$2,041.63	$6,124.90	$50,459.52
Karluk	8,052	863.20 [3.93]	$3,392.37	$10,177.12	$34,288.02
Kodiak	22,951				
Larsen Bay	19,222	403.50 [3.93]	$1,585.75	$4,757.26	$61,896.57
Old Harbor	8,008	491.10 [3.93]	$1,930.02	$5,700.06	$29,807.65
Ouzinkie	16,530	369.10 [3.93]	$1,450.56	$4,351.68	$53,576.36
Port Lions	14,960	279.80 [3.93]	$1,099.61	$3,298.84	$47,867.67
Lake and Peninsula Borough					

Community	Adjusted income for family of 3	Per capita subsistence harvest/year (in lbs.)	Per capita cash equivalent	Subsistence cash value for family of 3	Total income for family of 3 (cash + subsistence)
Chignik	13,188	187.90 [3.93]	$738.44	$2,215.34	$41,684.38
Chignik Lagoon	19,604	220.20 [3.93]	$865.38	$2,596.15	$61,314.05
Chignik Lake	7,765	279.00 [3.93]	$1,096.47	$3,289.41	$26,363.88
Valdez-Cordova Census Area					
Chenega Bay	9,211	308.80 [4.53]	$1,398.64	$4,196.59	$31,826.82
Cordova	23,408	[3.78]			
Tatitlek	8,674	351.70 [3.93]	$1,382.18	$4,146.54	$30,136.44
Valdez	26,968				
Whittier	17,032				

Community	Total income for family of 3	% total income from subsistence	1989 subsistence harvest (lbs.)	Cash value per capita subsistence, 1989	Cash value subsistence for family of 3, 1989	Percentage of income from subsistence, 1989	Change in % subsistence
Kenai Peninsula							
English Bay	$40,876.54	8%	140.6 [3.93]	$552.55	$1,657.67	4%	-4%
Homer							
Kenai							
Port Graham	$54,328.65	5%	121.6 [3.93]	$477.88	$1,433.66	2%	-3%
Seldovia							
Seward							
Soldotna							
Kodiak Island							
Akhiok	$50,459.52	12%	297.7 [3.93]	$1,169.96	$3,509.88	7%	-5%
Karluk	$34,288.02	29%	250.5 [3.93]	$984.46	$2,953.39	8%	-21%
Kodiak							
Larsen Bay	$61,896.57	7%	209.9 [3.93]	$824.90	$2,474.72	4%	-3%
Old Harbor	$29,807.65	19%	271.7 [3.93]	$1,067.78	$3,203.34	10%	-9%
Ouzinkie	$53,576.36	8%	88.8 [3.93]	$348.98	$1,046.95	2%	-6%
Port Lions	$47,867.67	6%	146.4 [3.93]	$575.35	$1,726.05	3%	-3%
Lake and Peninsula Borough							

Community	Total income for family of 3	% total income from subsistence	1989 subsistence harvest (lbs.)	Cash value per capita subsistence, 1989	Cash value subsistence for family of 3, 1989	Percentage of income from subsistence, 1989	Change in % subsistence
Chignik	$41,684.38	5%	208.6 [3.93]	$819.79	$2,459.39	6%	+1%
Chignik Lagoon	$61,314.05	4%	211.4 [3.93]	$830.80	$2,492.40	4%	n/a
Chignik Lake	$26,363.88	12%	447.6 [3.93]	$1,759.06	$5,277.20	20%	+8%
Valdez-Cordova Census Area							
Chenega Bay	$31,826.82	13%	146.1 [4.53]	$661.83	$1,985.49	6%	-7%
Cordova			[3.78]				
Tatitlek	$30,136.44	13%	214.8 [3.93]	$884.16	$2,532.49	8%	-5%
Valdez							
Whittier							

Sociocultural Implications

Subsistence pursuits are tied to all aspects of life in the villages affected by the oil spill and are key to the Alaska Native sociocultural system. For at least 11,000 years, Alaska Native people have depended on the lands and water of the EVOS area for their survival. Their traditional way of life is intimately tied to the harvesting, gathering, and use of subsistence foods.

The Alaska Native culture cannot easily be separated from the subsistence way of life and each person's relationship to the land, sea, and resources. The rules governing the harvesting and use of subsistence resources are derived from a combination of culture, tradition, and religious beliefs. Subsistence involves many social activities such as cooperative labor-sharing, the exchange of resources and information, transmission of knowledge and skills, and formation of values. The means of establishing prestige and maintaining peace traditionally involve the consumption, transfer, and exchange of fish, game, and their byproducts. These activities are necessary for the preservation of traditional family and community relationships that are essential to the physical and psychological well-being of Alaska Native communities. Continuous access to uncontaminated resources in a natural setting is also fundamental to the physical, spiritual, and psychological well-being of Alaska Native communities.

In Native villages, the hunt, the sharing of products of the hunt, and the beliefs surrounding the hunt, tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Generous hunters are considered good men. Good hunters are often leaders. The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and subsistence activities that occur in traditional Native society.

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 18 EVOS communities. Destruction and contamination of subsistence resources contributed to the sense of cultural dislocation experienced by some Alaska Natives in the area.

> Livelihoods destroyed, emotional stability of people destroyed, tremendous stress—these things will be etched on my mind for the rest of my lifetime, and I think that I will be grieving for many, many years to come over what I saw in the summer of 1989. (The Day the Water Died, 1990)

Real and perceived habitat contamination resulted in a 77-percent decline in subsistence resource harvesting (Fall 1990). 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, subsistence fishery was banned as a precaution against possible health-threatening effects of the oil spill on fish in the Sound. In Native villages, shortages of traditional foods resulted and persist.

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 harvesting 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. Contamination of traditional foods, and fear of contamination, led potential users to stop harvesting these resources. One Alaska Native had this to say:

> We depend on ourselves. . . And we depend on the seals, sea lions, butter clams, ducks, and sea life. Now they are disappearing. The sea life is disappearing. Even if they come around, we are staying away from them. (Alaska Oil Spill Commission, 1990)

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. Restoration proposals will address the contamination that continues to affect

Prince William Sound species and people who harvest them.

Commercial Fishing

Commercial fishing within the oil spill area is divided among three census regions (Figure III-A): Southcentral, which includes Prince William Sound and the outer Kenai Peninsula area; Kodiak, which surrounds Kodiak and Afognak Islands; and Bristol Bay, which includes the area between Kodiak and the Alaskan Peninsula.

During 1989, emergency commercial fishery closures were ordered throughout the spill area. Closures affected salmon, herring, crab, shrimp, rockfish, and sablefish. The 1989 closures resulted in sockeye overescapement in the Kenai River and in the Red Lake system (Kodiak Island). In 1990, a portion of Prince William Sound was closed to shrimp fishing. Spill-related sockeye overescapement is anticipated to result in low adult returns in 1994 and 1995. This may result in closure or harvest restrictions during these and, perhaps, subsequent years. Injuries and recovery status of rockfish, pink salmon, shellfish and herring are uncertain.

The fishing industry in the oil spill area is primarily a small-boat near shore fishery in contrast to the offshore highly capitalized fishery. The near shore fishery common in Prince William Sound, Cook Inlet, and Kodiak/Afognak Island area concentrate on seasonal salmon, herring, halibut, black cod and to a lesser extent on Dungeness, king, and tanner (snow) crab. The offshore fishery located in the western Gulf of Alaska is found well offshore, concentrating on groundfish, king, and tanner crabs. The nearshore fishery is dominated by Alaskan residents operating boats mostly in the 30 to 45 foot length. The offshore fishery is dominated by non Alaskan residents operating much larger vessels whose values range up to $40 million for the large factory trawlers.

In 1986, there were 28,663 permits purchased for the Alaskan commercial fisheries. Of these, 84% (24,059) were purchased by Alaskan residents; the remainder (4,604) were purchased by non-residents.

Alaska is considered the most important fishing state in the United States. In 1989 Alaska accounted for almost half the nation's catch in pounds, and 38% in value. The major species groups contributing to Alaska's commercial fisheries are salmon, shellfish (primarily crabs and shrimps), groundfish (mostly pollock, flatfishes, Pacific cod, black cod and rockfish), halibut and herring. No other state comes close to Alaska in either total harvest weight or value, according to statistics compiled by the U.S. Department of Commerce. Consequently, Alaska is a major exporter of fishery products.

The ex-vessel value of Alaska's commercial fishing industry ranks first among all U.S. states. The ex-vessel value of fishery landings in Alaska is more than twice the landed values of Washington, Oregon and California combined. In 1990, approximately 5.9 billion pounds of seafood worth $1.5 billion in ex-vessel value were landed into Alaskan ports. Salmon accounted for approximately 37% of the total value (Alaska Blue Book, 1991). In 1988, the value of the harvest in Prince William Sound (PWS) alone for salmon fisheries totalled $76 million; herring, $12.2 million; and shellfish, $2.4 million (AF&G, 1989).

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 non-profit (PNP) hatcheries, leaving a common property portion of the catch below the 10 year average (ADF&G, 1991).

The value of the combined 1989 commercial salmon harvest in Prince William Sound was estimated at $41.3 million, excluding hatchery sales. The drift gill net catch was valued at $23.8 million, setting the average earnings for the estimated 480 permit holders that fished in 1989 at $49,470. Seiners harvested $18.9 million worth of fish setting the average earnings for the estimated 235 permit fleet at $80,610. Because the Eshamy district was closed for the season, set net fishermen had no opportunity to fish in the Prince William Sound area in 1989 (ADF&G, 1991).

The Kodiak area commercial fisheries are dominated by salmon harvests, primarily pink, sockeye and chum. There is also a joint venture trawl fishery for walleye pollock in Shelikof Strait, and a longline fishery for halibut, sablefish, and cod. Herring are also harvested in the Kodiak/Afognak area, primarily in the spring for sac roe, as well as fall and winter fisheries for shellfish, primarily crab.

The fishery in Cook Inlet is geared primarily for sockeye salmon in the vicinity of the Kenai River. Further south along the Kenai Peninsula, the Homer area commercial fishing fleets target all species of salmon, shellfish, and halibut (USDOI, 1986).

Aside from the ex-vessel values of Alaska's fisheries and the economic activity (in terms of employment and personal income) generated from them, fishing generates revenues directly to the State of Alaska from taxes and licenses. State revenues generated in FY-86 from fisheries equalled $47.3 million, of which $43.4 million went to the general fund and $3.9 million went to the fish and game fund. Fishery revenues included fish taxes, marine fuel taxes, fishing permits, fishing licenses and other similar items.

Legal gear for the commercial harvest of salmon include purse seines, both drift and set gill nets, and trolling gear. Set and drift gill nets and purse seines are the most common gear type in the Kodiak area. Set and drift gill nets are also the most common gear for the Cook Inlet fishery. Drift gill net fishermen are the most numerous in Prince William Sound and are permitted to fish in the Bering River, Copper River, Coghill, Unakwik, and Eshamy districts (**Figure III-D**). During the 1989 season, 408 drift gill net permit holders participated in the Prince William Sound salmon fisheries. Set gill net gear is legal only in the Eshamy district. There are 30 total permits for this gear type. Purse seine gear is legal in the Eastern, Northern, Unakwik, Coghill, Northwestern, Southwestern, Montague and Southeastern Districts. Purse seiners, which catch most of the fish in the sound, fish all Prince William Sound districts, except Eshamy, usually beginning in early or mid-July, depending upon the strength of early pink salmon runs. Purse seine fishing continues usually into the first or second week of August. An estimated 243 purse seine permits were active during the 1989 season (ADF&G, 1991).

The seafood industry is the largest non-governmental employer in Alaska, providing approximately 16.4% of the state's jobs. It has been estimated that the Alaskan seafood industry provides 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 (Royce, 1991).

The seafood industry (harvesting and processing) in Southcentral Alaska employs approximately 4,000. Residents in Southcentral earn more from seafood harvesting than any other Alaska region. In the Kodiak region, the seafood industry is the dominant economic activity, employing over 2,500 residents. The Kodiak region is the only region completely within the oil spill area, and accounts for nearly 1/4 of the state's seafood processing jobs. Only the far eastern areas of the Bristol Bay region are within the oil spill area. This region is more dependent on the seafood industry than any other Alaska region. More than 70 percent of the region's private industry employment is in the seafood industry (McDowell Group, 1989).

Salmon Hatcheries and Management

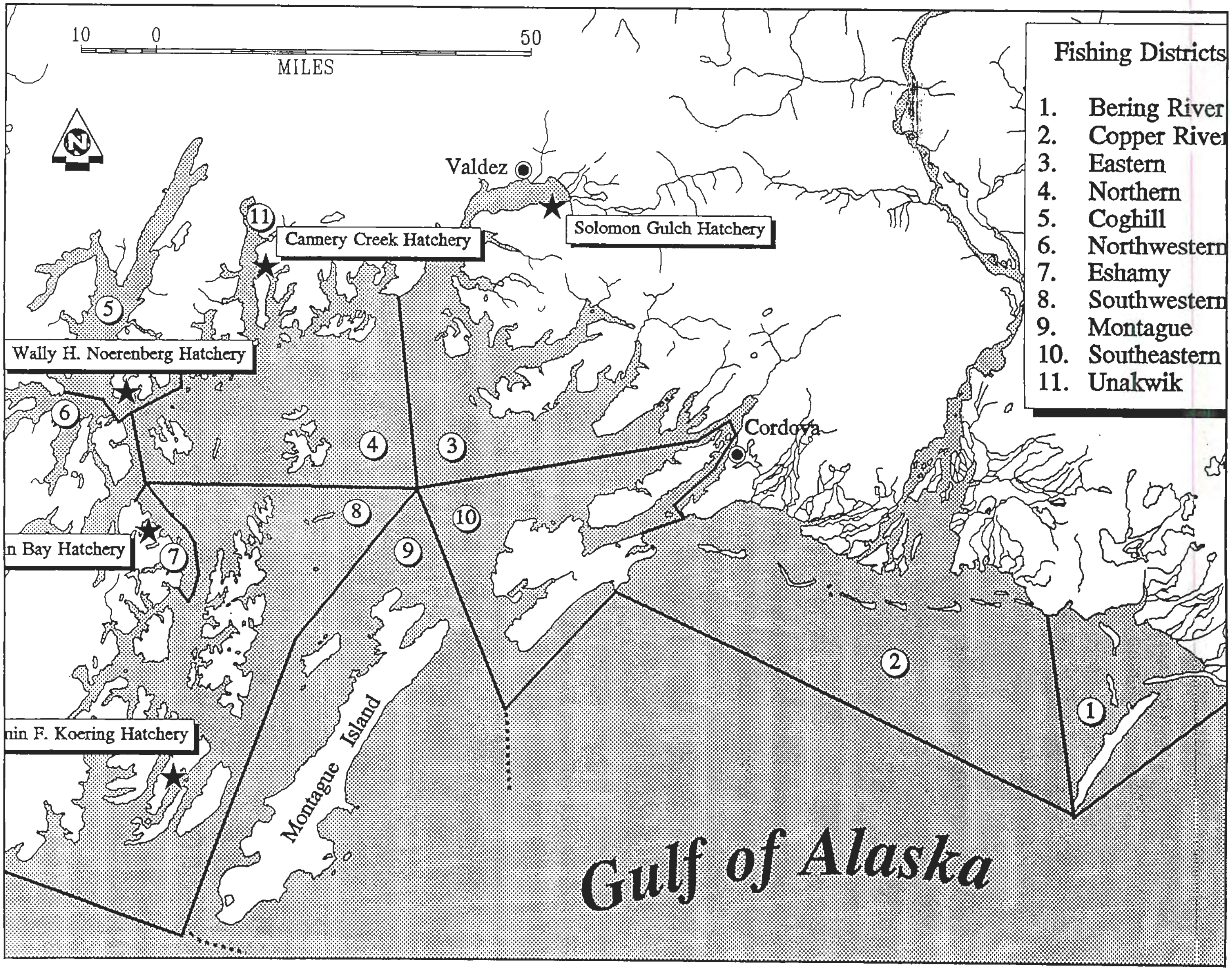

Figure III-D. Commercial Salmon Management Districts and hatcheries in the

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."

Salmon hatcheries in the Prince William Sound area include the Solomon Gulch Hatchery at Valdez operated by the nonprofit corporation, Valdez Fisheries Development Association (VFDA); The Main Bay Hatchery, the Armin F. Koering (AFK), Esther, (now the Wally H. Noerenberg Hatchery), and Cannery Creek hatcheries operated by the Prince William Sound Aquaculture Corporation (PWSAC). Cannery Creek is a FRED facility under a 20 year management lease to PWSAC (Figure III-D). Today, seven regional associations from Southeast Alaska to Kodiak produce salmon for common property fisheries (PWSAC, 1990).

The AFK and Cannery Creek Hatcheries produce primarily pink salmon; Noerenberg Hatchery produces all five species of Pacific salmon, the majority of which are pink, chum and coho. Main Bay Hatchery, in the western part of the Sound, currently produces pink salmon but is in the process of converting to sockeye salmon. The VFDA's Solomon Gulch hatchery in Valdez Arm produces pink, chum and coho salmon (PWSAC, 1990).

From the inception of the hatchery system the intent has been to protect the fisheries from cyclical weaknesses. During the 1970's, salmon runs declined throughout the state. In PWS, seining did not open at all in 1972 and 1974 because the returning wild runs were below fisheries management escapement levels for reproduction and commercial harvest needs (PWSAC, 1990).

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 millon fish were harvested in common property fisheries, and 909,219 fish were harvested in the special harvest area sales harvests of the two major PNP hatcheries in the area. 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 (Sharr et al, 1988).

Because egg-to-fry survival is 80 percent or higher in hatcheries as opposed to 20 percent or less in natural spawning beds, hatcheries allow at least a 4-fold increase in production from a given number of spawners (PWSAC, 1990).

In an average year, 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 (AF&G, 1989).

Benefits from the introduction of the hatchery system have been achieved at some cost, not only financially, but in terms of fishery conditions, both perceived and real. Hatchery salmon production, intended to both increase catches and reduce harvest variability, has resulted in changes in the distribution of catches by species, the gear types used, seasonal opportunity to fish in historic and traditional areas, and fishing patterns.

Hatcheries have added new complexities to management of salmon returns. Generally, the major salmon returns to hatcheries overlap with the timing of adjacent wild stock systems. Hatchery fish are randomly mixed with wild stock fish, following the same migration routes to their respective points of origin. Unlike the wild stock pink systems distributed uniformly, hatchery stocks in Prince William Sound return in mass to a limited number of release sites. In these areas termed terminal areas, hatchery fish are concentrated which provides a management opportunity to specifically target the commercial harvest on the surplus production.

A shift in the composition of salmon in the harvest by the common property fishery can be attributed to the hatchery system. Since the inception of the hatchery program in 1978, the wild stock contribution has declined. In the 1988-89 harvest seasons only 10-15% of the Prince William Sound catch was from wild stocks. Because recent wild stock returns have been quite small relative to hatchery returns, in order to achieve minimum escapement goals for wild stocks, 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 (PWSAC, 1990).

Four Alaskan agencies are involved in managing Alaska's salmon fisheries: The Alaska Board of Fisheries sets policy and promulgates the regulations; the Alaska Department of Fish and Game (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 amount of fishing effort; and the Alaska Department of Public Safety enforces the regulations (NPFMC, 1990).

In-season fisheries management is the responsibility of the Alaska Department of Fish and Game. 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 Board of Fisheries establishes the regulations that govern fisheries. Actions considered by the Board include changes in areas for the salmon fisheries, and the allocation of harvests among the various groups of fishermen. While ADF&G determines when and where fishery openings can occur, the Board of Fisheries regulations determine who can fish in the designated areas.

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).

Along with FRED, the U.S. Forest Service and PNPs have been largely responsible for implementing management measures or in-stream projects to rehabilitate, if necessary, and increase salmon populations in the Prince William Sound area. Past rehabilitation efforts have been aimed at restoring wild stocks to former levels of abundance through stream improvements, fish ladders, and other activities that improve natural spawning conditions. Stream rehabilitation projects are carried out by the U.S. Forest Service in cooperation with the ADF&G. The Forest Service has this responsibility since many of the spawning streams are located in the Chugach National Forest which surrounds Prince William Sound and the mouth of the Copper River. Between 1963 and 1982 there were 78 fish habitat improvement projects, 66 of which were completed by the Forest Service in Prince William Sound and Copper River delta areas.

Commercial Herring Harvest

The Pacific herring is also an important species to the Alaskan fishing industry because it 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 it is consumed by larger commercial species of fish such as salmon and halibut (Royce, 1991).

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 man-made enclosures (this is known as the pound-kelp fishery). The fourth and most important commercial harvest is the "sac-roe" fishery, in which herring are netted to collect the mature female's egg filled membrane or sac. Each year the state limits the sac-roe harvest to 20% of the estimated herring stocks (Royce, 1991).

There are five different herring fisheries in the Prince William Sound management area, that all target on what is treated as a single major stock of herring in the Sound. Management of the Prince William Sound herring fishery involves a maximum exploitation rate of 20% for the Prince William Sound herring biomass for all fisheries combined. The food and bait fishery is the only one that occurs in the fall and winter, generally in the Knowles Head area. This fishery is not limited, but generally has fewer than 10 boats participating annually. The four spring fisheries usually occur in the month of April, coinciding with the spawn timing of the Prince William Sound herring stock. The spring fisheries include: 1) a purse seine sac row fishery, that accounts for a large portion of the harvest and limited to approximately 100 permit holders, 2) a gill net sac row fishery with 25 limited entry permit holders, 3) a roe on kelp produced in pounds fishery with approximately 125 limited entry permit holders, and 4) a wild harvest fishery of natural roe on kelp, that is open to entry and has annual participation between 100 to 200 (ADF&G, 1991).

A growing market has developed for bottomfish, particularly black cod and rockfish in the oil spill area. Little research as been completed to determine stock levels, and management initiatives are still developing. Throughout Alaska, the bottomfish fishery has grown, and recent plans for new bottomfish processing plants scheduled to come on line over the next few years are expected to add to harvests and associated employment for this portion of the commercial seafood industry (Alaska Blue Book, 1991).

Commercial 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, tourism's obvious growth in the 1980s gave it legitimacy as a major industry.

Although the nature and extent of injury varied, approximately 43 percent of the tourism businesses surveyed in 1990 felt they had been significantly affected by the oil spill. 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 (McDowell 1990). 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 (RPWG 1993).

A visitor survey conducted by the Alaska Division of Tourism under the Alaska Visitors Statistics Program II (AVSP) revealed important statistics on the tourism industry. The survey results indicated that more than 750,000 people visited Alaska in 1989 from around the world 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% of the $304 million (ADT 1989a). Sixty-nine percent of the total summer visitors were vacation/pleasure visitors. Southcentral Alaska accommodated more visitors per year than any other region but, among the vacation/pleasure visitors, Southeast was the most visited region, with nearly three out of every four vacation/pleasure visitors visiting the region. Southcentral was second with two-thirds of the vacation/pleasure tourism market (ADT 1989b). Southwest was visited by only 6% of the total vacation/pleasure visitors (ADT 1989a) and thus captured 5% of the $304 million (ADT 1989b).

Survey results indicated that Anchorage, Seward, Kenai/Soldotna, Homer, Valdez/Prince William Sound, and Whittier were among the most visited communities in the Southcentral region and that King Salmon, Kodiak, Bethel were among the most visited communities in the Southwest region. 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. In addition, cultural attractions and museums were popular among Southcentral visitors (ADT 1989b).

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 and Denali. Hiking was also popular, especially among the Southwest and Denali visitors. Fishing was most popular in the Southwest, with twice the participation of the next leading fishing region, Southcentral (ADT 1989b).

The visitors of Southcentral 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 and was rated the best for flightseeing activity in the state (ADT 1989b).

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 non-developed recreational opportunities including hunting, fishing, hiking, camping, skiing, sightseeing, backpacking, climbing, dogsledding, snowmobiling, snowshoeing, kayaking, canoeing, power boating, sailing, flightseeing, photographing, and filming to the residents and visitors of the region (Castleman and Pitcher 1992). These recreational opportunities have helped create a growing tourism industry in the region.

The public land in the EVOS area include national parks and national forests, including Chugach National Forest, Kenai Fjords National Park, Katmai National Park and Preserve, Lake Clark National Park and Preserve, and Aniakchak National Monument and Preserve; national wildlife refuges including Alaska Maritime National Wildlife Refuge, Kenai National Wildlife Refuge, Kodiak National Wildlife Refuge, Alaska Peninsula National Wildlife Refuge, and Becharof National Wildlife Refuge; and state parks including Chugach State Park and Kachemak Bay State Wilderness Park (Figure III-B). Several other areas under State management, such as State Historic Sites, Marine Parks, Recreation Areas, and Recreation Parks also provide a variety of recreation. Besides the public lands and facilities, commercial recreational facilities exist in the oil spill area.

Hiking and camping, being relatively inexpensive and easily available, are by far the preferred mode of outdoor recreation for the majority of Alaska's residents and visitors. Although, there are very few trails, the vast taiga and tundra terrain (along with the perpetual daylight during hiking season) offers considerable flexibility to hikers (Castleman and Pitcher 1992). The abundant wildlife add the possibility of animal watching while hiking. Photography of the scenery, as well as the fauna and flora, go hand in hand with hiking and camping.

The oil spill has affected recreational activities in the area. The nature and extent of injury varied by user group and by area of use. About one quarter of respondents to a recreation survey in 1992 reported no change in their recreation experience, but others reported avoiding the spill area, reduced wildlife sightings, residual oil and more people. They also reported changes in their perception of recreation opportunities in terms of increased vulnerability to future oil spills, erosion of wilderness, a sense of permanent change, and concern about long-term ecological effects. However, some respondents reported a sense of optimism. There are indications that declines in recreation activities reported in 1989 appear to have reversed in 1990, but there is no evidence that they have returned to prespill levels. Large portions of land within Katmai National Park and the Becharof National Wildlife Refuge were oiled and have been designated wilderness areas by the Congress.

For the purposes of this section, the oil-spill area is divided into two regions: the Southcentral region which includes Anchorage, Kenai Peninsula, and Prince William Sound; and the Southwest region which includes Kodiak Island, Katmai, and other southwest locations. A brief description of recreational opportunities provided by each region is provided in the following sections.

Southcentral Alaska

Chugach National Forest, the second largest national forest, encompasses much of the Southcentral region. The 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 one major ski resort and six other resort facilities. The Portage visitor center and the Russian River located in this area are among the three most heavily visited areas in the state. Approximately 90% 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. Hiking is the main recreational activity in this 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 premier kayaking areas in the world. 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 includes both kayaking and wilderness camping.

The Kenai Peninsula is the most popular all around destination for both Alaskans and visitors (Kenai 1993). It is the most often viewed landscape in Alaska with the Seward/Anchorage highway being the most heavily used travel route in the state (USDA 1984). 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 in the Kenai Peninsula. The Kenai Fjords National Park, under the management of National Park Service, is an area with 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 sites (including the Kachemak Bay State Park) totaling several thousand acres (Kenai 1993).

Few refuges contain as diverse a landscape, as abundant fish and wildlife populations, or as varied recreational opportunities as the Kenai Refuge. Although not large compared to other refuges in Alaska, the Kenai Refuge supports more recreational use than any other refuge in the world. The wide array of facilities that support and encourage public use and protect refuge resources include, visitor centers, and 47 recreational sites including campgrounds, access areas, wayside, and trailheads. These facilities vary from small undeveloped sites to large campgrounds with tables, fire grates, parking-spurs, boat ramps, water wells, and sanitary facilities. Recreational opportunities in the Kenai Refuge include salmon fishing, camping in developed campgrounds along roads and trails to isolated and primitive areas, hunting, wildlife observation, sightseeing, canoeing, boating, horseback riding, crosscountry skiing, snowmobiling, and berry picking. Most visitors participate in several activities while on the refuge.

Besides the public lands, some cities also offer recreational opportunities on the Kenai Peninsula and their economy, to some extent, is 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 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 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 (Kenai 1993).

Prince William Sound (PWS), located within the Southcentral region at the northern-most point of the Gulf of Alaska, is a unique, pristine, wilderness abundant with land and marine wildlife. The Sound is filled with deep fjords, snow-covered mountain ranges, tidewater glaciers, and hundreds of islands. Prince William Sound is primarily travelled by boat with some areas accessed by float-equipped aircraft. Prince William Sound covers over 2,700 miles of coastline, 4.4 million acres of National Forest and three of North America's major icefields. Prince William Sound offers tremendous opportunities for hiking, sightseeing, wildlife viewing, glacier viewing, and fishing (PWS 1993).

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 (PWS 1993).

Outdoor recreation plays an important role in the lifestyles of many Alaskan residents. A public survey conducted on the lifestyles of southcentral Alaskans yielded information on the recreational activities that these residents engage in (Table I) (USDA 1984). The results of the survey indicated that driving, walking, and fishing were the most popular activities among the Southcentral Alaskans. Respondents also indicated that the important attributes of their favorite activities include getting away from usual demands, being close to nature, doing something exciting, experiencing new and different things, and being with family and friends. Attributes of favorite recreational places considered important by the respondents included fishing opportunities, scenery, and remoteness.

Recreation Participation of Southcentral Alaska Residents

Recreational Activities	Percent of Respondents who Engaged in Activity
Driving for pleasure	59
Walking/running for pleasure	53
Freshwater fishing	42
Attending outdoor sport events	37
Tent camping	31
Motor boating	30
Bicycling	29
Cross-country skiing	26
Target shooting	25
RV camping	24
Hiking with pack	22
Baseball/softball	19
Flying for pleasure	19
Sledding/tobogganing	17
Kayaking/canoeing	17
Off Road Vehicle winter	17
Off Road Vehicle summer	14
Outdoor tennis	17
Swimming/scuba diving	16
Alpine skiing	14

Southwest Alaska

The Southwest region includes the Kodiak Island group, the Alaska Peninsula, the Aleutian Islands, and Katmai. 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.

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 biggest brown bear population. Kodiak Refuge, established in 1941 to protect the habitat of brown bear and other wildlife, occupies about two-thirds 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 and bald eagle populations, the refuge is ideal for wildlife viewing. Other recreational activities include photography, rafting, canoeing, camping, backpacking, hiking, hunting, and fishing. A visitors 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 live, is accessible by air and is visited for viewing commercial fishing operations. The communities of Larsen Bay and Ports Lion on the Kodiak Island are visited for hiking, fishing, and hunting opportunities and their economy to a large extent is dependent on tourism (U.S. FWS 1987).

Recreational Fishing and Hunting

Recreational fishing and hunting constitute an important and distinct segment of the recreational activities in the EVOS region.

Sport Fishing

Sport fishing is one of the most popular recreational activity for both residents and visitors of Alaska. Marine and freshwater systems provide a variety of sport fishing opportunities in the oil-spill region. 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. Several species of Pacific salmon, rockfish, and halibut inhabit salt water. Species of Dolly Varden, rainbow and cutthroat trout are found in freshwater streams and lakes. Although sport fishing is popular throughout the state, seventy percent of Alaska's sport fishing occur in the Southcentral region and majority of which occur in the Kenai Peninsula because access by car from Anchorage to Kenai Peninsula is relatively easy (Castleman and Pitcher 1992). The Kenai River is well known for king salmon fishing. 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 etc. (ADF&G 1992a). In addition, there are management plans for king salmon on the Kenai River.

Historically (between 1984 and 1988), the number of anglers, fishing days, and fish harvest in the oil-affected area had been increasing at a rate of 10 - 16% per year.Since 1977, there has been a 4.5% average annual increase in the number of residents who sport fish, while the number of non-residents sport fishing has increased 16% 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 due to closures, fear of contamination, the unavailability of boats, and congestion at some sites outside the spill area (Carson and Hanemann 1992). The estimated number of anglers in the oil-affected region decreased 13% from 120,160 in 1988 to 104,739 in 1989, the number of days fished decreased 6% from 312,521 to 294,598, and the number of fish harvested decreased 10% from 352,630 to 318,981 (ADF&G 1992b). The area outside the oil spill, however, continued to experience the increase. In 1992, an emergency order restricting cutthroat trout fishing was issued for western Prince William Sound due to low adult returns. The closure is expected to continue at least through 1993. Also the Kenai River sockeye salmon overescapement following the oil spill may severely affect sport fishing as early as 1994. An estimated 124,185 lost recreational fishing days were calculated for 1989 due to

Recreational Hunting

Alaska has 12 species of big game, including several not found (muskox, Dall sheep), or very rare (wolf, wolverine, brown bear, caribou), in the other 49 states. Approximately 144,000 - 166,000 moose; 835,000 caribou; 60,000 - 80,000 Dall sheep; 32,000 -43,000 brown bears; over 100,000 black bears; 5,900-7,900 wolves; 2,100 muskoxen; 13,000 - 15,000 mountain goats; 350,000 - 400,000 black-tailed deer; 1,400 - 1,600 elk and 850 bison inhabit the state. Also abundant are 19 species of furbearers, three species of ptarmigan, four species of grouse, two species of hares and many species of waterfowl, migratory birds, raptors and marine mammals (Castleman and Pitcher 1992). Hunting is conducted according to the Alaska State Hunting and Trapping Regulations formulated by Alaska Department of Fish and Game, Board of Game Members (ADF&G 1992c, 1992d). These regulations specify bag limits and season area-wise for hunting. The many wildlife refuges, parks, and national forests located within the oil-affected region provide tremendous opportunities for hunting.

Following the oil spill, sport hunting of harlequin ducks was reduced by restrictions imposed in 1991 and 1992 in response to damage assessment studies. It is likely that these restrictions will continue until the species shows signs of recovery.

DRAFT

Chapter IV. Environmental Consequences

This chapter forms the scientific and analytic basis for the comparison of impacts among the proposed alternative implementation strategies (the alternatives) for the *EVOS* Restoration Plan. The environmental impacts or consequences that could occur from the implementation of each of the proposed alternatives are discussed in this chapter. The conclusions presented in this analysis are intended to guide decisionmakers in selecting the preferred alternative for the Restoration Plan. This chapter will also guide decisionmakers in developing a Record of Decision in compliance with the National Environmental Policy Act (NEPA) after comments are received from the public on the Draft Environmental Impact Statement (DEIS) and changes are incorporated as appropriate into the Final Environmental Impact Statement (FEIS).

The environmental consequences of the alternatives are the results of the application of different combinations of restoration options. Different mixes of options produce varying impacts on the human and natural environment. The title and number given each of the options, the resources and services they target, and the alternatives in which the options would be included are presented in Table 4-1. A complete description of the activities included in the options, and their expected effectiveness in restoring resources and services damaged by the *EVOS* are presented in the Draft Restoration Plan.

The no action alternative (Alternative 1) has been described in Chapter II of this DEIS. The no action alternative is the baseline conditions that exist under the current agency management of the resources in the *EVOS* area. The no action alternative provides a benchmark that enables decisionmakers to compare the magnitude of environmental effects of the options included in the other proposed alternatives. The four proposed alternatives (Alternatives 2–5) include actions, activities, and guidance over and above what is included under normal agency management. Normal agency management is conducted by many agencies with jurisdiction over the resources and services affected by restoration options included in the proposed alternatives of the Draft Restoration Plan. The no action alternative would include numerous resource management plans and guidance documents directing agency activities within the *EVOS* area. A complete description of all agency mandates and guidance affecting the *EVOS* area is beyond the scope of this Draft EIS. Under the no action alternative, there would be no change from the way normal agency management is currently practiced. Therefore, the no action alternative does not address the issues identified in Chapter I of the DEIS, and it is not analyzed for each option as the other four alternatives are in the following discussion.

This chapter is organized by the five issues presented in Chapter I. Under each issue, the impacts of implementing each alternative are discussed for individual resources and services. Following the discussion of alternatives is an analysis of specific impacts resulting from individual options is presented. An economic impact assessment is presented separately under Issue 4 (land uses, local economies, and communities) because the economic impact assessment was conducted differently than the impact assessment of resources and services damaged by the *EVOS*. The remainder of the chapter is devoted to discussions of threatened and endangered species, cumulative impacts associated with Restoration Plan implementation, irreversible and irretrievable commitments of resources, unavoidable adverse environmental consequences of Restoration Plan implementation, mitigation measures that may be appropriate for consideration when implementing Restoration Plan alternatives, and the analytical tools/methodology used in the impact analysis for this DEIS.

Option Descriptions

Table 4-1. List of alternatives and associated options.

Option	Alternative 3 Targets	Alternative 4 Targets	Alternative 5 Targets
Option 1: Implement cooperative programs between fishermen and agencies to reduce incidental take of harbor seals.	harbor seals	harbor seals	harbor seals
Option 2: Implement cooperative programs between subsistence users and agencies to assess the effects of subsistence harvest on sea otters and harbor seals.	harbor seals, sea otters	harbor seals, sea otters	harbor seals, sea otters
Option 3: Study techniques for changing black cod fishery gear to avoid conflicts between fishermen and killer whales.		killer whales	killer whales
Option 4: Intensify fisheries management to protect injured stocks.	sockeye salmon	cutthroat trout, Dolly Varden, pink salmon, rockfish, pacific herring, sockeye salmon	cutthroat trout, Dolly Varden, pink salmon, rockfish, pacific herring, sockeye salmon
Option 5: Improve freshwater wild salmon spawning and rearing habitats.	commercial and sport fishing	commercial and sport fishing	pink salmon, sockeye salmon
Option 6: Improve survival rates of salmon eggs to fry by using egg boxes, net pens, or hatchery rearing.	sockeye salmon	sockeye salmon	pink salmon, sockeye salmon

Option	Alternative 3 Targets	Alternative 4 Targets	Alternative 5 Targets
Option 7: Relocate hatchery runs of pink salmon to reduce the interception rate of wild stocks of pink salmon.		pink salmon	pink salmon
Option 8: Update the Alaska Anadromous Streams Catalog to ensure that the necessary protection and regulation is provided for all listed salmon streams in the spill area.			pink salmon, cutthroat trout
Option 9: Remove predators at injured colonies or remove predators from islands that supported murres, black oystercatchers, or pigeon guillemots before the spill.	common murre, pigeon guillemot	common murre, pigeon guillemot, black oystercatcher	common murre, pigeon guillemot, black oystercatcher
Option 10: Study use of artificial stimuli (decoys, vocalizations) to encourage recovery at affected murre colonies and accelerate recolonization of historic colonies.	common murre	common murre	common murre
Option 11: Study changes in fishing gear or timing as a way of minimizing incidental capture of marbled murrelets.	marbled murrelet	marbled murrelet	marbled murrelet
Option 12: Accelerate recovery of upper intertidal zone.	intertidal organisms	intertidal organisms	intertidal organisms, black oystercatcher
Option 13: Study the effects of disturbance in marine birds and mammals.	sea otter	sea otter, common murre, harbor seal	sea otter, common murre, harbor seal
Option 14: Study extent of oiling of mussel beds and techniques for removing oil from mussel beds.	harlequin duck, sea otter	harlequin duck, sea otter	harlequin duck, sea otter

Option	Alternative 3 Targets	Alternative 4 Targets	Alternative 5 Targets
Option 15: Propose modifications of sport and trapping harvest guidelines of injured river otter and harlequin duck populations to speed the rate of recovery.			river otter, harlequin duck
Option 16: Develop a site stewardship program to monitor archaeological sites.	archaeological sites	archaeological sites	archaeological sites
Option 17: Preserve archaeological sites and artifacts within the spill area.	archaeological sites	archaeological sites	archaeological sites
Option 18: Acquire replacements for artifacts removed from the oil spill area.	archaeological artifacts	archaeological artifacts	archaeological artifacts
Option 19: Develop new public recreation activities.	protect existing recreation opportunities	protect or increase existing recreation opportunities	protect or increase existing recreation opportunities, encourage new use
Option 20: Test subsistence foods for continued contamination.	subsistence foods	subsistence foods	subsistence foods
Option 21: Provide new access to traditional subsistence foods in areas outside the spill area to replace lost use.	subsistence foods	subsistence foods	subsistence foods
Option 22: Develop subsistence mariculture sites, shellfish hatcheries, and a technical research center.			subsistence foods

Option	Alternative 3 Targets	Alternative 4 Targets	Alternative 5 Targets
Option 23: Replace lost sport, commercial, and subsistence fishing opportunities by creating new fisheries for salmon or trout.	commercial and sport fishing, commercial tourism	commercial and sport fishing, commercial tourism	commercial and sport fishing, commercial tourism, subsistence fishing
Option 24: Develop and conduct public information programs through visitors' centers.			recreation and commercial tourism
Option 25: Establish a marine environmental institute and research foundation.			education

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

The impacts of restoration activities on each injured resource are analyzed by alternatives and individual options in the following section. Impacts on ecological services are discussed under Issue 3 (ecological change). Impacts on archaeological resources and injured human-based services are discussed under Issue 4 (land use, local economies, and communities).

Through implementation of Alternative 2, habitat protection and acquisition (HP&A) would not directly increase the rate of recovery of targeted injured resources and services beyond the natural rate, but would do the most toward assuring that the natural rate of recovery was achieved for all injured resources combined.

Alternative 3 would enhance the degree or rate of recovery over and above the natural processes occurring under Alternative 2 by including restoration activities for selected injured resources and services that are not included in Alternative 2.

Under Alternative 4, the degree or rate of recovery occurring under Alternatives 2 and 3 would be supplemented with general restoration activities intended to increase the rate of recovery for selected resources and services.

Alternative 5 would include restoration activities in addition to those included in Alternatives 2–4. These activities may increase the rate of recovery of selected species, in some instances above prespill levels.

The following discussion summarizes the effects of implementing restoration options included in each alternative for each of the resources and services targeted by restoration activities.

Biological Resources

Marine Mammals

Harbor Seals

Alternative 2 - Habitat Protection

Under Alternative 2, the majority of the restoration funds would be used for the implementation of HP&A. Special designations under HP&A could protect habitat areas used by harbor seals throughout the oil spill region. The impact of the implementation of Alternative 2 would be to secure undisturbed haulout sites and coastal habitat for harbor seals to use for pupping, molting, and foraging. Because HP&A would protect habitat over a wide region for a long duration, there is some potential for increasing the harbor seal population under this alternative. However, because habitat protection would not have a direct influence, any harbor seal population growth would be gradual over a long interval of time.

Options 1, 2, and 13 specifically target harbor seal populations under this alternative. Options 4 and 6 would indirectly affect harbor seals by increasing the short- and long-term fish supply available as a food source. Seventy-five percent of the restoration funds would be used for HP&A. Special designations under HP&A could protect habitat areas used by harbor seals throughout the oil spill region. Option 13 would also protect habitat, concentrating on areas used as haulouts for pupping, molting, and foraging. The main intent of Options 1 and 2 is to develop ways to keep from overharvesting harbor seals. This could maintain a healthy population for future use and assess subsistence use. The long-term impact of the implementation of Alternative 3 on harbor seals would be to provide larger areas of protected habitat, localized increases in food supply, and decreased mortality from bycatch. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact harbor seals, the potential for increasing the harbor seal population under this alternative would be moderate and occur only gradually because of the indirect nature of most of the options.

Alternatives 4 and 5 - Moderate Restoration and Comprehensive Restoration

Options 1, 2, and 13 directly target and impact harbor seal populations under Alternatives 4 and 5. Alternative 4 differs from Alternative 5 only with regard to options indirectly impacting harbor seals. Options 4, 6, 7, 21, and 23 are included in Alternative 4 and have an indirect impact on harbor seals. These options potentially provide additional food sources through restoration options that could increase fish stocks in the *EVOS* area. Alternative 5 includes the same options having indirect impacts as Alternative 4 and includes an additional option, Option 5, that could indirectly impact harbor seals by increasing the number of salmon available as a food source. Alternative 4 would receive approximately 50 percent of allocated funding for HP&A while Alternative 5 would receive approximately 35 percent. HP&A funding could protect haulout and coastal habitats used by harbor seals throughout the oil spill area. Option 13 would also protect habitat, concentrating on areas used as haulouts for pupping, molting, and foraging. The main intent of Option 2 is to develop ways to promote a sustained harvest among subsistence users, which would maintain a healthy population for future use. Option 1 would establish a program to educate fishermen on methods to reduce bycatch of harbor seals. The long-term impact of the implementation of Alternatives 4 and 5 on harbor seals would be to provide larger areas of protected habitat, to indirectly promote localized increases in food supply, and decreased mortality from bycatch. Short-term decreases in subsistence use would be an additional indirect effect of the alternative.

The following discussion describes all options in Alternatives 3, 4, and 5 that have direct or indirect effects on harbor seal populations.

Habitat Protection and Acquisition (HP&A) (Special designations)

One activity under HP&A would establish specially designated regions throughout the spill area to protect habitat. Assuming that important harbor seal habitats are protected (although sanctuaries would likely be designated only for other species), there would be an indirect, positive effect on harbor seals because they would have larger ranges of their preferred habitat available for undisturbed use. Protection of habitat would decrease the number of harbor seals killed incidental to commercial fishing or disturbed during haulout.

Option #4 (Intensify fisheries management to protect injured stocks)
Option #5 (Improve freshwater wild salmon habitats)
Option #6 (Improve survival of salmon eggs and fry)
Option #7 (Change or relocate existing hatchery salmon runs)
Option #23 (Create new salmon runs)

All of these options are de~~signed~~ to increase the abundance of salmon (and other fish) in the oil spill region. There would be a resulting indirect, positive effect on harbor seals because their main diet consists of the same fish affected by these options. By increasing fish numbers, harbor seals would have more to eat, be healthier due to steadier diet, and may slowly increase in abundance if salmon availability is a limiting factor.

Option #13 (Reduce disturbance at bird colonies, haulout sites, etc)

The purpose of this option is to designate buffer zones encircling important sites for the species in order to decrease disturbance. It is assumed that buffer zones would be established around known harbor seal haulout sites in the oil spill area, and that buffer zones would be maintained through the pupping and molting seasons from May until October. This option would decrease disturbance at harbor seal haulouts during times when seals are prone to panic, often stampeding and causing injuries/deaths and weakening mother-pup bonds. Weakening mother-pup bonds increases pup abandonment and leads to higher pup mortality. This option would have the indirect, positive result of decreasing harbor seal mortality caused by haulout disturbance.

Option #1 (Reduce the bycatch of harbor seals)

The purpose of this option is to improve the understanding of fishing interactions and harbor seals and ultimate reduce any problems. The option could include cooperative programs with commercial fishermen for reducing bycatch of harbor seals through reduction of entanglement and deterrent measures. This option could have the direct, long-term effect of increasing harbor seal population by reducing mortality caused by commercial fishing.

Option #2 (Cooperative program with subsistence users)

This option involves working with subsistence users to develop a information exchange program. This would give users up-to-date information to manage their harvest levels. If it is determined that reduced harvest by subsistence users would enhance resource recovery, voluntary reductions would directly help the harbor seal population. This option would have a short-term, positive effect on the harbor seal population because harvesting would be reduced to allow more rapid recovery of the injured population.

Option #21 (Provide access to traditional subsistence foods)

This option would aid subsistence users in gaining access to traditional subsistence resources in areas unaffected by the oil spill. This option would continue until contamination in resources is eliminated and injured subsistence resources have recovered. Because harbor seals are a subsistence resource, this option would have an indirect, positive effect on local harbor seal populations. By subsistence users taking advantage of access to unaffected resources, less harvesting of local harbor seal populations would occur. This option is only a temporary measure until resources recover, so the effects on harbor seals would be short-term.

Killer Whales

Alternative 2 - Habitat Protection

Only HP&A would affect killer whales in Alternative 2. HP&A could afford protection to rubbing beaches if these beaches were included within designated areas intended to protect other marine mammals or birds. This would have an indirect impact on the health of killer whales, and could have positive impacts on increases in whale populations.

Alternative 3 - Limited Restoration

Under Alternative 3, no options specifically target killer whales. HP&A and Options 4 and 13 could impact killer whale populations including the AB pod. HP&A and Options 4 and 45 could have a positive long-term impact by promoting better health, and promoting the sustained availability of food supplies.

Alternatives 4 and 5 – Moderate Restoration and Comprehensive Restoration

Under Alternatives 4 and 5, Option 3 is targeted for killer whales. This option could have a positive indirect impact. Alternatives 4 and 5 also include HP&A and Option 4, which may indirectly impact killer whale populations by inadvertently protecting rubbing beaches and maintaining food sources.

Options Related to Killer Whales

HP&A (Special designations)

HP&A could provide additional protection for killer whales by including rubbing beaches as part of marine sanctuaries where they would be regulated to minimize disturbance.

Creating designated areas would have an indirect, long-term effect on the killer whales for the same reasons as identified in Option 13. Killer whales use rubbing beaches to remove dead skin and parasites, a necessary procedure for the killer whale to maintain health, which could reduce mortality and increase populations.

Option #4 (Intensify fisheries management)

This option would implement fisheries management programs to control exploitation of injured species of fish through research and development of recommendations for incorporation into fisheries regulations. Restricting existing fisheries or redirecting them to alternate sites could have an indirect effect on killer whale populations by providing a food source for the resident pods of killer whales in the Gulf of Alaska. An additional food source could assure the continued presence and growth of the killer whale population in the Gulf of Alaska.

Option #43 (Reduce disturbance at bird colonies, haulout sites, etc.)
The purpose of this option is to designate buffer zones encircling important sites for marine mammals in ~~order to~~ decrease human disturbance of the animals. If killer whale rubbing beaches exist within buffer zones established for other species, this option could affect killer whale populations. Buffer zones created to limit boat traffic and disturbance around beaches known to be used by killer whales for rubbing could have an indirect effect on the health and presence of killer whales by providing them with a safe habitat for rubbing. Rubbing is essential for killer whales, both for comfort and to remove dead skin and parasites.

Option #3 (Change black cod fishery gear)

This option would affect killer whales by studying ways to minimize conflicts between the whales and fishermen. Historically, the gear type used in the Gulf of Alaska for black cod fisheries is the longline (baited hook and line). The killer whale is attracted to the black cod on the line and certain pods have learned to strip the cod from the lines. This has resulted in harassment and occasional shooting of the killer whales. This option could have a direct, long-term positive effect on killer whale population by reducing the mortality that may result from these conflicts with fishermen.

Sea Otters

Alternative 2 - Habitat Protection

Under Alternative 2, almost all of the restoration funds would be used for the implementation of HP&A. HP&A could protect habitat areas used by sea otters throughout the oil spill region. The indirect impact of the implementation of Alternative 2 could be to secure undisturbed haulout sites and coastal habitat for sea otters to use. Because HP&A could protect habitat over a wide region for a long duration, there is potential for increasing sea otter populations under this alternative. However, because habitat protection would not directly affect sea otter populations, growth may be gradual, sustained over a long interval of time.

Alternatives 3, 4, and 5 - Limited, Moderate, and Comprehensive Restoration

Alternatives 3, 4, and 5 would include the same options, all having the same impacts on sea otters. Differences would occur, however, in the allocation of HP&A under each alternative. Options 2, 13, and 14 directly target sea otters under each of these three alternatives. HP&A

would affect sea otter populations under this alternative. Option 14 may increase the long-term availability of healthy intertidal foraging areas for the sea otter if methods for cleaning oil from mussel beds can be identified. Seventy-five percent of the restoration funds under Alternative 3 would be used for HP&A. Under Alternatives 4 and 5, 50 percent and 75 percent (respectively) of restoration funds would be used for HP&A. These activities could protect habitat areas used by sea otters throughout the oil spill region. Option 13 would also protect habitat, concentrating on areas used as haulouts. The long-term impact of the implementation of these alternatives on sea otter populations could be positive and include the creation of larger areas of protected habitat and increased quality of food supplies, which could indirectly increase populations. Short-term decreases in subsistence use could have an additional indirect effect under these alternatives if it is determined that the subsistence harvest has an effect on sea otter populations. Although the impacts described would positively impact sea otters, the potential for increasing sea otter populations under these alternatives may occur gradually because of the indirect nature of the options.

Options Related to Sea Otters

HP&A (Habitat protection and acquisition)

HP&A would acquire land for the purpose of protecting habitat areas. Assuming that habitats important to the sea otter are protected (e.g., coastal zones, haulouts) and not used for recreation purposes that would disturb otters, there would be an indirect, positive effect on sea otters because they would have larger ranges of their preferred habitat available for undisturbed use. Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the sea otter population.

HP&A would also establish specially designated regions throughout the spill area to protect habitat. Protection of habitat would decrease the number of sea otters killed incidental to commercial fishing and by haulout disturbance. Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the sea otter population.

Option #2 (Cooperative program with subsistence users)

This option involves working with subsistence users to develop a information exchange program. This would give users up-to-date information to manage their harvest levels. If it is determined that reduced harvest by subsistence users would enhance resource recovery, voluntary reductions would directly help the sea otter population. This option would have a short-term, positive effect on the sea otter population because harvesting would be reduced to allow more rapid recovery of the injured population.

Option #13 (Reduce disturbance at bird colonies, haulout sites, etc)

The purpose of this option would be to designate buffer zones around important sites marine bird and mammal concentration sites in order to decrease disturbance. This option would have a limited effect on sea otters because their irregular haulout site use is less affected by disturbance. However, sea otters appear to need haulouts to clean and maintain the insulating qualities of their fur (Van Gelder, 1982). By protecting haulout areas, this option could have a slight, indirect, positive effect on increasing the health of the sea otter population.

Option #14 (Eliminate oil from mussel beds)

The purpose of this options would be to eliminate oil from mussel beds and decrease the oil contamination in the intertidal zone. Mussels and other intertidal invertebrates are the primary food source for sea otters. This option would have an indirect effect on the sea otter because of alterations in their primary food source. Food availability is limiting to sea otter populations because they need to eat large quantities in order to maintain the high metabolism necessary to stay warm in cold waters (Chapman, 1981). The short-term effect of disturbance and cleaning of the intertidal areas would be negative because of the decrease in food sources. The long-term, positive effect would be clean, uncontaminated sources of food for the future.

Terrestrial Mammals

River Otters

Alternatives 2, 3, and 4 - Habitat Protection, Limited and Moderate Restoration

Alternatives 2, 3, and 4 do not contain options that target river otters. However, under each of these alternatives, river otter populations could indirectly benefit from the protection afforded by HP&A. This protection could maintain existing populations and possibly lead to long-term increases in river otter populations if HP&A included parcels that increased the carrying capacity of river otter habitat.

Alternative 5 -Comprehensive Restoration

Alternative 5 is the only option that targets river otters. However, Option 15 could have a positive direct impact on river otter populations by reducing mortality that may occur from sport and trapping harvests.

Options Related to River Otters

HP&A (Habitat protection and acquisition)

HP&A could affect river otters by acquiring and protecting habitat necessary for otter survival. The option includes purchasing private land as a method of protecting river otter habitat. Suitable land would be purchased and managed by state or Federal agencies familiar with habitat requirements of river otter.

River otters of coastal Alaska live in abandoned burrows or lodges of other animals and in old growth forests along the shoreline and adjacent to suitable feeding areas. Acquiring and protecting suitable habitat could indirectly affect river otter by providing protected areas for breeding and resting when traveling along their ranges. Managing acquired habitat to provide favorable breeding grounds could promote long-term river otter population increases.

HP&A would also affect river otter by providing additional protection from human disturbances. This option would involve designating some coastal shorelines as marine sanctuaries where they would be regulated to minimize human disturbance of wildlife populations.

Designating areas could have long-term, indirect effects on the river otters by protection them from trapping, protecting otter food supplies, and providing safe, undisturbed areas for breeding. Otter populations could respond to this protection by increasing over the long-term.

Option #15 (Harvest guidelines)

This option would affect river otters by restricting trapping to subsistence use only, reducing bag limits for commercial trappers, or reduction and/or closure of both subsistence and commercial trapping.

Reducing or eliminating the number of river otter trapped would directly affect the river otter population by eliminating a source of mortality, and would allow a greater opportunity for river otter populations to increase. To the extent that the river otter population recovery is slowed due to trapping, this could have a long-term, positive impact on river otter populations.

Birds

Bald Eagle

Alternatives 2, 3, 4, and 5 - Habitat Protection; Limited, Moderate, and Comprehensive Restoration

There are no options under Alternatives 2, 3, 4, and 5 targeting bald eagles. However, each of these four alternatives includes HP&A that could indirectly impact bald eagles. The primary protective measure for bald eagles designated under each of the Draft Restoration Plan Alternatives 2 through 5 is HP&A. Alternative 2 allocates the largest percentage of funding to HP&A (91 percent), and Alternative 5 allocates the least (35 percent). Alternatives 3 and 4 allocate 75 percent and 50 percent, respectively. Consequently, the geographic extent of land acquisition for bald eagles would be greatest under Alternative 2 and smallest under Alternative 5.

Under Alternatives 3, 4, and 5, Option 9 may result in the implementation of measures to reduce predation by eagles on marine bird colonies. If measures are taken to reduce predation by eagles, this option could have a direct adverse impact on bald eagle populations because of the possible removal of young eagles under a program of eagle relocation to limit predation.

Options Related to Bald Eagles

HP&A (Habitat protection and acquisition)

This option could affect bald eagles by acquiring and protecting habitat required for breeding and nesting.

This option would have an indirect, long-term, positive effect on bald eagles by reducing disturbances to nesting and wintering eagles. On National Forests in Alaska, protection measures for bald eagles and their nesting habitats are prescribed in the Memorandum of Understanding between the USDA Forest Service and the U.S. Fish and Wildlife Service. The Memorandum provides for the exclusion of all land use activities within a buffer zone of 100 meter radius around all active and inactive bald eagle nests.

Option #9 (Removal of predator species)

This option could affect bald eagles by reducing their occurrence around marine bird colonies. Young eagles may be removed and provided to the eagle reintroduction program in the lower 48 states.

This could have a direct, short-term, negative impact on bald eagle populations. The effect would be short-term because the number of young birds that can be handled through the reintroduction program may be a limiting factor and compliance with the Bald Eagle Protection Act of 1940 must be considered.

Black Oystercatchers

Alternative 2 - Habitat Protection

Under Alternative 2, HP&A would have an indirect impact on the black oystercatcher population by providing protected habitat and preventing disturbance in the coastal areas used for nesting. Over 90 percent of the restoration funds for this alternative are allocated to the implementation of HP&A. The geographic extent of the impact from implementing this alternative would be large, including the entire oil spill area. Assuming the habitat would remain under protected status, the duration of the impacts associated with this habitat protection would be long-term, potentially leading to increases in the species population. This alternative could create long-term positive benefits to the black oystercatcher by insuring the necessary habitat to maintain healthy populations in the oil spill area.

Alternative 3 - Limited Restoration

Under Alternative 3, no would target black oystercatchers. Options 19, 14, 12, and 9, as well as HP&A, would indirectly impact the black oystercatcher. Option 19 could potentially have an indirect negative impact on oystercatcher populations if new recreation facilities were located in coastal habitat utilized for breeding and nesting. Introduction of human disturbance could adversely affect this species during nesting. Options 14 and 12 could indirectly impact this species by increasing food supplies and restoring habitat. Implementation of Option 19 could result in a reduction in terrestrial and avian predators of black oystercatcher chicks and eggs, having a positive impact on this species' population. HP&A would be implemented throughout the oil spill area, with 75 percent of the restoration funds being used to implement HP&A.

The primary emphasis of Alternative 3 is on the acquisition and protection of habitat as described in HP&A. Under Alternative 3, over 75 percent of restoration funds would be allocated to HP&A. Emphasis on this approach to restoration would have a long-term, positive impact on the black oystercatcher population if the habitat acquired provided protection of nesting and breeding habitat.

Alternative 4 - Moderate Restoration

Option 9, which would be directed at reducing predation, would be the only option targeting black oystercatchers under Alternative 4. As with Alternative 3, Alternative 4 devotes most of the available restoration funds (50 percent) to HP&A. As noted previously, this would have a positive, long-term impact on the black oystercatcher population by providing protected nesting, and breeding habitats throughout the oil spill area. Other options that would have an indirect impact on black oystercatchers, but that do not specifically target black oystercatchers, are the same in Alternative 4 as in Alternative 3 (i.e., Options 9, 12, 14, and 19).

Alternative 5 - Comprehensive Restoration

Under Alternative 5, Options 9 and 12 specifically target black oystercatchers. This differs from Alternative 4 in that Option 12 under Alternative 4 does not specifically target black oystercatchers. Similarly to Alternatives 3 and 4, Alternative 5 includes Options 14 and 19 that have a positive indirect impact on oystercatchers by potentially increasing nesting habitat and food sources. As a consequence of a larger number of options affecting this species, a larger restoration funding allocation (48 percent) has been proposed for implementing restoration options in addition to habitat acquisition and protection than in Alternatives 2, 3, or 4. A major focus of Alternative 5 is still habitat protection (allocated 35 percent of total funding), but there is a greater mix of options affecting the black oystercatcher under this alternative.

Options Related to Black Oystercatchers

HP&A (Habitat protection and acquisition)

Private land acquisition, or acquisition of partial interests in private lands, for the purpose of protecting habitats linked to resources injured by the oil spill, would be undertaken to prevent additional injury to those resources. Although black oystercatchers nest near the high tide zone, reduction of disturbance from upland activities could benefit species populations. Therefore, implementation of this option could have a positive, indirect, long-term effect on the black oystercatchers.

HP&A could have an additional positive, indirect, long-term effect on increasing black oystercatcher populations because under this option marine and intertidal areas in public ownership can be placed into special State or Federal land designations that provide increased levels of regulatory protection. By providing habitat protection and further reducing disturbances to the birds during their nesting periods, populations may increase.

Option #19 (Creation of new recreation sites and facilities)

Implementation of this option involves construction of new public recreation facilities which could have a negative, indirect, long-term effect on the black oystercatcher populations if creation of these facilities infringed on the breeding, nesting, or feeding habitat of this species. If creation of these facilities were not to infringe on their habitat requirements, but rather would draw tourists away from the breeding and nesting areas, this option would result in a potential positive, indirect, long-term impact to the black oystercatcher.

Option #14 (Eliminate oil from mussel beds)

Persistent oil in the mussel beds represents a potential threat to the black oystercatcher as this species utilizes the intertidal mussel beds for food. Implementation of this option could involve determination of the geographic extent of persistent oil as it pertains to the mussel beds and anadromous streams in Prince William Sound, and implementation of the most effective and least intrusive method of cleaning the beds and areas of contamination adjacent to anadromous streams.

This option could have a positive, indirect, long-term impact on the black oystercatcher because it could involve stripping or tilling of contaminated mussel beds and anadromous streams to increase flushing of residual oil, resulting in a reduction of the amount of oil available for bioaccumulation by mussels and other invertebrates. Therefore, less oil would be available for ingestion by predator species such as the black oystercatcher. There would also be a negative, indirect, short-term effect on the black oystercatcher due to the cleaning of the oiled mussel beds and anadromous streams. The proposed cleaning methods would result in a limited and temporary direct loss of mussels and associated invertebrates and algae from this habitat, ultimately resulting in a temporary reduction in prey for the black oystercatcher.

Option #12 (Accelerate recovery of upper intertidal zone)

The overall objective of this option is to facilitate recovery of the previously dominant brown algae *Fucus gardneri* (popweed). Implementation of this option would have a positive, indirect, and long-term effect on the black oystercatcher because this species utilizes the intertidal habitat to feed on limpets, mussels, clams, and chitons that would increase with the recovery of this zone. By implementing this option, it is anticipated that additional seaweeds and invertebrates would recolonize the intertidal zone, thus providing the black oystercatcher with an additional food source.

Option #7 (Removal of predator species)

Implementation of this option could result in a positive, indirect, long-term effect on black oystercatcher reproduction from the removal of introduced fox from islands along the Alaska Peninsula and Aleutians. A secondary goal would be to reduce avian predators. Foxes are predators of chicks and eggs, and their removal would allow black oystercatcher production on these islands to increase.

Reduction of avian predators would have a positive, indirect, short-term effect on the black oystercatcher ... glaucous-winged gulls, northern ravens, and bald eagles can ... nesting colonies.

Alternative 2, with more than 90 percent of available funds. ... would have an indirect impact on the harlequin duck reproductive potential if HP&A protected habitat for necessary breeding, nesting, and molting. The geographic extent of the impact from implementing this alternative would be large, ... Assuming the habitat would remain under protected status, ... associated with this habitat protection would be long-term, potentially ... increases in the species population. This alternative could create long-term positive impacts on harlequin duck by insuring the necessary habitat to maintain healthy populations within the spill area.

... only Option 14 would specifically target the species under ... as well as HP&A, may also have indirect impacts under Alternative 3. Option ... would potentially have an indirect, negative impact on the duck population because ... could disrupt breeding, nesting, and molting if recreation facilities ... harlequin's habitat. In contrast, if construction of these facilities would ... away from the breeding and nesting areas, the indirect impact of this option ... harlequin duck would be positive. Option 14 could ... by increasing food supplies which could improve the health ... increase the carrying capacity of the ecosystem. HP&A would be ... spill area, with 75 percent of the restoration funds being used ...

The emphasis ... 3 is on the acquisition and protection of habitat as ... in HP&A. Emphasis on this approach to restoration could have a long-term, positive impact on the harlequin duck population by providing protected nesting, breeding, and molting habitat.

Alternative 4 - Moderate Restoration

... same options, impacting the harlequin duck, as Alternative 3. Therefore, the impacts associated with Alternative 4 would be the same as those associated with Alternative 3. As with Alternative 3, Alternative 4 devotes a large portion of the available restoration funds (50 percent) to HP&A. As noted previously, this could have a positive, long-term impact on the harlequin duck population by providing protected nesting, and breeding habitats throughout the oil spill area.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes the most options affecting the harlequin duck. Options 14 and 15 specifically target harlequins. Option 19, as well as HP&A, would also be implemented under this alternative. As a consequence of the larger number of options affecting this species, a larger amount of restoration funding (48 percent) is being proposed for implementing restoration options than was allocated in Alternatives 2, 3, or 4. HP&A is still a major focus of this alternative (35 percent of total funding), as with the previous alternatives, but there is a greater mix of options affecting the harlequin duck to be implemented under Alternative 5.

In addition to the effects described previously, Alternative 5 would serve to increase the harlequin duck population if it is determined that temporarily limiting sport harvesting would benefit this species. Opportunities to increase the harlequin duck population may be high in localized areas, but the overall magnitude of the impact would likely be small.

Options Related to Harlequin Ducks

HP&A (Habitat protection and acquisition)

Private land acquisition, or acquisition of partial interests in private lands, for the purpose of protecting habitats linked to the resources injured by the oil spill, would be undertaken to prevent additional injury to those resources. Implementation of this option may include the acquisition of upland habitat and undisturbed riparian lands around anadromous streams. These habitats are conducive to the breeding and nesting of the harlequin duck.

Protecting harlequin ducks breeding and nesting habitat would have a positive, indirect, long-term effect because the protection of breeding and nesting habitat could lead to population increases.

Option #15 (Develop harvest guidelines)

Implementation of this option could involve imposing temporary restrictions or closure of hunting opportunities of this species in the oil-spill area. Post oil spill information indicates that the harlequin duck has suffered a decline in population and exhibited near total reproductive failure in some portions of the oil-spill area. Under this option, harvest pressure would be reduced or eliminated when it is shown to suppress the natural recovery rate of the harlequin duck. At present, an early season closure on the harvesting period is in effect.

It is not known how many ducks are harvested by hunters in the oil-spill area as harvest figures are reported for all of Southcentral Alaska. It is thought that the harvest is small. However, a harvest in September would take almost exclusively resident birds because migrants have not yet arrived from their breeding grounds further north.

Although the harvesting restrictions would be temporary, a reduction in harvest of this injured species would directly effect population levels by eliminating a source of mortality for resident birds, and providing additional opportunity for spill zone populations to reproduce. The effect would be long-term with regard to a potential recovery of the harlequin duck population in the oil-spill area if reproductive success is enhanced.

Option #19 (Creation of new recreation sites and facilities)

Implementation of this option would include construction of new public recreation facilities such as mooring buoys, boat ramps, picnic areas, campsites, and trails; and making public land available for commercial recreation facilities such as fuel stops, docks, and lodges. At this time, the specific proposed location of these new facilities is unknown, but it is assumed that facilities would be constructed in upland as well as tidal habitat.

The effects of implementing this option would be negative, indirect, and long-term on the harlequin duck population only if creation of these recreation sites and facilities would infringe on the pairing, breeding, and nesting habitat requirements of this species. If creation of these facilities were not to infringe on their habitat requirements, but rather would draw tourists away from the breeding and nesting areas, this option would result in a potential positive, indirect, long-term impact to the harlequin duck.

Option #14 (Eliminate oil from mussel beds)

Persistent oil in the mussel beds represents a potential threat to the harlequin duck, as the duck is dependent on these beds for food. This option would involve determining the geographic extent of persistent oil as it pertains to the mussel beds in Prince William Sound, and implementing the most effective and least intrusive method of cleaning the beds and areas of contamination adjacent to anadromous streams.

This option could have a positive, indirect, long-term effect on the harlequin duck because it would involve stripping or tilling of contaminated mussel beds and anadromous streams to increase flushing of residual oil, resulting in a reduction of the amount of oil available for bioaccumulation by mussels and other invertebrates. Therefore, less oil could be available for ingestion by predator species such as the harlequin duck. This could indirectly improve the health of this species by providing a healthy food source. There could also be a negative, indirect, short-term effect on the harlequin duck due to the cleaning of the oiled mussel beds and anadromous streams. The proposed cleaning methods would result in a limited and temporary direct loss of mussels and associated invertebrates and algae from this habitat, ultimately resulting in a temporary reduction in prey for the duck.

Common Murres

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement HP&A. Both activities under HP&A, habitat acquisition and special land designations could indirectly benefit common murres by protecting the nesting habitat if the HP&A activities include murre habitat.

Under this alternative there would be no direct effects on the common murre population. All indirect effects would be through the additional protection afforded the breeding colonies by regulations on public lands.

Alternative 3 - Limited Restoration

Under this alternative, common murres would be targeted by Options 9 and 10. For Option 9, studies to promote synchrony would be conducted, and for Option 10, there would be consideration of avian predator reduction. The emphasis of the options under this alternative is to stabilize the breeding synchrony and increase egg production at murre colonies. Because the geographic extent of the options in Alternative 3 covers the entire common murre breeding territory in the spill area, the magnitude of the combined positive indirect impacts of the options could be high. Similar to Alternative 2, HP&A would be included in Alternative, although less funding would be allocated (75 percent) under Alternative 3 than under Alternative 2.

Alternative 4 - Moderate Restoration

Option affecting common murres under this alternative are the same as listed under Alternative 3. Less money is available for HP&A, potentially resulting in increasing opportunities for human use of the area. The combined impacts on the common murre from these options could still be high.

Alternative 5 - Comprehensive Restoration

Under this alternative, common murres are targeted by three options (Options 9, 10, and 13). Implementation of Option 13 targets murres only under this alternative. Option 13 could result in regulating boat traffic around murre colonies. Because Alternative 5 includes more options than any of the other alternatives, as well as 35 percent allocation of funds for HP&A, the intensity or magnitude of the effects may be greater than under the other alternatives.

Options Related to Common Murres

HP&A (Habitat protection and acquisition)

Implementing this option could affect common murres by protecting breeding and fishing habitat throughout the oil spill area. However, only a few important murre habitats are available for acquisition. Therefore, this option would have a only a minimal effect on increasing murre populations by further reducing disturbances to the birds during their nesting period.

Implementing this option could affect common murres by protecting breeding and fishing habitat throughout the oil spill area.

This option would have an indirect, long-term effect on increasing murre populations by further reducing disturbances to the birds during their nesting period.

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

This option could restrict the speed or prohibit navigation of vessels within 1/2 or 1 mile of protected bird colonies. These restrictions could be implemented in all areas of the oil spill area. This option would affect the breeding and nesting success of common murres by reducing loud noises that can cause the adults to flush from the breeding ledges, kicking eggs off the cliffs and leaving eggs and young exposed to predators. The lower density and asynchronous nesting at the colonies within the oil-spill area have made the eggs and young more vulnerable to predation. Modifying boat traffic around these colonies may reduce additional disturbances.

This option could have a direct, long-term effect on common murre productivity by reducing the number of eggs lost and increasing the survival of chicks. While there is uncertainty regarding the exact level of disturbance that nearby boats have on nesting colonies, the decrease in potential disturbances could prevent additional loss of eggs and chicks during the recovery period. The effect of this option would be greatest during the initial recovery years while the proportion of young breeding birds is highest and additional measures are being undertaken to improve breeding synchrony. The effect could be long-term because the buffer zones would stay in place for the entire recovery period for the impacted colonies and may be left in place afterward as a protective measure when the colonies have been fully restored.

Option #16 (Increase productivity and success at murre colonies)

This option would affect common murres by developing and implementing a study to enhance social stimuli to promote breeding synchrony. This study would use decoys and recorded calls to give the illusion of typical breeding densities which may encourage a return to normal breeding patterns. The main effect of this study would be a direct, short-term increase in reproduction success since synchrony promotes earlier egg laying and increases the number of nesting birds to ward off predators. The effect would be short-term, in regards to total recovery time, because breeding synchrony is a density effect. In addition, Heinemann (1993) supports the idea that it is probably a threshold phenomenon, which means that until densities climb above the threshold, reproductive rates would stay very low. Once the required density has been reached, however, efforts to promote synchrony would no longer be needed. Negative effects of this technique may include decoys displacing breeding pairs or causing gaps between pairs thus increasing susceptibility to predation, and are assumed to be minimal and compensated for by the increase in synchrony.

Option #17 (Removal of predator species)

The primary goal of this option would be to reduce seabird egg and chick mortality by removing or reducing predators. Outside the spill area, the removal of introduced foxes from the islands would result in an indirect, long-term increase in murre production. Foxes are voracious predators of chicks and eggs and their removal would allow the productivity of these islands to increase.

The reduction of avian predators at the injured colonies would have an indirect, short-term increase in murre productivity. Glaucous-winged gulls, northern ravens, and bald eagles are effective predators on murre colonies with gulls sometimes accounting for 40% of the egg loss. Reducing avian predators at murre colonies is planned only for short-term benefits, because reduction techniques would likely not totally remove the predator populations.

Marbled Murrelets

Alternative 2 - Habitat Protection

Under this alternative, marbled murrelets could be affected by HP&A. Given the high level of funding, habitat acquisition is likely to extend throughout the range of the marbled murrelet. The magnitude of the impact for this alternative on marbled murrelets would be high because habitat acquisition is the most effective option for preventing rapid population declines and ensuring population recovery.

Alternatives 3, 4, and 5 - Limited, Moderate, and Comprehensive Restoration

Under each of the three alternatives (Alternative 3, 4, and 5), marbled murrelets would be specifically targeted by only one option (Option 11). The major differences among Alternatives 3, 4, and 5 are the amount of restoration funds allocated for HP&A, Alternative 3 including the most (75 percent) and Alternative 5 including the least (35 percent).

Options Related to Marbled Murrelets

HP&A (Habitat protection and acquisition)

HP&A would affect marbled murrelets by acquiring and protecting upland habitats necessary for successful breeding and nesting. An assumption concerning the implementation of HP&A is that some land containing these productive habitats is currently privately owned and consequently available for purchase or protection. This also assumes that the land area containing these habitats would meet the criteria necessary to make them a target for purchase or protection.

This activity would have an indirect, long-term effect on marbled murrelet populations. In the lower 48 States, the marbled murrelet has a declining nesting habitat base throughout most of its range where it nests in trees. Continued logging operations can be expected to cause a decline in population numbers. Land acquisition would help this species assuming that the land bought was in danger of being logged and that it is suitable as nesting habitat.

Implementing the special designation activity under HP&A could also affect murrelets by protecting breeding and fishing habitat throughout the oil spill area.

This activity would have an indirect, long-term effect on increasing murrelet populations by protecting feeding and nesting locations. A large designation area that would limit development activities and pollution sources may have a positive effect on the prey base.

Option #11 (Minimize the incidental take of birds)

Under this option, the extent of marine bird mortality by commercial fishing activities associated with fisheries (gillnet, drift, and set net) would be examined. If the mortality is found to represent a significant source of mortality for populations in the spill area, an effort would be made to develop new technologies or strategies for reducing encounters. These could involve suspending nets below the surface, closure of certain areas, elimination of night fishing, or directing fishing away from injured marine bird habitats.

To implement this option a number of steps would have to be taken: (1) research and document the extent of marine bird mortality in the spill area, (2) research new technologies or strategies for reducing encounters, and (3) incorporate relevant methodologies and strategies in fishery management plans. Assuming that all steps have been completed, this option would have an indirect, long-term effect on reducing accidental mortality and increase the marbled murrelet population.

Fish

Cutthroat Trout

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement HP&A. HP&A would both protect and acquire habitat, and establish special land designations, indirectly benefiting cutthroat trout by protecting the habitat required for spawning and rearing of fish. The duration of the impacts would be long-term assuming that the protected habitat is managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts are large and wide-spread, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to cutthroat trout by insuring the necessary habitat to maintain healthy fish populations.

Alternative 3 - Limited Restoration

There are no options under this alternative that specifically target cutthroat trout populations. Option 12, as well as HP&A, could indirectly increase cutthroat trout populations. Option 12 could increase the quantity and quality of food for adult cutthroat trout in the marine environment. HP&A could protect spawning areas throughout the spill area from further exploitation and degradation allowing for natural recovery. HP&A has the greatest emphasis placed on it under this alternative, with 75 percent of the restoration funds being allocated for HP&A. An indirect impact of Alternative 3 could lead to an increase in spawning success of cutthroat trout which could ultimately increase populations.

Alternative 4 - Moderate Restoration

The options under Alternative 4 that could affect cutthroat trout include 4 and 12, as well as HP&A. Only Option 4 targets cutthroat trout populations under this alternative. Option 4 could directly impact cutthroat trout populations by reducing commercial, sport, and subsistence fishing pressures, thus increasing spawning success. The direct impact of Alternative 4 on cutthroat trout would be an increase of spawning success and, ultimately, an increase in cutthroat trout population. Option 12 and HP&A would be the same in Alternative 4 as in Alternative 3, except that HP&A would be allocated less funding under Alternative 4.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes the most options targeting cutthroat trout. Like HP&A, Option 8 could provide further protection for spawning areas, allowing for increased spawning success. Option 5, which does not target cutthroat trout, is included in Alternative 5 and could indirectly impact this species if increased spawning habitat were made available through stream improvements intended to affect sockeye salmon. The impact of Alternative 5 on cutthroat trout could lead to an increase of spawning success and, therefore, a gradual increase in cutthroat trout population.

Options Related to Cutthroat Trout

HP&A (Habitat protection and acquisition)

HP&A could affect cutthroat trout populations throughout the spill area by acquiring damaged habitat and protecting it from further disturbance to allow for natural recovery. This would have a positive, indirect effect on the cutthroat trout by protecting spawning stocks so that reproductive success may increase. This would ultimately increase populations. The long-term effects would be that cutthroat trout habitat would be protected from further disturbance.

These activities could also affect cutthroat trout by giving special designations to uplands, coastal, and marine habitat that are utilized by trout for spawning and rearing. This could have an indirect, positive effect on cutthroat trout by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

Option #4 (Intensify fisheries management)

This option would affect cutthroat trout by intensifying fisheries management of this species. This option would protect injured stocks from further exploitation and allow for natural recovery through research and development of recommendations for incorporation into fisheries regulations by the Board of Fish. It is assumed that the intensified management of cutthroat trout would be designed to increase trout populations, but not to exceed the carrying capacity of the stocks. This option would have a positive, direct effect on trout populations by reducing commercial and sport fishing pressures on damaged stocks. This could increase the number of successful spawning adults, which would increase overall spawning success. The long-term effect would be an increase of cutthroat trout populations.

Option #5 (Improve freshwater wild salmon)

This option could affect cutthroat trout by improving access to salmon spawning areas by building fish passages or removing barriers. Creating fish passage for salmon could also provide opportunities for other anadromous species to utilize the streams for spawning. Cutthroat trout utilize some of the same streams as salmon. Therefore, this option could have an indirect, positive effect on cutthroat trout populations by creating fish passages and removing instream barriers. This would provide new and additional spawning habitat for cutthroat trout, which could increase spawning success and thereby increase populations. This could have a long-term effect on cutthroat trout because the new habitat could expand the current spawning area of trout for future reproduction. This effect would be long-term because the instream improvements could be maintained for many years.

Option #12 (Recovery of upper intertidal zone)

The option would have a very slight positive, indirect effect on cutthroat trout by improving habitat and the quantity of prey species available for adult trout. Adult cutthroat trout use the nearshore areas to feed after leaving the streams. Improving the intertidal zone would increase the quantity of prey species utilized by cutthroat trout. This could have a long-term effect on trout populations by increasing the survival rate of fish that may return to spawn.

Option #8 (Protect undocumented anadromous streams)

This option could affect cutthroat trout by listing streams utilized by salmon in the ADF&G Anadromous Stream Catalogue. Under the State Forest Practices Act and Title 16 of Alaska Statute requiring protection of anadromous streams, streams listed in the catalogue are provided with certain level of protection to avoid further disturbance. This could have an indirect, positive effect on cutthroat trout by protecting existing spawning areas from further disturbance, thus increasing spawning success and therefore increasing populations. The option would have a long-term effect because the streams would be protected from future degradation, allowing cutthroat trout populations to increase.

Dolly Varden

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement

HP&A. HP&A would both protect and acquire habitat,and establish special land designations, indirectly benefiting Dolly Varden by protecting the habitat required for spawning and rearing of fish. The duration of the impacts would be long-term, assuming that the protected habitat is managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts are large and wide-spread, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to Dolly Varden by insuring the necessary habitat to maintain healthy fish populations.

Alternative 3 - Limited Restoration

There are several options under this alternative that would affect Dolly Varden populations, although none specifically target the species. Option 12, as well as HP&A, could ensure adequate food supplies for adult Dolly Varden in the marine environment. HP&A could protect spawning areas throughout the spill area, thereby allowing for natural recovery. HP&A has the greatest emphasis placed on it under this alternative, with 75 percent of the restoration funds being allocated for HP&A, and only 12 percent of the funds for other restoration options. Alternative 3 would also include Option 6, which could indirectly provide an additional food source for Dolly Varden by increasing the number of salmon eggs and fry in streams inhabited by this species. The impact of Alternative 3 could lead to an increase in spawning success of Dolly Varden which would ultimately increase populations.

Alternatives 4 and 5 - Moderate and Comprehensive Restoration

Alternatives 4 and 5 both include Option 4, which targets Dolly Varden. Dolly Varden would also be indirectly affected by Option 12, as well as by HP&A, with 50 percent allocation for HP&A in Alternative 4 and 75 percent in Alternative 5. Option 4 could directly impact Dolly Varden populations if measures were implemented that reduced sport fishing pressures, thereby increasing spawning success. Alternatives 4 and 5 would also include Option 6, which is included in Alternative 3 as well. The impact of Alternatives 4 and 5 on Dolly Varden could include an increase of spawning success and, therefore, a gradual increase in populations.

Options Related to Dolly Varden

HP&A (Habitat protection and acquisition)

HP&A could affect Dolly Varden populations throughout the spill area by acquiring damaged habitat and protecting it from further disturbance to allow for natural recovery. This would have a positive, indirect effect on the Dolly Varden by protecting spawning stocks so that reproductive success may increase. This would ultimately increase populations. The long-term effects would be that Dolly Varden habitat would be protected from further disturbance.

HP&A could also affect Dolly Varden by giving special designations to uplands, coastal, and marine habitat that are utilized by Dolly Varden for spawning and rearing. This could have an indirect, positive effect on Dolly Varden by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

Option #4 (Intensify fisheries management)

This option would affect Dolly Varden by intensifying fisheries management of this species. This option would protect injured stocks from overexploitation and allow for natural recovery through research and development of recommendations for incorporation into fisheries regulations by the Board of Fish. It is assumed that the intensified management of Dolly Varden would be designed to increase Dolly Varden populations, but not to exceed the carrying capacity of the stocks. This option would have a positive, direct effect on Dolly Varden populations by reducing sport fishing pressures on damaged stocks. This could increase the number of successful spawning adults which would increase overall spawning success. The long-term effect would be an increase of Dolly Varden populations.

Option #12 (Recovery of upper intertidal zone)

The option would have a very slight positive, indirect effect on Dolly Varden by improving habitat and the quantity of prey species for adult Dolly Varden. Adult Dolly Varden use the nearshore areas to feed after leaving the streams. Improving the intertidal zone would increase the quantity of prey species available to Dolly Varden and increase the survival rate of fish that may return to spawn. Increasing the number of spawning fish could ultimately increase populations.

Option #6 (Improve survival of salmon eggs and fry)

This option could affect Dolly Varden by increasing survival of salmon eggs and larvae. Dolly Varden prey heavily on salmon eggs and larvae in the stream. An increase in the number of salmon eggs and larvae could have an indirect, positive effect on Dolly Varden by increasing the food supply for Dolly Varden. If salmon populations increase, this could have a long-term effect on the available food source for Dolly Varden, which would increase growth rates of Dolly Varden and thereby increase the number of adults that may return to spawn.

Pacific Herring

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be allocated to implement HP&A. HP&A would both protect and acquire habitat and establish special land designations. These activities would have no direct effects on open water Pacific herring.

Alternative 3 - Limited Restoration

Under Alternative 3, no options have been proposed that target Pacific herring. However, 75 percent of the restoration funds would be allocated to HP&A. As in Alternative 2, this would not directly affect open water Pacific herring.

Alternatives 4 and 5 - Moderate and Comprehensive Restoration

In addition to HP&A, Alternatives 4 and 5 include Option 4, which includes intensifying fisheries management of Pacific herring. Option 4 could lead to the implementation of management measures that reduce commercial, sport, and subsistence fishing. This could result in positive indirect impacts on herring stocks because of an increased number of spawning adults.

Options Related to Pacific Herring

Option #4 (Intensify fisheries management)

This option could affect Pacific Herring by intensifying fisheries management of this species. This option could protect injured stocks from overexploitation and allow natural recovery through research and development of recommendations for incorporation into fisheries regulations by the Board of Fish. The extent of damage to the herring population is unknown at this time. It is assumed that a damage assessment of the 1988, 1989 and 1990 year class of herring populations would be made, and that the results would indicate that recruitment of those year classes to the herring population was reduced and the population of herring has been reduced. This option would have a positive, direct effect on Pacific herring populations by reducing commercial and sport fishing pressures on damaged stocks. The effect would be long-term because the number of successful spawning adults would increase and thereby increase spawning success, which could ultimately lead to an increase in population.

Pink Salmon

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement HP&A. HP&A would both protect and acquire habitat and establish special land designations, indirectly benefiting pink salmon by protecting the habitat required for spawning and rearing of fish. The duration of the impacts would be long-term, assuming that the protected habitat is held by the public and managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts are large and wide-spread, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to pink salmon by insuring the necessary habitat to maintain healthy fish populations.

Alternative 3 - Limited Restoration

No options specifically target pink salmon under Alternative 3. However, Option 23 could indirectly affect pink salmon populations by reducing local fishing pressures on wild stocks. HP&A would protect spawning areas from further exploitation and degradation, which may allow for increased spawning and a gradual increase in pink salmon populations. Under this alternative the majority of the funds would be used for habitat acquisition, which could result in a long-term, positive impact to pink salmon populations if the habitat acquired protects needed salmon spawning and rearing streams.

Alternative 4 - Moderate Restoration

Alternative 4 includes two options that specifically target pink salmon, Options 4 and 7. Option 23 and HP&A could indirectly increase pink salmon populations. Option 23 could reduce commercial fishing pressure, thus protecting wild stocks, and HP&A would protect spawning areas from further exploitation and degradation, allowing for increased spawning. Option could directly impact pink salmon populations by reducing commercial, sport, and subsistence fishing pressures, thus increasing spawning success. Option 7 could affect pink salmon populations buy reducing the number of wild stocks intercepted during harvest of hatchery runs. The impact of Alternative 4 on pink salmon could lead to increased spawning success in the spill area, resulting in gradual population increases. Because Options 4 and 7 are specifically targeted to pink salmon populations, and all other options indirectly increase populations, the likelihood of increasing populations under this alternative is high.

Alternative 5 - Comprehensive Restoration

Alternative 5 specifically targets pink salmon under options 4, 5, 6, 7, and 8. Options 4 and 7 are the same as described under Alternative 4. Options 5 and 6 are intended to increase the availability of spawning and rearing habitat and success. Option 8 is intended to indirectly maintain or increase pink salmon populations by protecting streams not previously included in the anadromous stream catalog. Option 23 could affect pink salmon populations as identified in Alternative 3. HP&A would protect spawning areas from further exploitation and degradation as in Alternative 4, but a smaller allocation of funds (35 percent of the total) would be included in Alternative 5 than in Alternative 4 (50 percent). Because five options in Alternative 5 target pink salmon populations, the likelihood of increasing populations under this alternative is high.

Options Related to Pink Salmon

HP&A (Habitat protection and acquisition)

HP&A could affect pink salmon by protecting habitat throughout the spill area by acquiring damaged habitat and protecting it from further disturbance to allow for natural recovery. This would have a positive, indirect effect on the pink salmon by protecting spawning stocks so that reproductive success may increase. This would ultimately increase populations. The long-term effects would be that pink salmon habitat would be protected from further disturbance.

HP&A could also affect pink salmon by giving special designations to uplands, coastal, and marine habitat that are utilized by salmon for spawning and rearing. This could have an indirect, positive effect on pink salmon by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

Option #4 (Intensify fisheries management)

This option involves research and the development of recommendations for restricting or redirecting of existing fisheries. Changes to fisheries management would be implemented through regulations promulgated by the Alaska Board of Fish. This option could affect pink salmon by protecting injured stocks from excessive fishing pressures and allowing for natural recovery. It is assumed that the intensified management of pink salmon would be designed to increase salmon populations, but not to exceed the carrying capacity of the stocks to avoid further damage to the wild stocks. This option would have a positive, direct effect on salmon populations by reducing commercial and sport fishing pressures on damaged stocks. This could increase the number of successful spawning adults which would increase overall spawning success. The long-term effect would be an increase of pink salmon populations.

Option #5 (Improve freshwater wild salmon habitats)

This option could affect pink salmon by using two restoration techniques to increase populations: (1) construct salmon spawning channels and instream improvements and (2) improve access to salmon spawning areas by building fish passes or removing barriers.

Construction of salmon spawning channels and instream improvements of streams for pink salmon would have a direct, positive effect on salmon populations by increasing the spawning habitat quality to insure that stream flow, substrate, and dissolved oxygen concentrations are sufficient for egg and larvae survival, therefore increasing spawning success. This effect could be long term because the instream improvements might be maintained for many years. The extent of these improvements would be limited by the fact that approximately 80% of pink salmon spawning occurs in intertidal areas and would not benefit from this option.

Option #23 (Create new salmon runs)

This option would provide new commercial, sport, and subsistence fishing opportunities to replace those opportunities lost from the spill. In addition, this option might relieve fishing pressure on stocks damaged by the spill, assuming that timing and location of new fish runs would be managed in accordance with genetic and disease control guidelines to avoid further damage to natural stocks. Therefore, this option would have an indirect, positive effect on pink salmon by reducing fishing pressure and allowing damaged stocks to naturally recover and therefore increase populations. Increased competition for food and habitat from the introduced salmon would be minimal if the new salmon runs are terminated after wild populations have recovered.

Option #8 (Protect undocumented anadromous streams)

This option could affect pink salmon by listing streams utilized by salmon in the ADF&G Anadromous Stream Catalogue. Under the State Forest Practices Act and Title 16, streams listed in the catalogue are provided with certain level of protection to avoid further disturbance. This could have an indirect, positive effect on pink salmon by protecting existing spawning areas from further disturbance, thus increasing spawning success and therefore increasing populations. The option would have a long-term effect because the streams would be protected from future degradation, allowing pink salmon populations to increase.

Option #6 (Improve survival of salmon eggs and fry)

This option could affect pink salmon by rearing wild pink salmon eggs and fry in boxes, net pens, or hatcheries. Assuming that strict guidelines to prevent disease and overescapement are employed, this option could have a direct, positive effect on pink salmon by increasing the survival of eggs and larvae and improving spawning success. This would facilitate an increase in population. The effects would be long-term because it would restore wild pink salmon populations.

Option #7 (Relocate salmons runs)

This option would affect pink salmon by relocating or changing the timing of existing hatchery salmon runs in PWS. The concept is to minimize the interaction of hatchery reared fish and wild stocks during commercial harvests. This could have an indirect, positive effect on wild pink salmon in PWS because it would relieve fishing pressures on wild stocks. This could increase the number of spawning adults, thereby increasing spawning success. The effect would be long-term because the population of wild stocks could ultimately increase.

Rockfish

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be allocated to implement HP&A. Because rockfish are open water fish, acquisition of inland and coastal habitat would not directly affect this species. However, HP&A would indirectly benefit rockfish by protecting through special designations (such as marine sanctuaries) the habitat required for the spawning and rearing of fish, which could lead to increases in the numbers of fish. The magnitude of the impacts of this alternative on rockfish could be relatively low, with small benefits to rockfish stocks in the oil spill area.

Alternative 3 - Limited Restoration

Alternative 3 contains no options targeting rockfish populations. As in Alternative 2, HP&A could effect rockfish through the special designation and protection of potential rockfish habitat. This would allow uninterrupted reproduction in localized areas if appropriate habitat were included in the specially designated areas. This could ultimately increase rockfish populations on a relatively small basis.

Alternatives 4 and 5 - Moderate and Comprehensive Restoration

In addition to HP&A, Alternatives 4 and 5 include Option 4, which intensifies fisheries management of rockfish. This could directly impact rockfish populations in the spill area if management activities initiated under this option reduced rockfish exploitation, thus increasing the number of reproducing adults. This could provide greater opportunity for increasing rockfish populations in the affected areas.

Options Related to Rockfish

Option #4 (Intensify fisheries management)

This option would affect rockfish by intensifying fisheries management of this species. This option would protect injured stocks from further exploitation and allow for natural recovery through research and development of recommendations for incorporation into fisheries regulations by the Board of Fish. This option would have a positive direct effect on rockfish populations by reducing commercial and sport fishing pressures on damaged stocks. This could increase the number of adults for reproduction which would increase success. The long-term effect would be an increase of rockfish populations.

HP&A (Special Designations)

HP&A could affect rockfish by giving special designations to coastal and marine habitat that are utilized by rockfish for spawning and rearing. This could have an indirect, positive effect on rockfish by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

An assumption concerning this activity is that the designation of marine sanctuaries containing rockfish would be included.

Sockeye Salmon

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement HP&A. HP&A would both protect and acquire habitat, and establish special land designations indirectly benefiting sockeye salmon, possibly protecting habitat required for spawning and rearing of fish, leading to an increase in sockeye populations. The duration of the impacts would be long-term, assuming that the protected habitat is managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts is large and wide-spread, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term positive benefits to sockeye salmon by insuring the necessary habitat to maintain healthy fish populations.

Alternatives 3 and 4 - Limited and Moderate Restoration

Under these alternatives, Options 4 and 6 specifically target sockeye salmon. Option 23 could indirectly increase sockeye salmon populations under Alternatives 3 and 4 if, for example, Kenai River sockeye fishing is closed or restricted for multiple years and alternative runs are created to partially compensate for the loss. HP&A (75 percent and 50 percent, respectively) could protect spawning areas from further exploitation and degradation if the land acquired or protected included sockeye spawning habitat. Option 4 could directly impact sockeye salmon populations by managing populations to increase populations that were reduced because of overescapement. Option 6 could directly impact salmon populations by increasing the survival rate of eggs and larvae.

Because Options 4 and 6 are specifically targeted to increase sockeye salmon populations, and the remaining options indirectly increase populations, the magnitude of the impacts of these alternatives could be high.

Alternative 5 - Comprehensive Restoration

This alternative includes all the options and associated effects documented in Alternatives 3 and 4, with the addition of Option 5 that specifically targets sockeye salmon. HP&A, allocated 35 percent of available restoration funds under this alternative, would provide habitat protection throughout the spill area. The impact of Alternative 5 on sockeye salmon could be to increase spawning success, potentially increasing populations in the spill area.

Options Related to Sockeye Salmon

HP&A (Habitat protection and acquisition)

HP&A could affect sockeye salmon throughout the spill area by acquiring damaged habitat and protecting it from further disturbance to allow for natural recovery. This would have a positive, indirect effect on the sockeye salmon by protecting spawning stocks so that reproductive success may increase. This would ultimately increase populations. The long-term effects would be that sockeye salmon habitat would be protected from further disturbance.

HP&A could also effect sockeye salmon by giving special designations to uplands, coastal, and marine habitat that are utilized by salmon for spawning and rearing. This could have an indirect, positive effect on sockeye salmon by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

Option #4 (Intensify fisheries management)

This option would affect sockeye salmon by intensifying fisheries management of this species. This option would protect injured stocks from further exploitation and natural recovery through research and development of recommendations for incorporation into fisheries regulations by the Board of Fish. It is assumed that the intensified management of sockeye salmon would be designed to increase salmon populations, but not to exceed the carrying capacity of the stocks. This option would have a positive, direct effect on salmon populations by reducing commercial and sport fishing pressures on damaged stocks. This could increase the number of successful spawning adults which would increase overall spawning success. The long-term effect would be an increase in sockeye salmon populations.

Option #5 (Improve freshwater wild salmon)

This option would affect sockeye salmon by using three techniques to increase populations: (1) construct salmon spawning channels and instream improvements, (2) fertilize lakes to improve sockeye salmon rearing success, and (3) improve access to salmon spawning areas by building fish passes or removing barriers.

Construction of salmon spawning channels and instream improvements of streams for sockeye salmon would have a direct, positive effect by increasing the spawning habitat quality to insure that stream flow, substrate, and dissolved oxygen concentrations are sufficient for egg and larvae survival. This habitat improvement would increase spawning success, and subsequently increase the population. This effect would be long-term because the instream improvements could be maintained for many years.

Fertilization of degraded rearing lakes would increase the primary food source of sockeye salmon by supplementing nutrients in the lake to increase primary productivity and zooplankton, the primary food source for young salmon. Fertilizing the lakes would have an indirect, positive effect on sockeye salmon by allowing an increased escapement, increasing the number of spawning adults, increasing survival of juvenile salmon, and therefore increasing the sockeye population. The effect would be short-term, lasting only as long as the lake fertilization is continued. The effect could be long-term if fertilization was continued and forage fish remained abundant as a food source for growing adult populations.

Improving access to salmon spawning areas by building fish passes or removing barriers would have a direct, positive effect on sockeye salmon populations by providing new or additional habitat for sockeye salmon spawning. This could improve spawning success and increase the population of sockeye salmon. This would be a long-term effect because this new habitat would be available for the life of the salmon fishery.

Option #23 (Create new salmon runs)

This option would provide new commercial, sport, and subsistence fishing opportunities to replace those opportunities lost from the spill. In addition, this option might relieve fishing pressure on stocks damaged by the spill, assuming that timing and location of new fish runs would be managed in accordance with genetic and disease control guidelines to avoid further damage to natural stocks. Therefore, this option would have an indirect, positive effect on sockeye salmon by reducing fishing pressure and allowing damaged stocks to naturally recover and therefore increase populations. Increased competition for food and habitat from the introduced salmon would be minimal if the new salmon runs are terminated following recovery of wild populations.

Option #6 (Improve survival of salmon eggs and fry)

This option could affect sockeye salmon by rearing wild sockeye salmon eggs and fry in boxes, net pens, or hatcheries. Assuming that strict guidelines to prevent disease and overescapement were implemented, this option could have a direct, positive effect on sockeye salmon by increasing the survival of eggs and larvae and improving spawning success, thereby facilitating an increase in population. The effects would be long-term because it would restore wild sockeye salmon populations.

Coastal Biological Communities

Intertidal Organisms

Alternative 2 - Habitat Protection

HP&A would impact the intertidal zone only where marine ecosystems are designated as sanctuaries. The magnitude of impacts to intertidal organisms associated with HP&A would depend in part on the number of marine sanctuaries designated. Alternative 2 would allocate the largest amount of funds to HP&A of all the alternatives.

Alternatives 3 and 4 - Limited and Moderate Restoration

Option 12 under Alternatives 3 and 4 specifically targets intertidal organisms. Option 12 would include a study to determine ways to reestablish intertidal organisms in areas where they have been damaged. Option 14 could also affect intertidal organisms under Alternatives 3 and 4. Option 14 would study methods to remove oil from mussel beds. Option 21 may indirectly affect intertidal organisms as a result of increases in harvesting by subsistence users. Option 19 could indirectly affect intertidal organisms thorough the creation of recreation facilities that may adversely affect intertidal habitats that were previously undisturbed. Depending on the results of studies conducted under Options 12 and 14, these alternatives could have a high magnitude of impact on intertidal organisms.

Alternative 5 - Comprehensive Restoration

Under Alternative 5, the same options and impacts included in Alternatives 3 and 4 would be included. HP&A would also be included, but at a lower level of funding (35 percent). Additionally, Alternative 5 would include Option 22 to replace subsistence harvest of bivalve shellfish. This option could indirectly affect intertidal organisms by increasing their populations where bivalve mariculture feasible. Alternative 5 could have a high magnitude of impact on intertidal organisms depending on the results of studies under Option 12, and the feasibility of implementing Option 22.

Options Related to Intertidal Organisms

Option #19 (Create new recreation sites and facilities)

It is assumed that new recreation areas associated with the implementation of this option were not previously areas of high human activity. Consequently, construction of new recreational facilities could have an adverse, indirect, long-term effect on intertidal organisms because these facilities could contribute to increased use of a damaged areas that previously were little used or unused. Increased human use might include pollution, resource exploitation, trampling of sensitive vegetation, and disturbance of wildlife. This could slow the growth or reduce the number of organisms living in the damaged intertidal area.

Option #14 (Eliminate oil from mussel beds)

This option would produce a positive, direct, short-term effect on the mussel beds present on the intertidal environment by removing residual oil that is present in and adjacent to the mussel beds and reducing or eliminating the potential for further contamination of the mussels in the long-run. Consequently, less oil would be available for bioaccumulation by mussels and other invertebrates, and a positive, indirect effect would result to the health and safety of the predatory species (i.e., harlequin duck, black oystercatcher, sea otter, river otter) and humans (i.e., subsistence gatherers) that consume mussels. A direct, short-term, adverse effect would occur, in that, a minimal amount of mussels would be lost during the cleaning process; however, this effect would be a one-time event. This option would also include monitoring to assess the efficacy of stripping oil from mussel beds (i.e., the fate of oil in mussels and substrate, and the effects of oil on growth and reproduction of mussels). The effect from monitoring would be a positive, direct, long-term effect, because this knowledge would ensure more beneficial clean-up procedures in the event of future spills.

Option #12 (Accelerate recovery of upper intertidal zone)

This option would have a positive, direct, long-term effect on the intertidal zone because it would provide a mechanism to accelerate the recovery and increase the population of *Fucus* by providing improved growing and attachment substrates (i.e., installing burlap for substrate), irrigation, and supplementing the population of adult, reproductive-sized plants. Because many organisms in the intertidal zone depend on *Fucus* for food and cover, this would have a positive, indirect, long-term effect on these intertidal organisms.

Option #21 (Provide access to traditional subsistence foods)

It is assumed that subsistence harvests currently occur in the intertidal areas. Consequently, this would result in a positive, direct, short-term effect on spill-damaged areas of the shallow intertidal environment because it would restrict further subsistence activities in spill-damaged areas, thus preventing activities that might slow the recovery of populations of intertidal organisms.

Option #22 (Replace subsistence harvest opportunities for bivalve shellfish)

It is assumed that the development of subsistence mariculture sites would reduce further disturbance of the oil-damaged intertidal organisms by subsistence users. Consequently, a positive, direct, long-term effect on the intertidal environment would result from this option because it would prevent collection activities that might slow the population growth and recovery of clams and mussels, thus allowing the clam and mussel population to increase. It is also possible that hatchery-grown shellfish could be used to re-seed native oil-damaged beaches that are no longer oiled. Consequently, the option to develop a bivalve shellfish hatchery and research center would produce a positive, direct, long-term effect on the clams and mussels of the intertidal habitat by providing a mechanism for augmenting and accelerating the recovery and increasing the population of the native species.

Subtidal Organisms

Alternative 2 - Habitat Protection

HP&A may affect the subtidal zones through special designations, such as marine sanctuaries. Although Alternative 2 allocates more funds to HP&A than the other alternatives, the impacts would probably be of low magnitude because of the localized area affected in comparison to the total amount of subtidal zone within the *EVOS* area.

Alternatives 3, 4, and 5 - Limited and Moderate Restoration

Alternatives 3, 4, and 5 would include Option 14 that could indirectly impact subtidal organisms in an adverse manner because more oil may temporarily be suspended in the subtidal ecosystem if a mussel bed cleaning process were implemented. Option 14 would also have an indirect, positive impact on subtidal organisms by cleaning up the mussel beds and removing oil that would bioaccumulate in organisms over the long term. The indirect impact from Option 14 could have a low magnitude because even though the option may be implemented throughout the spill zone, it would affect only localized areas. Alternatives 3, 4, and 5 would also include Option 21, which may increase harvesting of subtidal organisms by subsistence users. This option may have a small localized impact on subtidal organisms within the *EVOS* area.

Options Related to Subtidal Organisms

Option #14 (Eliminate oil from mussel beds)

This option would produce an adverse indirect, short-term effect on organisms of the subtidal habitat because residual oil would be removed from the mussel beds and adjacent areas in the intertidal habitat and oil may temporarily become more available, in the water column, to the subtidal organisms. However, a positive, indirect, long-term effect would also occur because this oil would then be subject to more extensive weathering and eventually, less oil would be available for bioaccumulation by organisms of the subtidal environment.

Option #21 (Provide access to traditional subsistence foods)

It is assumed that subsistence harvests currently occur in the shallow subtidal areas. Consequently, this would result in a positive, direct, short-term effect on spill-damaged areas of the shallow subtidal environment because it would restrict further subsistence activities in spill-damaged areas, thus preventing activities that might slow the recovery of populations of subtidal organisms.

Issue 2: **How would activities directed at injured resources and services affect non-target resources and services?**

The impacts of restoration activities on nontarget resources are analyzed by alternatives and individual options in the following section. Impacts on ecological services are discussed under Issue 3 (ecological change). Impacts on nontarget human-based services are discussed under Issue 4 (land use, local economies, and communities).

Habitat acquisition and protection is the principal means for conserving non-target species within the Restoration Plan for Alternatives 2 through 5. Alternatives 2 through 5 could have a positive, indirect, long-term effect on non-target species conservation.

Many nontarget species reside within, or migrate through, the *EVOS* area. To varying degrees, they depend on the biological resources of the area for food, shelter, and reproduction. For example, Prince William Sound is a major feeding area for humpback whales in the North Pacific between spring and autumn. However, because no evidence of injury has been observed from the *EVOS*, no options have been proposed that impact humpback whales. There may be some indirect impacts to humpback food supplies or disturbances from recreational activities related to certain of the proposed restoration options, but the linkage between these impacts and the options is unclear and very speculative. Similarly, Peale's peregrine falcons rely on the *EVOS* resources for food and shelter. It is possible that habitat acquisition related to restoration plan would benefit falcons by preventing loss of habitat required for breeding and nesting. The projected impacts of restoration options for other nontarget species are discussed below.

Black Bear, Brown Bear, and Sitka Black-tailed Deer

No options were identified under Alternatives 2 through 5 that direct;y target black bear, brown bear, and Sitka black-tailed deer. These terrestrial species occasionally forage in the intertidal zones that may have been affected by the *EVOS*, but no direct link to injury has been shown to currently exist. HP&A that could involve acquisition of upland habitats used by these species could have a positive impact on bear and deer by ensuring the long-term maintenance of habitat necessary for their survival. Some restoration options included in Alternatives 3 through 5, such as those that would create new salmon runs, could indirectly benefit bears by providing them with a sustained long-term source of food. The intent of these options, however, is not to provide bear with an additional food source, rather, the intent is to increase populations of salmon. Consequently, though bears and deer may benefit from options targeting other resources and services, the impacts on these species would not be expected to have a high magnitude.

Steller's Sea Lions

Several lions are a marine mammal who like the terrestrial mammals (i.e., bear and deer), have not been specifically targeted by any of the options included in the proposed Restoration Plan alternatives. Several options included in Restoration Plan alternatives could indirectly impact sea lions by increasing the short and long-term food supplies. The long-term benefits sea lions from implementing alternatives would be larger areas of protected habitat and localized increases in food supply. Although these impacts would positively impact sea lions, the potential for increasing sea lion populations as a result of these indirect effects would be of a low magnitude because of the indirect nature of the effects.

Black-legged Kittiwake, Glaucous-winged Gull, Pigeon Guillemot, and Storm Petrel

HP&A targeting other terrestrial and marine species of birds and mammals would also affect the black-legged kittiwake, glaucous-winged gull, pigeon guillemot, and storm petrel by providing protected habitat for breeding and nesting. Up to 90 percent of the restoration funds allocated for these alternatives are allocated for HP&A. The geographic extent of the impact from implementing these alternatives would be large, including the entire *EVOS* area. Assuming the habitat would remain under protected status, the duration of the impacts associated with this habitat protection would be long-term and could provide long-term benefits to the black-legged kittiwake, glaucous-winged gull, pigeon guillemot, and storm petrel by insuring the necessary habitat to maintain healthy populations in the oil spill area. Options implemented under Alternatives 3 through 5 could lead to increases in those bird species' food supplies. Other options, such as those that are intended to minimize disturbance or depredation of other targeted species that share their habitat may indirectly benefit black-legged kittiwakes, glaucous-winged gulls, pigeon guillemots, and storm petrels. Positive impacts associated with these options could occur for a long duration but would not be expected to have a high magnitude.

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

The acquisition of private lands for habitat protection and the placing of public lands into special State and Federal land designations would promote only beneficial ecological change within the *EVOS* area. By enhancing the ecological integrity of the Greater *EVOS* Area Ecosystem, these activities would substantially promote the conservation of biodiversity. Therefore, implementation of habitat protection and acquisition (HP&A) under Alternatives 2 through 5 is the principal means for implementing ecosystem management and conserving biodiversity under the Restoration Plan. General restoration activities implemented under Alternatives 3, 4, and 5 would further enhance recovery of selected species toward natural ecological conditions.

As discussed in Chapter III, the physical and biological environment is better described as the Greater *EVOS* Area Ecosystem and includes the marine ecosystem, coastal ecosystem, and terrestrial ecosystem. All of the options could have some effect, although not always measurable or significant, on these ecosystems. Nonetheless, the cumulative effect of recovering resources constitutes a substantial benefit to the ecosystem. The relative benefits to biodiversity conservation within the Greater *EVOS* Ecosystem are presented below for each Alternative, and are subsequently discussed in more detail for individual restoration options.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement habitat protection and acquisition. HP&A is the principal means for implementing ecosystem management within the restoration plan and would have a strong positive, direct, long-term effect on biodiversity conservation. Special land designations under HP&A would also implement ecosystem management measures, albeit on the smaller scale of existing public lands, and would have a moderate positive, direct, long-term effect on biodiversity conservation. The large amount of funding allocated HP&A under this alternative (the entire budget minus 10 percent for administration and public information, and monitoring and research) indicates that Alternative 2 would be implemented over a wide geographic extent and would include parcels totaling a large number of acres. Assuming that the acquisition of lands includes management in perpetuity for ecosystem integrity, the duration of this effect would be long-term. Because of these factors, the magnitude of the impact on biodiversity conservation of this alternative would be high.

Alternative 3 - Limited Restoration

Nearly all of the options in the restoration plan would affect biodiversity conservation to some extent. Options 1, 3, 4, 6, 7, 9, 10, 11, 13, 15, and 22 would have very slight to slight positive, indirect effects on biodiversity by contributing to population enhancement of individual species. Options 5 and 12 would have a greater positive effect on biodiversity by improving local habitat conditions for whole communities of organisms. Habitat alteration from the construction of recreational sites (Option 19) and the possible oversupply of salmon (Option 23) could have slight negative effects on biodiversity. Research and information dissemination into the ecosystem status of the *EVOS* area under Options 8, 24, and 25 would have a slight positive, indirect effect on biodiversity.

Under Alternative 3, the impacts of these general restoration options would be overwhelmed by the strong positive effects of the habitat protection and acquisition. The large amount of funding allocated to the HP&A (75 percent of the entire budget) indicates that, as in Alternative 2, this alternative would implement habitat protection and acquisition over a wide geographic extent and include parcels totaling a large number of acres. Assuming that the acquisition of lands includes management in perpetuity for ecosystem integrity, the duration of this effect would be long-term. Because of these factors, the magnitude of the impact from this alternative on biodiversity conservation would be high.

Alternative 4 - Moderate Restoration

Nearly all of the options in the restoration plan would affect biodiversity conservation to some extent. Options 1, 3, 4, 6, 7, 9, 10, 11, 13, 15, and 22 would have very slight to slight positive, indirect effects on biodiversity by contributing to population enhancement of individual species. Options 5 and 12 would have a slightly greater positive effect on biodiversity by improving local habitat conditions for whole communities of organisms. Habitat alteration from the construction of recreational sites (Option 19) and the possible oversupply of salmon (Option 23) could have slight negative effects on biodiversity. Research and information dissemination on the ecosystem status of the *EVOS* area under Options 8, 24, and 25 would have a slight positive, indirect effect on biodiversity.

Under Alternative 4, the impacts of these options would be added to the strong positive effects of the habitat protection and acquisition. The substantial amount of funding still allocated to the HP&A (50 percent of the budget) indicates that this alternative would implement habitat protection and acquisition over a moderate geographic extent and include parcels totalling a lesser number of acres. Assuming that the acquisition of lands includes management in perpetuity for ecosystem integrity, the duration of this effect would be long-term. The combination of slight benefits from general restoration options and major benefits of habitat protection and acquisition would produce a moderate to high magnitude of the impact on biodiversity conservation for this alternative.

Alternative 5 - Comprehensive Restoration

Nearly all of the options in the restoration plan would affect biodiversity conservation to some extent. Options 1, 3, 4, 6, 7, 9, 10, 11, 13, 15, and 22 would have very slight to slight positive, indirect effects on biodiversity by contributing to population enhancement of individual species. Options 5 and 12 would have a slightly greater positive effect on biodiversity by improving local habitat conditions for whole communities of organisms. Habitat alteration from the construction of recreational sites (Option 19) and the possible oversupply of salmon (Option 23) could have slight negative effects on biodiversity. Research and information dissemination on the ecosystem status of the *EVOS* area under Options 8. 24, and 25 would have a slight positive, indirect effect on biodiversity.

Under Alternative 5, the impacts of these general restoration options would be added to the strong positive effects of the habitat protection and acquisition. The more limited amount of funding allocated to HP&A (35 percent of the budget) indicates that this alternative would implement habitat protection and acquisition over a limited geographic extent and include parcels totalling a moderate number of acres. Assuming that the acquisition of lands includes management in perpetuity for ecosystem integrity, the duration of this effect would be long-term. The combination of slight benefits from general restoration options and a lesser amount of major benefits of habitat protection and acquisition would produce a moderate magnitude impact on biodiversity conservation for this alternative. The greater emphasis on increased human uses under Alternative 5 could reduce the positive impact on biodiversity conservation.

Options Related to the Greater *EVOS* Ecosystem

Because the goal of the Restoration Plan is to benefit resources and services within the Greater *EVOS* Ecosystem, each of the options makes some contribution to the conservation of biodiversity. In order to discriminate relative degrees of benefit to biodiversity, a set of ten biodiversity evaluation criteria was applied to each restoration option. These criteria are adapted from the recent Council on Environmental Quality (1993) document on incorporating the consideration of biodiversity into the NEPA process.

1. Does the option manage resources from a "big picture" or ecosystem perspective?
2. Does it protect communities and ecosystems?
3. Does it minimize fragmentation and promote the natural pattern and connectivity of habitats?
4. Does it promote native species and avoid introducing non-native species?
5. Does it protect rare and ecologically important species?
6. Does it protect unique or sensitive environments?
7. Does it maintain or mimic natural ecosystem processes?
8. Does it maintain or mimic naturally occurring structural diversity?
9. Does it protect genetic diversity?
10. Does it monitor for biodiversity impacts, acknowledge uncertainty, and retain flexibility in management?

Where possible, each option was evaluated in terms of its potential effect on the area of sensitive habitats, status of sensitive habitats, number of sensitive species, population status (including genetic composition) of sensitive species, and status of the landscape.

Special attention was also paid to the various degrees of linkage among the different species within the greater ecosystem. Although, some impacts may be small on individual resources, the combined impact on the ecosystem may be substantial. At the same time, the impacts of some options may be large for certain species within the ecosystems, but not significant for the ecosystem. Because of the complexity of interactions within an ecosystem, natural recovery should be encouraged wherever possible. At the same time, this approach must include diligent protection of the system from continuing and new impacts. In any case, long-term monitoring of the recovery process and effectiveness of restoration activities is essential.

HP&A (Habitat protection and acquisition)

HP&A involves private land acquisition, or acquisition of partial interests in private lands, for the purpose of protecting habitats linked to the resources injured by the oil spill or to prevent additional injury to those resources. Implementation may include the acquisition of critical upland habitat for injured species, such as undisturbed riparian lands around anadromous streams or nesting areas in mature forests. This option directly addresses biodiversity conservation in coastal and terrestrial ecosystems, and by extension marine ecosystems (which are linked through ecological processes and are especially vulnerable to degrading activities occurring in upland environments).

Special designation activities under HP&A also directly address biodiversity conservation. Marine, coastal, and terrestrial areas in public ownership can be placed into special State or Federal land designations that provide increased levels of regulatory protection. An important feature of special designations is that they can provide a regulatory basis for managing an area on an ecosystem level, with the primary objective of restoring spill injuries. Like habitat acquisition, special designations would promote biodiversity by maintaining ecosystem integrity. It could also enhance the recovery of injured resources, because their recovery may be substantially delayed or prevented by future development on private lands.

Both land acquisition and special designation activities address each of the biodiversity evaluation criteria described above. In fact, the habitat acquisition criteria (HAC) developed under the Restoration Plan for identifying parcels often parallel these biodiversity evaluation criteria. The following discussion describes how HP&A (and its habitat acquisition criteria) address each of these biodiversity evaluation criteria.

1. HP&A takes a "big picture" or ecosystem view of *EVOS* restoration as evidenced by HAC #2 (The parcel should function as an intact ecological unit or essential habitats on the parcel must be linked to other elements/habitats in the greater ecosystem).

2. HP&A directly protects communities and ecosystems by preserving land units rather than managing individual species. HAC #4 (The parcel should benefit more than one species or service) is consistent with community rather than single species management.

3. HP&A could minimize fragmentation by uniting private parcels with lands already in protected status. This would promote the natural pattern and connectivity of habitats. The inclusion of HAC #6 in the parcel selection process (select vulnerable or potentially threatened areas) is evidence that without protection degradation of many parcels through logging, or other incompatible human uses, is imminent.

4. HP&A could promote native species and avoid introducing non-native species by transferring private lands into management programs that follow guidelines excluding exotic introductions.

5. Under HP&A, HAC #5 (the parcel should contain critical habitat for depleted, rare, threatened, or endangered species) explicitly includes protection of rare and ecologically important species. However, it is unlikely that individual parcels contain important for listed threatened or endangered species, or that the distribution of these species could be used to select parcels.

6. Under HP&A, HAC #1 explicitly states that selected parcels should contain essential habitats or sites, i.e., unique or sensitive environments. For example, old growth stands could be protected from logging through the acquisition of forested parcels.

7. HP&A could maintain natural ecosystem processes as evidenced by HAC #3 (adjacent land uses will not significantly degrade the ecological function).

8. Under HP&A, acquisition of prospective timber lands could help maintain naturally occurring structural diversity that would be lost through logging operations. Typically, logging simplifies natural forest pattern by reducing age classes and removing snags and downed wood.

9. HP&A could protect genetic diversity by maintaining the natural complement of subpopulations and individual variation within the ecosystem. In contrast, single species approaches to resource management can reduce genetic diversity of wild populations.

10. HP&A acknowledges the uncertainty inherent in ecosystem restoration. By maintaining a reservoir of natural areas, this HP&A could provide a benchmark for biodiversity monitoring and provide flexibility for future management decisions.

In summary, HP&A would have a strong positive, direct, long-term impact on the marine, coastal, and terrestrial ecosystems.

Option #1 (Reduce the bycatch of harbor seals)

The purpose of this option is to improve the understanding of fishing interactions and harbor seals and ultimately reduce any problems. The option could include cooperative programs with commercial fishermen for reducing bycatch of harbor seals through reduction of entanglement and deterrent measures. This option could contribute to population increases (improved species population status) of harbor seals. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine and coastal ecosystems.

Option #3 (Facilitate Changes in Black Cod Fishery Gear)

This option is designed to prevent the harassment and shooting of the killer whales that strip cod from longline gear. This option could contribute to improved population status of individual killer whale pods. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine ecosystem. These positive effects would be limited by their small magnitude (changes in populations numbers of a single species).

Option #4 (Intensify fisheries management)

This option involves research and the development of recommendations for restricting or redirecting of existing fisheries. Changes to fisheries management would be implemented through regulations promulgated by the Alaska Board of Fish. This option could contribute to population increases (improved species population status) of individual fish species. To the extent that these populations returned to natural levels, this option would have a moderate, indirect, long-term, positive effect on the marine, coastal, and terrestrial (as defined to include anadromous migration into freshwater streams) ecosystems. These positive effects would be limited by their magnitude (changes in populations numbers of selected species) and extent (expected changes in abundance only in targeted areas), but would be enhanced by the important ecological roles played by these abundant fish species.

Options #5 (Improvements to freshwater wild salmon habitats)

This option would involve a number of techniques designed to restore and enhance wild salmon populations in the oil-spill area including construction of salmon spawning channels and instream improvements, fertilization of lakes to improve rearing success, and improvement of access to spawning areas the construction of fish passes or the removal of barriers. This option could contribute to population increases (improved species population status) of pink and sockeye salmon. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine, coastal, and terrestrial (as defined to include anadromous migration into freshwater streams) ecosystems. These positive effects would be limited by their small magnitude (changes in population numbers to only a two species) and moderate extent (expected changes in abundance only in targeted areas). To the extent that habitats would be modified from natural conditions to benefit salmon, other native species could be adversely affected. In particular, nutrient enrichment might adversely affect natural invertebrate communities adapted to low nutrient conditions. Achieving passage beyond manmade blockages would benefit all species and constitute a moderate, positive, direct, long-term impact on the freshwater terrestrial ecosystem.

Option #6 (Improve survival of salmon eggs and fry)

This option is designed to increase survival of salmon eggs and larvae through the rearing of wild salmon eggs in boxes, netpens, or hatcheries, and their release into native streams. This option could contribute to population increases (improved species population status) of pink and sockeye salmon, and perhaps on predators feeding on salmon eggs and fry such as Dolly Varden. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine, coastal, and terrestrial (as defined to include anadromous migration into freshwater streams) ecosystems. These positive effects would be limited by their small magnitude (changes in populations numbers to only a few species) and moderate extent (expected changes in abundance only in targeted areas).

Option #7 (Change or relocate existing hatchery runs)

This option would involve changing the timing of hatchery run releases or releasing hatchery fish at remote locations to minimize the interaction of hatchery fish and wild salmon stocks during commercial harvest. This option would benefit natural populations of native species by reducing the adverse impacts of genetic mixing with hatchery fish. In contrast, relocation of hatchery runs may upset the natural conditions in new habitats adversely affecting resident species. Assuming that new runs would be undertaken only in streams previously supporting salmon populations (e.g., those blocked by dams or other obstructions), this option would result in a very slight, positive, indirect, short-term impact on the marine, coastal, and terrestrial (freshwater) ecosystems.

Option #8 (Protect undocumented anadromous streams)

This option involves listing undocumented anadromous streams in the State's catalogue to afford them legal protection under the State Forest Practices Act and under Title 16 of the Alaska Statute requiring protection of anadromous fish streams. This option could improve the understanding of natural ecosystem conditions in the *EVOS* area and could lead to better management decisions affecting the marine, coastal, and terrestrial ecosystems. This option would have a slight, positive, indirect, long-term impact on these ecosystems.

Option #9 (Removal of introduced predator species)

The primary goal of this option would be to remove introduced fox from islands along the Alaska Peninsula and Aleutians. A secondary goal could be to reduce avian predators. This option could contribute to population increases (improved species population status) in a number of species that face predation from introduced foxes. To the extent that fox removal is accomplished and natural community composition is returned, the coastal and terrestrial ecosystems could improve. Where natural predators are controlled, natural ecosystems processes may be temporarily disrupted. Assuming that foxes are successfully removed from large areas, this option would result in a slight, positive, direct, long-term impact on the coastal and terrestrial ecosystem. Although removal of introduced species can have a strongly beneficial impact on natural ecosystems, the limited extent of areas affected by foxes prevents the removal option from having a greater effect.

Options #10 (Increase murre productivity and nesting ledges)

Enhancing social stimuli, such as using decoys and recorded calls to give the illusion of typical breeding densities may encourage a return to normal breeding patterns. Largely experimental techniques that provide breeding ledges with sills, add partitions and/or roofs on nesting ledges, enlarge nesting ledges, and clear debris from otherwise suitable nesting sites would be undertaken following determination of feasibility. If specific techniques were shown to be feasible, this option could contribute to population increases in murres (improve species population status). To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine and coastal ecosystems. It is possible that intense management of these breeding areas may have negative affects on the coastal ecosystem through habitat alteration or disturbance, but it is assumed that these considerations would be taken into account during the determination of feasibility. The positive effects would be limited by their small magnitude (changes in populations numbers to only one species) and small extent (expected changes in abundance only in a few areas).

Option #11 (Minimize the incidental take of marine birds)

Under this option, the extent of marbled murrelet mortality resulting from gillnets and driftnets would be examined. If the mortality is found to represent a significant source of mortality for populations in the spill area, an effort would be made to develop new technologies or strategies for reducing encounters. This option could contribute to population increases (improved species population status) of this species. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine and coastal ecosystems. These positive effects would be limited by their small magnitude (changes in population numbers to only a few species) and small extent (expected changes in abundance only in a few areas).

Option #12 (Accelerate recovery of the upper intertidal zone)

This option would involve methods to remediate habitat heavily oiled and subjected to intensive clean-up measures. Implementation of this option would include installation of trickle irrigation systems designed to enhance moisture retention, use of biodegradable materials as additional substrate for germling attachment and cover, and transplanting adult plants attached to small rocks and cobble. The overall objective of this option is to facilitate recovery of the previously dominant brown algae *Fucus gardneri* (popweed). The loss of *Fucus* algae had a severe impact on the intertidal community that depends on this species for substrate attachment and physical shelter. Return of this algae could greatly benefit the intertidal community (increase area and improve status of sensitive habitats), and to a lesser degree those species that feed on intertidal organisms. Because of the degraded condition of the *Fucus*-based community, it is assumed that intrusive methods of restoration would not have significant adverse effects on the ecosystem. Therefore, this option would have a moderate, positive, direct, long-term impact on the coastal ecosystem. Only the limited extent to which this option can be implemented prevents it from having a larger positive impact.

Option #13 (Reduce disturbance at bird colonies, haulout sites, and concentration areas)

This option would involve the possible establishment of buffer zones around these sensitive areas, or other measures to reduce disturbance by permitting agencies. This option could contribute to population increase of individual bird and mammal species. To the extent that these populations returned to natural levels, this option would have a slight, indirect, long-term, positive effect on the marine and coastal ecosystems. These positive effects would be limited by their small magnitude (changes in populations numbers to only a few species) and moderate extent (expected changes in abundance only in targeted areas). Creation of small buffer areas would also benefit other seabirds that nest on target islands.

Option #14 (Eliminate oil from mussel beds)

This option would determine the geographic extent of remaining oil in mussel beds and implement the most effective and least intrusive method of cleaning. Persistent oil in the mussel beds continues to have adverse effects on the marine, coastal, and terrestrial (freshwater) ecosystems. The elimination of toxic effects to a variety of organisms and the return of spawning substrates and microhabitats to their natural condition (increase area of sensitive habitats) could greatly benefit the local aquatic communities. Lesser benefits could be reaped by species dependent on these beds and streams for food and habitat. In contrast, mechanical manipulation of mussel bed or stream bottom structure could have adverse effects on the aquatic communities, especially in the short term. Assuming that intrusive methods of oil removal would be required, the slight, direct, net positive effects of this option on the marine and coastal ecosystems would be likely only be realized in the long term.

Option #15 (Develop harvest guidelines)

This option would involve imposing temporary restrictions or closure of harvest opportunities for river otters and harlequin ducks in the oil-spill area. This option could contribute to population increases (improved population status) of these species. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the coastal and terrestrial ecosystems. These positive effects would be limited by their small magnitude (changes in populations numbers to only two species) and moderate extent (expected changes in abundance only in targeted areas).

Option #20 (Test subsistence foods for hydrocarbon contamination)

Testing subsistence foods for hydrocarbon contamination is assumed to be unrelated to toxic effects on native species. Therefore, this option would have no impact on the marine, coastal, or terrestrial ecosystems.

Option #22 (Replace subsistence harvest opportunities for bivalve shellfish)

This option would provide the facilities and infrastructure to restore, replace, and/or enhance affected shellfish populations and in particular, the subsistence use of shellfish. Additionally, there is the potential to use hatchery shellfish to re-seed native species on beaches damaged by oiling or clean up, once those beaches are no longer oiled. This option would not contribute to natural populations of native species, but might reduce harvest pressure on these populations. In addition, populations of species prey on bivalves may benefit. Therefore, this option would have a very slight, positive, indirect, short-term impact on the marine ecosystems.

Option #23 (Create new salmon runs)

This option would involve terminal hatchery runs and saltwater releases. This option would not contribute to natural populations of native species, but might reduce harvest pressure on these populations. Assuming that the new runs would be terminated following the recovery of wild stocks, predatory birds and mammals that feed on forage fish consumed by salmon would not be adversely affected by overabundant salmon depleting the food source. Therefore, this option would have a very slight, positive, indirect, short-term impact on the coastal and terrestrial ecosystems.

Option #24 (Visitor center)

This option involves construction and operation of a large visitor-center or expansion of an existing visitor center somewhere in the oil-affected area. Information from the visitor center would also be available to other visitor centers, government agencies, and organizations in the spill area. This option would remove natural habitat and alter ecological conditions at a single site over an area too small to produce a significant adverse effect on the coastal or terrestrial ecosystems. At the same time, this option could improve the public understanding of natural ecosystem conditions in the *EVOS* area and could lead to more compatible human uses of the area. This option would have a slight, positive, indirect, long-term impact on the marine, coastal, and terrestrial ecosystems.

Option #25 (Establish a marine environmental institute)

This option involves construction of a new marine environmental institute in an easily accessible area within the oil- spill region, for the purpose of studying the marine environment and providing public education. This option could remove natural habitat and alter ecological conditions at a single site over an area too small to produce a significant adverse effect on the coastal or terrestrial ecosystems. At the same time, this option could improve the public understanding and scientific knowledge of natural ecosystem conditions in the *EVOS* area and could lead to better management decisions and more compatible human uses of the area. This option would have a slight, positive, indirect, long-term impact on the marine, coastal, and terrestrial ecosystems.

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

The impacts of restoration activities on land uses, local economies, and communities are presented in the following section. Specifically, each injured human-based resource and service are analyzed by alternatives and individual options. Impacts on subsistence services are discussed under Issue 5 (subsistence).

Land Uses

Land uses surrounding local communities could be changed in response to habitat protection and acquisition activities. In some areas, timber management (including logging) and mining, would be replaced with expanded fishing and tourism opportunities. Under HP&A, future land uses would compliment the resource management goals and objectives of the Restoration Plan.

Under Alternative 2, the acquisition of private land for habitat protection and the special designation of public lands would preclude future development and reduce resource exploitation uses and in a large number of areas.

Under Alternatives 3 and 4, acquisition of private land for habitat protection and the special designation of public lands would preclude future development and reduce resource exploitation uses in a moderate to large number of areas.

Under Alternative 5, acquisition of private land for habitat protection and the special designation of public lands would preclude future development and reduce resource exploitation uses in a small to moderate number of areas.

Local Economies

Under Alternative 2, HP&A would receive 90% of restoration funds and therefore habitat acquisition might entail precluding substantial parts of the *EVOS* area from resource exploitation, principally logging. This could have a negative, short-term impact on local economies dependent on timber harvesting. In contrast, local economies dependent on tourism and marine resource exploitation (fishing) would benefit from protection of the ecosystem and the recovery of fisheries services. In the long term, sustainable development of *EVOS* area natural resources could be enhanced by protection of critical habitat areas.

Under Alternatives 3, 4, and 5 habitat acquisition would have a negative, short-term impact on local economies dependent on timber harvesting. In contrast, local economies dependent on tourism and marine resource exploitation (fishing) would benefit. General restoration activities under these alternatives might involve short-term disruption of some fishing activities, but the long-term recovery of the ecosystem and fisheries services would have a positive impact on all local economies.

Communities

The communities of the *EVOS* area are diverse in their economic base, infrastructure, and social organization. Nevertheless, all the communities experience and share in the region's areas of natural beauty and resources to some extent. Through the habitat acquisition and the special designation of public lands activities included in the Alternatives, the Restoration Plan would contribute to the preservation and protection of the greater ecosystem upon which *EVOS* community economies and social systems are dependent. Fishing and tourism are important industries in the *EVOS* area. The Alternatives would contribute to the comprehensive long-term management of these resources, and therefore facilitate the sustainable use of *EVOS* resources for all *EVOS* communities. Although short-term job displacement would occur in the timber industry, fishing and tourism would be enhanced.

The quality of life and lifestyle offered by the *EVOS* physical environment is important to community residents. Although habitat acquisition and the special designation of public lands may require *EVOS* communities to make short-term economic adjustments, long-term benefits outweigh short-term adjustments. The acquisition of land and changes in land use would permit comprehensive management of *EVOS* area resources for the long-term benefit of all *EVOS* communities.

Alternative 2 principally addresses the acquisition of private land for habitat protection and the special designation of public lands. The Alternative could have a short-term affect on certain local communities by shifting employment opportunities from forest industries to fishing and tourism industries. At the same time, habitat acquisition and protection efforts could provide long-term benefits to *EVOS* communities by enhancing the quality of life and lifestyle practiced.

Alternative 3, 4, and 5 also addresses the acquisition of private land for habitat protection and the special designation of public lands. This might affect community land use plans and reduce employment opportunities in the timber industry. At the same time, community benefits might accrue related to the enhancement of the fishing and tourism industries, and the protection of quality of life and lifestyle values. General restoration activities under these alternatives would might involve minor short-term adjustment in some social and cultural activities (see discussion of subsistence impacts under Issue 5), but the long-term recovery of the ecosystem and fisheries services would have a positive impact on all communities.

The remainder of this discussion summarizes the specific impacts of each alternative and individual options on the injured resources of wilderness areas and archaeological resources, and on the injured services of recreation (including sport fishing and hunting), commercial tourism, commercial fishing, and passive use relative.

Resources

Designated Wilderness Areas

Alternative 2, 3, 4, and 5 do not address specifically designated wilderness areas, but currently unplanned Congressional efforts to designate existing wilderness study areas (or non-study areas) would be consistent with the special designation activities under HP&A.

Archaeological Resources

Alternative 2 - Habitat Protection

This alternative does not address archaeological resources. The existing condition of archeological artifacts and resources would continue.

Alternative 3 - Limited Restoration

Under this Alternative Options 16 and 17 would affect archaeological resources. Option 16 would enhance the preservation of these resources by educating the public on the importance and uniqueness of the *EVOS* archaeological resources. The site stewardship program would encourage local communities to actively participate in and take responsibility for the preservation of archaeological resources. Option 17 addresses the need to repair damaged archaeological sites and would have the direct, positive, long-term effect of reducing additional degradation or decline of resources and services associated with archeological sites and artifacts.

Alternatives 4 and 5 - Moderate and Comprehensive Restoration

Options 16, 17, and 18 affect archaeology under these alternatives. The effects of Options 16 and 17 are described in Alternative 3. Option 18 would have the direct, positive long-term effect of replacing lost artifacts and increasing the number of resources and services associated with archaeological sites and artifacts. Both alternatives should provide long-term protection and preservation of the archaeological resources within the *EVOS* area.

Option #1 (Archaeological site stewardship program)

This option establishes an archaeological site stewardship program. Beach cleanup activities following the oil spill resulted in increased public knowledge of the exact locations of archaeological sites throughout the *EVOS* area. Archaeological sites and artifacts affected by looting and vandalism directly attributable to the oil spill has been occurring at disturbing levels. The site stewardship program would involve the recruitment, training, and coordination of a corps of local interested citizens to watch over threatened archaeological sites located within their home districts.

Although archaeological sites and artifacts cannot be restored, the site stewardship program is designed to stop additional damage to archaeological resources from looting and vandalism.

Members of the citizen corps may receive small cash payments for their volunteer duties. These payments may benefit the local economy by introducing additional cash into the economy.

Option 1 could have the effect of increasing local knowledge of and appreciation for archaeological sites and artifacts and ultimately stimulate interest and action in protecting archaeological resources for the long term.

Option #10 (Preserve archaeological sites and artifacts)

This option addresses the need to repair archaeological sites that sustained injury from oiling, oil spill cleanup, or vandalism, as well as the need to recover salvageable information from areas of illegal excavation. It has been estimated that at least 113 archaeological sites located on State and Federal lands within the *EVOS* area sustained injury. This option would focus on the 24 archaeological sites for which clear evidence of injury would benefit from restorative actions taken to prevent additional injury and provide professional documentation on archaeological sites. This option would have a direct, positive long-term effect on reducing additional degradation or decline of the resources and services associated with archaeological sites and artifacts.

Option #18 (Negotiate with museums and agencies to acquire replacements for artifacts looted from the spill area)

This option seeks to replace and/or recover those artifacts that have been lost as a result of oil spill cleanup activities or vandalism. It also seeks to place returned/recovered artifacts into public ownership for appropriate public display and scientific uses. Individuals and institutions with oil spill artifacts will be approached with offers of artifact purchase from the *Exxon Valdez* Oil Spill Trustees (member agencies). Acquired artifacts would be transferred to appropriate public institutions within the oil spill area for public display and appropriate scientific uses. This effort would provide replacement artifacts for those lost and would have a direct, positive long-term effect on the value of resources and services associated with archaeological sites and artifacts. Replacement would have the effect of providing Alaskans access to their rich cultural heritage.

Services

Recreation

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the funds would be used to implement HP&A. Habitat protection would provide enhanced recreational opportunities throughout the oil spill region and would specifically acquire habitats for developing recreational sites. Assuming that the habitat protection through special designation and land acquisition is afforded in perpetuity, the extent and the duration of the impacts could be high, creating long-term, positive benefits to recreation.

Indirect, negative impacts to recreation could also occur from restrictions on certain recreational activities that otherwise occurred on these lands. The impact would be short-term, assuming that the restrictions would be removed after the population of the targeted injured species have recovered. Therefore, the magnitude of the short-term impact would be low.

Alternative 3 - Limited Restoration

Under this alternative, Options 13, 11, 17, 19, 10, and 9, as well as HP&A, would affect recreation. Options 13, 11, 10, and 9 could indirectly benefit recreation throughout the oil spill area by increasing the population of marine birds and associated bird watching opportunities. Option 17 would benefit recreation by preserving archeological sites and artifacts that would attract visitors. Option 19 would have direct, positive impacts on recreation by constructing new recreational facilities throughout the oil spill area. As in Alternative 2, a large proportion (75 percent) of the restoration funds would be used for HP&A and could have long-term, positive impacts to recreation.

Alternative 4 - Moderate Restoration

Under this alternative, Option 18 would be added to the suite of options in Alternative 3. Option 18 would produce indirect, long-term, positive impacts on recreation by acquiring artifacts removed from the spill area. Approximately 50 percent of restoration funds would be allotted to HP&A and would have long-term, positive benefits to recreation as discussed previously.

Alternative 5 - Comprehensive Restoration

Under Alternative 5, Options 8, 24, and 25 would be added to the suite of options in Alternative 4. Option 8 would produce indirect, long-term, positive impacts on recreation. Options 24 and 25 would have direct, positive impacts on recreation by attracting visitors. The greater mix of options affecting recreation in Alternative 5 would have both short-term and long-term benefits to recreation within the *EVOS* area.

Options Related to Recreation

HP&A (Habitat protection and acquisition)

HP&A involves acquisition of or partial interests in private inholdings within Federal and State protected lands such as parks and refuges, to protect and better manage the habitat types linked to resources and services injured by the oil spill. Public ownership and enhanced protection of these lands would facilitate natural recovery by restricting activities stressful to already damaged populations, guard against future habitat degradation, and enhance the services provided. It is assumed that habitats for recreational sites would be acquired in visible areas readily accessible by roads.

HP&A also involves placing nearshore, coastal, and upland habitats in public ownership into special State or Federal land designations to provide increased levels of legal protection to injured resources and services supported by these lands. Designations include Alaska State Parks, Alaska Department of Fish and Game Special Areas, National Marine Sanctuaries, Federal Wilderness Areas, and State Public Use Areas.

Direct, long-term, positive effects would occur from habitat acquisitions for developing recreational sites. Direct, long-term effects would also occur from designations such as Alaska State Park and State Public Use Areas, which would provide additional recreational opportunities on these lands. These sites would attract more people, concentrate public use, and enhance recreational opportunities provided in the area. Other habitat protection activities would have indirect, long-term, positive effects on recreation. Indirect, long-term, positive effects would occur from other habitat acquisitions which would protect the ecosystem and wilderness quality of the area. Healthier ecosystems resulting from enhanced protection would attract visitors, potentially providing increased non-developed recreational opportunities. Short-term, negative effects on recreation could occur where habitat protection restricted or limited certain types of recreational activities on the protected lands.

Option #8 (Protect undocumented anadromous streams)

This option involves listing undocumented anadromous streams in the State's catalogue to afford legal protection under the State Forest Practices Act and Title 16 to injured anadromous species and their habitats. Short-term, negative effects would occur due to restrictions of ongoing instream activities. However, long-term effects would be realized as healthier ecosystems, resulting from enhanced resource protection, would provide increased recreational opportunities.

Option #9 (Increase productivity and survival of marine birds through predator control)
Option #10 (Increase productivity and success of murre colonies)
Option #11 (Minimize the incidental take of birds)

These options involve enhancing the population of marine bird species, especially on common murres, black oystercatchers, and pigeon guillemots, and marbled murrelets. Techniques including terrestrial and avian predator control, enhancing murre productivity at nest sites, and reducing encounters between these birds and gillnets deployed in high seas and coastal fisheries. Implementation of these options would have indirect, long-term, positive effects on recreation. These effects would occur because enhanced population of marine bird species would provide additional bird watching opportunities.

Option #13 (Reduce disturbance at bird colonies, haulout sites, etc)

As with the previous options, Option 13 would have positive effects on recreation in the long-term by increasing wildlife viewing opportunities associated with the increase in population of these injured species. This option involves establishment of buffer zones as special designation areas around important murre colonies and harbor seal haulout sites to reduce human disturbance. Restrictions within the buffer zones can range from limiting the speed of boat traffic within a couple hundred feet of a specific site for a short time each year, to prohibiting boat or air traffic within a half mile or mile of the location. Less stringent regulations would require tour or charter boat companies to change their use patterns for part of the year, but would not prohibit access. The most restrictive buffer zones could prevent access to a favorite viewing or fishing locations.

Implementation of this option would have indirect, long-term, positive and short-term, negative effects on recreation. Short-term, negative effects on recreation would be localized and would occur due to restrictions imposed on boat traffic that would limit opportunities for viewing murre colonies. It is assumed that the buffer zone restrictions would be removed once the population of injured species recover.

Option #18 (Acquire archeological artifacts)

This option seeks to replace and/or recover archeological artifacts that have been lost subsequent to the oil spill and return them to public ownership for appropriate public display in museums. The implementation of this option would have indirect, long-term, positive effects on recreation because it would enhance opportunities for the public to see these artifacts.

Option #19 (Create new recreation sites and facilities)

This option involves construction of new recreation sites and facilities on public land. In particular, the option involves construction of additional backcountry public facilities such as mooring buoys, boat ramps, picnic areas, caches, cabins, camping sites, and trails in National forests, monuments, parks, and wildlife refuges and state parks in the oil spill region. In addition, the option would make public land available for commercial recreation facilities such as fuel stops, docks, campgrounds, and lodges. This option would provide funds for planning and marketing these sites in the oil-spill area. It is assumed that recreational sites and facilities would be developed in easily accessible areas.

Implementation of this option would have direct, short-term, negative and long-term, positive effects on recreation. Short-term, negative effects would occur during construction activities that would limit or restrict temporary use of the site. Long-term, positive effects to recreation would occur because better sites and facilities would attract people and provide enhanced recreational opportunities. New sites and facilities would also enable the land managers to focus their information and education programs. Providing education on environmental awareness would enhance public knowledge for a common goal of sustained, sensitive, high-quality interaction with the environment. Recreational facilities would confine public use, limit human intervention, preserve the wilderness quality, resulting in enhanced sight-seeing and other non-developed recreational opportunities. Indirect, long-term, negative effects to non-developed recreation would occur due to congestion and loss of perceived pristine environment associated with increased human use. These negative effects would be minimized if the facilities are constructed in areas of previous human activity.

Option #24 (Visitors centers)

This option involves construction and operation of a large visitor center or expansion of an existing visitor center somewhere in the oil-affected area. Information from the visitor center would also be available to other visitor centers, government agencies, and organizations in the spill area. Implementation of this option would have direct and indirect, long-term, positive effects on recreation. Direct effects would occur because new visitor centers would attract visitors and confine public use. Indirect effects would occur because visitor centers would educate the public of oil spill-related injuries and subsequently help them better utilize and enjoy the area.

Option #25 (Marine environmental institute and research foundation)

This option involves construction of a new marine environmental institute in an easily accessible area, designated for the study of the marine environment and provision of public education within the oil spill region. Public exhibits and marine aquaria would be an integral part of the institute. Public exhibits would include living examples of Alaskan marine habitats, plants, animals, and seabirds. Implementation of this option would have direct and indirect, long-term, positive effects on recreation. Direct effects would occur because the facility would attract visitors. Public exhibits, especially the aquaria, would allow the public to closely observe marine creatures and habitats that they might never see. Indirect, long-term, positive effects to recreation would occur from environmental education programs developed and implemented by the institute to minimize additional human effects on injured resources and services.

Sport Fishing

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement HP&A. Habitat protection associated with rearing and spawning of fish species could potentially increase the population of these species in the long-term and, therefore, indirectly benefit sport fishing. Assuming that habitat protection through special designation and acquisition is afforded in perpetuity or until a self-sustaining population is reached, the extent and duration of the impacts would be large, creating long-term, positive benefits to sport fishing by protecting the habitat necessary to maintain a healthy population of fish.

Slight, indirect, negative impacts could also occur on sport fishing as a result of additional sport fishing restrictions (that did not exist prior to the acquisition or designation). Assuming the restrictions would be removed after the population of the injured species reached levels acceptable for harvest (as determined by the management agencies), the duration of the impact would be short-term.

Alternative 3 - Limited Restoration

Options affecting sport fishing under this alternative include Options 4, 13, 9, 19, 23, and 6.

as well as HP&A. Options 4, 5, 23, and 6, as well as HP&A, would benefit sport fishing either directly or indirectly by ultimately increasing the population fish. HP&A would receive 75 percent of the restoration funds.
As in Alternative 2, the emphasis on HP&A could have long-term, positive impacts to sport fishing by increasing species population available for fishing. Option 4 could have an adverse, indirect impact on sport fishing if restrictions are placed on areas where fishing can occur, and Option 19 could have a direct, positive impact on sport fishing when new facilities are constructed to improve access to sport fishing locations.

Alternative 4 - Moderate Restoration

In addition to the options under Alternative 3, Option 7 is included in this Alternative. This option has the potential to provide additional short-term benefits to sport fishing. As with Alternatives 2 and 3, Alternative 4 devotes most of the available restoration funds (approximately 50 percent) to the protection and acquisition of habitat. This can have long-term, positive benefits to sport fishing by enhancing the population of fish and associated sport fishing opportunities.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes implementation of all the options (4, 13, 5, 19, 23, 8, 6, and 7, as well as HP&A) affecting sport fishing. Option 8 is not included in other alternatives, and could produce additional indirect, long-term, positive impacts on sport fishing by enhancing the population of anadromous fish species. A larger amount of the restoration funding (48 percent) is being proposed for general restoration options under Alternative 5, although HP&A is still the major focus (35 percent of total funding). The greater mix of options affecting sport fishing in Alternative 5 would have both short-term and long-term benefits to sport fishing.

Options Related to Sport Fishing

HP&A (Habitat protection and acquisition)

HP&A involves acquisition of or partial interests in private inholdings within Federal and State protected lands such as parks and refuges throughout the oil spill area, to protect and better manage the habitat types linked to resources and/or services injured by the oil spill. It also involves designation of upland, coastal, and marine habitats in public ownership into special State or Federal land designations such as Alaska Department of Fish and Game Special Areas, Federal Wilderness Areas, and Marine Sanctuaries throughout the oil spill area. Both activities could affect sport fishing by protecting the habitat associated with fish rearing and spawning. It is assumed that certain designations would be subject to sport fishing restrictions that did not exist prior to the designation and that these restrictions would be removed once the populations recover.

Implementation of this option would produce indirect, long-term, positive effects on sport fishing, because habitat protection would enhance fish population and associated sport fishing opportunities. Short-term, negative effects could occur due to additional restrictions limiting sport fishing opportunities on the designated areas. The positive effects would be long term assuming that the habitat protection is afforded in perpetuity or until a self-sustaining population is reached.

Option #4 (Intensify fisheries management)

This option involves intensifying fisheries management to speed the natural recovery of injured stocks of pink salmon, sockeye salmon, herring, rockfish, Dolly Varden, and cutthroat trout by restricting existing fisheries or redirecting them to alternative sites. It is assumed that temporary restrictions on sport fishing would be imposed by the Board of Fish (following research and recommendations) until the injured stock increased to levels determined by management agencies to be acceptable for harvest. Long-term, positive effects could occur if increased fisheries management enhanced fish population in the long-term, thereby creating additional opportunities for sport fishing. Short-term, negative effects to sport fishing could occur from restrictions on sport fishing until the injured species recover.

Option #5 (Improve freshwater wild salmon habitats)

The objective of this option is to restore and enhance wild salmon populations by improving or supplementing its spawning and rearing habitats. Implementation of this option would have indirect, long-term, positive effects on sport fishing due to increases in wild salmon populations and associated sport fishing opportunities. Assuming wild salmon populations remain at high levels after the initial improvements, the effects would be long term .

Option #6 (Improve survival of salmon eggs and fry)

This option involves improving survival of salmon eggs and fry to restore injured salmon runs to pre-spill levels or to enhance either injured or equivalent runs above pre-spill levels. Wild salmon eggs would be reared in boxes, netpens, or hatcheries and subsequently released into streams. This option could have indirect, long-term, positive effects on sport fishing because increased salmon populations from artificial rearing of salmon eggs and fry would provide additional sport fishing opportunities. The effects could be long term if the subsequent reproduction of fish provided by the artificial rearing result in long-term increases in the harvest of naturally produced stocks.

Option #7 (Change or relocate existing hatchery salmon runs)

This option involves shifting the location and the timing of salmon runs released from hatcheries to decrease interception of injured, wild-stock pink salmon returning to spawning streams; thereby helping injured populations to recover more rapidly. The option would have indirect, long-term, positive effects on sport fishing similar to Option 6 by providing additional salmon fishing opportunities.

Option #8 (Protect undocumented anadromous streams)

This option involves listing undocumented anadromous streams in the State's Anadromous Stream Catalog to afford the stream protection under the State Forest Practices Act and Title 16, which could increase protection of injured anadromous species and their habitat. Implementation of this option would have indirect, long-term positive effects through enhanced populations of anadromous species and associated sport fishing opportunities.

Option #13 (Reduce disturbance at bird colonies, haulout sites, etc)

This option involves research and recommendations for designation of buffer zones around important marine birds and mammal habitats. The restrictions within the buffer zone could include limiting boat speeds or prohibiting boat traffic within a certain distance of the habitat for part of the year. It is assumed that the buffer zones may encompass favorite fishing locations and the restrictions would be in place during the fishing season. Implementation of this option could have direct, negative effects on sport fishing. If the species of concern recover rapidly and the buffer zones are removed, the adverse effects to sport fishing would be short term.

Option #19 (Create new recreation sites and facilities)

This option involves construction of boat ramps, mooring buoys, docks, and campsites on public land within the oil spill area. Implementation of this option would have direct, long-term, positive effects on sport fishing. New facilities would provide additional sport fishing opportunities by providing easy access to fishing locations and enhanced services.

Option #23 (Create new salmon runs)

This option entails starting new salmon runs on rivers that currently do not support such runs, to replace fishing opportunities lost due to closures resulting from the oil spill. Implementation of this option would have direct, positive effects on sport fishing by creating additional opportunities for sport fishing. Assuming the runs are terminated once the other target species recover, the effects would be short term.

Sport Hunting

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement HP&A. Habitat protection associated with game species population needs could potentially increase the population of these species in the long-term and, therefore, indirectly benefit sport hunting. Assuming that habitat protection through special designation and acquisition is afforded in perpetuity or until a self-sustaining population is reached, the extent and duration of the impacts would be large, creating long-term, positive benefits to sport hunting by protecting the habitat necessary to maintain a healthy population of game animals.

Slight, indirect, negative impacts could also occur on sport hunting as a result of additional sport hunting restrictions (that did not exist prior to the acquisition or designation). Assuming the restrictions would be removed after the population of the injured species reached levels acceptable for harvest (as determined by the management agencies), the duration of the impact would be short-term.

Alternatives 3 and 4 - Limited and Moderate Restoration

As in Alternative 2, the emphasis of theses alternatives is on the habitat acquisition and protection (75 and 50 percent of the restoration funds), likely resulting in a long-term, positive impact to hunting by increasing game species populations available for hunting. Option 19 is also included and would have indirect, long-term, positive impacts on hunting by making cabins and other facilities available for use by the hunters. This option could also have an indirect, long-term, negative impact on sport hunting because of conflicts with increased recreationists in the same area.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes implementation of Options 15 and 19, as well as HP&A. These activities would have both direct and indirect, long-term, positive impacts on hunting, as well as potential negative impacts on recreation as described previously. In contrast, Option 15 could have a direct, short-term negative impact by restricting hunting opportunities. To the extent that these restrictions contribute to recovery of the game populations, this option would have a long-term positive impact on hunting. Alternative 5 allocates the largest amount of the restoration fund (48 percent) to general restoration options affecting hunting.

Options Related to Hunting

HP&A (Habitat protection and acquisition)

This option involves acquisition of or partial interest in private lands associated with injured species and services for protecting these resources. It also involves designation of upland, coastal, and marine habitats in public ownership into special State or Federal land designations such as Alaska Department of Fish and Game Special Areas, Federal Wilderness Areas, and Alaska State Parks throughout the oil spill area. These activities would affect sport hunting by protecting the habitat associated with game species. It is assumed that important habitats under private ownership are available for purchase or protection and that these and special designation areas would be subject to more stringent regulations for hunting of injured game species until their populations recover.

Implementation of HP&A would have long-term, positive effects from increases in hunting opportunities as a result of increases in population of game species. Short-term, negative effects on hunting would occur due to additional restrictions that could temporarily close or restrict sport hunting on these lands.

Option #15 (Develop harvest guidelines)

This option would affect hunting and trapping by temporarily restricting or closing harvest opportunities for harlequin duck and river otter respectively in the oil spill region. The closure of or reduction in sport harvest and commercial trapping would be based on population data and harvest rates, and it is assumed that the restrictions would be in place for a maximum of two years.

Direct, short-term, negative effects would result from restrictions on sport hunting of the injured species. The magnitude of this effect would vary with the type of restriction. If the restrictions include complete closures of harvest, then the magnitude would be high. If the restrictions include reduction in bag limits or limited closure of the season, then the magnitude would be lower. Because the restrictions would apply only to harlequin ducks and river otters, the overall effect on hunting of all game species would be low. Enhanced population of these species would provide additional opportunities for hunting.

Option #19 (Create new recreation sites and facilities)

This option involves construction of recreational facilities such as cabins, campsites, caches and other facilities on public land throughout the oil spill area. It is assumed that the cabins and other facilities would be constructed in areas where they can be used by hunters during the hunting season. Long-term, positive effects would occur because cabins and other facilities would provide hunters a place to stay while on a hunting trip. Long-term, negative effects to sport hunting could might result from conflicts with additional recreationists attracted to the sites. The effects could be minimized if facilities are constructed specifically for the hunters and are not used by the recreationists during the hunting season.

Commercial Tourism

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the funds would be used to implement HP&A. Habitat acquisition and special designations would indirectly benefit commercial tourism because healthier ecosystems attract more tourists who, in turn, create demand for tourism-related goods and services. Assuming that the habitat protection continued in perpetuity, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to commercial tourism.

Indirect, negative impacts on commercial tourism could also occur at specific sites if limits were imposed on human use of the area (e.g., restricted boat traffic). In general, however, visitation and tourism to protected areas should increase, and site specific restrictions would not create lesser demand on tourism-related goods and services.

Alternative 3 - Limited Restoration

Options affecting recreation under this alternative include Options 13, 11, 17, 19, 10, and 9, as well as HP&A. Options 13, 11, 10, and 9 could indirectly benefit tourism by ultimately increasing the population of marine birds and associated bird watching opportunities which, in turn, would create demand for additional charter and tour-boat services and cruises. Option 17 could benefit tourism by creating demands for tour guides, visitor information booths, and other tourism-related services associated with visiting archeological attractions. Option 19 could have direct, positive impacts on commercial tourism by constructing new commercial recreational facilities that would attract more tourists throughout the oil spill area. As in Alternative 2, emphasis continues to be on HP&A (75 percent of funds) likely resulting in a long-term, positive impact to commercial tourism by creating healthier ecosystems and ultimately attracting more tourists.

Alternative 4 - Moderate Restoration

In addition to all the options identified in Alternative 3, Option 18 is included in this alternative. Option 18 would produce indirect, long-term, positive impacts on tourism related to viewing archeological resources. The combined impact of this alternative would be direct and indirect, long-term, positive and short-term, negative as described previously. As with Alternatives 2 and 3, Alternative 4 devotes most of the available restoration funds (approximately 50 percent) to the protection and acquisition of habitat. This would have long-term, positive benefits to commercial tourism.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes the options in Alternative 4 with the addition of Options 8, 24, and 25. Option 8 could produce indirect, long-term, positive impacts on commercial tourism by protecting valued salmon runs. Options 24 and 25 would have direct, positive impacts on commercial tourism by attracting tourists and creating demands for tourism-related goods and services. The larger number of general restoration options under Alternative 5 provides a greater mix of options affecting commercial tourism and would replace some indirect effects of HP&A with direct positive effects related to archaeology-based tourism.

Options Related to Commercial Tourism

HP&A (Habitat protection and acquisition)

HP&A involves acquisition of or partial interest in private lands associated with injured species and services for their protection. It also involves placing nearshore, coastal, and upland habitats in public ownership into special State or Federal land designations to provide increased levels of protection to injured resources and services supported by these lands. Several designations including Alaska State Parks, Alaska Department of Fish and Game Special Areas, National Marine Sanctuaries, Federal Wilderness Areas, and State Public Use Areas are considered.

Implementation of these activities would have long-term, positive effects because healthier ecosystems resulting from enhanced protection would attract more tourists who in turn would create demand for tourism-related goods and services. Short-term, negative effects on tourism might result from restrictions limiting human use of specific areas (e.g., restricted boat traffic) and fewer people would be visiting these areas.

Option #8 (Protect undocumented anadromous streams)

This option involves listing anadromous streams in the state catalog to increase protection of injured anadromous species and their habitat under the State Forest Practices Act and Title 16. Implementation of this option would have indirect, long-term positive effects on commercial tourism. After the ecosystem is restored and fisheries enhanced, the area would attract more tourists for sport fishing and other recreational activities.

Option #9 (Increase productivity and survival of marine birds through predator control)

This option involves reducing predator populations on marine birds, especially on common murre, pigeon guillemot, and black oystercatcher colonies, to enhance productivity and survival of these bird species. Implementation of this option would have similar effects on tourism as Option 11 by increasing bird watching opportunities.

Option #10 (Increase productivity and success of murre colonies)

This option involves increasing common murre productivity and the success of murre colonies. Common murres colonies are one of the most visited tourist attractions in the oil-spill area. Common murres suffered the greatest direct mortality from the oil spill of any bird species. It is assumed that some restrictions, similar to Option 13, would be imposed in and around the murre nesting sites to reduce human intervention in these areas. Implementation of this option would have indirect, short-term, negative and long-term, positive effects on tourism similar to Option 13.

Option #11 (Minimize the incidental take of birds)

This option involves facilitating recovery of marine bird species (common murre and marbled murrelets) by employing measures to reduce encounters between these birds and gillnets deployed in high seas and coastal fisheries. Implementation of this option would have indirect, long-term, positive effects on the tourism industry because enhanced marine bird populations would create additional opportunities for bird watching and consequently higher demand for various tourism-related services such as tour boats, tour guides, and cruises.

Option #13 (Reduce disturbance at bird colonies, haulout sites, etc)

This option involves designation of buffer zones around important marine birds and mammals habitats. The restrictions within buffer zones could include prohibiting boat or air traffic within a certain distance from the habitat. This could require tour or charter-boat companies to change their routes, and in critical conditions could prevent access to a favorite viewing or fishing location. Short-term, negative effects could occur from temporary restrictions imposed on charter and tour-boat companies, and air traffic; however, these effects would be localized. Long-term positive effects to tourism could occur when the populations of injured species recover creating additional wildlife viewing opportunities and consequently creating demand for additional charter and tour-boat services and cruises.

Option #18 (Acquire archeological artifacts)

This option seeks to replace and/or recover archeological artifacts that have been lost subsequent to the oil spill and to return them to public ownership for appropriate public display in museums. Implementation of this option would have indirect, long-term, positive effects on tourism similar to Option 17.

Option #19 (Create new recreation sites and facilities)

This option involves construction of new recreational sites and facilities on public land. This option involves construction of additional backcountry public facilities such as mooring buoys, boat ramps, picnic area, outhouses, caches, cabins, campsites, and trails. Assuming that these new facilities are operated and managed by the Federal or State government, implementation of this option would have direct, long-term, positive and negative effects on commercial tourism. Positive effects would occur because additional facilities would attract additional tourists and these tourists in turn would create demand on tourism-related goods and services. On the other hand, commercial tourism could be negatively affected because new facilities managed by government would might divert tourists from privately owned recreational facilities.

In addition, this option involves the planning and marketing of public land for new commercial recreation facilities such as fuel stops, docks, campgrounds, and lodges. Implementation of this activity would have direct, long-term, positive effects on commercial tourism because additional facilities would attract more tourists, create greater demand on goods and services, and enhance the tourism-related economy.

Option #24 (Visitor centers)

This option involves construction and operation of a large visitor center to provide information about the oil spill and the status of recovery. This option would have direct, long-term, positive effects on commercial tourism. Direct effects would result from tourists visiting the center and creating demands for goods and tourism-related services, such as tour buses and boats.

Option #25 (Marine environmental institute and research foundation)

This option involves establishing a new Marine Environmental Institute within the oil-spill area. Live exhibits and marine aquaria would be an integral part of this institution. This option would have direct, long-term, positive effects on tourism similar to Option 24, attracting tourists and creating demand for tourism-related goods and services.

Commercial Fishing

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement HP&A. HP&A would both protect and acquire habitat and establish special land designations, indirectly benefiting commercial fishing by protecting the habitat required for the spawning and rearing of fish and potentially increasing the numbers of fish harvested commercially. Assuming that the protection afforded habitat acquired for the public domain is held by the public and managed to promote healthy ecosystems in perpetuity, the impacts would create long-term, positive benefits to commercial fishing by insuring the necessary habitat to maintain healthy fish stocks in the oil spill area.

Alternative 3 - Limited Restoration

Options affecting commercial fishing in this alternative include Options 4, 13, 11, 19, 1, and 6, as well as HP&A. Options 4 and 6, as well as HP&A, would benefit commercial fishing either directly or indirectly by ultimately increasing the number of fish available for commercial harvest. HP&A would utilize 75 percent of the restoration funds. Options 1 and 11 could have direct, adverse impacts on commercial fishing resulting from the economic consequences of potential regulatory changes to existing methods of fishing. Options 13 and 19 could have adverse, indirect impacts on commercial fishing from restrictions placed on areas where fishing can occur, or conflicts with recreational boaters.

As in Alternative 2, the emphasis on HP&A can have long-term, positive impacts to commercial fishing by increasing fish populations available for harvest. This in turn increases the potential to increase income for commercial harvesters and processors.

Alternative 4 - Moderate Restoration

The options included in Alternative 4 that affect commercial fishing are Options 4, 13, 5, 19, 23, 3, 1, 6, and 7, as well as HP&A. Options 13, 5, 23, 6, and 7, as well as HP&A, have either direct or indirect, positive impacts on the commercial fishery by increasing the number or availability of fish for harvesting. Option 13 would lead to increases in the stocks of herring and pink salmon, rockfish, and sockeye salmon. Option 5 would lead to increases in the number of sockeye for harvest. Options 23 and 6 would ultimately lead to increases in the number of salmon available for harvest. Options 13, 11, 19, 3, and 1 would have either direct or indirect, adverse economic impacts on commercial fisheries in various locations throughout the oil spill area. However, as with Alternatives 2 and 3, Alternative 4 devotes most of the available restoration funds (approximately 50 percent) to the protection and acquisition of habitat. As noted previously, this can have positive, long-term impacts to commercial fishing through long-term maintenance of spawning and rearing habitat necessary to maintain fish stocks throughout the oil spill area.

Alternative 5 - Comprehensive Restoration

In addition to the options under Alternative 4, this alternative includes Option 8. Options 8 would have indirect, positive impacts on increases in salmon population through protection of anadromous streams. The larger amount of the restoration fund (48 percent) being proposed for general restoration options provides greater direct benefits to fish populations and consequently commercial fishing opportunities.

HP&A (Habitat protection and acquisition)

HP&A could affect commercial fishing by protecting habitat throughout the oil spill area. The absence of degrading activities in upland habitats is necessary to ensure the productivity of estuaries, streams, and lakes that produce the stocks of fish harvested commercially. It is assumed that land containing these productive habitats is currently privately owned and consequently available for purchase or protection after meeting the criteria necessary to make them a target for purchase or protection.

The effect on commercial fishing would be indirect, and fishing would benefit only if (1) the stocks of commercially harvested fish increase, or (2) the consistency of the harvest is ensured through the protection of productive fish spawning and rearing habitats. Additional stocks of fish for harvest would translate into additional income to commercial fishermen and commercial fish processing facilities. These benefits would be long-term assuming the habitat protection is afforded in perpetuity.

HP&A would also affect commercial fishing by establishing special designations throughout the oil spill area to protect upland, coastal, and marine habitats that contain productive fish producing or harvesting areas. Based on the assumption that marine sanctuaries containing a commercially harvestable fishery would be included, commercial fishing would be directly affected by limiting the area available for commercially harvesting fish. This would have an adverse economic effect on the fishermen that rely on these area for all or portions of their catch.

Option #1 (Reducing the bycatch of harbor seals)

This option involves research and recommendations for changing harvesting methods and harvest areas to prevent accidental take of harbor seals. The option could have direct, adverse effects on commercial fishermen resulting from the costs of modifying fishing methods and fishing gear to prevent the accidental take of harbor seals. Reductions in the number of fish harvested because of area restrictions and potential reduced effectiveness of the modified harvest gear may also reduce the income of fishermen participating in the affected fishery.

The effects of implementing this option would be long-term assuming that once the gear restrictions have been implemented they would likely be difficult to repeal.

Option #3 (Change black cod fishing gear)

This option would affect commercial fishing by subsidizing a voluntary change in the way black cod fisheries are harvested. Instead of using long lines (hook & line), some other gear type such as "pots" like those used in the British Columbia black cod fishery would be used. The objective of the option is to find a method of fishing for black cod that does not attract or provide the opportunity for killer whales to strip the catch, in turn reducing the conflict between killer whales and commercial fishermen.

For analysis purposes, it is assumed that long lines would be replaced by the "pot" type gear, which requires a boat of a certain size (larger than many currently used) to place and retrieve the pots.

Direct effects to commercial fishing would occur as a result of the costs incurred learning how to use the new gear types effectively. Costs may also be incurred by fishermen who choose to switch to the pot type gear but do not have boats large enough to use this gear type. Fishermen currently using small boats that cannot afford to acquire larger boats would not be able to participate in the fishery, and would either have to switch to a new fishery (assuming entry was permitted). The economic consequences to the individual who could no longer participate in the fishery could be severe.

Changing the gear types for the commercial black cod fishery would have short-term effects because it is assumed that changing the harvesting method would occur over a relatively short period of time, with a one-time cost for switching the gear and a short learning curve for determining the effective use of the new equipment.

Option #4 (Intensify fisheries management)

This option could affect commercial fishing by restricting existing fisheries or redirecting them to alternative sites. The option involves development of recommendations for new fishing regulations that would be implemented by the Alaska Board of Fish. In addition, this option may include research concerning commercial fisheries that would identify fish harvest levels, age and sex composition, natural mortality, seasonal movements, stock abundance, and recruitment. Commercial species that could be affected by this option include pink salmon and herring, sockeye salmon, and rockfish.

Direct effects on commercial fishing from management actions aimed at protecting injured stocks would include the added cost of redirected harvesting that requires longer travel times to and from port, and the loss, from regulatory constraints placed on harvest, of fisheries previously available for harvest. These effects would be direct, but would last for a short period of time, until the injured stock increased to levels acceptable for harvest (determined by the management agencies).

Indirect effects related to implementation of this option involve the increase in the long-term availability of salmon for harvest. Increased numbers of salmon resulting from the management activities could provide additional harvest opportunities, and a consequent increase in the income from the harvest. Additionally, the long-term viability of commercial fisheries would be enhanced by the research activities that provide better information for future management decisions that maintain stock availability and reduce harvest variability.

Option #5 (Improve freshwater wild salmon habitats)

This option would affect commercial fishing by increasing the number of wild salmon stocks available for harvest. The numbers of fish made available would be the result of improvements in the availability of food in spawning and rearing habitats and accessibility to spawning areas, which would increase fish survival and improve growth rates.

The indirect effect of implementing this option would be to enhance the opportunities for harvest through an increase in the number of fish available for harvest. Consequently, the value of the harvest would increase (assuming prices did not commensurately decline), increasing the income of the fishermen participating in the harvest.

The effects of implementing this option would be long term if wild salmon populations remained at high levels after the initial improvements were implemented.

Option #6 (Improving survival of salmon eggs and fry)

This option would affect commercial fishing by rearing wild salmon eggs in boxes, netpens, or hatcheries, and releasing them to native streams. This could increase the numbers of wild salmon available for harvest along the migration routes of adult salmon.

An indirect effect on commercial fishing from the improved survival of salmon eggs and fry would be more fish available for harvest, and additional harvest opportunities. An increase in the salmon catch would increase income for commercial harvesters and fish processors.

This option could have long-term effects if the additional fish provided by artificial rearing increase the potential for long-term increases in the harvest of naturally produced stocks.

Option #7 (Change or relocate existing hatchery runs)

This option involves changing the timing of hatchery run releases, or releasing hatchery fish at remote locations in an effort to minimize the interaction of hatchery fish and wild salmon stocks during commercial harvests. Ultimately, the objective of the option is to increase wild salmon stocks.

The short-term direct effect to commercial fishing from implementing this option could involve harvest area closures, changes in the time of year for harvesting, and possible increases in the distances traveled to reach open harvesting areas. These changes in harvest strategy could have economic consequences such as increases in the cost of harvest. Because the implementation of the option would require careful planning to ensure that interception of the wild stocks is avoided, consideration of the costs of the harvest should be an important part in the planning process. If fishermen are not willing to travel to the locations where the hatchery runs have been relocated, the objective of this option would be compromised.

The long-term, indirect effects from implementing this option would occur as a result of an increase in the wild salmon stocks. Once the stocks have recovered to a level where they can be sustained under harvesting, an economic benefit to commercial fishing would be realized from the additional fish available for harvest, and the associated value of those additional fish.

Option #8 (Protect undocumented anadromous streams)

This option would affect commercial fishing by protecting streams that contribute to the number of anadromous fish available for harvesting. This option would identify streams for inclusion in the Anadromous Stream Catalogue, which would afford them protection under the State Forest Practices Act and Title 16. Any stream listed in the catalogue would be protected by a buffer zone to prevent stream encroachment (development close to the stream).

It is assumed that the streams currently not in the catalogue could add to the available fishery if they were included (i.e., there is some damage currently occurring to the stream that has reduced its productivity), and that harvesting is currently allowed in the area during the migration of the adult fish. Based on the assumptions, commercial fishing could directly benefit from the increase in the number of fish available for harvest, and the consequent additional income that could result from that harvest.

The positive effects associated with the implementation of this option would be expected to be long-term because of the continued protection afforded the stream once it is listed in the catalogue.

Option #11 (Minimize the incidental take of birds)

This option would be directed at the commercial fishing activities associated with gillnet, drift, and set net fisheries. The option could involve suspending nets below the surface, closure of certain areas, elimination of night fishing, or directing fishing away from injured marine bird habitats.

This option could directly affect the commercial fishing industry as a result of costs incurred to modify gillnets for use while suspended below the surface. If fisheries were closed, this could also cause direct, adverse economic effects by reducing the volume of fish caught, increasing the cost to travel to new harvest locations, and increasing competition for the available fishery. This would reduce fishing opportunity and the associated volume of the harvest for boats previously utilizing the closed areas.

The effects of implementing this option could be long-term, lasting for as many years as it may take for the injured species populations to rebound to preferred management levels.

Option #13 (Reduce disturbance at bird colonies, haulout sites, etc)

This option could affect commercial fishing operations by restricting the speed or prohibiting navigation of fishing vessels near protected bird colonies and marine mammal haulout sites. If recommended, these restrictions would be implemented would occur from May to September to encompass the affected species' molting and pupping seasons.

An assumption concerning the effects of implementing this option is that there are commercially harvestable fish populations that would be encompassed by the protected zone near the colonies and haulout sites. The indirect effect to commercial fisheries from protecting these sites would be a reduction in available harvest locations, which may affect the volume of the harvest. If vehicle speed reductions restrict the type of fishing gear that could be used, this may also indirectly affect the ability to commercially harvest fish.

This option may result in long-term effects lasting until the injured species populations being protected recover.

Option #19 (Create new recreation sites and facilities)

This option could affect commercial fishing throughout the oil spill area by increasing the number of boat ramps, mooring buoys, and other facilities that increase the number of recreational boaters.

The effects of implementing this option would be indirect as a result of increased recreational boater traffic and potential conflicts with commercial fishing boats and gear. These conflicts could occur if recreational boaters accidently snagged commercial fishing gear causing the gear to fail, or inhibited the operation of the fishing vessel by operating too close to the vessel. In general, the greater the number of boats operating in the same area, the greater the potential for conflicts and collisions. Damage to gear or the fishing vessel would have an adverse economic effect on the commercial operator involving repair costs.

Option #23 (Create new salmon runs)

This option could affect commercial fishing by creating new salmon runs. The option would involve the placement of a hatchery or remote release site at a river where a terminal harvest could occur.

The indirect effects on the commercial fishery of new salmon runs (and the consequent increase in salmon populations) would be to increase opportunities for harvesting salmon. An increase in the number of salmon harvested would have direct positive economic effects on commercial fishermen involved in the harvest. There may also be direct adverse economic effects on commercial fishermen if the distance traveled to the harvest site is greater than previously required to harvest the same number of fish.

If the runs are terminated once the other target species have recovered, the effects of this option would be short term.

Transportation

EVOS Restoration Plan options 4, and 12 may indirectly affect transportation in the EVOS area. Option 4 may restrict the routes of ferries and aircraft traveling near marine bird colonies or marine mammal haulout sites. Option 12 could affect transportation by construction of recreational facilities, that could increase traffic on the existing transportation systems in the vicinity of the new facilities. The type of transportation system affected would depend on where the facilities are located (e.g., along ferry routes, major highways, etc.).

Alternative 1 - No Action Alternative

The No Action Alternative does not involve implementation of any option. Under this alternative, transportation services would operate as they do currently. None of the effects related to the various options described in the above section would occur.

Alternative 2 - Habitat Protection

Under this alternative, only options 37 and 40 would be implemented. It is unlikely that this alternative would have an impact on transportation.

Alternatives 3, 4, and 5 - Limited Restoration/Moderate Restoration/Comprehensive Restoration

Options affecting recreation in these alternatives are the same, and include options 4, and 12. Options 4 could adversely impact ferry and aircraft related transportation services because of the potential to require changes in the routes of these services. Option 12 may adversely affect any or all of the existing transportation services (roads, boats, air traffic) by increasing traffic on the existing systems. By far the greatest emphasis of all of these alternatives is habitat acquisition and protection (options 37 and 40), which are unlikely to impact transportation.

Options Related to Transportation

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc.)

This option may affect transportation because of the restrictions on entry into buffer zones used to prevent disturbance of bird colonies and haulout sites. The assumption being made is that these buffer zones could encompass ferry routes and aircraft routes. Restricting the routes of ferries and aircraft would be an indirect adverse impact to transportation because rerouting these routes would increase transport time and cost (additional fuel). The effects could be long-term lasting until the buffer zone restrictions are removed.

Option #12 (Creation of new recreation sites and facilities)

Option 12 would be implemented throughout the EVOS area, and it is assumed that recreational sites and facilities would be constructed in easily accessible areas along existing roadways, ferry routes or aircraft routes. Consequently, it is assumed that this option would not involve construction of major roadways for accessing these sites. Implementation of this option could have indirect, long-term adverse effects on transportation by increasing traffic on the existing transportation systems in the vicinity of the new recreational facilities.

Passive Use

The natural beauty, quality of life, and lifestyle offered by the *EVOS* area is important to *EVOS* residents, Alaska residents, and residents of areas beyond Alaska. Appreciation of the unique attributes offered by the *EVOS* area is a passive use of *EVOS* resources which extends far beyond local boundaries. Preservation and protection of the *EVOS* environment and resources permits a continuation of the passive use values. Potentially, the passive use of *EVOS* resources could result in economic benefits to the *EVOS* area associated with stimulated tourism.

Alternative 2 allocates over 90% of restoration funds to HP&A. The protection of natural habitat areas in public ownership (especially when they received special designation) is the principal means for enhancing and ensuring the passive appreciation of the environment by the general public. Therefore, the protection of the *EVOS* ecosystem afforded under this alternative would greatly enhance the passive use of *EVOS* natural resources.

Alternatives 3, 4, and 5 also allocate large proportions of restoration funds to HP&A (35 to 75%). In addition, they include general restoration options that directly enhance the recovery of individual injured natural resources with the *EVOS* area. To a lesser extent, these alternatives enhance the passive use of the greater *EVOS* ecosystem by ensuring and designating protected natural areas. The positive impact of HP&A is augmented by the greater passive enjoyment the public receives from knowing that individual species are recovering to their natural levels.

Economic Impacts

As noted in the Analytical Tools section of Chapter II, the Forest Service's IMPLAN economic computer model was used to perform an economic impact assessment identifying the economic impacts of implementing each of the proposed *EVOS* Restoration Plan alternatives. Because Alternative 1 is the No Action Alternative, it is reflected in the "baseline" condition against which the impacts of Alternatives 2-5 are compared.

IMPLAN estimates change in income and employment as the product of the demand change (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 level by using borough population and employment data, and ratios of employment to output. The boroughs and census areas included in this assessment are the Municipality of Anchorage, Kenai Peninsula Borough, Kodiak Island Borough, and the Valdez-Cordova Census Area. This area covers the *EVOS* area and the closest major economic center (Anchorage), which was included to insure that the flow of goods in and out of the oil spill area is adequately accounted for in the IMPLAN economic model. At present, the benchmark national data is for 1990.

The key assumptions in the IMPLAN economic assessment are that each industry has an output and that 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 timeless and technology does not change.

IMPLAN's output classification system is based on systems defined by the Bureau of Economic Analysis (BEA-Department of Commerce) and the Standard Industrial Classification (SIC) used by the Office of Management and Budget. The analysis is conducted using 528 industries and the results are aggregated into 10 sectors. The 10 sectors are as follows:

1. Agriculture, Forestry and Fishing - These businesses engage in agricultural production, forestry, commercial fishing, hunting and trapping and related services. Agricultural production firms produce crops and livestock. Forestry firms operate timber tracts, tree farms, forest nurseries or perform forestry services. Fishing, hunting and trapping covers commercial fishing, fish hatcheries, fish and game preserves and commercial hunting and trapping.

2. Mining - These businesses extract minerals occurring naturally. Mining includes quarries, wells, milling and other preparations commonly done at mine site.

3. Construction - These businesses build new work, additions, alterations and repairs.

4. Manufacturing - These businesses mechanically or chemically transform materials or substances into new products. The materials and substances are produced by other

sectors (e.g., agricultural, forests and fisheries) or other manufacturers.

5. Transportation, communication and utilities - These businesses provide to the public or to other businesses passenger and freight transportation, communication services, electricity, gas, steam, water or sanitary services. The U.S. Postal Service is included here.

6. Trade - These businesses retail merchandise to households or wholesale it to retailers; other wholesalers; to other businesses; or act as agents or brokers in buying or selling goods.

7. Finance, Insurance and Real Estate - These businesses engage in the fields of finance, insurance and real estate.

8. Services - These businesses provide a variety of services for individuals, businesses, governments, and other organizations. Examples include hotels, amusements, health, legal, engineering and other professional services.

9. Government - This sector includes the legislative, judicial, administrative and regulatory activities of Federal, State, local and international governments. Government-owned businesses are classified according to the activity in which they are engaged.

10. Misc. Special Services - These cannot be classified in any other industry.

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 follows:

Administration and public information - Federal, State and local government

Monitoring and research - Federal, State and local government and universities

General restoration - State and local government, private fisheries and construction

Habitat protection - Forestry, real estate, households

Respending of Habitat Protection - Securities, social services, construction, households

The last category "Respending of Habitat Protection" does not appear in the Summary. It is part of the modeling exercise. 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).

When 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 strong leakage from the regional economy.

By inputing 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 for baseline conditions in the six columns shown in Table IV-B. These baseline conditions represent the No Action Alternative. 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 man-year equivalents to produce industry output.

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 $630 million of the civil settlement funds in five alternatives spending scenarios were analyzed. The spending represents annual amounts continuing for ten years. The results are given for the six economic indicators described previously, and by sector. Table IV-B depicts the regional economy as it currently exists with no consideration of restoration fund spending. Analysis of the spending scenarios identify absolute change from the baseline.

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.

Table IV-B. Baseline economic conditions used for the economic impact assessment of *EVOS* Restoration Plan alternatives implementation.

Base	Analysis of Alternatives 1990$ Millions					
Economic Sector	Final Demand $	Industry Output $	Employee Comp. $	Property Income $	Value Added $	Employment #
Agriculture, Forest and fisheries	340.7	462.1	28.1	151.3	189.6	8,091
Mining	6,061.0	6,199.0	502.4	2,835.3	4,745.4	6,335
Construction	1,246.1	1,420.3	495.1	363.9	861.9	11,751
Manufacturing	948.6	1,072.4	226.5	82.0	319.5	7,655
Transportation, communication and Utilities	1,933.3	2,265.9	543.7	768.5	1,405.1	13,795
Trade	1,125.7	1,252.6	752.6	138.2	1,035.4	33,790
Finance, insurance, and real estate	988.3	1,137.4	245.4	337.3	734.1	11,329
Services	2,018.0	2,514.4	944.9	546.2	1,507.8	48,779
Government	2,105.6	2,151.5	1,934.2	76.5	2,010.7	46,428
Misc. Special sectors	44.5	12.3	0.0	33.4	33.4	0
Total	16,811.8	18,487.9	5,673.1	5,332.7	12,843.0	187,953

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.

Using Alternative 2 (Habitat Acquisition) as an example, the total change in the regional economy is depicted as follows: Final demand, the regional purchases of goods and services is reduced by 0.08%, with the largest drop (0.19%) in the agriculture/forest/fisheries sector, and the largest gains in the construction sector (0.05%); industry output, the regional supply of goods and services, falls by 0.13% with the largest loses (0.20%) in agriculture/forest/fisheries, and the largest gains (0.04%) in construction. Employee compensation increases by (0.009%) with the largest increases occurring in the services sector (0.08%) and the largest decrease in the agriculture/forest/fisheries sector (0.14%). Property income decreases by 0.10%, with no sector reporting more than a 0.02% increase, but the agriculture/forest/fisheries sector declining by 0.09%. Value added, the costs added within the region to produce industry output, drops by 0.04% with the construction and services sectors each experiencing growth exceeding 0.03%, while agriculture/forest/fisheries declines more than 0.11%. And lastly, employment, which is the number of person-year equivalents to produce industry output, increases by slightly more than 0.35% with the largest gains in the services sector (0.51%), and the largest loss of jobs in the agriculture/forest/fisheries sector (0.23%). By far, the largest economic impact from the implementation of Alternative 2 would be the adverse impact experienced by the agriculture/forest/fisheries 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% 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 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.

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 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.

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

Subsistence harvesting contributes to the overall income of *EVOS* residents. Acquisition of private land for habitat protection or placing public lands into special State and Federal land designations might restrict subsistence uses on certain lands. In contrast, general restoration activities would benefit subsistence hunting and fishing through increases in populations of selected species, enhancement of opportunities for subsistence use, and cultivation of replacement species. Under Alternatives 3, 4, and 5, acquisition of private land for habitat protection or placing public lands into special designations might restrict subsistence uses.

Subsistence resource harvesting is important to residents within the *EVOS* area. The residents of most *EVOS* communities supplement their cash incomes by the harvesting of subsistence food sources. In addition, the seasonal nature of most cash employment opportunities and the expense and limited availability of commercially produced goods increases the importance of subsistence resources. The Restoration Plan Alternatives seek to preserve and protect the resources of the *EVOS* area. Consequently, the Alternatives could have a positive impact on *EVOS* communities by enhancing the subsistence harvesting opportunities.

There would be no effects on human health and safety resulting from implementation of any of the proposed Restoration Plan alternatives.

Subsistence

Alternative 2 - Habitat Protection and Acquisition

HP&A could affect subsistence use of resources if protection measure such as the designation of marine sanctuaries prohibited short-term subsistence harvesting. There may also be some effect on subsistence harvests depending on whether the land that is acquired is transferred into state versus Federal ownership. Subsistence rights differ under State and Federal law as discussed in Chapter III of the DEIS. The difference in State versus Federal ownership may be reflected in terms of the competition for resources among subsistence harvesters. Lands under State ownership may be available to more subsistence users than land under Federal ownership because of the State definition of subsistence users is broader than what is stated under Federal law.

Alternatives 3 and 4 - Limited and Moderate Restoration

Alternatives 3 and 4 include 3 options that specifically target subsistence use of resources in the *EVOS* area. Options 20, 21, and 23 would evaluate the safety of subsistence foods, provide access to uninjured resources, and replace harvest opportunities (respectively). Additionally, under Alternatives 3 and 4, HP&A could change the nature of access to some *EVOS* areas.

Option #23 (Replace Subsistence Opportunities by Creating New Salmon Runs)

This option entails starting new salmon runs to replace fishing opportunities lost due to closure resulting from the oil spill. This option may restore services by providing replacement harvests, but may not restore injuries to fish species populations.

Terminus runs originating from and returning to hatcheries or remote release sites could be started under Option 23.

In an effort to minimize additional injury to subsistence and other user groups. Fishing pressures could be redirected to target these new runs until injured stocks recover. In addition, this option could enhance fishing opportunities above pre-spill levels. The impact to subsistence users may be of a high magnitude over the short-term, providing needed replacement of lost harvest opportunities.

Option #20 (Test Subsistence Foods for Hydrocarbon Contamination)

This option addresses the need to restore the confidence of subsistence users in the safety of subsistence resources. Subsistence harvesters may be reluctant to harvest and consume food resources perceived as contaminated. This option could involve the monitoring of hydrocarbon levels in selected subsistence species, communicating findings to subsistence harvesters, and integrating the findings of other studies of oil-spill related injuries into previously developed health advice.

Although the overall restoration monitoring may serve to scientifically define the "edibility" of subsistence foods, involvement of the impacted community representatives in the sampling, testing, and analysis processes may help to overcome the hydrocarbon contamination health risks perceived by subsistence harvesters. This option would have a high likelihood of stimulating the return of subsistence harvest to pre-spill levels and may reduce subsistence harvesters' anxiety about the safety of these resources.

Option #21 (Provide Subsistence Users Access to Traditional Foods)

This option could provide transportation funds to transport subsistence harvesters from areas that have experienced declines to areas where resources were not injured. In addition, funds would be provided to allow people in other subsistence communities to gather, preserve, and send subsistence foods to subsistence communities damaged by the *EVOS*.

The continuation of subsistence harvest activities could help ensure that traditional hunting skills and culturally important harvesting and sharing practices would not be diminished. The option may improve subsistence recovery by providing traditional subsistence foods to villages where they are not readily available. The provision of transportation funding would continue until populations have recovered from oil spill-related injuries, and foods are no longer perceived to be contaminated. The magnitude of these impacts could be high because of the importance of subsistence harvests on subsistence communities.

Alternative 5 would include the same option continued in Alternatives 3 and 4, and would also include an additional option specifically targeting subsistence uses of the environment. Alternative 5 includes Option 22, which is not included in Alternatives 3 and 4. Option 22 could provide additional opportunities for harvesting bivalve shellfish. Similar to Alternatives 2 through 5 includes HP&A, although the allocation of funding for HP&A would be lower.

Option #22 (Subsistence Harvest Opportunities for Bivalve Shellfish)

This option would provide the facilities and the infrastructure to restore, replace, and/or enhance affected bivalve shellfish populations, such as mussels and clams, affected by the oil spill and cleanup efforts. Facilities and infrastructure to restore, replace, and/or enhance affected shellfish populations could be provided. Particular emphasis could be placed on the replacement and/or enhancement of shellfish used for subsistence.

Option 22 would fund the development of shellfish mariculture in subsistence communities. Cultivated species may include oysters, mussels, scallops, and a variety of clams. The cultivated shellfish would be used to supplement subsistence harvests as a replacement for traditional foods damaged by the *EVOS*.

Complementing this option would be the creation of a shellfish hatchery using concepts already developed for the Seward shellfish hatchery and the Alaska Fish and Game Mariculture Technical Center. Engineering and biological expertise will be retained to conduct a feasibility analysis of the project. If construction funds are approved at a later date, direct restoration, replacement, and/or enhancement of bivalve shellfish will be accomplished via an onshore production hatchery operated by the private sector using technology developed at a State-operated research center. The hatchery will provide seed stock for mariculture operations or the re-seeding of beaches.

Shellfish farming in subsistence communities could provide a food source to replace traditional food sources that were injured by the oil spill, or are perceived by subsistence user as being unsafe to eat. Farmed shellfish could be a replacement for contaminated shellfish or for other types of traditional foods that are in lower abundance. As with any option that could replace or enhance the amount of subsistence harvests in subsistence communities, this option could have a high magnitude of impact, with positive benefits throughout the duration of the mariculture operations.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service and the National Marine Fisheries Service have jurisdiction over Federally listed threatened and endangered species. At present, these agencies are considering the potential impacts of implementation of the Restoration Plan on listed threatened and endangered species, and candidate species for listing.

Cumulative Impacts

According to CEQ regulations (40 CFR 1508.6), cumulative impacts result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes these other actions. Significant impacts can result from actions that are individually minor but that in combination can have significant impacts over a period of time. Cumulative impacts could include the effects of other planned management actions, facilities and transportation construction, and other restoration actions being undertaken.

At the programmatic level, cumulative impacts are mainly the result of management actions, regulations, and policy decisions by other agencies (i.e., effects of programs on other programs) than effects from site-specific projects. For site-specific projects, proximity to other actions is an important determinant in assessing the cumulative impact. This component is generally missing at the programmatic level where general types of actions are considered.

To identify the potential impacts of other agencies' actions on the Restoration Plan's proposed alternatives, information on planned projects was requested from Federal, State, and local agencies, as well as Native entities located in or managing lands within the oil spill area. Among the agencies contacted were those that could have cumulative impacts at the programmatic level, such as the Federal Highway Administration, the U.S. Soil Conservation Service, the U.S. Bureau of Mines, the U.S. Army Corps of Engineers, the Environmental Protection Agency, the Federal Aviation Administration, the Alaska Marine Highway System, the Alaska Department of Transportation, the Alaska Department of Commerce, and the Alaska Energy Authority.

Several programmatic management actions are planned for the oil spill area. Many of these actions have been the subject of NEPA documentation. Environmental Impact Statements have been completed for the Chugach National Forest Plan and the Kenai National Wildlife Refuge. In addition, NEPA documentation is occurring at the site-specific level and will continue as specific projects are proposed for implementation in response to the Restoration Plan. An example of this is the EIS currently in progress for the expansion of the Main Bay Hatchery in Prince William Sound.

While the Final Restoration Plan is being developed, several projects similar to those proposed for the Plan have already been implemented under Annual Work Plans or have been proposed by the State and acted on by the Trustee Council. Alaskan House Bill No. 269 has already appropriated funds from the *Exxon Valdez* Oil Spill Restoration Fund for acquiring inholdings to the Kachemak Bay State Park for the protection and restoration of resources damaged by the spill, to enhance sport fishing services lost or diminished by the oil spill, and to restore, replace, or enhance subsistence resources. The Chenega Bay IRA Council is planning dock and port improvements and the development of a Chenega Bay Marine Service Center and is requesting matching funds from the Trustee Council. In addition, separate restoration actions are being planned using funding from the Alyeska settlement.

Several other transportation-related activities are currently planned or under way for the spill area. Any cumulative impacts of these planned activities would generally result from increased human access to formerly remote areas; this increased access could lead to gains in commercial tourism, recreation, commerce, sport fishing, and sport hunting. Increased access could also require new or increased infrastructure. Additional impacts, such as stormwater runoff, sedimentation, and increased human activity could be associated with construction of new facilities.

Under ADOT and FAA, construction has begun on a small airport at Chenega Bay, which was formerly accessible only by float plane. Activities included in the 1993-1999 Federal Highway Expansion Program, such as construction of a Cordova access road, may also affect implementation of the options contained in the Final Restoration Plan. Construction of a road from Whittier to Portage, replacing the train and ferry lines, is another reasonably foreseeable future development that could affect implementation of Restoration Plan options. Plans are also being developed to construct a 6-mile road from Cordova to Shepherd Point, which would allow access to a deep-water port that could accommodate freight and cruise ship traffic. Finally, the Department of Transportation is researching the possibility of constructing a new ferry dock in Tatitlek and a road to the new dock. Building a new road and ferry dock is also planned for Chenega Bay.

With the exception of construction projects to promote recreational opportunities, the majority of activities in the Restoration Plan would be implemented by regulation or through land acquisition. Cumulatively, land acquisition could have an effect on the amount of timber available for harvest, but until specific properties are targeted for purchase, the cumulative effects are unknown.

Irreversible and Irretrievable Commitment of Resources

Irreversible use of a resource results in the loss of the option of use in the future. Irreversible commitment applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity that are renewable only over long periods of time.

Identifying a resource as irretrievable refers to the loss of production, harvest, or use of natural resources. For example, some or all of the timber production from an area is lost irretrievably while an area is serving as a recreational facility. The production lost is irretrievable, but the action is not irreversible. If the use changes, it is possible to resume timber production.

The alternatives proposed for implementation in the *EVOS* Restoration Plan do not involve any irreversible or irretrievable commitments of resources. Some options would ultimately involve construction of recreational facilities or in-stream physical habitat improvements (e.g., fish ladders). No site specific plans for construction activities were included for review in this DEIS. Upon proposal of detailed construction plans, an environmental analysis will be performed that will determine whether resources would be irreversibly or irretrievably affected.

Mitigation

Mitigation, as defined by the Council on Environmental Quality (CEQ) in 40 CFR 1508.20, includes impact avoidance through choosing not to implement an action, or parts of that action; minimizing impacts through limiting the degree or magnitude of the action and its implementation; correcting impacts by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and compensating for the impact by replacing or providing substitute resources or environments.

At a programmatic level, mitigation would be comparable to implementation of planning activities as documented in Forest Service Management Plans, State or Federal highway administration management plans, and State or Federal resource management plans (e.g., Alaska State Hunting Regulations). Standards specified in Federal and State regulations are intended to provide a level of protection for all managed resources that is adequate to mitigate significant adverse environmental impacts from implementation of the proposed *EVOS* Restoration Plan. For example, the National Forest Management Act regulations and Forest Service Directives System would be used as a guideline for standard procedures and appropriate mitigation pertaining to the use and future development of wilderness areas for recreational purposes, including construction of backcountry sanitation facilities. The Alaska State Hunting Regulations specify bag limits and hunting seasons by species and game management unit to protect these resources from overharvesting. Regulations are not mitigation in the NEPA context, although these regulations can have the some effect as mitigation proposed where no regulatory agency has jurisdiction.

Although all practical means to minimize any adverse environmental effects resulting from implementation of the proposed *EVOS* Restoration Plan would be employed, no specific mitigation measures have been proposed as additional environmental analysis are expected at the project level.

The following Federal and State laws and regulations would provide protection to affected resources and services, and although those statutes are not mitigation in the NEPA context, they would help to ensure the prevention of adverse effects from implementation of the proposed *EVOS* Restoration Plan:

- Endangered Species Act of 1973 (16 U.S.C. 1531)
- Marine Mammal Protection Act of 1972 (16 U.S.C. 1361 *et seq.*)
- Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712)
- Bald Eagle Protection Act of 1940 (16 U.S.C. 668)
- Alaska Coastal Management Act of 1977 (A.S. 46.40)
- Coastal Resource District Management Plans (6 AAC 80 & 85)
- ADF&G Anadromous Stream and Fishway Acts (A.S. 16.05.870)
- Clean Water Act of 1977 (33 U.S.C. 1251 & 1344)
- National Historic Preservation Act of 1966 (16 U.S.C. 470 *et seq.*)
- Section 22 (g) of Alaska Native Claims Settlement Act of 1972

- State and local zoning regulations.

Site specific mitigation measures will be included in future environmental documents prepared for specific projects proposed pursuant to the *EVOS* Restoration Plan.

Analytical Tools/Methodology

This section describes the general principles and specific aspects of the impact assessment methodology used for this analysis of the impacts projected to result from implementation of the *Exxon Valdez* Oil Spill Restoration Plan. The impact assessment methodology described below was used to analyze each of the proposed alternatives.

This methodology takes into account both the dynamic nature of the Restoration Plan and the generic definition of the options to be included in the Restoration Plan alternatives. For each of the resources and services being evaluated, certain assumptions regarding the actual implementation of options were necessary. As appropriate, these assumptions are identified in the analysis of impacts in Chapter IV for each resource and service included in the analyses.

To perform the impact analysis of the proposed action (implementing the Restoration Plan) presented in Chapter IV, analysts employed a methodology that accounted for the various impacts that affect the biological, physical, and socioeconomic environment. Impacts were classified in five ways: direct, indirect, short-term, long-term, and cumulative. These types of impacts are interdependent. There can be long-term direct impacts, short-term cumulative impacts, and so on. For each resource or service being evaluated, the analysts identified the type of impact to help the reviewers and decisionmakers make sound, reasoned decisions for the short term as well as for the long term.

Direct impacts are those that are the immediate result of, or the initial reaction to, the action being evaluated. Indirect impacts are those that are the reaction to the direct impacts, or the second-tier impacts. In other words, indirect impacts are the consequence of direct impacts, and are not in themselves a direct result of the action. Indirect impacts are often difficult to identify because they may or may not occur, making their definition speculative. Quantifying indirect impacts is usually not possible or warranted. Additionally, there is often little distinction between indirect impacts, particularly in the long term, and cumulative impacts.

Cumulative impacts are a summation of the impacts related to the action being evaluated and concurrent actions being taken that are similar to, or are in close proximity to, the action being considered. Cumulative impacts often are not identifiable until well after the action has been taken. At the same time, however, they can be the source of controversy and litigation. The analysts responsible for writing this EIS have made every effort to account for cumulative impacts in the environmental impact analyses.

Short-term impacts are those that occur for a relatively short time and then abate. If the time frame is an important variable that should be considered by the decisionmaker, this is stated in the text. Long-term impacts are those whose duration or manifestation occurs for a relatively long time or that become manifest at some future time. As with short-term impacts, the long-term time frame is specified if it may influence the decisions to be made. To ensure that the full impact of the action being considered is identified, the full complement of impact types is considered in the environmental impact analysis.

As a basis for the determination of impacts, the analysts considered certain predetermined factors to arrive at impact determinations. When performing the analysis of impacts on various resources and services, the action being analyzed was viewed in terms of these factors. This approach allowed the analysts to preform a systematic analysis and to document the process used to reach their determinations and conclusions.

For determining the affects of proposed actions on the natural environment, the following four factors were used:

- Magnitude
- Geographic extent
- Duration and frequency
- Likelihood.

The ***magnitude*** of an impact reflects its relative size, amount, or intensity. The ***geographic extent*** of an impact considers how widespread the impact might be. The ***duration and frequency*** of an impact considers whether it is a one-time event, an intermittent occurrence, or a chronic occurrence. The ***likelihood*** of an impact assesses whether a possible impact is likely to occur.

Because the magnitude of an impact captures its intensity, taking into consideration the other three factors, this criterion has been closely analyzed and given particular attention in the assessment of environmental impacts. If the magnitude of an impact is expected to be large, this is generally stated in the impact analyses.

The specific aspects of the process followed by EIS team analysts, while following the general procedure described above, depended upon the resource or service being evaluated. In general, however, the process of developing and presenting minimum levels of evidence and analysis of impacts for all resources and services is essentially the same. The reasons for using a generally uniform, systematic approach are (1) to satisfy the NEPA requirement for a "hard look" at the actions being proposed, and (2) to provide decisionmakers with sufficient information to make informed decisions, while ascribing to the "rule of reason" implicit in the NEPA process.

Whereas an Environmental Assessment (40 CFR 1508.9) aims to provide sufficient evidence and analysis for determining the significance of impacts, an EIS assumes that significant impacts would occur from the implementation of the proposed action, in this case the *EVOS* Restoration Plan. Consequently, impacts described in this Draft EIS are presented with the intent of providing decisionmakers with an analysis of all impacts, regardless of their significance.

The first step in the analysis was the review of impact-related data and literature. This information was synthesized to provide a "snapshot" of the baseline conditions described in Chapter III of the EIS. Because this is a programmatic EIS, involving no new research, the use of existing data was essential. No new research efforts or analytical tools were necessary or warranted for the EIS given the nature of the decisions to be made regarding Restoration Plan alternatives.

After obtaining the necessary understanding of the resources (species) and services (human uses) included in Restoration Plan alternatives, the most important aspect of the evaluation process was to define, to the degree possible, each of the options being proposed for implementation in the various alternatives. In order to do this, all information available describing the options has been reviewed. This includes all option write-ups that currently exist, such as option short-forms, project proposals, "Opportunities for Habitat Protection/Acquisition," and Restoration Framework documents. The specificity of the option descriptions were the limiting factor in the identification of impacts.

Each analyst compared the issues identified in Chapter I with the restoration options affecting the resource or service being evaluated. A determination of the degree to which each of the issues is addressed by each alternative was compiled and presented following the impact analyses of all options and alternatives. This effort was intended to ensure that each issues was addressed to the fullest extent possible.

For resources and services such as air, water, sediment, or designated wilderness areas for which no restoration options were identified, no determination of impact has been made. Statements regarding the future submission of proposals affecting these resources include references to the preparation of additional environmental analyses (i.e., Environmental Assessments or Environmental Impact Statements). In addition to those resources for which no restoration options were proposed, resources or services affected by proposed and possible future options that specifically target an area, species population, or user group may also require further environmental analysis. The intent of identifying this need is to ensure that future options that the Trustee Council may want to consider for funding are not precluded from consideration under the Restoration Plan because they were not considered in the EIS.

The economic impact analysis was conducted apart from the impact analysis for physical, biological, and cultural resources. For the economic impact assessment of Restoration Plan implementation, the USDA Forest Service's IMPLAN economic impact assessment model was used. Results of IMPLAN analyses are presented for each alternative in the Restoration Plan.

IMPLAN is a computer model developed by the United States Department of Agriculture to perform regional economic impact analysis. The model is versatile and allows analysis of economies as small as one county and its associated industries. For this analysis, the Alaska data set, based on 1990 Census data, was used.

Using IMPLAN to perform an economic impact analysis proceeds as follows. First, the regional economy experiences a change, up or down, in demand. Next, the changes in spending and respending associated with the demand change are traced through the economy. Finally, the consequences of the demand change are stated in terms of direct, indirect, and induced changes in regional income, population, and employment.

Direct effects calculated by IMPLAN are changes associated with the immediate effects of changes in demand. Indirect effects reflect changes in input needs such as additional purchases to produce additional output in industries associated with the directly affected industries. Induced effects are the changes in spending patterns caused by the changes in income generated by the direct and indirect effects.

For example, the purchase of development rights would cause a decrease in output by the forest products industry (direct effect). In turn, the industries that supply the forest products industry would see their sales fall (indirect effects). Finally, the decrease in demand would cause income and employment to fall, reducing spending in the economy in general (induced effects). The corollary is also true. In this example, the purchase of development rights increases the income of the owners of the rights. They spend this income, which increases demand for the products they buy (direct effects). In turn, the industries that supply the directly affected industries experience an increase in demand for their products (indirect effects). Finally, this increase in demand increases employment and income, which stimulates the economy in general (induced effects).

At its simplest level, the estimated change in income and employment is the product of the demand change (in this case, an alternative) and a multiplier. Multipliers are specific to a region and industry. Multipliers have the ability to consider three interrelated factors. First, not all alternative-related income would be spent; some would be saved. Second, some alternative-related spending would occur outside the economic study region. Third, only some alternative-related income spent within the region may create more jobs. The IMPLAN approach considers these factors when it computes multipliers for the economic impact assessment presented in this chapter.

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Notes

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Draft
Exxon Valdez Oil Spill Restoration Plan

Prepared by:

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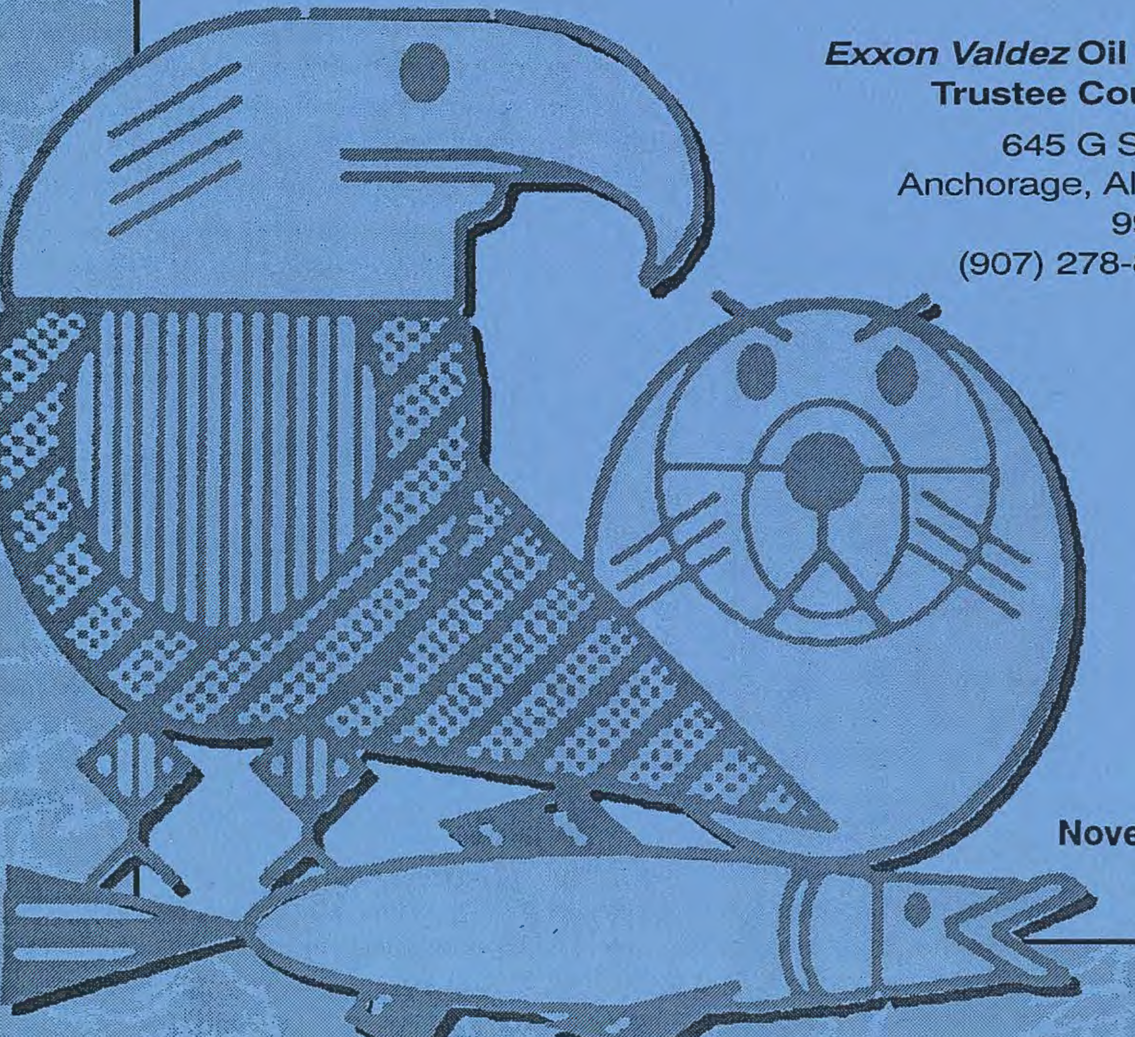

November 1993

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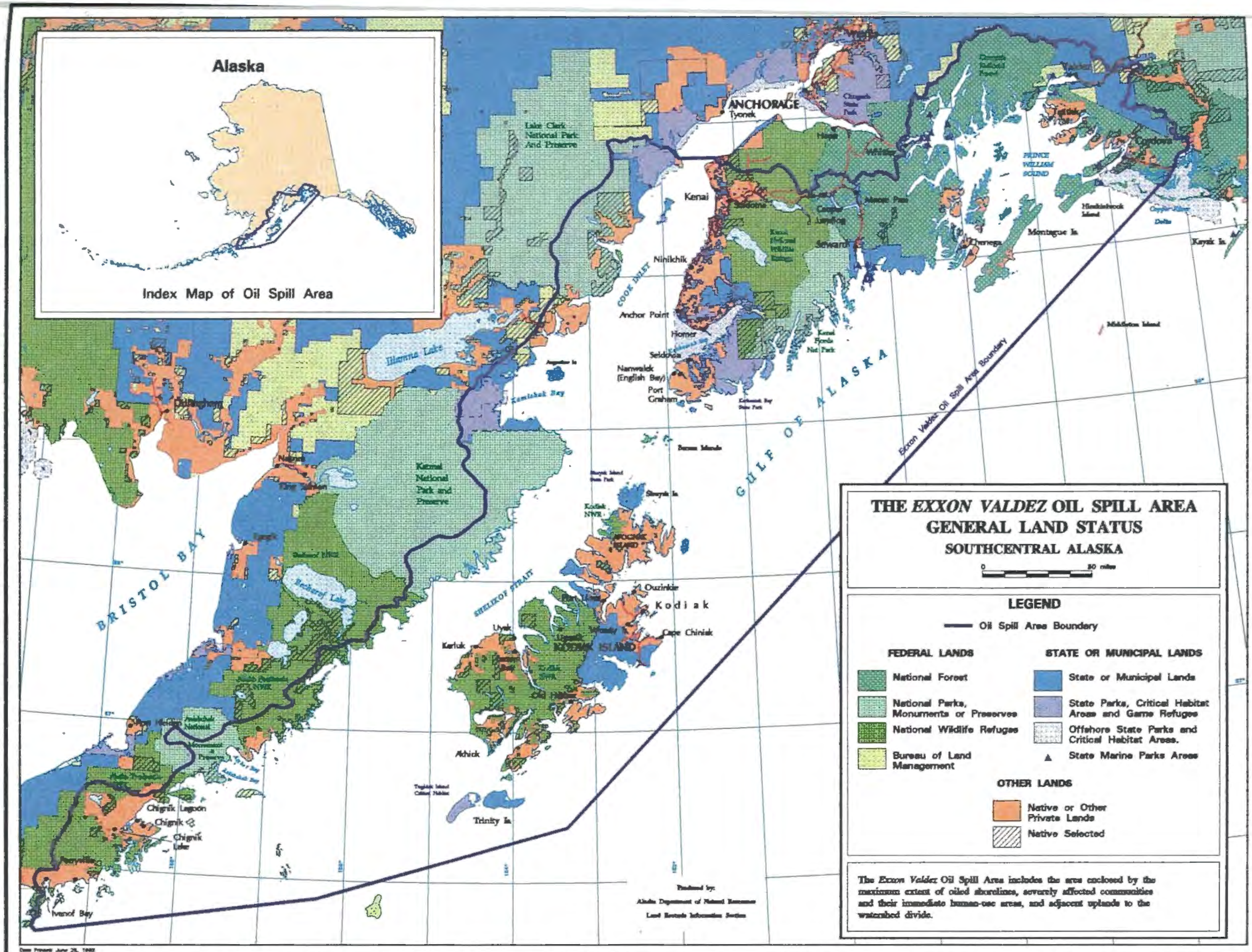

Alaska
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Oil Spill Area Boundary
FEDERAL LANDS
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National Parks, Monuments or Preserves
National Wildlife Refuges
Bureau of Land Management
STATE OR MUNICIPAL LANDS
State or Municipal Lands
State Parks, Critical Habitat Areas and Game Refuges
Offshore State Parks and Critical Habitat Areas.
State Marine Parks Areas
OTHER LANDS
Native or Other Private Lands
Native Selected
The Exxon Valdez Oil Spill Area includes the area enclosed by the maximum extent of oiled shorelines, severely affected communities and their immediate human-use areas, and adjacent uplands to the watershed divide.
Exxon Valdez Oil Spill Area Boundary
GULF OF ALASKA
BRISTOL BAY
SHELIKOF STRAIT
COOK INLET
PRINCE WILLIAM SOUND
ANCHORAGE
Tyonek
Kenai
Ninilchik
Anchor Point
Homer
Seldovia
Nanwalek (English Bay)
Port Graham
Seward
Whittier
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Tatitlek
Cordova
Chenega
Montague Is.
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Kayak Is.
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Lake Clark National Park And Preserve
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Uyak
Karluk
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Akhiok
Trinity Is.
Chignik Lagoon
Chignik
Chignik Lake
Perryville
Ivanof Bay
Produced by:
Alaska Department of Natural Resources
Land Records Information Section

Draft Restoration Plan

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Chapter 1
Introduction

Purpose of the Document

In 1989, the *Exxon Valdez* oil spill 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 $600 million remains available to fund restoration activities.

The *Exxon Valdez* Restoration Plan provides long-term guidance for restoring the resources and services injured by the oil spill. It contains policies for making restoration decisions and describes how restoration activities will be implemented.

Background

The Oil Spill. Shortly after midnight on March 24, 1989, the T/V *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska, spilling eleven million gallons of North Slope crude oil. It was the largest tanker spill in United States' history. That spring the oil moved along the coastline of Alaska, contaminating portions of the shoreline of Prince William Sound, the Kenai Peninsula, lower Cook Inlet, the Kodiak Archipelago, and the Alaska Peninsula. Oiled areas include a National Forest, four National Wildlife Refuges, three National Parks, five State Parks, four State Critical Habitat Areas, and a State Game Sanctuary. Oil eventually reached shorelines nearly 600 miles southwest from Bligh Reef where the spill occurred. The map preceding the table of contents shows the spill area. The spill area includes all of the shoreline oiled by the spill, severely affected communities, and adjacent uplands to the watershed divide.

Response. During 1989, efforts focused on containing and cleaning up the spill, and rescuing oiled wildlife. Skimmers worked to remove oil from the water. Booms were positioned to keep oil from reaching salmon hatcheries in Prince William Sound and Kodiak. A fleet of private fishing vessels known as the "Mosquito Fleet" played an important role in protecting these hatcheries, assisting the skimmers, and capturing oiled wildlife and transporting them to rehabilitation centers. Exxon began to clean up beaches under the direction of the U.S. Coast Guard with advice from federal and state agencies and local communities. Several thousand workers cleaned shorelines, using techniques ranging from cleaning rocks by hand to high-pressure hot-water washing. Fertilizers were applied to some oiled shorelines to increase the activity of oil-metabolizing microbes, an activity known as bioremediation.

The 1989 shoreline assessment, completed after the summer cleanup ended, showed that a large amount of oil remained on the shorelines. In the spring of 1990, the shoreline was again surveyed in a joint effort by Exxon and the state and federal governments. The survey showed that much work remained to be done in 1990. The principal clean-up method used in 1990 was manually cleaning the remaining oil, but bioremediation and relocation of oiled beach material to the active surf zone were also used in some areas.

Shoreline surveys and limited clean-up work occurred in 1991, 1992, and 1993. In 1992, crews from Exxon and the state and federal governments visited eighty-one sites in Prince William Sound and the Kenai Peninsula. They reported that an estimated seven miles of the 21.4 miles of shoreline surveyed still showed some surface oiling. This number does not include oiling that may have remained on shorelines set aside for monitoring natural recovery. The surveys also indicated that subsurface oil remained at many sites that were heavily oiled in 1989. No sites were surveyed on Kodiak Island or the Alaska Peninsula in 1992. Earlier surveys suggested that most of the light oil (scattered tar balls and mousse) which remained on Kodiak Island and the Alaska Peninsula would degrade by 1992. While there may be a few exceptions, the surveys determined that the cost and potential environmental impact of further cleanup was greater than the problems caused by leaving the oil in place. The 1992 cleanup and the 1993 shoreline assessment were concentrated in those areas where oil remained to a greater degree — Prince William Sound and the Kenai Peninsula.

Natural Resource Damage Assessment. During the first summer after the spill, one state and three federal government agencies directed the Natural Resource Damage Assessment field studies to determine the nature and extent of the injuries as needed for litigation purposes. The federal agencies were the U.S. Department of the Interior, U.S. Department of Agriculture, and the National Oceanic and Atmospheric Administration. The state agency was the Alaska Department of Fish and Game. Expert peer reviewers provided independent scientific review of ongoing and planned studies and assisted with synthesis of results. Most damage assessment field studies were completed during 1991.

Settlements

On October 8, 1991, the U.S. District Court approved a plea agreement that resolved various criminal charges against Exxon, and a civil settlement that resolved the claims of the United States and the State of Alaska against Exxon for recovery of civil damages resulting from the oil spill.

The Criminal Plea Agreement. As part of the criminal plea agreement, the court fined Exxon $150 million -- the largest fine ever imposed for an environmental crime. Of this amount, $125 million was remitted due to Exxon's cooperation with the governments during the cleanup, timely payment of many private claims, and environmental precautions taken since the oil spill. Of the remaining $25 million, $12 million was paid to the North American Wetlands Conservation Fund for wetlands enhancement in the U.S., Canada and Mexico, and $13 million was paid to the federal treasury. As part of the Plea Agreement, Exxon also agreed to pay restitution of $50 million to the United States and $50 million to the State of Alaska. The state and federal governments separately manage these $50 million payments. Funds from the criminal plea agreement are *not* under the authority of the Trustee Council, and the use of these funds is not guided by this plan.

Civil Settlement and Restoration Fund. 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 the Alaska and the United States. Both were approved by the U.S District Court.

According to the Consent Decree between Exxon and the state and federal governments, Exxon must make ten annual payments totaling $900 million. The first payment was made in December 1991; the last payment is due in September 2001. As of November 1993, three payments totaling $340 million have been received. The payment schedule is provided in Appendix A. The terms of the Consent Decree and Memorandum of Agreement require that funds paid by Exxon are first to be used to reimburse the federal and state governments for the costs of cleanup, damage assessment, and litigation. Settlement funds remaining after the reimbursements are to be used for purposes of restoration. The use of the restoration fund is guided by this plan.

The Consent Decree with Exxon also has a reopener provision that allows the governments to claim up to an additional $100 million between September 1, 2002 and September 1, 2006 to restore one or more resources or habitats that suffered a substantial loss or decline as a result of the spill. Under the Consent Decree, the reopener is available only for any losses or declines that could not reasonably have been known or anticipated from information available at the time of the settlement.

The Memorandum of Agreement provides the rules for spending the restoration funds. Those rules are:

- Restoration funds must be used "...for the purposes of restoring, replacing, enhancing, or acquiring the equivalent of ***natural resources*** injured as a result of the Oil Spill and the reduced or lost ***services*** provided by such resources...."

- Restoration funds must be spent on restoration of natural resources in Alaska unless the Trustees unanimously agree that spending funds outside of the state is necessary for effective restoration.

- All decisions made by the Trustees (such as spending restoration funds) must be made by unanimous consent.

The Memorandum of Agreement and other settlement documents define a number of important terms.

Restore or **Restoration** means any action, in addition to response and clean-up activities required or authorized by state or federal law, which endeavors to restore to their prespill condition any natural resource injured, lost, or destroyed as a result of the Oil Spill and the services provided by the resource or which replaces or substitutes for the injured, lost or destroyed resource and affected services. Restoration includes all phases of injury assessment, restoration, replacement, and enhancement of natural resources, and acquisition of equivalent resources and services.

Replacement or acquisition of the equivalent means compensation for an injured, lost or destroyed resource by substituting another resource that provides the same or substantially similar services as the injured resource.

Enhancement means any action that improves on or creates additional natural resources or services where the basis for improvement is the prespill condition, population, or use.

Natural resources means the land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to or managed by the state or federal governments. Examples of natural resources are birds, fish, mammals, and subtidal plants and animals.

The Consent Decree also provides that funds may be used to restore archaeological sites and artifacts injured or destroyed by the spill.

In addition to restoring natural resources, funds may be used to restore reduced or lost **services** (including human uses) provided by injured natural resources. Humans use the services provided by resources injured by the spill in a variety of ways: subsistence, commercial fishing, recreation (including sport fishing, sport hunting, camping, and boating), and tourism are services that were affected by injuries to fish and wildlife. Injured services also include the value derived from simply knowing that a resource exists. (This service is called "passive use.")

Restoration funds may not be used to compensate individuals for their own private losses. For example, the personal loss of income by individual fishermen or commercial guides must be settled through private lawsuits. Although the federal and state governments have settled their claims against Exxon, private lawsuits against Exxon are still pending.

Past Expenditures

Of the $900 million from the civil settlement, approximately $600 million remain to fund future restoration activities. A summary of past expenditures is given in the table below. Further detail about the past expenditures from civil settlement funds and a schedule of future payments are presented in Appendix A.

The Civil Settlement Funds as of November 1993
Figures in Millions of Dollars

Past Payments by Exxon	**Past Reimbursements, Deductions, Withdrawals & Commitments**
$340 million	$252.1 million: • $139.1 to reimburse the federal and state governments for past damage assessment, cleanup, response, restoration, and litigation expenses; • $39.9 deducted by Exxon for costs of cleanup completed after January 1, 1991; • $15.5 for the 1992 Work Plan; • $51.3 for the 1993 Work Plan (including Kachemak Bay purchase, and downpayment toward purchase of Seal Bay); • $6.3 for interim funding for the 1994 Work Plan.
Future Payments	**Future Commitments**
$560 million by 2001	Between $40 - $70 million to reimburse the governments for past expenses.
	Total remaining for restoration
	Approximately $580 - $610 million
Total Payments	**Total Expenses**
$900 million	$900 million

Post-settlement Trustee Organization

The Clean Water Act requires that the President and the Governor designate natural resource trustees to oversee natural resource damage claims and restoration. In the 1991 MOA, three federal and three state trustees were designated to administer the restoration fund and to restore resources and services injured by the oil spill. The members are:

State of Alaska Trustees
- Commissioner of the Department of Environmental Conservation
- Commissioner of the Department of Fish and Game
- Attorney General

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

The Trustees established the Trustee Council to administer the Restoration Fund. The State Trustees serve directly on the Trustee Council. The Federal Trustees have each appointed a representative in Alaska to serve on the Council.

The Trustee Council uses funds from the civil settlement for activities to restore injured resources and services. It *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 to provide information to those agencies or other groups.

Public Involvement and Information

The importance of public participation in the restoration process was recognized in the Exxon settlement and is an integral part of the agreement between the state and federal governments. The Memorandum of Agreement and Consent Decree approved by the court specify that:

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

In January 1992, public meetings were held and written comments requested for recommendations about establishing a Public Advisory Group. Comments addressed the role, structure, and operating procedures for the group. The Public Advisory Group was formed in October 1992 to advise the Trustee Council on all matters relating to the planning, evaluation, and allocation of funds, as well as the planning, evaluation, and conduct of injury assessments and restoration activities. This group consists of seventeen members who represent a cross-section of the interest groups and public affected by and concerned about the spill. There are also two ex-officio members chosen by the Alaska State House of Representatives and the Alaska State Senate.

Additional public meetings were held in May 1992 on the *Restoration Framework Volume I*, which outlined restoration issues and a general framework for restoration. A third set of meetings was held in April-May 1993 to discuss Alternatives for the Draft Restoration Plan. Many of the policies in this plan were suggested by the public during the 1993 meetings.

Most Trustee Council meetings include a public comment period that is teleconferenced to sites in the spill area. Verbatim transcripts of the meetings are available to the public a few days after the meeting. Documents, such as those proposing projects for funding, are distributed for public review before Trustee Council decisions.

Implementing the Restoration Plan

The Restoration Plan provides long-term guidance for restoring the resources and services injured by the oil spill. It does not list individual restoration projects. Each year, the Restoration Plan will be implemented through an annual or multi-year work plan. The work plan describes the projects funded by the Trustee Council from the restoration fund. To be funded, projects must be consistent with the rules for use of the restoration fund (see pages 3 and 4), and with the policies, objectives, and restoration strategies of this Restoration Plan.

The Trustee Council may change the Restoration Plan in response to new scientific data, or to changing social and economic conditions. However, new scientific data may be incorporated into restoration decisions without the need to change the plan. It will be necessary to change the plan only if the Trustee Council determines that the plan is no longer responsive to restoration needs.

Legal Compliance. This plan and individual restoration projects must comply with a variety of state and federal laws and regulations, including the National Environmental Policy Act (NEPA). Projects that are likely to have little or no significant environmental effect require only minimal additional work. Projects with significant environmental impact may require that an Environmental Assessment or an Environmental Impact Statement be prepared. In addition, other permits may be required before final approval and implementation of the project.

Concepts Important to Understanding this Plan

Public Comment on Alternatives. Many of the policies in this plan respond to issues that were raised during public discussion of the Alternatives for the Draft Restoration Plan (the "newspaper brochure"). The public comment period for alternatives began in April and ended August 6, 1993. Approximately 2,000 people commented during that time. Many of these comments were in response to a questionnaire included in the newspaper brochure that focused public attention on specific policy questions. The policies in the next chapter address those policy questions or other issues raised by the public. To obtain a copy of the *Summary of Public Comment on Alternatives*, please write or call the *Exxon Valdez* Restoration Office. See Appendix D for a complete list of restoration planning documents.

Categories of Restoration. This plan divides restoration activities into four categories:
- General Restoration
- Habitat Protection and Acquisition
- Monitoring and Research
- Public Information and Administration

General Restoration includes a wide variety of restoration activities. Some General Restoration activities will improve the rate of natural recovery by directly manipulating the environment. Other activities protect natural recovery by managing human uses or reducing marine pollution. A few general restoration activities may involve facilities. Facilities may direct human use away from sensitive areas, support other restoration activities, or replace facilities needed for access and damaged by the spill.

Habitat Acquisition and Protection may include the purchase of private land or interests in land, such as conservation easements, mineral rights, or timber rights. On existing public land within the spill area, it may include recommendations for changing agency management practices. Protecting and acquiring land may minimize further injury to resources and services, and may allow recovery to continue unimpeded.

Monitoring and Research includes gathering information about how resources and services are recovering, whether restoration activities are successful, and what continuing problems exist in the general health of the affected ecosystems. It provides important information to help direct the restoration program. In addition, it will provide useful information to resource managers and the scientific community that will help restore the injured resources and services.

Public Information and Administration includes activities required to prepare work plans, negotiate for habitat protection, involve the public, and operate the restoration program. These are necessary administrative expenses that are not attributable to a particular project. The category includes these and other day-to-day public information functions such as responding to public inquiries.

Chapter 2
Policies

This chapter presents policies to guide restoration activities. Each policy addresses an issue that was raised during public discussion of the Alternatives for the Draft Restoration Plan. This chapter lists the policies and then discusses the rationale for each.

Policies

1. The restoration program will take an ecosystem approach.

2. Restoration activities may be considered for any injured resource or service.

3. 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:
   - when the most effective restoration actions for an injured migratory population are in a part of its range outside the spill area, or
   - 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.

4. Restoration activities will emphasize resources and services that have not recovered. Resources and services will be enhanced, as appropriate, to promote restoration. Restoration projects should not adversely affect the ecosystem.

5. Projects designed to restore or enhance an injured service:
   - must have a sufficient relationship to an injured resource,
   - must benefit the same user group that was injured, and
   - should be compatible with the character and public uses of the area.

6. Competitive proposals for restoration projects will be encouraged.

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

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

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

Discussion

This section restates each policy and explains the reasons for adopting it.

1. 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 and to injured resources and services.

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.

The public has frequently commented on the need to take an ecosystem approach to restoration. This policy adopts that view.

2. Restoration activities may be considered for any injured resource or service.

This policy allows restoration of any natural resource or service injured by the spill. Data on population injury is incomplete because prespill data is lacking for many resources, and because some resources would require much more study to determine whether a population decline occurred. Thus, restricting restoration to spill-caused population declines, as some public comments advocated, would result in partial restoration of spill-related injuries. However, all expenditures of settlement funds must be linked to injured resources and services, and the proposed policy would permit restoration activities for all resources and service with a spill-related injury, not just those that suffered a measured decline in population.

Knowledge of spill-related injuries will improve as continuing research and monitoring work provide more information about the effects of the spill. Improved understanding of injuries and ecosystem problems will be incorporated into restoration decisions. Current understanding of injuries is presented in Appendix B.

During the 1993 public review of Alternatives for the Draft Restoration Plan, most people supported targeting activities to all injured resources or services.

3. 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:

- when the most effective restoration actions for an injured migratory population are in a part of its range outside of the spill area, or

- when the information acquired from recovery and monitoring activities outside the spill area will be significant for restoration or understanding injuries within the spill area.

This policy directs the majority of funds to be focused on the spill area, where the most serious injury occurred and the need for restoration is greatest. It also provides the flexibility to restore and monitor outside the spill area under limited circumstances. Examples are restoration and monitoring for migratory seabirds and marine mammals.

There is enough need for restoration activities within the spill area and within Alaska to use all of the remaining settlement fund. However, there is also need for flexibility to consider restoration activities outside the spill area. If restoration were prohibited outside the spill area, effective restoration techniques might be excluded. If monitoring were restricted to the spill area, biological information useful for the restoration and management of an injured resource might be missed.

This policy is consistent with the majority of public comment made on the Alternatives for the Draft Restoration Plan. Two-thirds of all comments favored restricting restoration to the spill area because the link to injury is strongest in the spill area, funds are limited, and needs are great in the spill area. Those who favored restoration outside the spill area said that activities can sometimes be more effective there, especially for migratory seabirds and marine mammals.

4. Restoration activities will emphasize resources and services that have not recovered. Resources and services will be enhanced, as appropriate, to promote restoration. Restoration projects should not adversely affect the ecosystem.

This policy focuses restoration efforts on recovery of injured resources and services. These are frequently the resources in most need of attention. The policy also recognizes that protection or other restoration activities may increase populations above the level that existed before the spill.

Some people expressed concern that some restoration activities, such as those that increase populations beyond prespill levels, could upset the natural balance of the ecosystem and divert limited funds away from resources that have not yet recovered. This policy addresses those concerns by discouraging restoration activities that adversely affect the ecosystem.

5. Projects designed to restore or enhance an injured service:

- must have a sufficient relationship to an injured resource,
- must benefit the same user group that was injured, and
- should be compatible with the character and public uses of the area.

The restoration fund may be used to restore the reduced or lost services provided by injured resources. The relationship between the proposed activity and the injured resource which caused the reduced or lost service is the subject of the first part of this policy. The policy requires that a project to restore or enhance an injured service must be sufficiently related to a natural resource. It can be related to a natural resource in various ways. It could directly restore a resource, provide an alternative resource, or restore access or people's use of the resource. The strength of the required relationship has not been defined by law, regulation, or the courts. However, a connection with an injured resource is necessary. In determining whether to fund a project to restore services, the strength of the project's relationship to injured resources will be considered.

A few examples may help understanding. One way to aid commercial fishing is to restore injured salmon runs or to provide alternative runs. However, the restoration fund cannot be used to give cash grants to fishermen to cover spill-related losses. This latter idea is unrelated to an injured resource.

As a second example, recreation was injured, in part, because the resources it relies on were injured. Habitat may be purchased to provide alternative areas for recreation where uninjured resources exist. The restoration fund may also be used to provide access to recreation areas, compatible with the character and public uses of the area. In these cases, the restoration activity has a relationship to injured resources — it provides replacement resources or better use of the injured resources. However, the restoration fund could not be used to promote recreation in general, such as through subsidy of a boat show, because there is no relationship to an injured resource.

The second part of the policy ensures that the injured user groups are the beneficiaries of restoration. If the justification for an action is to restore a service, it is important that the user group that was injured be the one that is helped.

The last part of the policy addresses a public concern about possible changes in the use of the spill area. It allows improvements in the services without producing major changes in use patterns. For example, a mooring buoy in an anchorage may improve boating safety without changing patterns of use. Projects to be avoided are those that create different uses for an area, such as constructing a small-boat servicing facility in an area that is wild and undeveloped.

During the review of the Alternatives for the Draft Restoration Plan, public comments varied on the issue of using restoration funds for providing opportunities for human use. Some responses opposed providing these opportunities, because people said that human use is unrelated to restoration. Others favored actions that decrease the impact of human use or said that these kinds of projects would improve the lifestyle of those affected by the spill.

6. 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 have increased each year and will 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.

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

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

8. 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.

9. 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 authorities and the historic level of agency activities.

Chapter 3
Categories of Restoration Actions

The restoration program includes four categories of restoration actions: General Restoration, Habitat Protection and Acquisition, Monitoring and Research, and Public Information and Administration. This chapter describes activities within each category. It also describes how decisions are made about projects and presents policies that apply to each category.

The Alternatives for the Draft Restoration Plan asked the public to indicate the emphasis they would place on each restoration category. Although this approach was useful in asking the public about the relative importance to place on these categories, this plan does not prescribe a fixed allocation of the restoration fund. The restoration program must be able to respond to changing conditions and new information about injury, recovery, and the cost and effectiveness of restoration projects. When making annual funding decisions, the Trustee Council will use the public comments received on the restoration alternatives as well as comments that may be received in the future.

General Restoration

General Restoration activities are a principal tool used to focus on the restoration of individual injured resources and services. General Restoration includes a wide variety of restoration activities. This plan uses the term to include all activities that are not Habitat Protection and Acquisition, Monitoring and Research, or Public Information and Administration. General Restoration activities fall into one of the following three types:

- Manipulation of the Environment;
- Management of Human Use; or
- Reduction of Marine Pollution.

A few General Restoration activities will improve the rate of natural recovery. Most of these activities involve manipulation of the environment. Other activities protect natural recovery by managing human uses or reducing marine pollution. A few General Restoration activities may involve facilities. Facilities may direct human use away from sensitive areas, support other restoration activities, or replace facilities needed for access and damaged by the spill.

Manipulation of the Environment. Some General Restoration techniques restore injured resources and services by directly manipulating the environment. Examples include building fish passes to restore fish populations, or replanting seaweed to restore the intertidal zone to prespill conditions.

A common public comment on alternatives was that manipulation of the environment has the potential to adversely affect the ecosystem. While some people recommended individual projects, others recommended relying on natural recovery where appropriate.

When evaluating projects that manipulate the environment, the potential for adverse effects on the ecosystem will be considered. Those projects that will effectively accomplish an important restoration objective without adversely affecting the ecosystem are more likely to be funded.

Management of Human Use. Some General Restoration projects involve managing human use to aid restoration. Examples include redirecting hunting and fishing harvest, or reducing human disturbance around sensitive bird colonies. Many projects that manage human use do so to protect injured resources, services, or their habitat.

Reduction of Marine Pollution. Reducing marine pollution can remove a source of stress that may delay natural recovery. The public frequently recommended preventive actions to stop ongoing marine pollution. However, expenditures for most activities designed to prevent catastrophic oil spills or to plan for their cleanup are not allowed by the terms of the civil settlement.

Restoration projects whose primary emphasis is to reduce marine pollution may be considered:
- where the marine pollution is likely to affect the recovery of a part of the injured marine ecosystem, or of injured resources or services; and
- where the project will not duplicate existing agency activities.

Making Decisions About General Restoration Projects

Deciding which General Restoration projects deserve funding involves deciding which restoration tasks are most important, and which projects best accomplish those tasks. When assessing the importance of a General Restoration project, at least the following factors will be considered:

- *Natural recovery.* Is the resource or service recovering? Is it likely to recover even if the General Restoration project is not funded? Will recovery take a very long time? Will the project significantly decrease the time to recovery?

- *The value of an injured resource to the ecosystem and to the public.* Is the resource an endangered or threatened species? What is its ecological significance? To what extent is it used for human purposes such as commercial fishing, recreation, or subsistence?

- *Duration of benefits.* Will the benefits be recognized twenty or thirty years from now?

- *Technical feasibility.* Are the technology and the management skills available to successfully implement the project? Projects of unproven feasibility may be funded if demonstrating the feasibility and then carrying out the project is likely to be an effective method of achieving restoration.

- *Likelihood of success.* If a project is successfully implemented, how likely is it to accomplish its objective? Is it possible to tell whether a project has an effect on recovery?

- *Relationship of costs to expected benefits.* Do benefits equal or exceed costs? Ability to meet this criterion will not be based on a cost/benefit analysis, but on a broad consideration of the direct and indirect costs, and the primary and secondary benefits. It will also take into account whether there is a less expensive method of achieving substantially similar results.

- *Will the project cause harmful side effects?* Restoration projects should neither adversely affect ecosystem relations nor adversely affect any injured or noninjured resource or service.

- *Will the project help a single resource or benefit multiple resources?* Preference will be given to projects that benefit multiple resources rather than to those that benefit a single resource. However, appropriate single-resource projects will be considered when they provide effective restoration. This approach will maximize benefits to ecosystem and to injured resources and services.

- *Effects on health and human safety.* Are there any potential health or safety hazards to the general public?

- *Consistency with applicable laws and policies.* Is the project consistent with federal and state laws and regulations, and with the policies of this plan?

- *Duplication.* Does a project duplicate the actions of another agency or group?

Habitat Protection and Acquisition

Habitat protection and acquisition is one of the principal tools of restoration. It is important in ensuring continued recovery in the spill area.

Resource development, such as harvesting timber or building subdivisions, may alter habitat that supports resources or services. Protecting and acquiring land may minimize further injury to resources and services already injured by the spill, and allow recovery to continue with the least interference. For example, the recovery of harlequin ducks might be helped by protecting nesting habitat from future changes that may hamper recovery.

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 services. In addition, cooperative agreements with private owners to provide increased habitat protection are also possible.

Most public comments on the restoration alternatives favored using habitat protection and acquisition as a means of restoration. In addition, most of those who commented also asked that it receive a majority of the remaining settlement fund.

In the Alternatives for the Draft Restoration Plan, the public was asked to describe areas they would like the Trustee Council to acquire or protect. Many people recommended areas for purchase. The areas recommended are distributed throughout the spill area and are listed in Appendix C.

If restoration funds are used to protect a parcel, it must contain habitat important to an injured resource or service. The following injured resources might benefit from the purchase of private land or property rights: pink and sockeye salmon, Dolly Varden and cutthroat trout, Pacific herring, bald eagle, black oystercatcher, common murre, harbor seal, harlequin duck, marbled murrelet, pigeon guillemot, river otter, sea otter, intertidal organisms, and archaeological sites.

Habitat protection and acquisition is a means of restoring not only injured resources, but also the services (human use) dependent on those resources. Subsistence, recreation, and tourism, benefit from the protection of important fish and wildlife habitats, scenic areas, such as those viewed from important recreation or tourist routes, or important subsistence harvest areas. For example, protecting salmon spawning streams benefits not only the salmon, but also commercial, subsistence, and recreational fishermen.

Habitat protection on existing public land and water may include recommendations for changing agency management practices. The purpose, in appropriate situations, is to increase the level of protection for recovering resources and services above that provided by existing management practices. The Trustee Council may conduct studies within the spill area to determine if changes to public land and water management would help restore injured resources and services. If appropriate, changes will be recommended to state and federal management agencies. Recommendations for special designations, such as parks, critical habitats, or recreation areas, may be made to the Alaska legislature or the U.S. Congress.

Habitat and Acquisition Protection Policies

In addition to the policies of Chapter 2, the following specific policies apply to Habitat Protection and Acquisition.

- Private lands considered for purchase will be ranked according to the potential benefits that purchase and protection would provide to injured resources and services. Those parcels that greatly benefit the injured resources and services will be highly ranked.

- State and federal governments will purchase lands on the basis of a willing seller and a willing buyer.

- In order to make the best use of restoration funds, purchases will not exceed fair market value. Appraisal of individual parcels of land will precede all purchases.

- Habitat protection will follow an ecosystem approach by emphasizing acquisition of large parcels, such as watersheds, that support multiple injured species and ecologically linked groups of species. Protecting and acquiring small parcels may benefit larger surrounding areas, provide access to public land, or provide critical benefits to a single resource or service.

- Public comments will be considered when determining habitat protection priorities. Many comments about specific parcels have already been received.

- Acquired land will be managed by the most appropriate state or federal agency based on the resources to be protected, management needs, and ownership of surrounding and nearby lands.
- Except where specific restoration activities for acquired land exceeds normal agency efforts, land management costs will be met from existing agency budgets.

- Lands acquired with restoration funds will be managed in a manner benefitting injured resources and services. Covenants that outline management objectives will be determined by the time of purchase.

- Subsistence use should not be displaced through acquisition or protection of land or changing management practices

Making Decisions About Habitat Protection and Acquisition

The Restoration Plan provides general guidance for Habitat Protection and Acquisition activities. More detailed guidance will be given in the *Comprehensive Habitat Protection and Acquisition Process: Large Parcel Evaluation and Ranking*. That document was completed in November 1993. This comprehensive process will outline criteria and procedures for evaluating and ranking large parcels of private lands for protection and acquisition.

The large parcel analysis will address private property parcels larger than 1,000 acres that are within the spill area and whose owners have indicated an interest in having their lands evaluated for the protection and acquisition program. Smaller parcels may be evaluated in the future. For each parcel of land, the Trustee Council will decide the type of protection or ownership rights needed for restoration, and how it will be managed. In addition, for each parcel the Council will decide whether and when to begin negotiations with the landowner. The type of protection and management will also be the subject of negotiation with the landowner.

Monitoring and Research

The Monitoring and Research program provides important information to help guide restoration activities. This information includes how well resources and services are recovering, whether restoration activities are successful, and what continuing problems exist in the general health of the affected ecosystems.

A lack of long-term research into ecosystem relationships and problems may result in less effective restoration and possibly continued injury. Inadequate information may require managers to unduly restrict human use of the resources, and could compound the injury to services, such as commercial fishing and subsistence. Inadequate information may also lead to management actions that inadvertently reduce the productivity and health of a resource, inappropriate restoration actions, or restoration opportunities missed for lack of knowledge.

The Monitoring and Research program includes three parts:
- Recovery Monitoring;
- Restoration Monitoring; and
- An Ecological Monitoring and Research Program.

Recovery Monitoring. Information about recovery is important in designing restoration activities, and determining which activities deserve funding. Recovery Monitoring will track the rate and degree of recovery of the resources and services injured by the spill. It will also determine when recovery has occurred. For resources that are already recovering, it may detect reversals or problems with recovery. For resources that are not recovering, recovery monitoring will determine the status of the injury, whether it is worsening, and when the population stabilizes or recovery begins.

Restoration Monitoring. To maintain an effective restoration program, the Trustee Council must learn whether the projects it funds accomplish their purposes. Restoration Monitoring will provide that assessment. It evaluates the effectiveness of individual restoration activities. Most restoration projects will incorporate evaluation procedures into their project design.

An Ecological Monitoring and Research Program. This program will provide information about key relationships in the ecosystem that affect injured resources and services. For example, understanding problems with food sources, habitat requirements, and other ecosystem relationships of an injured resource or service will provide information for more effective restoration and management. The program may include research to determine why some resources are not recovering. It may also provide a baseline for early identification of future problems. Finally, the Ecological Monitoring and Research program may also provide new information about previously unknown spill injuries or change the understanding about known injuries.

Long-term Monitoring and Research: Recovery Monitoring, and Ecological Monitoring and Research After 2001. The need for monitoring the status of spill-affected ecosystems will continue for a long time. For example, some salmon return in cycles of four to six years, and other resources have lives that are much longer. To be effective, monitoring may have to span more than one salmon generation. Sometimes research is necessary to understand why a resource is not recovering. In many cases, research must precede effective restoration or improved management decisions that will protect a resource or service. For these reasons, some research and monitoring activities will require long study times.

Long-term research cannot be accomplished without long-term funding. Because the Monitoring and Research program is currently being developed, a reliable estimate of long-term funding needs is not available. The Trustee Council will provide funding to continue monitoring and research activities after the last Exxon payment is made in 2001. However, until the program is designed and more cost information is known, the amount of money, length of time, and funding mechanisms cannot be determined.

Other Monitoring and Research Policies

In addition to the policies of Chapter 2, the following specific policies apply to Monitoring and Research.

- The Trustee Council will make or approve funding decisions about monitoring and research activities. The Council is responsible for the restoration of resources and services, including the monitoring and research component of restoration, and cannot assign that responsibility elsewhere.

- Monitoring and research proposals, as well as the overall program design, will be subject to independent scientific review. Without independent review, the Trustee Council and the public cannot be assured that scientific judgements are free of bias.

- Local advice about problems and priorities will be integrated into the decision process. The spill area is over 600 miles long. The ecological conditions and problems of the Kodiak Area are different from those of Prince William Sound. For the program to be responsive to local conditions, local advice must be integrated into the annual and long-term decisions about problems, projects, and priorities.

- To ensure the maximum benefit from a Monitoring and Research program, all parts of the program must be integrated, and techniques and protocols should be consistent where appropriate. As much as possible, the program should follow a long-term plan.

- The Monitoring and Research program will be integrated with existing monitoring and research activities by agencies and other groups, but it will not duplicate or replace them.

Public Information and Administration

Funding is required to prepare work plans, negotiate for habitat purchases, involve the public, and operate the restoration program. These are necessary administrative expenses that are not attributable to a particular project. The Public Information and Administration category includes these and other day-to-day public information functions, such as responding to public inquiries or seeking local opinion and advice.

The public has voiced concern that too much money is being spent on administration. Administrative expenses averaged 26% of the 1992 Work Plan, and 8% of the 1993 Work Plan. As more restoration activities occur, and as initial planning and implementation expenses are finished, administrative expenses will decrease both in absolute terms and as a percentage of the work plan.

Public Information and Administration Policy

The Trustee Council will seek to minimize the administrative cost of the restoration program. The goal is for administrative costs to average no more than 5% of overall restoration expenditures over the remainder of the settlement period (through October 2001).

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Chapter 4
Objectives

The goal of restoration is recovery of all injured resources and services. This chapter expresses objectives to meet this goal. Objectives are defined as the recovery of individual injured resources and services. This chapter also presents strategies for achieving objectives. For some resources, little is known about their injury and recovery, so it is difficult to define recovery or develop restoration strategies.

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

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

Restoration strategies are presented under three headings: Natural Resources, Other Resources, and Services. Because restoration strategies for natural resources differ according to the degree of recovery, they are subdivided into strategies for recovering resources, resources that are not recovering, and resources whose recovery is unknown.

The combination of individual restoration objectives and strategies into a unified restoration program will result in an ecosystem approach that recognizes the interconnections between species, and between species and their physical environment. The definitions of recovery and the restoration strategies also reflect consideration of ecosystem relationships. For example, recovery of intertidal and subtidal communities are defined, in part, as a return to ecosystem functions and services that would have existed in the absence of the spill; and the restoration strategy for some injured resources includes research into why they are not recovering, such as declining or contaminated food sources or disruption of ecosystem relationships. Appendix B presents more detailed information about the status of injury and recovery of resources and services.

Natural Resources

Recovering Resources

The following resources are believed to be recovering. This list is expected to change as the condition of injured resources changes and knowledge about them improves.

Bald eagles	Killer whales
Black oystercatchers	Sockeye salmon (Red Lake)

Restoration Strategy. Restoration of recovering resources will rely primarily on natural recovery because, for most recovering resources:

- They are expected to fully recover over time;
- People can do little to accelerate their recovery; and
- Waiting for natural recovery is not likely to significantly harm a community or industry in the long term. (Subsistence, commercial fishing, and recreation are addressed under "Services.")

However, if a resource is not expected to recover fully on its own or if waiting for natural recovery will cause long-term harm to a community or service, appropriate alternate means of restoration would be undertaken.

The restoration strategy for recovering resources has three parts:

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

<u>Monitor recovery.</u> For resources believed to be recovering, the monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that a resource may not recover as expected, alternate means of restoration will be considered.

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

Definitions of Recovery. This section defines recovery for each recovering resource.

Bald eagles: 200 to 300 bald eagles may have been killed in the spill. However, population estimates made in 1989, 1990, and 1991 indicate that there may have been an increase in the bald eagle population since the previous survey conducted in 1984. Productivity also decreased in 1989, but appeared to have recovered by 1990. Because population and productivity appear to have returned to prespill levels, bald eagles may have already recovered from the effects of the spill.

Black oystercatchers are recovering, although they may still be exposed to hydrocarbons when feeding in intertidal areas. They will have recovered when populations attain prespill levels and when reproduction and growth in oiled areas are comparable to those in unoiled areas.

Killer whales: Thirteen whales disappeared from one pod in Prince William Sound between 1988 and 1990. The injured pod is growing again. Killer whales will have recovered when the injured pod grows to at least 36 individuals (1988 level).

Sockeye salmon (Red Lake) declined in population because of adult overescapement in 1989. The Red Lake system may be recovering because the plankton has recovered, and fry survival improved in 1993. Sockeye salmon in Red Lake will have recovered when populations are healthy and productive and exist at prespill abundances. One indication of recovery is when fry production in Red Lake is at prespill levels.

Resources Not Recovering

The following resources show little or no sign of recovery nearly five years after the spill. This list is expected to change as the condition of injured resources changes and knowledge about them improves.

Common murres
Harbor seals
Harlequin ducks
Intertidal Ecosystem
Marbled murrelets
Pacific herring
Pigeon guillemots
Pink salmon
Sea otters
Sockeye salmon (Kenai River)
Subtidal Ecosystem

Restoration Strategy. Except for certain protective measures, attempts to restore these resources without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for these resources emphasizes determining why they are not recovering and eliminating threats to the remaining populations. Where sufficient knowledge about the nature of injury exists, the restoration strategy also encourages actions to promote recovery because:

- The populations of some of these resources are in a steep decline and may not recover without help; and
- Some of these resources have subsistence or economic importance and their recovery is linked to the recovery of these services. (Restoration strategies under "Services" also apply to these resources.)

The restoration strategy for resources that are not recovering has four parts:

Conduct research to find out why these resources are not recovering. Effective restoration requires an understanding of why resources are not recovering. For some resources the reason is known; however, for most the reason is unknown. Suspected causes include declining or contaminated food sources and disruption of ecosystem relationships.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once a resource is recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities and the importance of the resource for recovery of a service. However, if a resource is expected to recover fully through natural recovery alone and waiting for natural recovery to occur will not cause long-term harm to a community or industry, the restoration strategy would rely primarily on natural recovery.

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

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

Definition of Recovery. This section defines recovery for each resource that is not recovering. Some of these resources were in decline before the spill and may never return to prespill levels.

Common murres show signs of recovery in some colonies. However, breeding is still inhibited in some colonies, although differences in breeding patterns may be attributable to conditions that existed before the spill. They will have recovered when populations return to prespill levels at all the injured colonies.

Harbor seals were in decline before the spill. Census counts from 1990 to 1992 at haulouts in Prince William Sound may indicate that the population has stabilized in the Sound. If the population has stabilized, normal growth may replace the animals lost. However, if the long-term decline continues, the affected population may not recover. Recovery will have occurred when harbor seals within the oiled area are at a population level comparable to that which would likely have occurred in the absence of the spill.

Harlequin ducks: There are indications of population decline and possibly reproductive failure. Harlequin ducks will have recovered when populations have returned to prespill levels, or when differences between oiled and unoiled areas are eliminated.

Intertidal ecosystem: The lower intertidal zone and, to some extent, the middle intertidal zone are recovering. However, injuries persist in the upper intertidal zone, especially on rocky sheltered shores. Recovery of this zone appears to depend, in part, on the return of adult *Fucus* in large numbers. Intertidal communities in the upper intertidal zone will have recovered when community composition, population abundance of component species, and ecosystem functions and services in each injured intertidal habitat have returned to levels that would have prevailed in the absence of the oil spill.

Marbled murrelets and pigeon guillemots were in decline before the spill and may not attain prespill population levels. The causes of the prespill decline are unknown, but the decline is expected to continue. They will have recovered when population trends are stable or increasing.

Pacific herring studies have demonstrated egg mortality and larval deformities. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, the stocks in Prince William Sound do not appear to be healthy. They will have recovered when populations are healthy and productive and exist at prespill abundances. One indication of recovery is when the age-class structure and the relative strength of the spawning run in Prince William Sound are comparable to those in Sitka Sound. Historically, the size and age structure of herring populations in Prince William Sound and Sitka Sound have been closely correlated.

Pink salmon studies have demonstrated egg mortality, fry deformities, and reduced growth in juveniles. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, the stocks in Prince William Sound do not appear to be healthy. They will have recovered when populations are healthy and productive and exist at prespill abundances. An indication of recovery is when egg mortalities in oiled areas match prespill levels or levels in unoiled areas.

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

Sockeye salmon (Kenai River): Because of fisheries closures in 1989, a third year of high escapements of adult salmon exceeded the fry-rearing capacity of the lakes in the Kenai River system. Smolt production declined from 30 million in 1989 to six million in 1990 and continued to decline to less than one million in 1992 and 1993. Sockeye salmon will have recovered when populations are healthy and productive and exist at prespill levels. One indication of recovery is when Kenai and Skilak Lakes support sockeye smolt outmigrations comparable to prespill levels.

Subtidal ecosystem: Certain subtidal organisms, like eelgrass and some species of algae, appear to be recovering. Other subtidal organisms, like leather stars and helmet crabs, showed little sign of recovery through 1991. Subtidal communities will have recovered when community composition, population abundance of component species, and ecosystem functions and services in each injured subtidal habitat have returned to levels that would have prevailed in the absence of the oil spill.

Recovery Unknown

It is not known whether the following resources are recovering because insufficient data are available. This list may be modified as knowledge about these resources improves.

Clams	River otter
Cutthroat trout	Rockfish
Dolly Varden	

Restoration Strategy. Until more is known about the nature and extent of injuries and the degree of recovery for these resources, restoration will rely primarily on natural recovery, aided by monitoring and protective measures.

The restoration strategy for resources whose recovery is unknown has three parts:

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

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

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

Definition of Recovery. This section defines recovery for each resource for which the status of recovery is unknown.

Clams: Littleneck clams and butter clams on sheltered beaches were killed by oiling and clean-up activities. In addition, growth appeared to be reduced by oil, but determination of sublethal or chronic effects is awaiting final analyses. Clams will have recovered when populations and productivity are at prespill levels.

Cutthroat trout and Dolly Varden have grown more slowly in oiled areas than in unoiled areas. They will have recovered when growth rates within oiled areas are comparable to those for unoiled areas.

River otters may have suffered sublethal effects from the spill and continuing exposure to hydrocarbons. Indications of recovery are when habitat use and physiological indices have returned to prespill conditions.

Rockfish were exposed to hydrocarbons and showed sublethal effects. Furthermore, closures to salmon fisheries increased fishing pressures on rockfish which may be affecting their population. However, the extent and mechanism of injury to this species are unknown. Without further study, recovery cannot be defined.

Other Resources

Archaeological Resources

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

Archaeological resources cannot recover in the same sense as biological resources. Restoration cannot regenerate what has been destroyed, but it can prevent further degradation of both sites and the scientific information that would otherwise be lost.

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

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

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

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

Definition of Recovery. Because they are nonrenewable, archaeological resources cannot recover in the same sense as biological resources. They will be considered recovered when spill-related injury ends, and looting and vandalism are at or below prespill levels.

Designated Wilderness Areas

The oil spill delivered oil in varying quantities to the waters adjoining the seven areas designated as wilderness within the spill area. Oil was also deposited above the mean high tide line in these areas. During the intense clean-up seasons of 1989 to 1990, hundreds of workers and thousands of pieces of equipment were at work in the spill area. This activity was an unprecedented imposition of people, noise, and activity on the area's undeveloped and normally sparsely occupied landscape.

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

Definition of Recovery. Designated Wilderness areas will have recovered when oil is no longer encountered in these areas and the public perceives them to be recovered from the spill.

Services

Subsistence

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

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

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

<u>Promote recovery of subsistence as soon as possible.</u> Many subsistence communities will be significantly harmed while waiting for subsistence resources to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of subsistence resources and services. This objective may be accomplished through increasing availability, reliability, or

quality of subsistence resources, or increasing the confidence of subsistence users. Specifically, if subsistence harvest has not returned to prespill levels because users doubt the safety of particular subsistence resources, this objective may take the form of increasing the reliability of the resource through food safety testing. Other examples are the acquisition of alternative subsistence food sources and improved use of existing resources.

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

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

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

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

Commercial Fishing

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

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

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

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

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

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

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

Recreation and Tourism

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

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

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

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

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

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

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

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

Passive Uses

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

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

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

Appendix A
Allocation of the Civil Settlement Fund

In a civil settlement, Exxon Corporation agreed to pay the United States and the State of Alaska $900 million over a 10-year period to restore resources injured and services reduced or lost as a result of the *Exxon Valdez* oil spill.

Table A-1 shows the schedule of payments over this period.

As of September 1993, $340 million of the $900 million civil settlement had been paid by Exxon Corporation. Exxon makes its payments to a Joint Trust Fund held by the U.S. District Court for use by the Trustee Council. About $250 million has been reimbursed to the governments, credited to Exxon, or committed for restoration or damage assessment. Some of the approved expenditures have not yet been withdrawn from the Joint Trust Fund.

Table A-2 presents the allocation of expenditures as of November 1993. Although only 38% of the $900 million settlement has been received, expenditures are shown as percentages of the total settlement: 16% has been reimbursed to the state and federal governments for expenses; 9% has been committed to annual Work Plans; and 4% has been credited to Exxon for clean-up expenses. Seventy-two percent is uncommitted.

Table A-3 shows how the 1992 Work Plan allocated funds among habitat protection and acquisition, other restoration projects, damage assessment, and administration. The 1992 Work Plan emphasized completion of damage assessment studies.

Table A-4 shows how the 1993 Work Plan allocated funds among habitat protection and acquisition, other restoration projects, damage assessment, and administration. The figures reported for the 1993 Work Plan are for the period 3/1/93 to 9/30/93. The 1993 Work Plan was for a seven-month period of transition to the federal fiscal year, which began 10/1/93. The 1993 Work Plan emphasized restoration.

Table A-5 presents interim allocations for the 1994 Work Plan. Many of these allocations are for the three-month period 10/1/93 to 12/31/93. Additional allocations will be made after the Restoration Plan is completed.

Table A-1
Schedule of Payments

Date	Amount
December 1991	**$ 90 million**
December 1992	**$150 million**
September 1993	**$100 million**
September 1994	**$ 70 million**
September 1995	**$ 70 million**
September 1996	**$ 70 million**
September 1997	**$ 70 million**
September 1998	**$ 70 million**
September 1999	**$ 70 million**
September 2000	**$ 70 million**
September 2001	**$ 70 million**
Total	**$900 million**

Table A-2
Allocation of Expenditures as of November 1993

Purpose	Amount	Percent	Comments
Reimbursements to state government	**$78,300,000**	**9%**	
Reimbursements to federal government	**60,817,165**	**7%**	
1992 Work Plan	**15,549,400**	**2%**	See Table A-3.
1993 Work Plan	**51,326,800**	**6%**	See Table A-4.
1994 Work Plan	**6,276,600**	**1%**	See Table A-5.
Credit to Exxon for clean-up costs after 1/1/91	**39,900,000**	**4%**	
Uncommitted	**647,830,035**	**72%**	
TOTAL	**$900,000,000**	**100%**[1]	

Funds not yet withdrawn from the Joint Trust Fund are earning interest.
[1] Percentages do not add up to 100 because of rounding.

Table A-3
1992 Work Plan

The Trustee Council approved $19,211,000 for the 1992 Work Plan, which was undertaken during the period March 1, 1992 through February 28, 1993. Thirty-nine percent was budgeted to close out or continue Natural Resource Damage Assessment, 26% was for administration, and 35% was for restoration. The unobligated balance for the State for that period was $3,661,600. Future withdrawals from the fund will be reduced by that amount. The unobligated balance for the federal government will be determined at a later date. Considering the unobligated balance reported so far, a total of $15,549,400 was actually spent on the 1992 Work Plan.

ALLOCATIONS: 1992

Purpose	Amount	Percent
Habitat Protection and Acquisition	$1,243,400	6%
Other Restoration Projects	5,484,000	29%
Damage Assessment	7,407,500	39%
Administration	5,076,100	26%
Total Budgeted	$19,211,000	100%
Unobligated Balance	3,661,600	
Total Spent	$15,549,400	

The remainder of this table describes restoration projects approved in the 1992 Work Plan. It does not describe damage assessment or administration projects. Habitat protection and acquisition projects are listed separately from other restoration projects because of the high degree of interest shown in them.

Table A-3 (cont'd)

HABITAT PROTECTION AND ACQUISITION PROJECTS: 1992

No.	Project Title	Project Description	Budget
R15	**Marbled Murrelet Restoration Study**	Determine marbled murrelet nesting habitat in the spill area and identify their use of those habitats.	**$419,300**
R47	**Stream Habitat Assessment**	Identify and prioritize private lands where an imminent and significant habitat alteration threat exists.	**399,600**
R71	**Harlequin Duck Restoration and Monitoring**	Locate, identify, and describe harlequin duck nesting habitat in PWS; determine width of forested buffer strips, and feasibility of stream habitat enhancement techniques.	**424,500**
		Habitat Protection & Acquisition - Subtotal	**$1,243,400**

OTHER RESTORATION PROJECTS: 1992

No.	Project Title	Project Description	Budget
R11	**Murre Recovery Monitoring**	Document rate of recovery of murres breeding in the Barren Islands and Puale Bay.	**$316,700**
R53	**Kenai River Sockeye Salmon Restoration**	Restore injured Kenai River sockeye salmon stocks through improved stock assessment, capabilities, regulation of spawning levels, and modification of human use.	**674,200**
R59	**Genetic Stock Identification**	Evaluate the use of all possible techniques to maximize the accuracy and precision of stock identification analyses and incorporate parasite data into models.	**320,900**
R60AB	**Prince William Sound Pink Salmon**	Recover coded-wire tags in the catches and spawning populations of pink salmon in Prince William Sound.	**1,479,700**
R60C	**Pink Salmon Egg/Fry**	Monitor recovery of wild pink salmon stocks in Prince William Sound.	**492,800**

Table A-3 (cont'd)

OTHER RESTORATION PROJECTS: 1992 (cont'd)

No.	Project Title	Project Description	Budget
R73	**Harbor Seals**	Monitor movements, hauling out, and diving behavior of harbor seals in Prince William Sound.	**$25,000**
R90	**Dolly Varden Char Monitoring**	Remove weir material and camp equipment and produce final report.	**91,500**
R92	**GIS Mapping and Analysis**	Develop information as needed to evaluate or implement restoration projects.	**125,500**
R102	**Herring Bay Experimental and Monitoring Study**	Determine what factors limit or facilitate recolonization of the intertidal by algae, especially *Fucus*, and invertebrates; and to provide controlled, long-term natural recovery monitoring of intertidal communities.	**485,600**
R103	**Oiled Mussels**	Determine the geographical extent of oiled mussel beds in the spill area, the intensity of oil remaining in mussels, and the underlying organic mat in order to assess possible linkage with continuing injury to harlequin ducks, oystercatchers, sea otters, and river otters.	**874,000**
R104A	**Site Stewardship**	Recruit, educate, and involve local people to protect archaeological resources in their areas.	**159,200**
R105	**Instream Habitat and Stock Restoration Techniques for Anadromous Fish**	Determine preliminary restoration techniques for specific sites; select the most appropriate fish restoration projects.	**348,100**
R106	**Dolly Varden Restoration**	Prepare final report for the data collected in this project through 1991.	**34,900**
R113	**Red Lake Sockeye Salmon Restoration**	Increase survival of wild salmon in Red Lake (Kodiak Island) by incubating eggs and rearing fry in Pillar Creek Hatchery and transplanting them to the lake.	**55,900**
		OTHER RESTORATION PROJECTS -Subtotal	**$5,484,000**

Table A-4
1993 Work Plan

The Trustee Council approved $51,326,800 for the 1993 Work Plan, which was undertaken during the seven-month period 3/1/93 through 9/30/93. Of that amount, 77% was for habitat protection and acquisition, 14% for other restoration projects, 1% for Natural Resource Damage Assessment, and 8% for administration.

ALLOCATIONS: 1993

Purpose	Amount	Percent
Habitat Protection and Acquisition	**$39,666,600**	**77%**
Other Restoration Projects	**6,932,300**	**14%**
Damage Assessment	**592,100**	**1%**
Administration	**4,135,800**	**8%**
Total	**$51,326,800**	**100%**

The remainder of this table describes restoration projects approved in the 1993 Work Plan. It does not describe damage assessment or administration projects. Habitat protection and acquisition projects are listed separately from other restoration projects because of the high degree of interest shown in them. Two major actions were taken in 1993 to protect important areas of habitat under imminent threat: purchase of private inholdings in Kachemak Bay State Park (near Homer) and commitment to purchase lands near Seal Bay on Afognak Island (near Kodiak).

In addition to the projects listed below, the Trustee Council has tentatively approved the expenditure of $1.5 million toward construction of the Alutiiq Repository and Culture Center, a Native museum and culture center, to educate the public and provide a center for research and preservation of artifacts injured by the oil spill.

Table A-4 (cont'd)

HABITAT PROTECTION AND ACQUISITION PROJECTS: 1993

No.	Project Title	Project Description	Budget
93033	**Harlequin Duck Restoration Monitoring Study in PWS, Kenai and Afognak**	Study harlequin duck reproductive failure in western Prince William Sound; on outer Kenai coast and Afognak Island determine if there is reproductive failure and characterize their nesting habitat.	**$300,000**
93034	**Pigeon Guillemot Colony Survey**	Identify and map pigeon guillemot colonies.	**165,800**
93051	**Anadromous Streams and Marbled Murrelets**	Assess marbled murrelet nesting habitat; survey anadromous fish streams on candidate lands for habitat protection.	**1,222,300**
93059	**Habitat Identification Workshop**	Identify parcels of nonpublic lands with habitat necessary for recovery of injured resources and services under imminent threat.	**42,300**
93060	**Accelerated Data Acquisition**	Collect and organize existing resource data needed to evaluate habitat protection and acquisition proposals.	**43,900**
93064	**Imminent Threat Habitat Protection**	Protect habitat under imminent threat. The amount budgeted for this project includes $7.5 million toward the purchase of inholdings in Kachemak Bay State Park, and a downpayment of $29,950,000 toward the purchase of uplands near Seal Bay on Afognak Island. The total purchase price for Seal Bay parcels will not exceed $38.7 million. The rest of the allocation is for actions necessary to complete acquisitions, such as title search and appraisal.	**37,850,000**
		Habitat Protection and Acquisition - Subtotal	**$39,666,600**

Table A-4 (cont'd)

OTHER RESTORATION PROJECTS: 1993

No.	Project Title	Project Description	Budget
93003	**Salmon Egg to Pre-emergent Fry Survival**	Continue to monitor egg mortalities in the oiled and unoiled wild pink salmon streams.	**$686,000**
93006	**Site-specific Archaeological Restoration**	Assess injury at 24 sites and restore 19 of them.	**260,100**
93012	**Genetic Stock Identification of Kenai River Sockeye Salmon**	Develop a comprehensive database of sockeye salmon stocks in Cook Inlet.	**300,600**
93015	**Kenai River Sockeye Salmon Restoration**	Increased monitoring and management of the sockeye salmon stocks in the Kenai River and Upper Cook Inlet north of Anchor Point.	**512,600**
93016	**Chenega Bay Chinook and Silver Salmon (NEPA Compliance)**	NEPA compliance for the replacement of subsistence resources by permitted releases of chinook and coho salmon at designated sites near Chenega village from stocks of hatchery near Esther Island. The Trustee Council has deferred action on the decision whether to implement this project.	**10,700**
93017	**Subsistence Food Safety Survey and Testing**	Work with communities to identify and map areas and resources of continuing concern to subsistence users; sample subsistence foods from these areas.	**307,100**
93022	**Monitor Murre Colony Recovery**	Monitor the recovery of murres in the Barren Islands.	**177,200**
93024	**Restoration of Coghill Lake Sockeye Salmon Stock**	Restore natural productivity of Coghill Lake for sockeye salmon through use of lake fertilization techniques.	**191,900**
93035	**Black Oystercatchers/ Oiled Mussel Beds**	Determine whether black oystercatchers breeding on shorelines with persistent oil contamination in Prince William Sound are affected by their use of these habitats.	**107,900**
93036	**Oiled Mussel Beds**	Document continued bioavailability of petroleum hydrocarbons to consumers of contaminated mussels and determine the rate of recovery of oiled mussel beds.	**404,800**

Table A-4 (cont'd)

OTHER RESTORATION PROJECTS: 1993 (cont'd)

No.	Project Title	Project Description	Budget
93038	**Shoreline Assessment**	Assess the shoreline hydrocarbon concentrations and, where appropriate, carry out necessary treatment using local work crews. Cost includes $15,000 for U.S. Coast Guard transportation.	**$539,200**
93039	**Herring Bay Experimental and Monitoring**	Determine what factors limit or facilitate recolonization of the intertidal by algae, especially *Fucus*, and invertebrates; and to provide controlled, long-term natural recovery monitoring of intertidal communities.	**507,500**
93041	**Comprehensive Monitoring**	Design the monitoring component of the Restoration Plan.	**237,900**
93042	**Killer Whale Recovery**	Obtain photographs of individual killer whales occurring in AB pod and document natural recovery.	**127,100**
93043	**Sea Otter Demographics and Habitat**	Restore sea otter populations by determining what is limiting their recovery and identifying important sea otter habitat in Prince William Sound for possible protection.	**291,900**
93045	**Marine Bird/Sea Otter Surveys**	Obtain annual estimates of the summer and winter populations of marine birds and sea otters in Prince William Sound to determine whether populations that had declined are recovering.	**262,400**
93046	**Habitat Use, Behavior, and Monitoring of Harbor Seals**	Monitor the abundance and trends of harbor seals in oiled and unoiled areas of Prince William Sound and characterize habitat use, hauling out and diving behavior.	**233,500**
93047	**Subtidal Monitoring**	Monitor recovery of sediments, hydrocarbon-degrading microorganisms, eelgrass beds, and shallow fish species in the subtidal environment.	**1,000,800**
93053	**Hydrocarbon Database**	Estimate the amount of *Exxon Valdez* oil that is present in environmental samples analyzed for hydrocarbons that are collected during restoration.	**105,500**

Table A-4 (cont'd)

OTHER RESTORATION PROJECTS: 1993 (cont'd)

No.	Project Title	Project Description	Budget
93057	**Damage Assessment Geographic Information System**	Complete statistical analysis and geographic information system mapping support for existing damage assessment studies and provide a database for restoration.	**67,500**
93062	**Restoration Geographic Information System**	Provide statistical and spatial analysis and geographic information system mapping support for approved restoration projects.	**123,300**
93063	**Anadromous Stream Surveys**	Develop proposals and designs for appropriate and cost-effective instream habitat and stock restoration projects.	**59,400**
93065	**Prince William Sound Recreation Project**	Develop a statement of injury, management goals, and proposals for restoration of recreation in Prince William Sound and identify and evaluate potential special designations that would benefit recreation and management of Prince William Sound. The estimated project cost is $71,000. Unused funds will be used to fund other activities approved by the Trustee Council.	**72,000**
93067	**Pink Salmon Coded-wire Tag Recovery**	Recover coded-wire tags from pink salmon in Prince William Sound to distinguish between wild stocks and hatchery stocks.	**220,000**
93068	**Non-pink Salmon Coded-wire Tag Recovery**	Recover coded-wire tags from fish other than pink salmon.	**126,400**
		OTHER RESTORATION PROJECTS - Subtotal	**$6,932,300**

Table A-5
1994 Work Plan

The Trustee Council approved interim funding of $6,276,600 for the 1994 Work Plan, which began on October 1, 1993. Many of the allocations were for the three-month period October 1, 1993 to December 31, 1993. Additional allocations will be made after the Restoration Plan is completed. The interim funding for administrative expenses includes certain 12-month costs, such as lease of office space. Once all allocations are made, administrative expenses are expected to be about five percent of the total.

ALLOCATIONS: 1994

Purpose	Amount	Percent
Habitat Protection and Acquisition	$558,500	9%
Other Restoration Projects	430,800	7%
Data Analysis and Report Preparation for 1993	3,273,000	52%
Administration	2,014,300	32%
Total	**$6,276,600**	**100%**

The remainder of this table describes restoration projects approved in the 1994 Work Plan. It does not describe damage assessment or administration projects. Habitat protection and acquisition projects are listed separately from other restoration projects because of the high degree of interest shown in them.

Table A-5 (cont'd)

HABITAT PROTECTION AND ACQUISITION PROJECTS: 1994

No.	Project Title	Project Description	Budget
94110	**Data Acquisition and Support**	Provide logistical and technical support for habitat evaluation.	**$273,600**
94126	**Habitat Protection and Acquisition Fund**	Facilitate purchase of habitat protection rights and develop post-acquisition management recommendations.	**284,900**
		Habitat Protection and Acquisition - Subtotal	**$558,500**

OTHER RESTORATION PROJECTS: 1994

No.	Project Title	Project Description	Budget
94064	**Habitat Use, Behavior, and Monitoring of Harbor Seals in PWS**	Monitor the abundance and trends of harbor seals in oiled and unoiled areas of Prince William Sound.	**$2,500**
94166	**Herring Spawn Deposition and Reproductive Impairment**	Improve the accuracy of the fisheries management of herring resources in Prince William Sound and determine if genetic damage occurred because of the spill.	**37,100**
94185	**Coded-wire Tagging of Wild Pink Salmon in Prince William Sound**	Provide marked fish of known origin for eventual recovery in either the commercial catch or the escapement.	**34,800**
94191	**Investigating and Monitoring of Oil Related Egg and Alevin Mortalities**	Continue to monitor egg mortalities in the oiled and unoiled wild pink salmon streams.	**85,400**
94217	**Prince William Sound Area Recreation Implementation Plan**	Develop a prioritized list of recreation restoration projects, identify and describe potential special designations, identify real or perceived injury to the recreation resource and services in Prince William Sound, and develop management goals to restore recreation in Prince William Sound.	**30,000**

Table A-5 (cont'd)

OTHER RESTORATION PROJECTS: 1994 (cont'd)

No.	Project Title	Project Description	Budget
94258	**Sockeye Salmon Overescapement**	Continue to examine the effects of large 1989 overescapements.	**141,000**
94320	**Ecosystem Monitoring**	Develop an ecosystem monitoring plan.	**100,000**
		OTHER RESTORATION PROJECTS - Subtotal	**$430,800**

Appendix B
Injury and Recovery

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BACKGROUND

The T/V *Exxon Valdez* struck Bligh Reef in March, just before the most biologically active season of the year. The resulting oil spill occurred during the seaward migration of salmon fry, major migrations of birds, and the primary breeding season of most species of birds, mammals, fish, and marine invertebrates in the spill's path. Many animals, such as sea otters and marine birds, were killed by the oil in open water. Approximately 1,500 miles of southcentral Alaska's coastline were oiled (about 350 miles were heavily oiled), frequently with devastating impact to the upper intertidal zone. Direct oiling killed many organisms, and beach cleaning, particularly high-pressure, hot-water washing, had a devastating effect on some intertidal communities. The spill also affected services (human uses), including subsistence, recreation, commercial fishing, and other uses. Some resources and services remain vulnerable to persistent oil in intertidal areas.

This appendix was originally presented in June of 1993 in the Supplement to the Summary of Alternatives. It has been updated to reflect new information gained from further analysis or completion of damage assessment studies. This appendix describes in detail the injuries sustained by individual resources and services, and what scientists and resource managers know about the present status of recovery. Table B-1 lists injured resources and lost or reduced services. Where possible, expectations for the progress of natural recovery are also projected. Information on injury and recovery is summarized in Tables B-4, B-5, and B-6.

INJURY TO NATURAL RESOURCES

Natural resource injuries from exposure to oil spilled by the T/V *Exxon Valdez* or due to the cleanup include:

(1) **Mortality**. Death caused immediately or after a period of time by contact with oil, clean-up activities, reductions in critical food sources caused by the spill, or other causes.

(2) **Sublethal Effects**. Injuries that affect the health and physical condition of organisms (including eggs and larvae), but do not result in the death of juvenile or adult organisms. However, injuries that initially appear to be sublethal can, over time, be fatal. Also, some sublethal effects, such as reproductive impairment, can eventually result in population reductions.

(3) **Degradation of Habitat**. Alteration or contamination of flora, fauna, and the physical components of the habitat.

Due to the large geographical area, multiple habitat types, and many species impacted by the spill, it is highly unlikely that all injuries to natural resources will be studied or fully documented.

Injuries Resulting in a Population Decline

The most serious injuries result in large population declines. In these cases, injury may persist for more than one generation. For example, the common murre was the most severely impacted bird species. Several large colonies in the Gulf of Alaska may have lost 35 to 70% of their breeding adults, a loss that may not be restored for many generations. Another example is in intertidal areas where populations of many species of plants and invertebrates declined as a result of oiling and cleanup.

If serious enough, mortality, sublethal injuries, or degradation of habitat may result in measurable population declines. For example, sublethal injuries that impair reproductive ability in a large portion of a population could result in a population decline.

Injuries Not Resulting in a Measurable Population Decline

There are several reasons why population declines were not measured in some species.

(1) The injury may not have been severe enough to cause mortality or a population decline.

(2) Spill-related population declines may have been impossible to distinguish from natural variations in population levels. Population census techniques are usually able to detect only relatively large population changes.

(3) Population declines may have occurred initially but some species may have compensated by increasing productivity. The net effect would be no reduction in population.

(4) Some species were not studied or were studied insufficiently to determine any injury, including population declines.

INJURY TO OTHER NATURAL RESOURCES

The cleanup increased public knowledge of archaeological site locations, which resulted in looting and vandalism of archaeological resources. Also, archaeological sites may have been damaged by oiling. Archaeological resources could be irretrievably lost if looting and vandalism continue. Since archaeological resources, such as sites and artifacts, are not living, renewable resources, they have no capacity to heal themselves.

The spilled oil also contaminated waters adjacent to designated Wilderness Areas, and was deposited above the high tide line in many cases. The intense cleanup resulted in an unprecedented disturbance of the area's undeveloped and normally uninhabited landscape. The massive intrusion of people and equipment associated with cleanup has ended, but direct injury to wilderness and intrinsic values lingers.

REDUCED OR LOST SERVICES

The oil spill impacted a wide range of services (human uses), including commercial fishing, subsistence (hunting, fishing, and gathering), passive use, recreation and tourism. Examples of recreation include sea kayaking, backcountry camping, sport fishing, and hunting.

Services were reduced or lost if the *Exxon Valdez* oil spill or cleanup:

(1) reduced the physical or biological functions performed by natural resources that support services; or
(2) reduced aesthetic and intrinsic values, or other indirect uses provided by natural resources; or
(3) reduced the desire of people to use a natural resource or area.

DEFINING AND ESTIMATING RECOVERY

Many resources and services will recover without intervention. Other resources and services, especially those that were declining before the spill, may continue to decline if present trends continue. For many resources and services, there is no known restoration approach that will effectively accelerate recovery. However, in most cases, there are actions that can prevent further stress on resources.

To maximize the benefits of restoration expenditures, the Trustee Council will consider the rate and degree of natural recovery before investing restoration dollars. The Trustee Council has adopted the following definition of recovery for the purpose of restoration.

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 usually defined as a return to prespill conditions or to conditions comparable to those of nonoiled areas. For resources that were in decline before the spill, like marbled murrelets, recovery may consist of stabilization of the population at a lower level than before the spill. Factors to be considered when assessing recovery include reproductive success, growth and survival rates, and the age and sex composition of the injured population.

Full ecological recovery will have been achieved when the population of flora and fauna are again present at former or prespill abundances, healthy and productive, and there is a full complement of age classes at the level that would have been present had the spill not occurred. A recovered ecosystem provides the same functions and services as would have been provided had the spill not occurred.

It is extremely difficult to predict the amount of time needed for a species to recover. Scientists often use models based on factors such as growth, mortality, and reproductive rates. However, for many of the biological resources injured by the *Exxon Valdez* oil spill, the background information was not available to develop these predictive models. For those resources, peer reviewers and agency scientists based their estimates of recovery on the best available information from the damage assessment and restoration studies, the scientific literature and other sources.

Estimates of recovery provided in this section should be used with caution, but they are the best that can currently be provided. For some estimates, there is also substantial disagreement within the scientific community. The estimates are likely to change as recovery continues, more information is provided through monitoring, and more is learned about the species. Recovery estimates for services are not provided. Recovery of services is linked, in part, to the resources that support the service, but is also linked to changes in human perception of injury and can vary widely among user groups.

Table B-1 lists injured resources and lost or reduced services. The table breaks down biological resources into those that are recovering and not recovering, and those for which the recovery status is unknown. The table reflects the current understanding, but the recovery status of each resource and service will change over time. If new injuries are documented in the future, resources and services will be added to the list.

Table B-1 List of Injured Resources and Lost or Reduced Services

INJURED RESOURCES			LOST OR REDUCED
BIOLOGICAL RESOURCES		OTHER	SERVICES (Human Uses)
Recovering Bald eagle Black oystercatcher Intertidal organisms (some) Killer whale Sockeye salmon (Red Lake) Subtidal organisms (some) **Recovery Unknown** Clams Cutthroat trout Dolly Varden River otter Rockfish	**Not Recovering** Common murre Harbor seal Harlequin duck Intertidal organisms (some) Marbled murrelet Pacific herring Pigeon guillemot Pink salmon Sea otter Sockeye salmon (Kenai River) Subtidal organisms (some)	Archaeological resources Designated Wilderness Areas	Commercial fishing Passive uses Recreation and Tourism including sport fishing, sport hunting, and other recreation uses Subsistence

A SUMMARY OF INJURY AND RECOVERY

MARINE MAMMALS

Harbor Seals

Injury: 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 haul-out areas in Prince William Sound that have been regularly surveyed since 1984, 86% of the seals seen in the postspill spring (April) survey were extensively oiled and a further 10% were lightly oiled. This included many pups. By late May, 74% 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.

Recovery: Because harbor seal populations have declined precipitously since 1984, and the underlying causes of this decline are unknown, it is difficult to predict recovery from the oil spill. However, stable counts in 1990 to 1992 at haulouts within Prince William Sound may indicate an end to the ongoing decline within the Sound. There is evidence suggesting that the subsistence harvest has declined since the spill, which may contribute to the stabilization of the population. If the population has stabilized, normal production growth may soon begin to replace the estimated 300 seals killed during the spill. However, additional information on the rate of exchange between seal populations in Prince William Sound and the Gulf of Alaska, particularly with the large Copper River Delta population, as well as a better understanding of the causes of the prespill decline, would be required to improve predictions of the time needed for recovery.

Humpback Whales

Injury: The only apparent effect of the spill on humpback whales was a temporary displacement from preferred habitat in Lower Knight Island Passage during the summer of 1989. There is no evidence that any humpbacks were killed by the spill, nor has reproduction been affected. Photodocumentation studies confirmed that normal use of lower Knight Island Passage resumed in late 1989.

Recovery: Other than a temporary displacement, there is no evidence of injury. No estimate of recovery was made.

Killer Whales

Injury: Thirteen killer whales disappeared from one pod (extended family group) between 1988 and 1990, and are presumed to have died. Approximately 140 killer whales forming nine distinct pods regularly use Prince William Sound, and are considered resident pods. There are also transient pods and other resident pods with wider ranges that enter the Sound occasionally.

In the summer of 1989, there were more than 9 whales missing from resident pods. The AB pod, which had 36 individuals when last seen in the Sound in the fall of 1988, was missing 7 animals, for an unprecedented 19.4% mortality rate. In 1990, an additional 6 individuals were found missing from AB pod, resulting in an annual mortality rate of 20.7% (prespill mortality for the resident AB pod typically ranged from 3.1 to 9.1% from 1984 to 1988). The rate of natural mortality in killer whales in the North Pacific is about 2% per year. All of the missing whales were either females or immature animals, and in several cases calves were orphaned. No births were recorded in 1989 or 1990. Due to the fidelity of killer whales to the pod, and the strong bonds observed between mothers and calves, the missing whales are presumed to have died. However, no dead individuals were ever recovered.

The cause of death is uncertain. Some experts think that the circumstantial evidence points to the spill. Other experts acknowledge that something very unusual happened to AB pod in 1989 and 1990, but that based on current knowledge of whale biology, the circumstances of the spill and the toxicity of crude oil, these deaths may not be due to contact with oil spilled by the T/V *Exxon Valdez*.

Recovery: Despite the loss of a large number of reproductive females, AB pod is growing again. One birth was recorded in 1991; two births in 1992, and one in 1993. It is expected that AB pod may not recover to its prespill level of 32 to 36 individuals for more than a decade.

Sea Lions

Injury: Results from sea lion studies were inconclusive concerning the effects of the spill. Several sea lions were observed with oiled pelts, and oil was likely absorbed by some tissues.

Sea lions have experienced a severe decline over the last 30 years in the north Pacific Ocean--as great as 93%. This decline combined with seasonal movements, which are significant but not well understood, precluded determining if the sea lion population in the Gulf of Alaska was affected by the spill. Sea lions were counted at eight haul-out sites, located mainly in the Gulf of Alaska. Some of these sites were oiled, although oiling was patchy and generally short-lived, but away from these sites sea lions were observed swimming through oil. Ten sea lions were found dead in oiled areas, mainly on rocky beaches, but it is not known how many of these deaths were attributable to natural mortality, or if any were due to oiling.

Recovery: Since there is no evidence that sea lions were injured by the oil spill, no estimate of recovery time was made.

Sea Otters

Injury: 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 sea otters in Prince William Sound and 20,000 in the Gulf of Alaska. It also is estimated that there are a total of 150,000 sea otters in Alaska.

During 1989, 1,013 sea otter carcasses were collected, including animals that died during capture and rehabilitation. Veterinarians determined that up to 95% of the deaths were attributable to oil. This information, coupled with estimates of the probability of finding carcasses, data from boat surveys, and computer models, indicated that injuries were extensive, killing an estimated 3,500 and 5,500 sea otters in the first few months following the spill.

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

Recovery: While little or no evidence of recovery has been detected, sea otters are expected to eventually recover to their prespill population. The rate of recovery will be dependent on the growth rate of the injured population. Under ideal conditions sea otters can expand their population at 9% per year. For sea otter populations already established in an area like Prince William Sound, the growth rate is usually closer to 2 - 3% per year. Future rates of population increase are difficult to estimate. However, if stress remains negligible, recovery may take less than two decades.

TERRESTRIAL MAMMALS

Brown Bear

Injury: In the Kodiak Archipelago and on the Alaska Peninsula, brown bears forage in the intertidal zone, where clams are a favorite food. Brown bears also apparently scavenged the carcasses of sea otters and birds that washed ashore after the spill. Analyses of fecal material and samples of bile indicated that some brown bears had been exposed to oil. High concentrations of oil were found in the bile of one yearling brown bear found dead in 1989. The mortality rate for cubs is close to 50% for the first two years, and it is uncertain if this death was associated with oil exposure.

Recovery: Since there is no evidence that brown bears were injured by the spill, no estimate of recovery time was made.

Black Bear

Injury: There was an initial attempt to study the potential effects of the spill on black bears, but due to the difficulty of finding, tagging, or observing this species in dense vegetation, the effort was quickly abandoned. No carcasses or other indications of oil spill-related injuries were ever reported.

Recovery: Since there is no evidence that black bears were injured by the spill, no estimate of recovery time was made.

<u>River Otters</u>

Injury: Following the oil spill, twelve river otter carcasses were found on beaches, representing some unknown fraction of the total number killed. The bile from two river otters collected from oiled areas in 1989 was analyzed and found to contain elevated concentrations of hydrocarbons. This indicates that surviving river otters could have ingested contaminated food.

There are indications that chronic oil exposure may affect river otters in Prince William Sound, although there is uncertainty about the evidence. First, river otters captured in oiled areas after the winter of 1989-1990 weighed less than those captured in unoiled areas, while they were of the same overall length. Since the oiled population is an island population (Knight Island) and the unoiled population is from a mainland location (Ester Passage), and there are no comparative prespill length and weight data from the two areas, it is difficult to determine whether this represents an effect of the spill. Second, chemical factors in the blood show slight differences between study areas: in the oiled population, haptoglobin concentrations and some amino transferase enzyme activities are slightly elevated. These differences could be caused by disease, handling stress, parasites, oil exposure, or a combination of these factors.

A reduction in the number of prey species (but not in the quantity of food ingested) was noted in the diets of river otters in the oiled areas between 1989 and 1990; this reduction was not seen in the nonoiled study areas. This reduction was probably due to the severe impact of the spill on the intertidal and shallow subtidal fauna in the oiled portions of Knight Island. Also, on Knight Island the average size of territories of river otters was larger than on the mainland, potentially a result of having to forage over a larger area to find sufficient food. However, the significance of this size difference is uncertain because of the lack of prespill data and follow-up studies.

Finally, data from an analysis of river otter droppings in latrine sites was equivocal. The results of one analysis suggested that estimated populations sizes were not different between the study areas, and another suggested differences. Conclusions are problematic because of the relatively small sample sizes employed and the possibility that populations in the two study areas were different before the spill.

Recovery: Most of the evidence of injury to the river otters was gathered in 1989 and 1990, although some of the parameters that are designed to indicate continuing sublethal injury still showed differences in 1991, including length-weight differences. Without a reliable way to detect small changes in populations (it is probable that a small number of river otters were killed), it is difficult to predict when the population will recover. With a population density of approximately one otter for every two to three kilometers of shoreline in suitable habitats, the percentage of the population that requires replacement appears to be relatively small.

Sitka Black-tailed Deer

Injury: Deer often forage in the intertidal zone on seaweed. Since seaweeds were extensively contaminated on oiled shores, deer were probably exposed to oil. In fact, tissues from deer taken by subsistence hunters and chemically analyzed were found to contain, in some cases, indications of oil contamination. The deer were, however, determined to be safe to eat. No evidence was found that populations of Sitka black-tailed deer were injured by the spill. Most deer carcasses found in 1989 on islands in Prince William Sound were probably the result of winter kill.

Recovery: Since there was no evidence from the damage assessment studies that Sitka black-tailed deer were injured by the spill, no estimate of recovery time was made.

Mink

Injury: Mink forage in the intertidal zone and, therefore, could have been exposed to oil by contact or by ingestion of contaminated food. However, due to the lack of prespill information on population abundance and distribution and the difficulties of assessing population trends postspill, an assessment of injury to mink employing field studies was judged impractical. Instead, a laboratory study of mink was carried out to determine if oil-contaminated food affected reproduction. However, no reproductive effects were documented, even when high concentrations of weathered crude oil were added to their diet.

Recovery: Since there is no evidence that mink or other small mammals were injured by the spill, no estimate of recovery time is required.

BIRDS

Bald Eagles

Injury: There are estimated to be 27,000 adult bald eagles in Alaska. About 2,000 of these are in Prince William Sound and about 6,000 are found along the northern coast of the Gulf of Alaska. Bald eagles encountered floating oil while preying on fish and oil-contaminated carcasses, and heavy oiling of the plumage led to loss of flight and probably also loss of body heat. Preening also exposed eagles to oil ingestion.

There were 151 eagles found dead after the spill; an estimated 200 to 300 may have been killed. However, there is considerable uncertainty as to the total number of eagles killed by the spill. Seventy-four percent of radio-tagged eagles that died of natural causes in a postspill study were found in forests and other inland areas. If this carcass deposition pattern is representative of eagles dying from acute oil exposure, then total mortality based mainly on the recovery of carcasses during beach searches would be about 430 individuals. However, it seems unlikely that acutely oiled birds would die in similar locations as those that died of natural causes.

Most aerial surveys to estimate population size and productivity were conducted in Prince William Sound. Population estimates made in 1989, 1990, and 1991 indicate that there may have been an increase in the bald eagle population since the previous survey conducted in 1984, although considerable variability was associated with this data. Population estimates for the three postspill years were not significantly different from one another.

Estimates of productivity indicate that in 1989, 85% of nests in moderately and heavily oiled areas failed, compared to 55% in lightly oiled and nonoiled areas. In 1990, there was actually higher productivity in oiled than in nonoiled areas. It is estimated that the loss of production in 1989 was equivalent to 133 chicks.

Recovery: Since the number of eagles lost appears to be less than the change that can be detected by the aerial survey techniques, it may not be possible to follow recovery to prespill numbers. It also appears that the lost chick production in 1989 will not have a measurable impact on the population. Bald eagles are recovering, and may have already recovered from the effects of the spill.

Black Oystercatchers

Injury: The spill caused population declines and sublethal injuries to black oystercatchers. Nine black oystercatcher carcasses were recovered from beaches after the spill. It is unknown how many additional oystercatchers were killed by the spill but were not recovered. Prespill (1972-1973, 1984) and postspill population surveys suggest that within Prince William Sound, an estimated 120 - 150 black oystercatchers, representing 12 to 15% of the total estimated population, died as a result of the spill. Mortality outside of Prince William Sound is unknown, but the total spill-area population is thought to be approximately 2,000 birds.

In addition to mortality caused directly by the spill, oiling also affected their reproductive success. Egg volume and the weight of chicks raised in oiled areas were lower compared to those raised in nonoiled areas; however, there are no prespill data, and it is not known if those conditions existed before the spill. Other measures such as hatching success, fledgling success, and chick production were not different between oiled and nonoiled areas. It is quite possible that in 1989 and 1990, disturbance associated with clean-up activities of oiled study areas, for example, Green Island, contributed to these differences.

Recovery: While black oystercatchers are recovering, an estimate of their recovery time is difficult to make. There is significant uncertainty associated with any estimate of recovery made because the population growth rate for black oystercatchers is unknown. However, if the growth rate is equal to Eurasian oystercatchers (6.25%) and there are no lingering sublethal injuries, the calculated estimate of recovery is several decades. Finally, the potential contribution of immigration from nonoiled areas on recovery is not easily estimated.

<u>Murres</u>

Injury: The oil spill caused population declines and sublethal injuries at murre colonies in the Gulf of Alaska. Including both common murres and thick-billed murres, there are about 12 million murres in Alaska, and 1.4 million in the Gulf of Alaska region. About 1.2 million of the total population in the Gulf of Alaska nest on the Semidi Islands, which were not directly impacted by the oil. Murres are particularly vulnerable to floating oil and have been killed in large numbers by oil spills elsewhere in the world.

At the major breeding colonies studied (Chiswell Islands, Barren Islands, Puale Bay, and the Triplets), an estimated 120,000 to 134,000 adult breeders were killed by contact with oil. The oil arrived in early April just as birds were beginning to congregate at the colonies in anticipation of breeding. If the rate of mortality is adjusted for birds not counted on the colonies, but feeding at sea, it is estimated that 170,000 to 190,000 breeding birds were killed. In general, it is estimated that between 35% and 70% of the breeding adults at the above colonies were killed by the spill. It is not known where pre-breeding juveniles were at the time of the spill, or if many were killed.

The timing of reproduction was found to be different between oiled and unoiled areas after the spill. At the Barren Islands and at Puale Bay, egg laying was about a month late in 1989, 1990, and 1991, compared to the unoiled Semidi Islands. In 1992 there were some indications that breeding was returning to normal at places in the Barren Islands colony. At the Chiswell Islands, laying was not observed in 1989, and laying was late in 1990. Because fewer birds were occupying these colonies, it is likely that the rate of predation was much greater than normal, since these colonies rely on sheer numbers of birds to discourage predation by gulls and eagles. Furthermore, the delay in egg-laying (estimated to be one month) in the Barren Islands, Puale Bay and the Chiswell Islands since the spill, may result in an additional loss of chicks unable to survive the first autumn storms in the Gulf of Alaska. Conservatively, the estimate of lost production associated with delayed reproduction could exceed 300,000 chicks.

In February and March 1993, there was a major die off of murres around the Kenai Peninsula. Exact figures are not available, but thousands of murres probably died during this time. Although lack of food has been implicated in this die off, other explanations have not been eliminated.

Recovery: The degree of recovery necessarily varies among the affected colonies. There are preliminary indications of recovery at the Barren Islands in 1991 and 1992, but it is not yet known when the timing of reproduction will return to normal. Agency scientists estimate that it could take many decades and perhaps a century before the injured murre populations return to their prespill levels. Variables affecting recovery time include the amount of disturbance near colonies and the rate of migration from healthy colonies.

Harlequin Ducks

Injury: The oil spill caused population declines and appears to have caused sublethal injuries in harlequin ducks. Of the six species of sea ducks studied, harlequin ducks feed highest in the intertidal zone where most of the stranded oil was initially deposited and, in some cases, still persists. An estimated 1,000 harlequin ducks were killed by the spill. The resident prespill population of harlequin ducks in western Prince William Sound was estimated to be approximately 2,000. Wintering migrants increase this population in the western Sound annually by 10,000. With few exceptions since 1989, neither breeding adults nor fledglings have been located in the heavily oiled areas of western Prince William Sound. Breeding activity in the nonoiled eastern Prince William Sound appears to be normal.

Elevated concentrations of hydrocarbons and their metabolites were found in the bile of harlequin ducks collected in western Prince William Sound in 1989. If residual oil in the diet is affecting reproduction, then the effect should begin to diminish once the threshold for toxicity is reached and the levels of persistent oil decrease in the environment. Unfortunately, we have no information after 1989 that determined exposure levels in bile for harlequin ducks in western Sound. Also, there is so little known about how oil may affect reproduction and what physiological changes can be induced by feeding on oiled prey. For these reasons, the possible causes of breeding failure have not been established.

Recovery: There appears to be diminished reproduction in harlequin ducks in oiled areas of western Prince William Sound. There are no indications that recovery has occurred. Scientists disagree on the time it will take harlequin ducks to recover to their prespill levels, but estimates suggest that recovery may not occur for several decades. Recovery could depend upon final degradation of oil in intertidal habitats where harlequin ducks feed, if it can be assumed that continued injury is due to ingestion of oil contaminated food.

Marbled Murrelets

Injury: Approximately 612 marbled murrelets were recovered from beaches following the spill. Based on other carcass recovery studies, this suggested that between 8,000 and 12,000 birds may have been killed by the oil spill, which appears to be about 5 - 10% of the current population in the affected area. The available postspill data indicated that the marbled murrelets population has declined since the last census conducted in the mid-1980s. The oil spill probably increased the prespill rate of decline for this species in the spill area, although the incremental injury is difficult to estimate.

Recovery: Since the spill, surveys conducted in Prince William Sound have resulted in population estimates of 107,000 in 1989; 81,000 in 1990; and 106,000 in 1991. With such variation in postspill population estimates, it is not yet possible to determine a trend in marbled murrelet abundance in Prince William Sound. The data collected in the 1970s and 1980s indicate that the population was declining before the spill. Although there is uncertainty associated with the causes of this decline, scientists expect it to continue. There are several factors that could account for this decline including a diminished food supply, increased predation, reduced nesting habitat, or fishery interactions, but there are no conclusive data indicating if any or all of these factors affected the population.

Because of the population decline, the marbled murrelet population is not expected to return to prespill population levels. Estimates of when the population may stabilize vary widely among experts but may be more than a decade. Estimates of further decline range from 20 to 50%, but again there is much uncertainty.

Pigeon Guillemots

Injury: Because these birds forage nearshore and often congregate on rocky beaches, they were vulnerable to the spilled oil. Five hundred and sixteen guillemot carcasses were recovered after the spill. Total mortality is estimated to be between 1,500 to 3,000 individuals, and may be as much as 10 to 15% of the pigeon guillemot population in the Gulf of Alaska. The results of boat surveys in Prince William Sound indicate that the population of this species was 14,600 in 1973. After the spill, the populations were 4,000 in 1989; 3,000 in 1990; and 6,600 in 1991. The population in Prince William Sound was probably declining prior to the spill, but the survey data indicate that the decline in oiled areas was greater than in nonoiled areas. For the Naked Island group, results of postspill surveys indicated a 40% decline in abundance compared to the latest prespill surveys in the mid-1980s. The decline showed a correlation with degree of shoreline oiling. The oil spill probably increased the rate of decline for this species in the spill area, although the magnitude of incremental injury is difficult to estimate.

Recovery: Pigeon guillemots may not return to prespill population levels, as their population was probably declining prior to the spill. The reasons for the long-term decline are unknown which makes predictions of future population trends extremely difficult. The population is expected to stabilize sometime over the next several decades, but estimating the population size when it stabilizes is even more uncertain.

Other Birds

Numerous other birds were affected by the spill. The most direct evidence of injury comes from the carcasses of birds found on the beaches after the spill in 1989. A list of the species recovered during the spill can be found in Table B-1. Some of the other species found dead included falcons, ducks, sandpipers, phalaropes, gulls, terns, auklets, puffins, various passerines, loons, grebes, shearwaters, petrels, cormorants, kittiwakes, and geese. In general, the number of dead birds recovered probably represents only 10 -15% of the total numbers of individuals killed. For most species, there are no reliable prespill data that will allow accurate assessment of the significance of estimated losses. Other important information comes from boat surveys carried out after the spill using similar techniques to those used in 1972-1973 and 1984-1985 surveys. Other birds that declined more in oiled than in nonoiled areas since the early 1972-1973 surveys include the Northwest crow and cormorant. A similar comparison based on the 1984-1985 surveys showed that cormorant, Arctic tern, and tufted puffin declined more in oiled areas.

Recovery: There is a great deal of uncertainty about the recovery of populations of individual species because many were not studied.

FISH

Cutthroat Trout and Dolly Varden

Injury: Both Dolly Varden char 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. Both species were captured at weirs on five stream 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.

While survival of Dolly Varden returning to oiled streams in 1990 was 32% less than those returning to nonoiled streams, and survival appeared to be 57% less for cutthroat trout returning to oiled streams in 1990, these differences are not statistically significant. There also are no prespill data with which to compare these results. However, it was determined that larger cutthroat trout grew significantly less in oiled areas in 1989, 1990, and 1991. Dolly Varden growth rates were also reduced between 1989 and 1990.

Recovery: Dolly Varden and cutthroat trout in oiled areas may have sustained a sublethal injury (slower growth in oiled areas). Scientists cannot estimate a recovery time without further study.

Pacific Herring

Injury: The extremely poor return of Prince William Sound herring in 1993 has residents very concerned. Because data were not collected from the 1993 herring run, and because herring populations naturally fluctuate greatly between years, it is difficult to understand the cause of the decline at this time. The following discussion describes injuries identified by damage assessment studies from 1989-1992.

The oil spill caused sublethal injuries to Pacific herring in Prince William Sound, but scientists do not know whether these injuries resulted in a population decline. Pacific herring spawned in intertidal and subtidal portions of Prince William Sound shortly after the spill. As much as 10% of the intertidal spawning habitat and 40% of the staging areas of herring in Prince William Sound may have been exposed to oil. Oiled spawning areas included portions of Naked and Montague islands.

Studies conducted in 1989 and 1990 showed a slight but statistically significant higher rate of egg mortality in oiled areas, compared to nonoiled areas. In 1989, rates of larval mortality, lethal and sublethal genetic damage, and physical deformities also were greater in oiled areas. There also is some evidence of differences in histopathological condition and reproductive success in oiled areas in 1989. However, all differences between oiled and unoiled study sites were less pronounced in 1990, and were not observed in 1991.

Three-year-old herring exposed as eggs or larvae in 1989 were under-represented in the 1992 and 1993 spawning migrations. Compared to Sitka Sound, which correlates closely with Prince William Sound in herring recruitment, the 1992 and 1993 returns of the 1989 year class were lower in Prince William Sound than expected. Data comparing herring biomass and age composition of Prince William Sound and Sitka Sound from 1969 to 1992 demonstrates a statistically significant correlation between the size and age structure of herring migrations in these two areas. There also was an outbreak of viral hemorrhagic septicemia (VHS) in herring returning to Prince William Sound in 1993, but it is not known if the disease is linked to the oil spill. Unusual oceanographic conditions, including poor plankton blooms in Prince William Sound, may have contributed to poor adult returns in 1993.

Recovery: More study of the factors affecting herring production is required in order to better predict the return of herring in Prince William Sound to pre-1989 conditions. The complex population dynamics of Pacific herring make it very difficult to predict the extent of injury or estimate natural recovery rates.

Pink Salmon

Injury: The oil spill caused sublethal injuries to wild populations of pink salmon, but there is some uncertainty about the extent of effects on population levels. Extremely low returns of hatchery-produced and wild fish to Prince William Sound in 1993 have focused attention on this issue.

Seventy-five percent of the wild pink salmon spawn intertidally at the mouth of streams in Prince William Sound. There was no apparent change in the use of this habitat in the summer of 1989, and many salmon deposited their eggs in the intertidal portion of oiled streams. In the autumn of 1989, egg mortality in oiled streams averaged about 15%, compared to about 9% in nonoiled streams. Since 1989, egg mortality has generally increased, until in 1991, there was an approximate 40 to 50% egg mortality in oiled streams, and 18% mortality in nonoiled streams. This trend continued in 1992.

Although the differences between egg mortality in oiled and nonoiled streams over the first two years are likely attributable to the effects of oil, the persistence of these differences four years after the spill was entirely unexpected and the exact reasons not understood. In this regard, natural factors that vary between oiled and nonoiled streams, e.g.,the degree of wave exposure, have not been eliminated as possible causes of persistent differences. Also, the studies of pink salmon carried out after the spill have documented that adults released as fry from nearby hatcheries are wandering into streams and spawning with wild stocks. The potential effect of this phenomenon on egg survival has not been investigated. Some scientists suggest that the longer the differences in egg mortality persist, the less likely it will be that oil is the cause or a contributing cause. However, if it assumed that differences between oiled and nonoiled streams is due to oil and that losses in eggs translate proportionately into adult loss, then this effect accounts for almost a 6% decrease in run strength since the spill.

Pink salmon fry released from hatcheries as well as wild pink salmon fry leaving their natal streams in the spring of 1989 were also exposed to oil in the open water. Both pink salmon and chum salmon juveniles were exposed to sufficient amounts of oil to induce enzymes that metabolize oil. In addition, tagged pink salmon fry released from the hatcheries and collected in oiled areas were smaller than those collected in nonoiled areas, even after accounting for the effects of food supply and temperature. The rate of return of pink salmon adults is dependent on conditions during the juvenile stage; and lower food supply, temperature, and growth will likely result in a lower return of adults the following year. Based on oil-induced reductions in juvenile growth, the estimated effect of the spill on the 1990 return of wild stock pink salmon was a reduction of 1.86 million fish.

Despite the differences in egg mortality and juvenile growth, tagging data do not indicate whether pink salmon populations were affected by the oil spill. For example, fry that were tagged as they left their streams in 1990, and were recaptured as returning adults in 1992 did not show differences in survival between oiled and nonoiled streams. Larger sample sizes may have provided more definitive results. There is uncertainty whether or not the increased egg mortality seen in the oiled streams is affecting the adult populations. Unusual oceanographic conditions, including poor plankton blooms, may have contributed to poor adult returns in 1993.

Recovery: The most apparent injury to pink salmon is to egg survival. This difference in mortality rates between oiled and nonoiled streams persisted in 1992. For at least the first four years after the spill, the rate appears to be worsening, both in oiled and nonoiled areas. Some experts believe that the spill reduced the adult population and estimate that recovery will take more than a decade.

Rockfish

Injury: The oil spill may have caused sublethal injuries to rockfish, but it is unknown whether or not population declines also 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 prevalances of organ lesions in 1989, 1990, and 1991, although there is some uncertainty associated with causes of these pathological changes. In 1990 and 1991, oil exposure was documented in fish collected from oiled but also nonoiled sites.

An additional unknown is the degree to which postspill increases in fishing pressure may be impacting rockfish. Partially due to numerous spill-related commercial fishing closures (salmon and 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. While harvests decreased since 1990, 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.

Recovery: Because there is still considerable uncertainty that rockfish experienced significant direct mortality or sublethal effects, a natural recovery rate was not estimated.

Sockeye Salmon

Injury: Kenai River and Red Lake/Kodiak sockeye salmon stocks may have suffered population declines as well as sublethal injuries. This potential injury is unique, since 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 (overescapement) of spawning fish to the Kenai and Red Lake systems in 1989, although this was the third consecutive year of overescapement to the Kenai River system.

For the Kenai system, more than 900,000 spawning fish returned each year from 1987 through 1989, when the system was managed for a return of only 500,000 fish a year. The cumulative effect of too many spawning adults in the Kenai River system has been a decline in smolt production. Although the exact mechanism by which this occurred is not clear, it is believed that availability of food (planktonic crustacea) are insufficient to meet the needs of the greater number of fry produced. Fewer fry surviving their first winter in rearing lakes result in fewer outmigrant smolt in the spring. Smolt production in the Kenai River system has declined as follows: 1989, 30 million; 1990, 6 million; 1991, 2.5 million; and 1992 and 1993, less than 1 million. Outmigrations of smolt from the system have been on the decline since 1990, and the forecasted returns in 1994, 1995, and 1996 are below escapement goals.

Recovery: There are no indications of recovery in the Kenai River. The Red Lake system may be recovering since the plankton have recovered and fry survival improved in 1993. Estimates of population recovery vary among experts but could exceed a decade to attain a 10-year population average similar to the prespill population levels. The Kenai River recovery could be prolonged if plankton populations do not recover to prespill population concentrations and salmon develop a cyclic pattern with large returns in some years followed by very small returns in others. Recovery could occur more quickly if plankton populations return to normal by 1993, and there is a normal adult escapement.

SHELLFISH

Crab, Shrimp, Sea Urchin and Oyster

Injury: While clams, mussels, crab, shrimp, sea urchins and oysters are all commonly referred to as shellfish, injuries to clams and mussels are addressed in the section on **Intertidal Communities**.

Dungeness crab and brown king crab studies ended early in 1989 due to the scarcity of these species in the spill area. Fishing pressure and natural predation may have reduced population levels prior to the spill. However, public comments from Kodiak Island and Alaska Peninsula communities identified several locations where high crab mortality (primarily Dungeness crabs) or declining crab populations have been noticed since 1989.

There also is little conclusive evidence to suggest that spot shrimp were injured by the oil spill. There were no studies on sea urchins, and oyster studies (on farmed oysters) ended after a legal interpretation indicated that the Natural Resource Damage Assessment Rules did not apply. However, since oil is known to have impacted subtidal sediments and communities, it is possible that undocumented exposure and injury occurred for several shellfish species not studied.

Recovery: Because it was not possible to establish that these species were injured by oil, no estimate of recovery was made.

INTERTIDAL COMMUNITIES

Injury: The intertidal zone is the area of beach between the low and high tide extremes. 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 the upper intertidal zone. With tidal action, oil penetrated deeply into cobble and boulder beaches that are relatively common on the rocky islands of the spill area. Cleaning removed much of the oil from the intertidal zone, but subsurface oil persisted in many heavily oiled beaches, and in mussel beds, which were avoided during the cleanup.

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 have been emphasized in the injury studies.

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 seaweed <u>Fucus gardneri</u> (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 <u>Fucus</u> was reduced following the spill, the coverage of opportunistic plants (ephemeral algae) that characteristically flourish in disturbed area was increased. The average size of <u>Fucus</u> plants was reduced, as was the reproductive potential of those plants surviving the initial oiling.

<u>Clams.</u> 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. They are very concerned about the effects of the oiled clams on their subsistence lifestyles and on the overall ecosystem. Also, in 1990, comparisons

of abundance of intertidal fishes indicated fewer fish in oiled areas, but such differences were not found in 1991.

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

Recovery: 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 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 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 is also 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, since it may take several years for invertebrate species to return after *Fucus* has recolonized an area.

SUBTIDAL COMMUNITIES

Injury: The oil spill caused population declines and sublethal injuries in the communities of plants and animals found below low tide. Several kinds of subtidal environments were studied after the spill: eelgrass beds, *Laminaria* (kelp) beds, fjords and the deep bottom (40 to 100 meters). All these studies relied on comparisons between oiled and nonoiled environments. Study sites also were matched for conditions (sediment grain size, depth, etc.) likely to affect the distribution and abundance of organisms.

The greatest differences were seen for small organisms living in the sandy sea bottom below eelgrass beds--they were less abundant in oiled environments. Among affected groups were amphipods, known from previous studies to be highly sensitive to oil. In addition, there were larger organisms that showed differences in abundance, most notably the crab *Telemesus* was less abundant in oiled areas. Two separate studies found that eelgrass in oiled areas did not bloom as well after the spill as in nonoiled areas. Other organisms, however, were more abundant in oiled areas--juvenile cod and some small mussels that live on eelgrass. Even greater differences were observed in the abundance of fauna at depths from 6-20 meters below the oiled eelgrass beds, where there were far fewer individuals in oiled areas.

The results of other subtidal studies were more equivocal. Chemical analyses show that *Exxon Valdez* oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases. Reduced abundances in fauna were encountered in several oiled bays at 100 m, but the causes of these differences are not clear. Some flatfish had elevated amounts of hydrocarbons in their bile in 1989 and 1990, and slightly elevated prevalences of gill damage.

Recovery: Analysis of invertebrates associated with eelgrass beds collected in 1991 indicated that differences noted in 1990 between oiled and nonoiled areas had started to converge. Another year of study in 1993 may indicate if this trend has continued. Because recovery has been observed in shallow (<20m) subtidal habitats, full recovery is expected in most cases within several years.

OTHER RESOURCES

Archaeological Resources

Injury: The oil-spill area has been occupied by Native peoples for at least 11,000 years. The spill area also contains artifacts from the post-European contact era. It is estimated that the oil-spill area contains between 2,600 and 3,137 historic properties, including 1,287 known sites that have been recorded in the Alaska Heritage Resources Survey.

Currently, 24 sites are known to have been adversely affected by clean-up activities, or looting and vandalism linked to the oil spill. One hundred thirteen sites are estimated to have been similarly affected. Injuries attributed to looting and vandalism (linked to the oil spill) are still occurring.

Injuries to archaeological sites include theft of surface artifacts and masking of subtle clues that archaeologists depend upon to identify and classify sites. Key diagnostic artifacts have been illegally taken, ancient burials have been violated, and potholes dug by looters have destroyed critical evidence contained in the layered sediments. Additionally, vegetation has been disturbed which has exposed sites to accelerated erosion. The effect of oil on the soil chemistry and organic remains may reduce or eliminate the utility of radiocarbon dating in some sites. Other injuries to archaeological sites have not yet been reported and the actual extent of damage will not be known for decades.

Some injuries, particularly looting and vandalism, are continuing and are on the rise in the spill area because of on-going human intrusion into previously pristine areas.

Recovery: Archaeological sites cannot recover in the same sense as biological species or organisms. They represent a category of finite, nonrenewable resources. Injury to this resource results not only in the loss of important scientific data, but in an irretrievable loss of Alaska's cultural heritage. Its importance was emphasized in over 100 comments received from the public throughout the state of Alaska. Restoration cannot regenerate what has been destroyed, but it can successfully prevent further degradation of both sites and the scientific information. Documentation of injured sites is necessary to preserve the artifacts and scientific data which remain in the vandalized sites.

Designated Wilderness Areas

Injury: 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, a sense of 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 clean-up 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.

Recovery: 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.

SERVICES (HUMAN USES)

Commercial Fishing

Injury: During 1989, emergency commercial fishery closures were ordered in Prince William Sound, Cook Inlet, and the waters around Kodiak Island and the Alaska Peninsula. Harvests were closed or restricted for pink and sockeye salmon, herring, crab, shrimp, rockfish, smelt and sablefish. In 1990, portions of Prince William Sound were closed to shrimp and salmon fishing for the same reason. (See Table B-2.) All of the 1989 and 1990 closures were done to prevent harvest of oiled fish and were not triggered by population reductions in these species. As of December 1993, there are no spill-related commercial fishery closures in effect.

Significant impacts on fisheries may result from too many fish returning to the Kenai River system in 1989. During the 1989 commercial sockeye fishery closures, large numbers of fish escaped harvest to spawn. This resulted in an unusually large number of salmon fry moving into the lakes to feed. Sockeye fry spend up to two years feeding in fresh water before migrating to the ocean. Previous Kenai River overescapements in 1987 and 1988 compounded the problem. It is hypothesized that the salmon fry overgrazed the zooplankton available to them in the upper layers of the lakes. This reduced rates of growth and survival for the fry. Fry survival in the Kenai system was very poor for three years in a row. This will probably result in severely reduced adult returns to the Kenai system starting in 1994. Closure of Kenai

River sockeye fisheries would have major impacts on many user groups.

The extent of injury to rockfish is not fully understood, although a few mortalities were caused by exposure to petroleum hydrocarbons and residual hydrocarbons have been found in tissues and bile. An additional, indirect injury may have been inflicted by significantly increased commercial fishing pressures. Following the multiple, spill-induced fishery closures, many commercial fishermen re-directed harvest efforts towards rockfish. Little is known about current population levels and how well they will be able to withstand the increased pressure. However, rockfish are known to have low rates of reproduction and growth and have been seriously damaged by overfishing in other places. Thus, the possibility exists that the increased rockfish harvest may overfish the population.

Public comment indicated concern that the oil spill had caused or could cause the following fishery impacts:

(1) poor Prince William Sound pink salmon returns in 1992 and 1993;
(2) potential reductions of sockeye returns in Chignik Lake due to 1989 sockeye overescapements;
(3) poor Prince William Sound herring returns and disease problems in 1993; and
(4) decreased Prince William Sound spot shrimp populations.

As of December 1993, biologists do not know whether these events were caused by the oil spill.

Recovery: Kenai River sockeye recovery will depend on recovery and availability of zooplankton populations in the lakes used by rearing fry. It is not yet known how many year classes of sockeye fry will be directly impacted by food shortages. However, the number of outmigrating Kenai River smolt was extremely low in 1991, 1992, and 1993, indicating that at least two consecutive year classes were impacted by overescapement. Kenai River smolt will return as adults in 1994, 1995, and 1996. The number of adults returning from these reduced outmigrations will almost certainly be lower than normal and may not be able to produce enough eggs to rebuild the runs within a single generation. If this turns out to be the case, adult returns to the Kenai in 1999, 2000, and 2001 may also be low. The Red Lake system also suffered overescapement in 1989 but may be recovering since plankton have recovered and fry survival improved in 1993.

Insufficient data exist to determine whether rockfish continue to be impacted by hydrocarbon contamination or if they are being harmed by overfishing. The lack of data could result in additional damage to the species. The long-term impacts of the injuries herring and pink salmon are uncertain.

TABLE B-2	COMMERCIAL FISHERY CLOSURES
Prince William Sound	
Pacific Herring	Gillnet and purse seine sac roe fisheries and pound and wild roe-on-kelp fisheries closed April 3, 1989.
Shrimp	Pot shrimp fishery closed while in progress on April 3, 1989. Trawl shrimp fishery closed on April 9, 1989. A small spot shrimp harvest area near Knight, Eleanor, and Smith Islands was closed in 1990.
Sablefish (black cod)	Closed April 1, 1989. Reopened in inside waters only, in conjunction with the halibut opening on June 12, 1989.
Dungeness Crab	Closed April 30, 1989.
King Crab	Closed on October 1, 1989.
Groundfish	Closed April 30, 1989. Reopened with the June 12, halibut opening.
Miscellaneous Shellfish	On April 24, 1989, it was announced that no miscellaneous shellfish permits would be issued.
Pink and Sockeye Salmon	Closures of commercial drift and setnet fisheries in Eshamy District, Northern District (surrounding Naked and Perry Islands), parts of Culross Island Subdistrict, Southwestern District, and parts of Montague Island District. In 1990, two setnet areas near Eshamy Bay were closed for four days and then reopened. In addition, portions of the northern and eastern shorelines of Latouche Island, and waters around Eleanor and Ingot Islands were closed to fishing.

TABLE B-2 (cont.) Upper Cook Inlet	
Sockeye Salmon	With the exception of a very minor opening of a small portion of the Central District, the commercial drift gillnet season was closed because of oil. In addition, setnet fishing in the Upper Subdistrict south of the Kasilof River was closed for the 12-hour regular fishing period on July 7, 1989, due to the presence of oil on beaches.
Lower Cook Inlet	
Shrimp	Closed April 30, 1989. Reopened July 7, 1989.
Miscellaneous Shellfish	On April 24, 1989, it was announced that no miscellaneous shellfish permits would be issued to harvest these species in the Outer and Eastern Districts until the danger of oil contamination had passed.
Groundfish	The Outer and Eastern Districts were closed at noon, April 30, 1989. The fishery reopened to all species except sablefish on June 12, in conjunction with the 24-hour halibut opening.
Smelt	Smelt remained closed along with groundfish in the Outer and Eastern Districts on April 30, 1989. When groundfish reopened, smelt fishing remained closed.
Pacific Herring	The sac roe fishery in the Outer and Eastern Districts closed on April 15, 1989, prior to the anticipated opening date of April 20, 1989.
Pink Salmon	The seine fishery in the Kamishak District opened on June 1, 1989, and was closed by emergency order on June 8, 1989. Portions of Kamishak District north of Contact Point were opened after July 20, based on run strength. The Tutka Bay Subdistrict north of the HEA powerlines was closed to seining on July 10, and opened later the same day after further assessment showed the commercial fishery would not be impacted.

TABLE B-2 (cont.) Kodiak	
Pacific Herring	Approximately 34 of 56 management units were closed for the duration of the sac roe fishing season.
Sockeye and Pink Salmon	The commercial season was scheduled to begin June 9, 1989. The fishery openings were postponed until June 19, when only the setnet fishery in the Alitak District opened; there were approximately 114 days fished in this setnet fishery by 87 fishermen. The only other commercial opening to occur during the 1989 salmon season was a two-day seine opening in Karluk Lagoon, on the west side of Kodiak Island, in mid-September. The entire Kodiak Management Area closed to commercial salmon fishing at the conclusion of the Lagoon fishery.
Chignik	
Sockeye Salmon	The Chignik fishery opened on June 12, 1989. However, portions of the Eastern District were closed due to the presence or close proximity of oil in the Kilokak Rocks area, and in Imuya and Wide Bays. The ADF&G announced a 24-hour fishing period on June 26, for a portion of the Chignik Bay District. The area was limited to a small portion of this district due to the presence of oil in surrounding areas, and was later closed the same day due to the presence of mousse and sheen. Additional closures occurred on July 27, and August 5, 1989.

Passive Use

Injury: Passive uses of resources include the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other non-use values.

The areas of Alaska impacted by the oil spill supported a large diverse ecosystem that was valued by large numbers of the American public who did not visit the area. The spill killed substantial numbers of different bird species and marine mammals as well as oiling much of the coastline in the impacted areas. The spill also had substantial effects on the fish, bird, and wildlife populations. While some of these effects may be of relatively short duration, others, such as recovery of various bird populations, are likely to take decades.

A contingent valuation study of the American public done in 1991 found that approximately 95% were still aware of the *Exxon Valdez* oil spill, and that over 50% spontaneously named the spill as one of the worst environmental accidents to occur in the world during their lifetime. The median household was willing to pay $31 to prevent a spill similar to the *Exxon Valdez* in the future. Multiplied by the number of U.S. households, this results in an estimate of spill damages of $2.8 billion.

Recovery: The animals initially killed are irreplaceable. Fish and wildlife populations are recovering at different rates. Much of the oil in shoreline areas has been removed or has weathered to varying degrees. However, full recovery will not occur until the public also perceives that injured resources have recovered.

Recreation and Tourism

Injury: This statement of injury to recreation has been derived from reference material, public comment, and comment from agency managers. A comprehensive recreation injury assessment has not been conducted. Although this summary covers the entire spill area, most of the information is from Prince William Sound.

Recreation can be divided into two categories, commercial and non-commercial. Commercial recreation (tourism) includes uses by clients and operators of tourism services such as boat tours, fishing charters, and flightseeing services. Non-commercial 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.

Injuries to the natural resources as well as the oil-spill cleanup and other post-spill activities have caused injury to recreation and tourism. Injury is divided into five categories:

(1) quantity; (2) quality; (3) perception; (4) location; and (5) facilities.

Quantity. Some commercial recreation and tourism businesses were injured by the reduction in visitors and visitor spending as a result of the spill. Businesses relying on individual bookings, rather than packaged tours, were hurt more by reduced bookings. Non-commercial recreation also decreased in some parts of the spill area.

Because oil fouled beaches, there was and still is a reduction of quality destinations available to some recreation users. There was a reduction in quantity and quality of wilderness-based destinations because clean-up activities brought people, noise, and large motorized equipment throughout the spill area and disturbed the area's undeveloped and normally sparsely occupied landscape.

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. 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.

There was a significant decline in sport fishing in the oil-spill area following the oil spill. The loss to sport anglers in 1989 is estimated to be $31 million. In 1992, cutthroat trout sport fishing in western Prince William Sound was closed due to low adult returns, and in 1991, a restriction on the sport hunting of harlequin duck was imposed.

Quality. The quality of recreation experiences decreased as a result of the spill due to crowding, residual oil, and fewer fish and wildlife. During the cleanup efforts, thousands of additional people in the spill area reduced wilderness qualities. Some communities were directly affected by crowding. The degree of injury differs for different forms of recreation. For instance kayakers have been much more affected by this quality reduction than cruise ship passengers.

The injuries to fish and wildlife reduced the amount that were seen or caught by people visiting the area. In addition, seeing oil diminished the appreciation of the natural setting. More heavily oiled areas experienced more injury to the quality of recreation.

Perception. The oil spill caused injury to the way people perceive recreation opportunities in the spill area. According to public comment, changes in perceptions include: (1) increased sense of vulnerability of the ecosystem in regard to future oil spills; (2) erosion of wilderness character; (3) a sense of permanent change; (4) a sense of complete disruption of the ecosystem and contamination of the food chain; (5) a sense of unknown or unseen ecological effects; and (6) a sense of threat to archaeological resources.

These perceptions caused people to change destinations and trip plans, resulting in injuries to tourism, sport fishing, boating, recreation-cabin bookings, and community businesses among others.

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.

Location. The location of recreation use was altered by changed use patterns and displaced use. 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 they historically engaged in.

Facilities. Some recreation facilities were injured by the spill, most from overuse or misuse during 1989 and 1990. For example, the Green Island public-use cabin and Fleming Spit camp area near Cordova experienced over use, sanitation problems, and resource degradation.

Recovery: Public comment shows persisting oil, crowding, diminished aesthetics, reduction of wilderness character, reduction of wildlife sightings, tainted food sources, disturbance of cultural sites, and evidence of clean-up activities all to be continuing injuries to recreation. According to recent public comment, some displaced users are returning to parts of the spill area, while others still avoid the heavier oiled areas. Recovery of recreation is largely dependent on the recovery of the natural resources. As natural resources recover, recreational experiences will improve. The projected decrease in the Kenai River sockeye salmon returns could cause additional injury to recreation on the Kenai Peninsula. Use patterns continue to change in relation to the recovery of the resources, perceptions, and the effects of restoration projects.

Subsistence

Injury: Before the *Exxon Valdez* oil spill, the Alaska Department of Fish and Game's Subsistence Division documented 15 Native Alaskan communities (with about 2,200 people) in Prince William Sound, Lower Cook Inlet, Kodiak and the Alaska Peninsula that relied heavily on subsistence resources. These resources included salmon, halibut, cod, rockfish and Dolly Varden; marine invertebrates such as clams, chitons, shrimp, crabs, and octopus; marine mammals (harbor seals and sea lions); land mammals such as deer (Prince William Sound and Kodiak Island), black bear and goats (Prince William Sound and Lower Kenai Peninsula); birds including ptarmigan, waterfowl, and gulls eggs; and wild plants. Many of these species were studied after the spill, and the results of these studies are summarized in this section. The mean number of resources used per household ranged from 10 to 25, and generally every household in these communities participated in subsistence harvests. The per capita subsistence harvest ranged from nearly 200 pounds to over 600 pounds per year.

Table B-3 illustrates changes in harvest levels in the first year (April 1989 to March 1990) following the spill. Subsistence harvests of fish and wildlife in eleven of these villages (Chenega Bay, Tatitlek, Nanwalek (English Bay), Port Graham, Karluk, Old Harbor, Akhiok, Larsen Bay, Ouzinkie, Port Lions, and Chignik Lagoon) declined from 4 to 77%, compared to prespill harvest levels. The reasons for this decline varied among communities and households, but most dealt with the reduced availability of injured species and perceived consequences of the oil spill, especially the concern for potential health effects caused by consuming subsistence resources from the spill area.

Table B-3 does not reflect the injuries to subsistence use that occurred in Alaska Peninsula communities. After the spill, people in this area harvested fewer marine resources, but increased harvest levels of terrestrial species. Also, many people were and continue to be concerned about the safety of traditional foods and some families avoided using certain species.

Chemical analytical studies conducted in 1989-1991 measured levels of metabolites in the bile and petroleum hydrocarbons in edible tissues of subsistence foods. These studies found that most resources tested (fish, some species of shellfish, deer, ducks, marine mammals) contained no or very low levels of petroleum hydrocarbons, and that eating foods with those levels posed no health risk. Exposure to oil did not necessarily render organisms unsafe to eat since some exposed animals were found to have low or non-existent levels of hydrocarbons and their metabolites in their edible tissues. Some samples of shellfish, however, had unacceptably high levels of petroleum hydrocarbons. This prompted advisories, starting in 1989, that shellfish should not be collected from obviously oil-contaminated areas. This advice has not changed.

Recovery: Table B-3 summarizes changes in harvest levels in Native villages following the oil spill. The finding that subsistence harvests had partially recovered in 5 villages during the 1990-1991 timeframe suggested increased confidence in using some subsistence resources. However, the continued very low levels of harvest at Chenega Bay and Tatitlek, Nanwalek (English Bay) and Ouzinkie, and the continued concern in some households in many villages that some subsistence foods remained unsafe to eat, suggested that the injury persisted through the second year following the spill.

While published reports are not yet available for the period of April 1991 to the present, it is believed that subsistence harvests have not returned to prespill averages in all affected Native communities, especially Chenega Bay and Tatitlek. Concern over potential long-term health effects of consuming resources from the spill area, a loss of confidence on the part of subsistence hunters and fishermen in their abilities to determine if traditional foods are safe to eat, and the reduction in available resources are all factors likely to affect recovery of subsistence use.

TABLE B-3. Subsistence Harvests Before and After the *Exxon Valdez* Oil Spill:

COMMUNITY	PRESPILL YEAR ONE (per capita harvest in pounds)	PRESPILL YEAR TWO (per capita harvest in pounds)	OIL SPILL YEAR (per capita harvest in pounds)	PERCENT CHANGE	POSTSPILL YEAR ONE (4/90 - 3/91) (per capita harvest in pounds)
Prince William Sound					
Chenega	308.8	374.2	148.1	-56.6 (e)	143.1
Tatitlek	351.7	643.5	214.8	-56.8 (e)	155.2
Lower Cook Inlet					
Nanwalek (English Bay)	288.8	(c)	140.6	-51.3 (b)	181.1
Port Graham	227.2	(c)	121.6	-46.5 (b)	213.5
Kodiak Island					
Akhiok	519.5	159.3	297.7	-12.3 (e)	(d)
Karluk	863.2	381.0	250.5	-59.7 (e)	395.2
Larsen Bay	403.5	200.9	209.9	-30.5 (e)	340.4
Old Harbor	491.1	419.3	271.1	-40.4 (e)	(d)
Ouzinkie	369.1	405.7	88.8	-77.1 (e)	204.9
Port Lions	279.8	328.3	146.4	-51.8 (e)	(d)
Alaska Peninsula					
Chignik Bay	187.9	(c)	208.6	+11.0 (b)	(d)
Chignik Lagoon	220.2	(c)	211.4	-4.0 (b)	(d)
Chignik Lake	279.0	(c)	447.6	+60.4 (b)	(d)
Ivanof Bay	455.6	(c)	489.8	+7.5 (b)	(d)
Perryville	391.2	(c)	394.2	+0.8 (b)	(d)

(a) Prespill study years are: Tatitlek 1987-88 and 1988-89; Chenega, 1984-85 and 1985-86; Nanwalek (English Bay) and Port Graham, 1987; Kodiak Island Borough, 1982-83 and 1986; Alaska Peninsula, 1984. The "spill year" is 1989 for all communities, except Chenega and Tatitlek, for which it is April 1989-March 1990.
(b) Compared to the most recent previous year.
(c) Only one previous measurement was taken.
(d) Not determined.
(e) Compared to the average of both prespill years.

Resources:
Summary of Results of Injury Assessment Studies

The tables in this part of the appendix summarize the results of the injury assessment studies for all natural resources and archaeology completed after the *Exxon Valdez* oil spill. Table B-4 shows whether there was initial mortality caused by the spill, whether the spill caused a measured population decline, and whether there is evidence of sublethal injury. For some resources, an estimate is available for the total number of animals initially killed by the spill. If available, that estimate is shown in parentheses under the initial mortality column. For many resources, the total number killed will never be known. For other resources and archaeology, listed in Table B-5, information on injury is not quantitative.

The "Status of Recovery" columns show the best estimate of recovery using the most recent information. The columns show resources' progress toward recovery to the condition and population levels that scientists estimate would have occurred in the absence of the spill. The "Current Population Status" column shows a resource's progress from any "Decline in Population after the Spill." Similarly, the column labeled "Continuing Sublethal Effects" shows whether a sublethal injury is ongoing.

TABLE B-4 Resources: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
MARINE MAMMALS										
Harbor Seals (d)	YES (300)	YES	YES	POSSIBLY STABLE, BUT NOT RECOVERING (b)	UNKNOWN	YES	YES (e)	UNKNOWN	UNKNOWN	Many seals were directly oiled. There was a greater decline in population indices in oiled areas compared to unoiled areas in PWS in 1989 and 1990. Population was declining prior to the spill and no recovery evident in 1992. Oil residues found in seal bile were 5 to 6 times higher in oiled areas than unoiled areas in 1990.
Humpback Whales	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Other than fewer animals being observed in Knight Island Passage in summer 1989, which did not persist in 1990, the oil spill did not have a measurable impact on the north Pacific population of humpback whales.

(a) 1993 field reports are not yet finalized.
(b) There may have been an unequal distribution of injury within each region.
(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.
(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Killer Whales	Yes (13)	YES (h)	UNKNOWN	RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	13 adult whales of the 36 in AB pod are missing and presumed dead. The AB pod has grown by 4 whales since 1990. Some experts think that the loss of 13 whales in 1989, 1990 is unrelated to oil spill.
Sea Lions (d)	UNKNOWN	YES (h)	NO	CONTINUING DECLINE	(f)	(f)	(f)	(f)	(f)	Several sea lions were observed with oiled pelts and oil residues were found in some tissues. It was not possible to determine population effects or cause of death of carcasses recovered. Sea lion populations were declining prior to the oil spill.
Sea Otters	YES (3,500 TO 5,500)	YES	YES	STABLE, BUT NOT RECOVERING	YES, POSSIBLY	YES	YES	YES (e)	YES (e)	Postspill surveys showed measurable difference in populations and survival between oiled and unoiled areas in 1989, 1990, and 1991. Survey data have not established a significant recovery. Prime-age animals were still found on beaches in 1989, 1990, and 1991. Sea otters feed in the lower intertidal and subtidal areas and may still be exposed to hydrocarbons in the environment.

(a) 1993 field reports are not yet finalized.
(b) There may have been an unequal distribution of injury within each region.
(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.
(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
TERRESTRIAL MAMMALS										
Brown Bear	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Hydrocarbon exposure was documented on Alaska Peninsula in 1989 including high hydrocarbon levels in the bile of one dead cub. Brown bear feed in the intertidal zone and may still be exposed to hydrocarbons in the environment.
Black Bear	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	No field studies were done.
River Otters	YES (TOTAL NUMBER UNKNOWN)	NO	YES, POSSIBLY	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Exposure to hydrocarbons and possible sublethal effects were determined, but no effects were established on population. Sublethal indicators of possible oil exposure remained in 1991. River otters feed in the intertidal and shallow subtidal areas and may still be exposed to hydrocarbons in the environment.
Sitka Black-tailed Deer	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Elevated hydrocarbons were found in tissues in some deer in 1989.
Mink	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Studies limited to laboratory toxicity studies.

(a) 1993 field reports are not yet finalized.
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(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.
(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
BIRDS										
Bald Eagles	YES (200 or more)	NO	YES	POSSIBLY RECOVERED	NO	YES	YES	YES (e)	YES(e)	Productivity in PWS was disrupted in 1989, but returned to normal in 1990. Exposure to hydrocarbons and some sublethal effects were found in 1989, but no continuing effects were observed on populations.
Black-legged Kittiwakes	YES (NUMBER UNKNOWN)	NO	NO	NO CHANGE	NO	YES	YES (e)	YES (e)	YES (e)	Total reproductive success in oiled and unoiled areas of PWS has declined since 1989. Hydrocarbon contaminated stomach contents were detected in 1989 and 1990. This species is known for great natural variation and reproductive failure may be unrelated to the oil spill.
Black Oyster-catchers	YES (120-150 ADULTS; UNKNOWN FOR CHICKS	YES	YES	RECOVERING	YES	YES	YES (e)	YES (e)	YES (e)	Differences in egg size between oiled and unoiled areas were found in 1989. Exposure to hydrocarbons and some sublethal effects were determined. Populations declined more in oiled areas than unoiled areas in postspill surveys in 1989, 1990, and 1991. Black oystercatchers feed in the intertidal areas and may still be exposed to hydrocarbons in the environment.

(a) 1993 field reports are not yet finalized.
(b) There may have been an unequal distribution of injury within each region.
(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.
(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Common Murres	YES (170,000 to 300,000)	YES	YES	DEGREE OF RECOVERY VARIES IN COLONY	YES	NO	YES	YES	YES	Measurable impacts on populations were recorded in 1989, 1990, and 1991. Breeding is still inhibited in some colonies in the Gulf of Alaska.
Glaucous-winged Gulls	YES (NUMBER UNKNOWN)	NO	NO	NO CHANGE	NO	YES (e)	YES (e)	YES (e)	YES (e)	While dead birds were recovered in 1989, there is no evidence of a population-level impact when compared to historic (1972, 1973) population levels.
Harlequin Ducks	YES (APPROX. 1000)	YES	YES, POSSIBLY	UNKNOWN	YES	YES	YES (e)	YES (e)	YES (e)	Postspill samples showed hydrocarbon contamination. Surveys in 1990-1992 indicated population declines and possibly reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may still be exposed to hydrocarbons in the environment.
Marbled Murrelets (d)	YES (8,000 TO 12,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Measurable population effects were recorded in 1989, 1990, and 1991. Marbled murrelet populations were declining prior to the spill.

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(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Peale's Peregrine Falcons	UNKNOWN	YES (h)	NO	(f)	(f)	(f)	(f)	(f)	(f)	When compared to 1985 surveys a reduction in population and lower than expected productivity was measured in 1989 in the PWS. Cause of these changes are unknown.
Pigeon Guillemots (d)	YES (1,500 TO 3,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found externally on eggs.
Storm Petrels	YES (NUMBER UNKNOWN)	NO	NO	NO CHANGE	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	Few carcasses were recovered in 1989 although petrels ingested oil and transferred oil to their eggs. Reproduction was normal in 1989.
Other Seabirds	YES (number unknown)	VARIES BY SPECIES	UNKNOWN	VARIES BY SPECIES	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	Seabird recovery has not been studied. Species collected dead in 1989 include common, yellow-billed, Pacific, red-throated loon; red-necked and horned grebe; northern fulmar; sooty and short-tailed shearwater; double-crested, pelagic, and red-faced cormorant; herring and mew gull; Arctic and Aleutian tern; Kittlitz's and ancient murrelet; Cassin's, least, parakeet, and rhinoceros auklet; and horned and tufted puffin.

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(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Other Sea Ducks	YES (875)	NO	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Species collected dead in 1989 include Stellar's, king and common eider; white-winged, surf and black scoter; oldsquaw; bufflehead; common and Barrow's goldeneye; and common and red-breasted merganser. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil.
Other Shorebirds	YES (NUMBER UNKNOWN)	VARIES BY SPECIES	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Species collected dead in 1989 include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpipers; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.

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(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.
(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Other Birds	YES (NUMBER UNKNOWN)	NO (NOT STUDIED)	UNKNOWN	UNKNOWN	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	Species collected dead in 1989 include emperor and Canada goose; brant; mallard; northern pintail; green-winged teal; greater and lesser scaup; ruddy duck; great blue heron; long-tailed jaeger; willow ptarmigan; great-horned owl; Stellar's jay; magpie; common raven; northwestern crow; robin; varied and hermit thrush; yellow warbler; pine grosbeak; savannah and golden-crowned sparrow; white-winged crossbill.

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(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
FISH										
Cutthroat Trout	NO	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	NO	NO	NO	Differences in survival between anadromous adult populations in the oiled and unoiled areas were not statistically different; however, differences in growth between adult populations in the oiled and unoiled areas were found in 1989, 1990, and 1991.
Dolly Varden	NO	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	Differences in survival between anadromous adult populations in the oiled and unoiled areas were not statistically different. Growth rates between 1989 and 1990 were reduced.
Pacific Herring	YES, TO EGGS AND LARVAE	YES (h)	YES	SEE COMMENTS	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable difference in egg counts between oiled and unoiled areas were found in 1989 and 1990. Lethal and sublethal effects on eggs and larvae were evident in 1989 and to a lesser extent in 1990; in 1991, there were no differences between oiled and unoiled areas. Herring exposed as eggs or larvae in 1989 were under-represented in 1992 and 1993 returns. It is unknown whether 1993 disease outbreaks were due to the spill.

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(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Pink Salmon (Wild) (d)	YES, TO EGGS	YES (h)	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial egg mortality in 1989. Egg mortality continued to be high in 1991 and 1992. Abnormal fry were observed in 1989. Reduced growth of juveniles was found in the marine environment, which can be correlated with reduced survival to adulthood. It is unknown whether poor returns in 1993 are linked to the spill.
Rockfish	YES (20) (g)	NO	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	Few dead fish were found in 1989 in condition to be analyzed. Exposure to hydrocarbons with some sublethal effects were determined in those fish, but no effects established on the population. Closures to salmon fisheries increased fishing pressures on rockfish which may be impacting population.

(a) 1993 field reports are not yet finalized.
(b) There may have been an unequal distribution of injury within each region.
(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.
(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Subtidal Communities	YES	YES	YES	VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable impacts on population of plants and animals were determined in 1989. Eelgrass and some species of algae appear to be recovering. Amphipods in eelgrass beds recovered to prespill densities in 1991. Leather stars and helmet crabs show little sign of recovery through 1991.

(a) 1993 field reports are not yet finalized.
(b) There may have been an unequal distribution of injury within each region.
(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.
(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

TABLE B-5 Other Natural Resources and Archaeology: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Resource	Description of Injury	Status of Recovery	Geographic Extent of Injury (b)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Air	Air quality standards for aromatic hydrocarbons were exceeded in portions of PWS. Health and safety standards for permissible exposure levels were exceeded up to 400 times.	Recovered	YES	NO	NO	NO	Impacts diminished rapidly as oil weathered and lighter factions evaporated.
Sediments	Oil coated beaches and became buried in beach sediments. Oil-laden sediments were transported off beaches and deposited on subtidal marine sediments.	Patches of oil residue remain intertidally on rocks and beaches and buried beneath the surface at other beach locations. Oil remains in some subtidal marine sediments and has spread to depths greater than 20 meters.	YES	YES	YES	YES	Unweathered buried oil will persist for many years in protected low-energy sites.
Water	State of Alaska water quality standards may have been exceeded in portions of PWS. Federal and State oil discharge standards of no visible sheen were exceeded.	Recovered	YES	YES	YES	YES	Impacts diminished as oil weathered and lighter fractions evaporated.

(a) 1993 field reports are not yet finalized.
(b) There may have been an unequal distribution of injury within each region.
(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.
(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury	Status of Recovery	Geographic Extent of Injury (b)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Archaeological sites/artifacts	Currently, 24 sites are known to have been adversely affected by oiling, clean-up activities, or looting and vandalism linked to the oil spill. One hundred thirteen sites are estimated to have been similarly affected. Injuries attributed to looting and vandalism (linked to the oil spill) are still occurring.	Archaeological sites and artifacts cannot recover; they are finite, non-renewable resources.	YES	YES	YES	YES	
Designated Wilderness Areas	Many miles of Federal and State Wilderness and Wilderness Study Area coastlines were affected by oil. Some oil remains buried in the sediments of these areas.	Oil has degraded in many areas but remains in others. Until the remaining oil degrades, injury to Wilderness Areas will continue.	YES	YES	YES	YES	

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(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Services:
Summary of Results of Injury Assessment Studies

Table B-6 summarizes information concerning lost or reduced services damaged by the spill. Much of the injury to services and the information about those injuries is not quantitative. The table reflects the qualitative content of the information. The "Description of Reduction or Loss" column recounts the impacts of the spill on each service. The "Status of Recovery" shows the most recent information on recovery.

The information used for this table is taken from injury assessment studies, information from agency managers, and, for recreation, a Key Informant Interview study conducted by the Restoration Planning Working Group in December 1992.

TABLE B-6 Services: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Passive Use	The areas of Alaska impacted by the oil spill supported a large diverse ecosystem that was valued by large numbers of the American public who did not visit the area. The spill killed substantial numbers of different bird species and marine mammals as well as oiling much of the coastline in the impacted areas. The spill also had substantial effects on the fish, bird, and wildlife populations. While some of these effects may be of relatively short duration, others such as recovery of various bird populations are likely to take decades.	The animals initially killed are irreplaceable. Fish and wildlife populations are recovering at different rates. Much of the oil in shoreline areas has been removed or has weathered to varying degrees.	YES	YES	YES	YES	A contingent valuation study of the American public done in 1991 found that approximately 95% were still aware of the *Exxon Valdez* oil spill, and that over 50% spontaneously named the spill as one of the worst environmental accidents to occur in the world during their lifetime. The median household was willing to pay $31 to prevent a spill similar to the *Exxon Valdez* in the future. Multiplied by the number of U.S. households, this results in an estimate of spill damages of $2.8 billion.

(a) There may have been an unequal distribution of injury within each region.

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Recreation and Tourism (e.g., hunting, sportfishing, camping, kayaking, sailboating, motorboating, environmental education)	The nature and extent of any reduction or loss of services varied by user group and by area. Some commercial recreation and tourism businesses were injured by the reduction in visitors and visitor spending as a result of the spill. Non-commercial recreation also decreased in some parts of the spill area. The quality of recreation experiences decreased as a result of the spill due to crowding, residual oil, and fewer fish and wildlife. The oil spill caused injury to the way people perceive recreation opportunities in the spill area. The location of recreation use was altered by changed use patterns and displaced use. A few recreation facilities were impacted by the spill, most from overuse or misuse during 1989 and 1990. Overall, recreation use declined significantly in 1989. Between 1989 and 1990, a decline in sport fishing (number of anglers, fishing trips, and fishing days) were recorded for PWS, Cook Inlet and the Kenai Peninsula.	Public comment shows persisting oil, crowding, diminished aesthetics, reduction of wilderness character, reduction of wildlife sightings, tainted food sources, disturbance of cultural sites, and evidence of clean-up activities all to be continuing injuries to recreation. Some displaced users are returning to parts of the spill area, while others still avoid the heavier oiled areas. Recovery of recreation, especially sport hunting and fishing, is largely dependent on the recovery of injured species. As species recover, recreational experiences will improve. The projected decrease in the Kenai River sockeye salmon returns could cause additional injury to recreation on the Kenai Peninsula. Use patterns continue to change in relation to the recovery of the resources, perceptions, and restoration projects.	YES	YES	YES	YES	Survey respondents also reported changes in their perception of recreation opportunity in terms of increased vulnerability to future oil spills, erosion of wilderness, a sense of permanent change, concern about long-term ecological effects, and, in some, a sense of optimism.

(a) There may have been an unequal distribution of injury within each region.

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Commercial Fishing	During 1989, emergency commercial fishery closures were ordered in PWS, Cook Inlet, Kodiak and the Alaska Peninsula. This affected salmon, herring, crab, shrimp, rockfish, and sablefish. The 1989 closures resulted in sockeye over-escapement in the Kenai River and in the Red Lake system (Kodiak Island). In 1990, portions of PWS were closed to shrimp and salmon fishing.	Currently there are no area-wide oil spill-related commercial closures in effect. Management actions to try to compensate for the spill are still in effect. Oil spill-related sockeye over-escapement in the Kenai River system is anticipated to result in low adult returns in 1994 and beyond. Over-escapements may result in closure or harvest restrictions during these and perhaps in subsequent years. Returns of pink salmon and and herring to Prince William Sound were very low in 1993. It is uncertain to what degree this is linked to the spill.	YES	YES	YES	YES	Injuries and recovery status of rockfish, pink salmon, shellfish, and herring, are uncertain. Therefore, future impacts on these fisheries are unknown.

(a) There may have been an unequal distribution of injury within each region.

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Subsistence	Subsistence harvests of fish and wildlife in 11 of 15 villages surveyed declined from 4 - 77% in 1989 when compared to prespill levels. At least 4 of the 11 villages showed continued lower than average levels of use in the period 1990-1991; this decline is particularly noticeable in the Prince William Sound villages of Chenega and Tatitlek. In 1989-1991, chemical analysis indicated that most resources tested, including fish, marine mammals, deer, and ducks, were safe to eat. Starting in 1989, health advisories were issued indicating that shellfish from oiled beaches should not be eaten.	Many subsistence users believe that continued contamination to subsistence food sources is dangerous to their health. In addition, village residents believe 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.	YES	YES	YES	YES	For detailed information on village subsistence use, see Table B-3.

(a) There may have been an unequal distribution of injury within each region.

Appendix C
Areas Recommended by the Public for Purchase or Protection

During the public comment period in April and May of 1993, the public recommended many areas for purchase or protection. The list of recommended areas, by region, appears below.

Prince William Sound

Bainbridge Island
Chenega Island
Chugach National Forest
Cordova area private lands
Dangerous Passage
Eshamy/Jackpot Bay
Evans Bay
Fish Bay
Hawkins Island
Hinchinbrook Island
Icy Bay
Knight Island
Knowles Head
Latouche Island
Montague Island
Naked Island
Nelson Bay
Olsen Bay
Orca Bay/Narrows[1]
Patton Bay
Port Fidalgo
Port Gravina (including Bear Trap Bay)
Red Head
Rude River
Sheep Bay
Simpson Bay
Two Moon Bay
Windy Bay

Kenai Area

Chrome Bay
Gull Island
Kamishak Bay
Kenai Fjords National Park
Kenai Peninsula
Port Chatham
Rocky Bay

Kodiak Area

Afognak Island
Fox/Red Fox Bay
Karluk River
Kodiak Island
Kodiak National Wildlife Refuge
Long Lagoon
Pauls & Laura Lake Chain
Shuyak Island/Strait
Sitkalidak Island
Sturgeon River

General

Tongass National Forest

State and federal governments will purchase lands on the basis of a willing seller and willing buyer. The above list of areas were recommended by the public. Some of the areas listed may not be available for purchase or protection.

1. Orca Narrows/Orca Bay was the only area that people specifically stated that they were opposed to acquiring.

Appendix D
Planning Publications

The following publications have been produced by the *Exxon Valdez* Trustee Council's Restoration Planning Work Group in the development of this plan:

Restoration Following the *Exxon Valdez* Oil Spill: Proceedings of the Public Symposium, Anchorage, Alaska, July 1990.

Restoration Planning Following the *Exxon Valdez* Oil Spill: August 1990 Progress Report, Anchorage, Alaska, August 1990.

Restoration Framework, Anchorage, Alaska, April 1992.

Draft *Exxon Valdez* Oil Spill Restoration Plan: Summary of Alternatives for Public Comment, Anchorage, Alaska, April 1993.

Supplement to Draft *Exxon Valdez* Oil Spill Restoration Plan Summary of Alternatives for Public Comment, Anchorage, Alaska, June 1993.

Summary of Public Comment on Alternatives, Anchorage, Alaska, September 1993.

The following publications were produced by contractors for the *Exxon Valdez* Trustee Council's Restoration Planning Work Group.

Boland, J. M., Comprehensive Review and Critical Synthesis of the Literature on Recovery of Ecosystems Following Disturbances: Marine Invertebrate Communities, Pacific Estuarine Research Laboratory, California, October 1992.

Jones and Stokes Associates, Inc., Proceedings of the Workshop on Programs to Protect Marine Habitats, Bellevue, Washington, January 1992.

Jones and Stokes Associates, Inc., Summary Report on Programs to Protect and Manage Marine Habitats, Bellevue, Washington, January 1992.

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