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Draft
Exxon Valdez Oil Spill
Restoration Plan

Prepared by:

***Exxon Valdez* Oil Spill**
Trustee Council

645 G Street
Anchorage, Alaska
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(907) 278-8012

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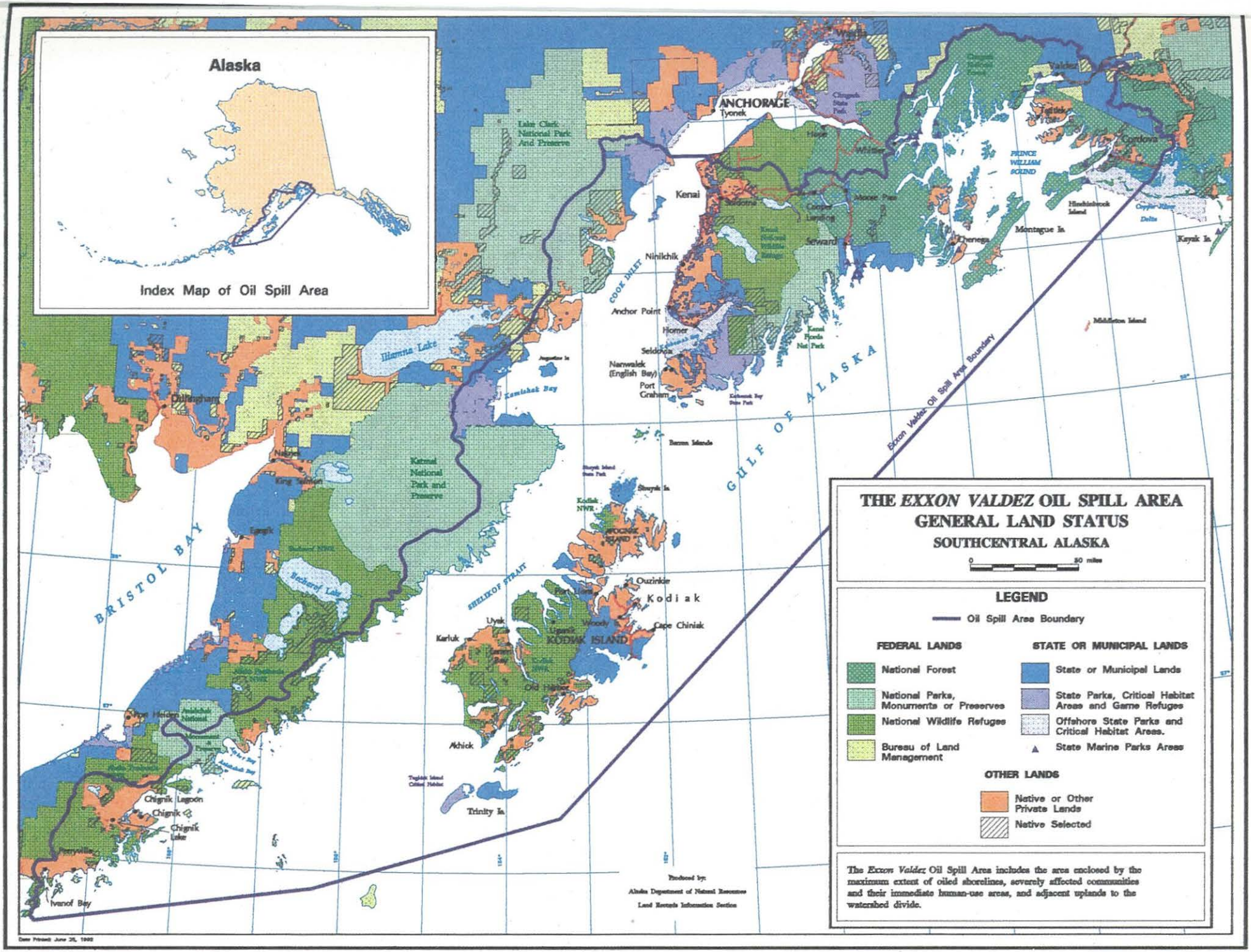
Alaska
Index Map of Oil Spill Area
THE EXXON VALDEZ OIL SPILL AREA
GENERAL LAND STATUS
SOUTHCENTRAL ALASKA
0
80 miles
LEGEND
Oil Spill Area Boundary
FEDERAL LANDS
National Forest
National Parks, Monuments or Preserves
National Wildlife Refuges
Bureau of Land Management
STATE OR MUNICIPAL LANDS
State 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.
Produced by:
Alaska Department of Natural Resources
Land Records Information Section
Exxon Valdez Oil Spill Area Boundary
ANCHORAGE
Tyonek
Kenai
Nikiski
Cook Inlet
Anchor Point
Homer
Seldovia
Nanwalek (English Bay)
Port Graham
Kamishak Bay
Iliamna Lake
Dillingham
Naknek
King Salmon
Katmai National Park and Preserve
Egegik
Becharof Lake
Bristol Bay
Shelikof Strait
Kodiak
Ouzinkie
Uyak
Karluk
Woody Island
Cape Chiniak
KODIAK ISLAND
Old Harbor
Akhiok
Trinity Is.
Barren Islands
Shuyak Is.
Kodiak NWR
Afognak Is.
Gulf of Alaska
Prince William Sound
Valdez
Cordova
Hinchinbrook Island
Montague Is.
Kayak Is.
Seward
Whittier
Hope
Moose Pass
Cooper Landing
Chenega
Middleton Island
Kenai Fjords Nat. Park
Katmai NWR
Alaska Peninsula NWR
Becharof NWR
Hallo Bay
Chignik Lagoon
Chignik
Chignik Lake
Perryville
Ivanof Bay

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:

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

Monitor recovery. 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.

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

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
Cutthroat trout
Dolly Varden
River otter
Rockfish

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:

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

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

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

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:

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

quality of subsistence resources, or increasing the confidence of subsistence users. Specifically, if subsistence harvest has not returned to prespill levels because users doubt the safety of particular subsistence resources, this objective may take the form of increasing the reliability of the resource through food safety testing. Other examples are the acquisition of alternative subsistence food sources and improved use of existing resources.

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

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

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

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.

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

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

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

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 SERVICES (Human Uses)
BIOLOGICAL RESOURCES		OTHER	
Recovering Bald eagle Black oystercatcher Intertidal organisms (some) Killer whale Sockeye salmon (Red Lake) Subtidal organisms (some)	**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
Recovery Unknown Clams Cutthroat trout Dolly Varden River otter Rockfish			

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.

River Otters

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.

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 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 *Fucus gardneri* (rockweed or popweed), barnacles, limpets, periwinkles, clams, amphipods, isopods, and marine worms were less abundant at oiled than nonoiled sites. Although there were increased densities of mussels in oiled area, they were significantly smaller than mussels in the nonoiled areas, and the total biomass was significantly lower. While the percentage of intertidal areas covered by *Fucus* was reduced following the spill, the coverage of opportunistic plants (ephemeral algae) that characteristically flourish in disturbed area was increased. The average size of *Fucus* plants was reduced, as was the reproductive potential of those plants surviving the initial oiling.

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

COMMERCIAL FISHERY CLOSURES TABLE B-2	
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.

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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.
(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.	
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.
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(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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(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.

The Nature Conservancy, Options for Identifying and Protecting Strategic Fish and Wildlife Habitats and Recreation Sites: A General Handbook, Anchorage, Alaska, December 1991.

Nevissi, A. E., T.H. Sibley, and C. Chang, Comprehensive Review and Critical Synthesis of the Literature on Recovery of Ecosystems Following Disturbance: Fish and Shellfish, University of Washington, Washington, September 1993.

Nur, N. and D.G. Ainley, Comprehensive Review and Critical Synthesis of the Literature on Recovery of Marine Bird Populations from Environmental Perturbations, Point Reyes Bird Observatory, California, March 1992.

Parametrix, Inc., ABA Consultants, and Goldstream Consulting, Monitoring Recovery Following the *Exxon Valdez* Oil Spill: A Conceptual Monitoring Plan, Kirkland, Washington, June 1993.

Stewart, B.S., P.K. Yochem, and J.R. Jehl Jr., Review and Critical Synthesis of the Literature on Recovery of Ecosystems Following Man-Induced and Natural-Phenomena-Related Disturbances: Harbor Seals and Killer Whales, Hubb-Sea World Research Institute, California, June 1992.

Versar, Inc., Restoration Planning Following the *Exxon Valdez* Oil Spill: Draft Technical Workshop Report, Columbia, Maryland, September 1990.

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