RPWG I

DRAFT

Laurel Jolour Draft 1993 Restoration Work Plan RPWG I

Laurel Hanging Folder RPWG I

Chapter I: Purpose and Need

Introduction

The *Exxon Valdez* Oil Spill

On March 24, 1989, the tanker *Exxon Valdez* r... Prince William Sound, Alaska, causing the largest oil spill in U... 11 million gallons (3,035,000 liters) of North Slope crude ... rn Prince William Sound and along the western coast of th... jury to both natural resources and services (human uses) in A...

The weather for the first 3 days following the spill was calm and did not move the oil from the immediate area, although the slick expanded during that time (Figure I-A). On the second day, however, a major storm moved oil through the Sound to the southwest, where it reached beaches on Little Smith, Naked, and Knight Islands (Figure I-B). Within 6 days of the spill, oil reached the Gulf of Alaska (Figure I-C). The leading edge of the oil slick reached the Chiswell Islands and the Kenai Peninsula by April 2 and the Barren Islands by April 11 (Figure I-D). By the middle of May 1989, some 470 miles (750 km) of shoreline had been oiled, including parts of Prince William Sound, the Kenai Peninsula, the Kodiak Archipelago, and the Alaska Peninsula. During the summer of 1989, oil from the spill was found as far as 600 miles (965 km) from Bligh Reef, the site of the grounding.

recorded shoreline oiled.

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

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

Litigation and Settlement

RPWG
I

DRAFT

Chapter I: Purpose and Need for Action

Introduction

The *Exxon Valdez* Oil Spill

On March 24, 1989, the tanker *Exxon Valdez* ran aground in Bligh Reef in Prince William Sound, Alaska, causing the largest oil spill in U.S. history. Approximately 11 million gallons (3,035,000 liters) of North Slope crude oil moved through southwestern Prince William Sound and along the western coast of the Gulf of Alaska, causing injury to both natural resources and services (human uses) in Alaska.

The weather for the first 3 days following the spill was calm and did not move the oil from the immediate area, although the slick expanded during that time (Figure I-A). On the second day, however, a major storm moved oil through the Sound to the southwest, where it reached beaches on Little Smith, Naked, and Knight Islands (Figure I-B). Within 6 days of the spill, oil reached the Gulf of Alaska (Figure I-C). The leading edge of the oil slick reached the Chiswell Islands and the Kenai Peninsula by April 2 and the Barren Islands by April 11 (Figure I-D). By the middle of May 1989, some 470 miles (750 km) of shoreline had been oiled, including parts of Prince William Sound, the Kenai Peninsula, the Kodiak Archipelago, and the Alaska Peninsula. During the summer of 1989, oil from the spill was found as far as 600 miles (965 km) from Bligh Reef, the site of the grounding.

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

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

Litigation and Settlement

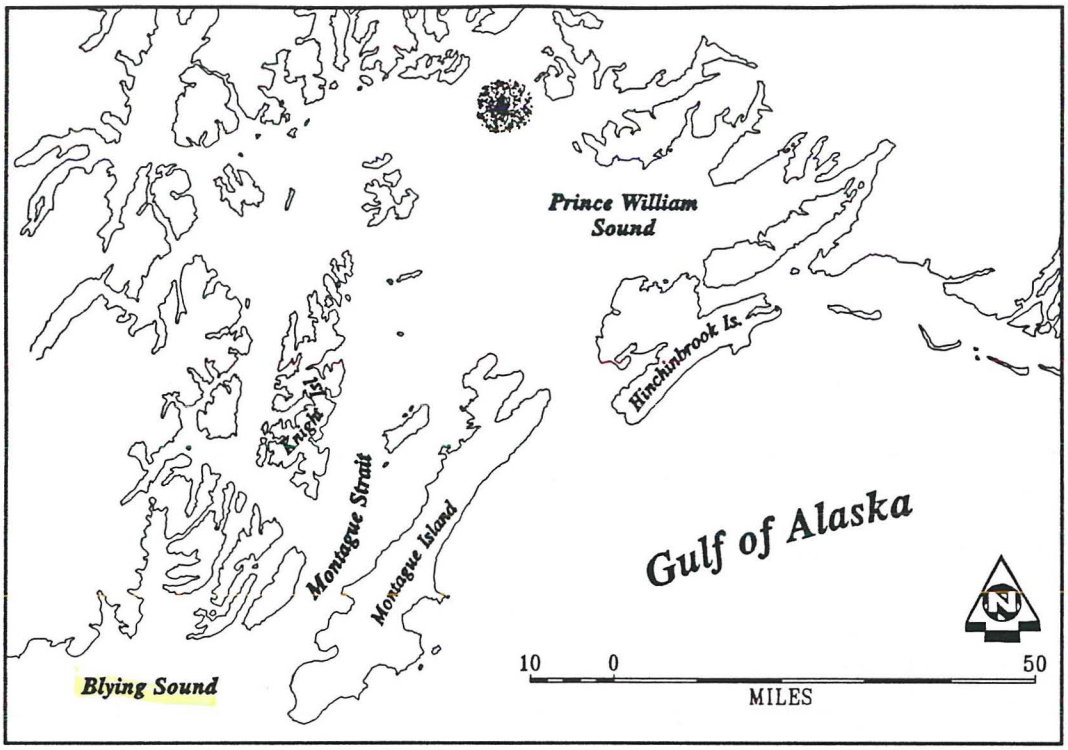


Figure I-A. Approximate distribution of the floating oil on 24 March 1989 (adapted from Galt and Payton, 1990).

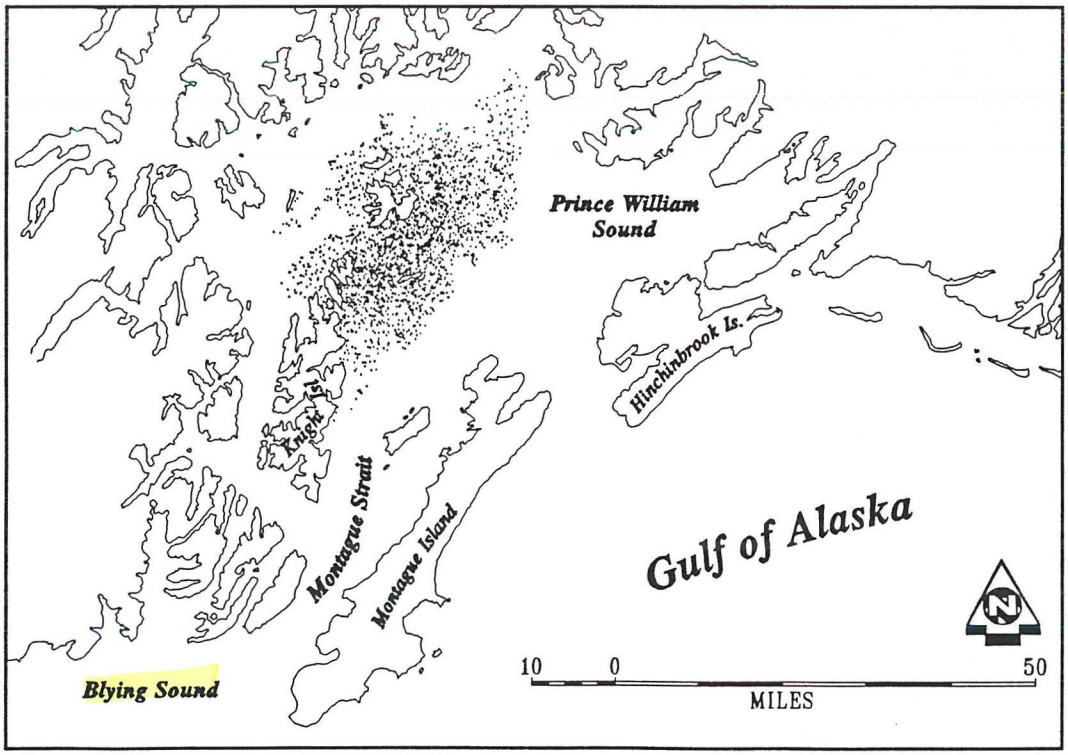
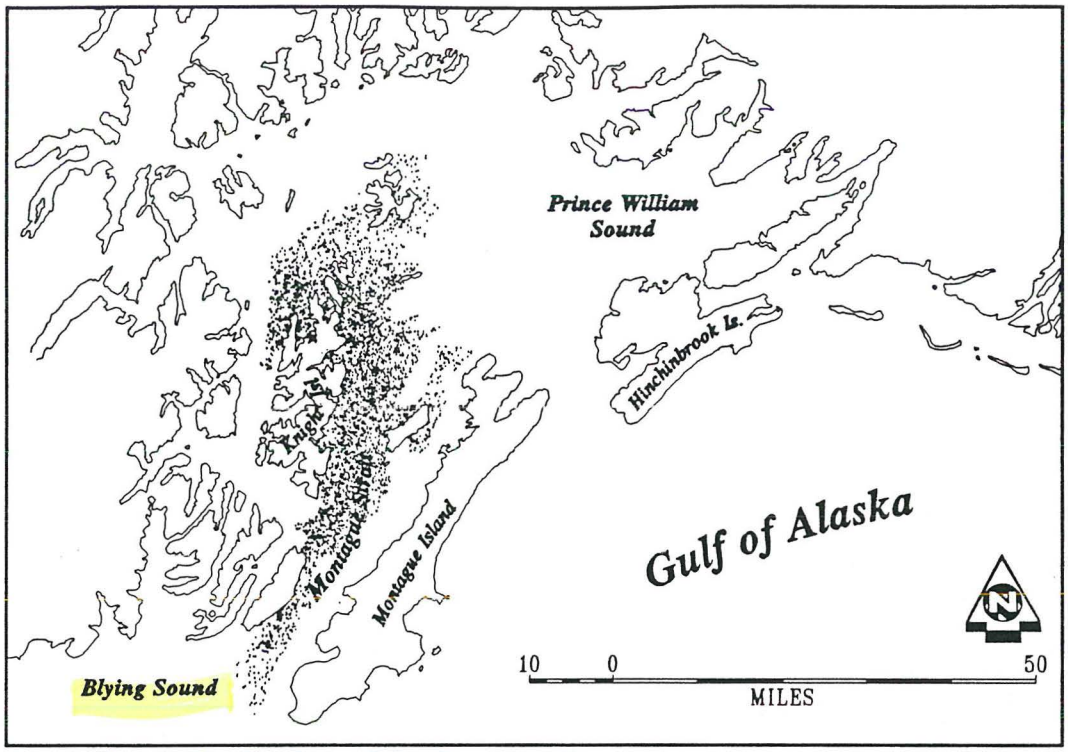


Figure I-B. Approximate distribution of the floating oil on the afternoon of 26 March 1989 (adapted from Galt and Payton, 1990).



Approximate distribution of the floating oil, midday 30 March 1989 (adapted from Galt and Payton, 1990).

After the spill, both President George Bush and Alaska Governor Steve Cowper declared their intent to restore both the affected ecosystem and the local economy. In March 1991, the United States and the State of Alaska joined in filing civil charges against the Exxon Corporation, Exxon Pipeline Company, and Exxon Shipping Company. Separate criminal complaints were also filed. The Federal Government brought charges under authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 U.S.C. § 9601 *et al.*), the Clean Water Act (33 U.S.C. 1251 *et seq.*), the Migratory Bird Treaty Act (16 U.S.C. § 703 *et seq.*), the Refuse Act (33 U.S.C. § 407, 411), and other Federal regulations. Private citizens also made claims for damages against Exxon, many of which are still pending.

On October 8, 1991, the U.S. District court approved an agreement that settled the claims of the United States and the State of Alaska against Exxon Corporation and Exxon Shipping Company. Exxon Corporation and Exxon Shipping entered guilty pleas to the criminal charges against them, admitting that they had violated several environmental regulations. A fine of $150 million dollars was imposed by the judge. Of this amount, $125 million was forgiven because the Exxon companies had cooperated with the Government during the cleanup, had already paid many private claims, and had tightened their environmental

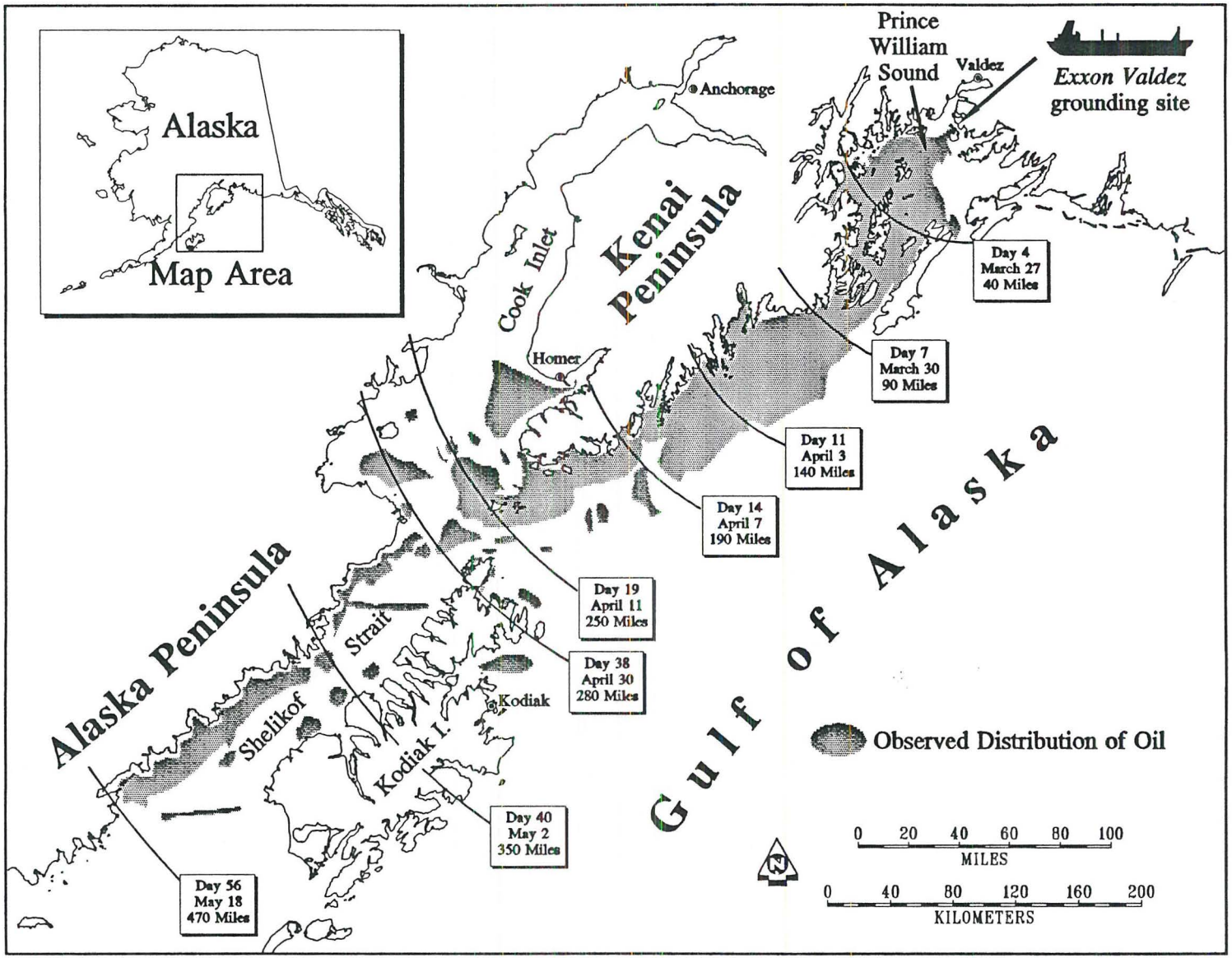


Figure I-D. Composite overview of oil-spill tracking from March 24, 1989 to June 20, 1989. All degrees of oiling are represented. Adapted from State of Alaska, Dept. of Environmental Conservation map.

controls after the spill. Of the remaining $25 million, $12 million was deposited into the North American Wetlands Conservation Fund, and $13 million was deposited into the Victims of Crime Account. These funds are not controlled by the Trustee Council and are therefore not considered in the Restoration Plan.

As part of the criminal settlement, the compainies also agreed to pay $100 million as restitution. Half of this money was paid to the United States and half was paid to the State of Alaska. The funds are managed separately by the United States and by the State. By 2order of the United States District Court, these funds are to be used "exclusively for restoration projects, within the State of Alaska, relating to the *Exxon Valdez* spill." The court order defines restoration to include—

> restoration, replacement, and enhancement of affected resources; acquisition of equivalent resources and services; and long-term environmental monitoring and research programs directed to the prevention, containment, cleanup, and amelioration of oil spills.

The terms of the civil settlement were approved in civil actions A91-082 (*United States v. Exxon Corp.*) and A91-083 (*State of Alaska v. Exxon Corp.*) on October 8, 1991. As part of this settlement, the Exxon companies agreed to pay the United States and the State of Alaska as much as $900 million over a period of 10 years. These payments are deposited in an interest-bearing account administered by the Federal Court Registry Investment System. As funding needs for restoration projects are identified, the Trustees apply for disbursement of funds from the account.

Civil action A91-081 (*United States v. State of Alaska*) resolved the claims the United States and the State of Alaska had against each other and established them as co-trustees in the collection and joint use of the restoration funds. Under this agreement, the governments are to use the funds for the purposes of—

> restoring, replacing, enhancing, rehabilitating, or acquiring the equivalent of natural resources injured as a result of the *Exxon Valdez* oil spill and the reduced or lost services provided by such resources.

The Trustees may also use the money to reimburse spill-related expenses such as litigation costs, response, and damage assessment.

The civil settlement states that the Trustees are responsible for making all decisions regarding funding, injury assessment, and restoration. Half of the Trustees represent the State of

Alaska and half represent the United States. They are the Commissioner of the Alaska Department of Environmental Conservation (ADEC), the Commissioner of the Alaska Department of Fish and Game (ADF&G), the State Attorney General, the Secretary of the U.S. Department of the Interior (DOI), the Secretary of the U.S. Department of Agriculture (USDA), and the Administrator of the National Oceanic and Atmospheric Administration (NOAA). Each of the Trustees has appointed representatives to the Alaska-based Trustee Council.

The Trustee Council consists of the three Alaska Trustees and three Federal representatives. The Alaska Regional Forester represents USDA, the Special Assistant to the Secretary of the Interior represents DOI, and the Regional Director of the National Marine Fisheries Service represents NOAA. Each member of the Trustee Council has, in turn, appointed a member to the Restoration Team, a management group that makes recommendations to the Trustee Council and receives input from the Restoration Planning Work Group.

Purpose and Need for Action

~~As described previously,~~ The civil settlement agreement resulted in a Memorandum of Agreement and Consent Decree whereby the United States and the State of Alaska agreed to act as co-trustees in the collection and joint use of all natural resource damage recoveries ~~(up to~~ $900 million) resulting from the *Exxon Valdez* oil spill. Among the guidelines established in the Memorandum of Agreement and Consent Decree was that the Trustees establish a mutually acceptable structure for decisionmaking.

The implementation of the proposed action, the Restoration Plan, would assist in the decisionmaking process by establishing management direction to guide all activities aimed at restoring natural resources and the services they provide. Program-level guidelines, like those included in the Draft Restoration Plan, would assist in the evaluation and implementation of future proposed restoration activities. These activities would be developed annually and would be judged by the criteria set forth in the Restoration Plan.

The proposed action is to implement the Restoration Plan, which is described in detail in the Draft Restoration Plan released with this Draft Environmental Impact Statement (DEIS). The final composition of the Restoration Plan is to be decided by the Trustee Council, and the analysis included in the DEIS will be considered in their decision.

The restoration planning effort started in 1990, prior to any settlement of claims against the parties responsible for the spill. In February 1992, the Trustee Council determined that the

Restoration Plan being developed was a major Federal action. Under Section 102(2)(c) of the National Environmental Policy Act (42 U.S.C. § 4341 as amended),

> all agencies of the Federal Government shall . . . (c) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on . . . (i) the environmental impact of the proposed action.

This DEIS was prepared to comply with NEPA and the regulations established by the President's Council on Environmental Quality (CEQ) for implementing NEPA procedures (40 CFR 1500–1508 as amended). Pursuant to NEPA and CEQ's regulation, it documents the analysis of potential impacts related to implementing the Restoration Plan. The EIS serves as a decision-aiding tool to ensure that Federal agency actions take into consideration the policies and goals of NEPA. An EIS is prepared by integrating as many of the natural and social sciences as may be warranted based on the potential effects of the proposed action. The direct, indirect, and cumulative impacts of the proposed action are analyzed.

The Restoration Plan

The purpose of the Restoration Plan is to set guidelines for spending the remainder of the civil settlement funds for restoration activities. The Restoration Plan will provide long-term guidance for restoring resources and services injured by the *Exxon Valdez* oil spill. Each year, an Annual Work Plan will be developed to implement the Restoration Plan. The Annual Work Plan contains the different restoration activities to be funded that year, based on the policies and spending guidelines of the Restoration Plan, future public comments, and changing restoration needs.

Once the Restoration Plan is adopted, it may be changed as needed to respond to new information about injuries and recovery, to make use of new technology, or to respond to other changing conditions. The Plan describes each of the alternatives, explains the evaluation criteria used, and outlines the differences among each of the alternatives. It discusses an approach to implementing the alternatives. The Plan also covers budgeting, administration, funding mechanisms, monitoring, and public participation. This EIS will help decisionmakers and the public determine which of the possible alternatives for the Restoration Plan should be implemented.

The Plan addresses five major policy questions:

- Which resources and services should be targeted for restoration efforts?

Should restoration actions address all injured resources and services, or should they address only those biological resources whose populations declined measurably as a result of the spill?

- For how long should restoration actions last?

  Should they be undertaken until a resource has recovered, then stopped? Or should they continue beyond the point of restoration to pre-spill levels?

- Which restoration actions should be undertaken?

  Should the plan include only those actions that are expected to produce substantial improvement over the rate of natural (unaided) recovery? Or should actions believed to produce at least some improvement over the rate of unaided recovery be included as well?

- In what geographic area should restoration actions be taken?

  Should action be limited to the spill area, or should actions be taken in any area where there is a link to injured resources or services ~~within the State of Alaska~~?

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

  Should human use and access to spill-~~damaged~~ areas be decreased? Protected? Increased? Or should new opportunities for human use be considered?

Each of the alternatives described in the Restoration Plan represents a possible approach to restoration. The actions fall into four basic categories.

- Habitat protection and acquisition.

  This category contains options designed to limit further harm to species within the spill area by protecting ~~their~~ habitats. Habitat protection options include acquiring privately held land, obtaining rights to privately held land, or changing the management of publicly held land.

- General restoration.

This category includes options that manipulate resources directly, such as replanting seaweed in intertidal areas. It also includes options that manage human use of affected areas, such as a plan to reduce human disturbance near seabird nesting areas.

- Monitoring and research.

  This category contains options designed to determine whether the environment is recovering and what humans can do to accelerate the recovery process. Monitoring falls into four subcategories: recovery monitoring, restoration monitoring, ecosystem monitoring, and restoration research.

- Administration and public information activities.

  Funding levels for these activities depend on the number and scope of other options undertaken. As more projects and programs are implemented, the percentage of funds that must be allocated to management and administration increases. This category also includes providing information to the public about restoration activities and the progress of recovery.

Roles of the Agencies

The Trustees selected the USDA Forest Service, Anchorage, to act as the lead agency in developing the DEIS (See 40 CFR 1501.5–7, 1503.1, and 1508.16). In this capacity, the Forest Service uses its implementing regulations, policies, and procedures for ensuring compliance with NEPA. Among the lead agency's responsibilities is the coordination of the public scoping process. To ensure that the public had opportunity to provide input to the decisionmaking process, the Forest Service held meetings in May 1992 in Seldovia (teleconferenced to Port Graham), Homer, Kodiak, Juneau, Tatitlek, Valdez, Seward, Whittier, Chenega Bay, Anchorage, Cordova, and Fairbanks. In November 1992, agencies and individuals were invited to an "open house" held in Anchorage.

In addition to managing scoping, the Forest Service selected and supervised third-party contractors to produce the analyses and public scoping documents, including this DEIS. Contractors provided impartial analysis and input, as well as an independent evaluation of the Restoration Plan.

The Department of Interior and the National Marine Fisheries Service served as cooperating agencies. Working with the Forest Service, they participated in the NEPA process and contributed to scoping.

As required by Forest Service policy, the planning record for the Restoration Plan EIS includes the data and information used in the analysis of the alternatives, scoping records, a chronology, and other relevant information. The planning record is available for public review.

Role of the Public

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

In addition, a Public Advisory Group, formed in October 1992, was established to advise the Trustee Council on all matters relating to the planning, evaluation, and allocation of available funds, as well as the planning, evaluation, and conduct of injury assessments and restoration activities. This group is made up of 17 individuals who represent a cross-section of the interest groups and public affected by and concerned about the spill.

Issues

Issues raised by the public, agencies, community leaders, and other knowledgeable individuals and organizations were identified during the scoping process. Identification of relevant issues is based on "reviews of similar actions, knowledge of the area or areas involved, discussions with community leaders, and/or consultations with experts and other agencies familiar with such actions and their effects" (FSH 1909.15 (11.5)). From the issues identified during scoping, several have been deemed relevant to the environmental effects of implementing the Restoration Plan. These issues are addressed in this document. Issues determined to be outside the scope of this document are listed in the Restoration Framework published in April 1992 and in the Draft Restoration Plan.

Eight issues identified during scoping were determined to be crucial to the environmental impact analysis. Condensed explanations of these issues are presented below.

- How would restoration activities affect local economies and communities?

  Some proposed restoration activities may require the creation of new jobs. The number and kinds of new jobs, as well as their anticipated pay, are of interest to the public. There is also concern that employment may be reduced in industries that could be adversely affected by implementation of certain restoration options. Additionally, the effect of increased or decreased employment on the economy and services of the local communities concerns the public, as well as government agencies and private industry.

- How would restoration activities contribute to restoring injured resources and services?

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

- How would restoration activities affect land uses?

  The public has anticipated that changes in land use would be the obvious consequence of restoration activities that involve the acquisition of land for protection or enhancement. Ownership of some land may move from the private sector to the public sector. Increased protection of lands already under public management may be considered. Some changes in land management would decrease opportunity for such activities as logging and mining; others would increase access to recreation sites.

- How would activities directed at injured resources and services affect non-target resources and services?

  Each of the proposed restoration activities aims to aid a particular resource or service; however, the potential exists for other resources and services to be

affected as well. Although an action could be designed to improve recovery of a specific resource, the same action could also indirectly affect non-target resources and services. Potential impacts include changes in the number or structure of non-target species populations as a result of restoration-associated changes in the amount or quality of available habitat or food sources.

- What ecological change would occur in the spill area as a result of restoration activities?

  Ecological change in the spill area is the intent of proposed restoration activities. Many of the proposed activities aim to change ecosystem diversity and species abundance. Anticipated ecological changes might include structural changes in habitat and changes in species populations.

- What changes to subsistence uses would occur as a result of restoration activities?

  is Chug analysis Fed. Lands

  Some of the proposed restoration actions are directed at restoring subsistence uses of resources in the spill area. Subsistence, or the traditional and customary use of renewable natural resources in rural areas, was affected by contamination of subsistence species and by users' perception of contamination. Restoration activities that focus on subsistence could increase the abundance of subsistence species in the area or could increase access to resources not previously available for subsistence harvest. Subsistence may be affected by the implementation of options that are not intended to address subsistence; this potential for impact is considered in the analysis of the alternatives.

- What effects would restoration actions have on human health and safety?

  combine w/ subsistence

  The spill affected human health and safety primarily through the contamination of certain subsistence resources. Eating oil-contaminated food is harmful to humans, as is direct bodily contact with crude oil. To avoid injury to humans, fisheries were closed and harvesting of affected species was discouraged immediately after the spill occurred. Some of the restoration activities aim to decrease the levels of harmful hydrocarbons in subsistence resources. Others focus on obtaining and publicizing research to determine the level of persisting contamination, if any, in harvested resources.

- What effects would restoration activities have on scientific information used to monitor environmental recovery and manage resources and services?

  To determine the effectiveness of restoration activities, monitoring of the affected resources and services would be required. Such monitoring would produce information that could facilitate the effective management of resources and services, as well as future restoration efforts. Variables include the amount and quality of scientific data collected, the total number of investigations completed for each of the subject resources, and the usefulness of these data in future restoration and management decisions.

Many other issues were raised during the EIS scoping process and the restoration planning process. The majority of the issues raised addressed Restoration Plan alternatives and options, suggesting additional options for inclusion in the Plan. A list of issues raised that are germane to the Restoration Plan is contained in the Draft Restoration Plan that accompanies this DEIS. Those issues that did not address restoration or Restoration Plan, or that were not germane to the EIS, are identified in the planning record for this EIS.

DEIS Organization

Consistent with Forest Service policy, the DEIS places special emphasis on Chapter IV, Environmental Consequences. Chapter II, Alternatives Considered, presents the five alternatives under consideration. Chapter III presents a summary-level account of the affected environment that will serve as a baseline against which potential impacts will be measured. Chapter IV discusses the projected impacts of implementing each of the proposed alternatives. Additional information, including a glossary, an index, and reference list, is included in the appendices to this document.

DRAFT

Chapter II: Alternatives Considered

Introduction

The *Exxon Valdez* Restoration Plan contains five possible alternatives for restoration. These alternatives, including the required "no action" alternative, are briefly described in this chapter. The injured resources and services (human uses) that would likely be affected by implementation of each of the alternatives are summarized in Figure x. For more detailed information about the alternatives, please refer to the Restoration Plan.

This chapter needs to contain a brief summary of plans and what is in each alt.

Each of the alternatives is made up of several option categories. Options are specific projects or programs designed to aid in the restoration of the spill area. As described in Chapter I, the options fall into four basic categories: (1) habitat protection and acquisition, (2) general restoration, (3) monitoring and research, and (4) administration and public information activities. In addition, each of the alternatives answers five policy questions:

- Which resources and services should be targeted?
- How long should restoration actions last?
- Which restoration actions should be undertaken?
- In what geographic area should actions be taken?
- To what extent, if any, should restoration actions create or enhance opportunities for human use?

The option categories and the answers to the policy questions outlined above vary from alternative to alternative. The percentage of funds to be allotted to each of the option category differs for each of the alternatives.

Alternative 1: No Action

see App B pg 3 Rest. Plan for start of normal agency mgt. Add info from parks etc to complete.

The "no action" alternative, which Federal guidelines require as part of the analysis in Chapter IV, consists entirely of normal agency management activities. If this alternative were implemented, no new activities or programs would be instituted as a result of the oil spill, and the scope of present activities and programs would not change. Agency monitoring of natural recovery would remain at present levels. Agency responsibilities would remain substantially unchanged. None of the funds from the civil settlement would be spent if this alternative were implemented. as stated in current management plans.

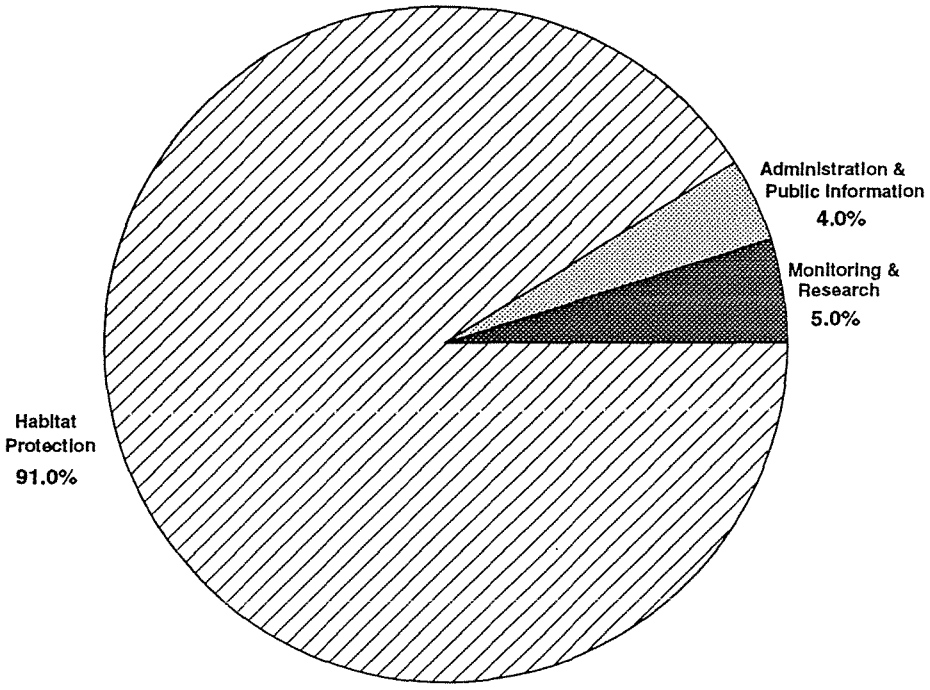
Alternative 2: Habitat Protection

The goal of Alternative 2 is to protect strategic lands and habitats important to the long-term recovery of injured resources and services from further damage. The primary means of protection in this alternative would be the acquisition of private land interests or changes in the management of currently held public lands. Monitoring and research would be conducted to evaluate the effectiveness of protection measures and to track the recovery of damaged resources and services. Actions included in this alternative would be confined to the area affected by the oil spill.

The pie chart on the next page shows the approximate division of funds for this alternative. The majority of the funds would be used to acquire and protect lands within the spill area.

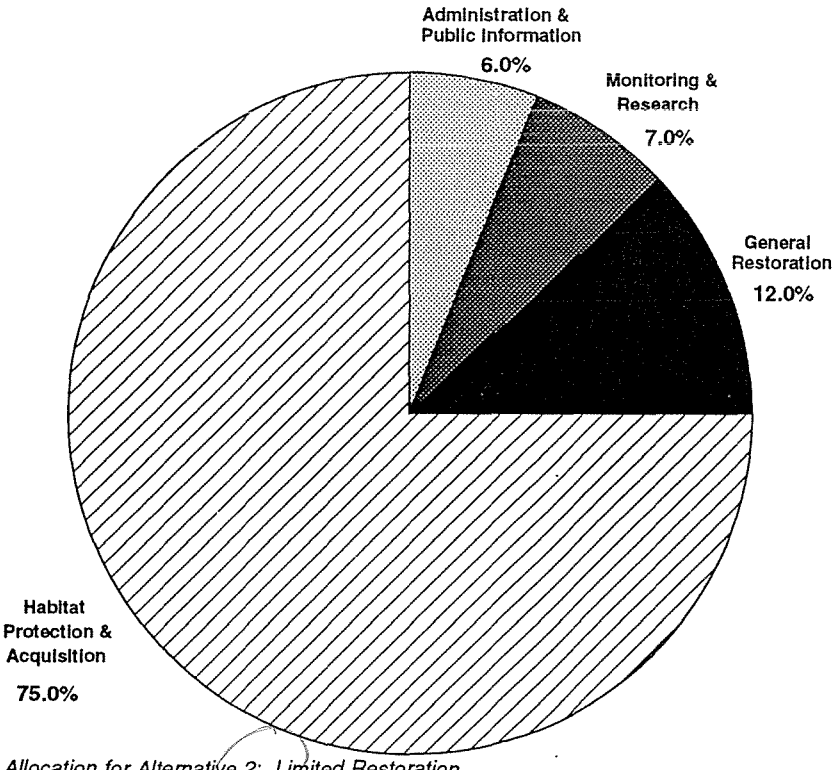
Alternative 3: Limited Restoration

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



Funding Allocation for Alternative 2: Habitat Protection

The pie chart below shows the approximate division of funds for this alternative. Although the majority of the funds would be used to acquire and protect lands within the spill area, this alternative also includes funding for general restoration activities.

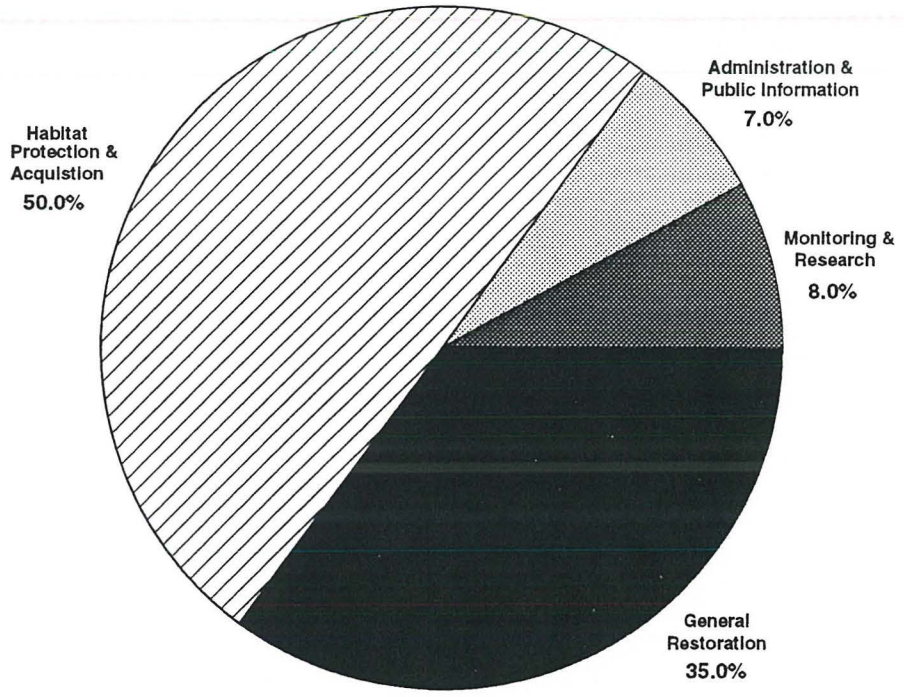


Funding Allocation for Alternative 2: Limited Restoration

Alternative 4: Moderate Restoration

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

The pie chart below shows the approximate distribution of funds under this alternative. About half of the settlement funds would be used for habitat protection and acquisition. A significant portion of funds would go to general restoration, and monitoring and administration funds would be slightly increased over Alternative 3.

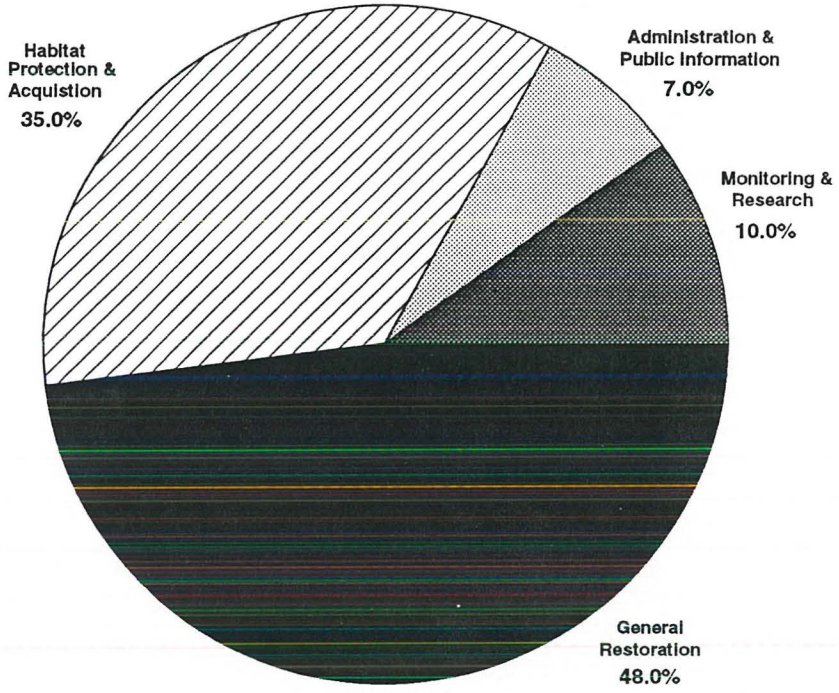


Funding Allocation for Alternative 4: Moderate Restoration

Alternative 5: Comprehensive Restoration

Alternative 5 is the broadest in scope of the proposed alternatives. It would help all injured resources and services, both within the spill area and in other parts of Alaska. Unlike Alternatives 3 and 4, this alternative includes actions to aid resources and services that have already recovered, as well as those that have not. Actions likely to produce some improvement over unaided recovery would be allowable under this alternative. Habitat protection is a smaller part of this alternative. Alternative 5 also allows for expansion of current human use and encourages appropriate new uses. Monitoring and research would also be included.

As the pie chart below shows, funding percentages under this alternative would be more evenly distributed among the option categories. In this alternative, the majority of funds would be used for general restoration activities. The percentage allotted to habitat protection and acquisition is the least of all the alternatives except the "no action" alternative.



Funding Allocation for Alternative 5: Comprehensive Restoration

Other Alternatives Considered and Rejected

Alternative A, considered and rejected by the Restoration Team, is similar to Alternative 1, the "no action" Alternative described above. Under this alternative, no funds would have been spent for habitat acquisition and protection or for general restoration activities. Only monitoring and administration activities would have been undertaken. The Restoration Team removed this alternative from consideration because [NOTE TO REVIEWERS: WHAT REASON SHOULD BE GIVEN? SHOULD FUNDING PERCENTAGES BE PROVIDED HERE?]

[NOTE TO REVIEWERS: PLEASE SUPPLY ANY OTHER ALTERNATIVES CONSIDERED AND REJECTED THAT SHOULD BE INCLUDED IN THIS SECTION. A PARAGRAPH SIMILAR TO THE ONE ABOVE WOULD BE HELPFUL. PLEASE DESCRIBE WHAT THE ALTERNATIVE WOULD HAVE DONE, FUNDING LEVELS IF NECESSARY, AND WHY THE ALTERNATIVE WAS REJECTED.]

General Analysis of the Alternatives

[NOTE TO REVIEWERS: WE ARE CURRENTLY PLANNING TO INCLUDE TWO TABLES IN THIS SECTION. ONE WOULD SHOW ALTERNATIVES ALONG THE HORIZONTAL AXIS AND RESOURCES/SERVICES AFFECTED ALONG THE VERTICAL AXIS. THE OTHER WOULD DO THE SAME AT THE OPTION LEVEL. WE ARE IN THE PROCESS OF DECIDING WHETHER THESE TABLES SHOULD INDICATE WHETHER EFFECTS ARE POSITIVE OR NEGATIVE.]

Analytical Tools/Methodology

This section describes the general principles and specific aspects of the impact assessment methodology used for this analysis of the impacts projected to result from implementation of the *Exxon Valdez* Oil Spill Restoration Plan. The impact assessment methodology described below was used to analyze each of the proposed alternatives.

This methodology takes into account both the dynamic nature of the Restoration Plan and the generic definition of the options to be included in the Restoration Plan alternatives. For each of the resources and services being evaluated, certain assumptions regarding the actual implementation of options were necessary. As appropriate, these assumptions are identified in the analysis of impacts in Chapter IV for each resource and service included in the analyses.

To perform the impact analysis of the proposed action (implementing the Restoration Plan) presented in Chapter IV, analysts employed a methodology that accounted for the various impacts that affect the biological, physical, and socioeconomic environment. Impacts were classified in five ways: direct, indirect, short-term, long-term, and cumulative. These types of impacts are interdependent. There can be long-term direct impacts, short-term cumulative impacts, and so on. For each resource or service being evaluated, the analysts identified the type of impact to help the reviewers and decisionmakers make sound, reasoned decisions for the short term as well as for the long term.

Direct impacts are those that are the immediate result of, or the initial reaction to, the action being evaluated. Indirect impacts are those that are the reaction to the direct impacts, or the second-tier impacts. In other words, indirect impacts are the consequence of direct impacts, and are not in themselves a direct result of the action. Indirect impacts are often difficult to identify because they may or may not occur, making their definition speculative. Quantifying indirect impacts is usually not possible or warranted. Additionally, there is often little distinction between indirect impacts, particularly in the long term, and cumulative impacts.

Cumulative impacts are a summation of the impacts related to the action being evaluated and concurrent actions being taken that are similar to, or are in close proximity to, the action being considered. Cumulative impacts often are not identifiable until well after the action has been taken. At the same time, however, they can be the source of controversy and litigation. The analysts responsible for writing this EIS have made every effort to account for cumulative impacts in the environmental impact analyses.

Short-term impacts are those that occur for a relatively short time and then abate. If the time frame is an important variable that should be considered by the decisionmaker, this is stated in the text. Long-term impacts are those whose duration or manifestation occurs for a relatively long time or that become manifest at some future time. As with short-term impacts, the long-term time frame is specified if it may influence the decisions to be made. To ensure that the full impact of the action being considered is identified, the full complement of impact types is considered in the environmental impact analysis.

As a basis for the determination of impacts, the analysts considered certain predetermined factors to arrive at impact determinations. When performing the analysis of impacts on various resources and services, the action being analyzed was viewed in terms of these factors. This approach allowed the analysts to preform a systematic analysis and to document the process used to reach their determinations and conclusions.

For determining the affects of proposed actions on the natural environment, the following four factors were used:

- Magnitude
- Geographic extent
- Duration and frequency
- Likelihood.

The ***magnitude*** of an impact reflects its relative size, amount, or intensity. The ***geographic extent*** of an impact considers how widespread the impact might be. The ***duration and frequency*** of an impact considers whether it is a one-time event, an intermittent occurrence, or a chronic occurrence. The ***likelihood*** of an impact assesses whether a possible impact is likely to occur.

Because the magnitude of an impact captures its intensity, taking into consideration the other three factors, this criterion has been closely analyzed and given particular attention in the assessment of environmental impacts. If the magnitude of an impact is expected to be large, this is generally stated in the impact analyses.

The specific aspects of the process followed by EIS team analysts, while following the general procedure described above, depended upon the resource or service being evaluated. In general, however, the process of developing and presenting minimum levels of evidence and analysis of impacts for all resources and services is essentially the same. The reasons for using a generally uniform, systematic approach are (1) to satisfy the NEPA requirement for a "hard look" at the actions being proposed, and (2) to provide decisionmakers with sufficient information to make informed decisions, while ascribing to the "rule of reason" implicit in the NEPA process.

Whereas an Environmental Assessment (40 CFR 1508.9) aims to provide sufficient evidence and analysis for determining the significance of impacts, an EIS assumes that significant impacts would occur from the implementation of the proposed action, in this case the *EVOS* Restoration Plan. Consequently, impacts described in this Draft EIS are presented with the intent of providing decisionmakers with an analysis of all impacts, regardless of their significance.

The first step in the analysis was the review of impact-related data and literature. This information was synthesized to provide a "snapshot" of the baseline conditions described in Chapter III of the EIS. Because this is a programmatic EIS, involving no new research, the use of existing data was essential. No new research efforts or analytical tools were necessary or warranted for the EIS given the nature of the decisions to be made regarding Restoration Plan alternatives.

After obtaining the necessary understanding of the resources (species) and services (human uses) included in Restoration Plan alternatives, the most important aspect of the evaluation process was to define, to the degree possible, each of the options being proposed for implementation in the various alternatives. In order to do this, all information available describing the options has been reviewed. This includes all option write-ups that currently exist, such as option short-forms, project proposals, "Opportunities for Habitat Protection/Acquisition," and Restoration Framework documents. The specificity of the option descriptions were the limiting factor in the identification of impacts.

Each analyst compared the issues identified in Chapter I with the restoration options affecting the resource or service being evaluated. A determination of the degree to which each of the issues is addressed by each alternative was compiled and presented following the impact analyses of all options and alternatives. This effort was intended to ensure that each issues was addressed to the fullest extent possible.

For resources and services such as air, water, sediment, or designated wilderness areas for which no restoration options were identified, no determination of impact has been made. Statements regarding the future submission of proposals affecting these resources include references to the preparation of additional environmental analyses (i.e., Environmental Assessments or Environmental Impact Statements). In addition to those resources for which no restoration options were proposed, resources or services affected by proposed and possible future options that specifically target an area, species population, or user group may also require further environmental analysis. The intent of identifying this need is to ensure that future options that the Trustee Council may want to consider for funding are not precluded from consideration under the Restoration Plan because they were not considered in the EIS.

The economic impact analysis was conducted apart from the impact analysis for physical, biological, and cultural resources. For the economic impact assessment of Restoration Plan implementation, the USDA Forest Service's IMPLAN economic impact assessment model was used. Results of IMPLAN analyses are presented for each alternative in the Restoration Plan.

IMPLAN is a computer model developed by the United States Department of Agriculture to perform regional economic impact analysis. The model is versatile and allows analysis of economies as small as one county and its associated industries. For this analysis, the Alaska data set, based on 1990 Census data, was used.

Using IMPLAN to perform an economic impact analysis proceeds as follows. First, the regional economy experiences a change, up or down, in demand. Next, the changes in spending and respending associated with the demand change are traced through the economy. Finally, the consequences of the demand change are stated in terms of direct, indirect, and induced changes in regional income, population, and employment.

Direct effects calculated by IMPLAN are changes associated with the immediate effects of changes in demand. Indirect effects reflect changes in input needs such as additional purchases to produce additional output in industries associated with the directly affected industries. Induced effects are the changes in spending patterns caused by the changes in income generated by the direct and indirect effects.

For example, the purchase of development rights would cause a decrease in output by the forest products industry (direct effect). In turn, the industries that supply the forest products industry would see their sales fall (indirect effects). Finally, the decrease in demand would cause income and employment to fall, reducing spending in the economy in general (induced effects). The corollary is also true. In this example, the purchase of development rights increases the income of the owners of the rights. They spend this income, which increases demand for the products they buy (direct effects). In turn, the industries that supply the directly affected industries experience an increase in demand for their products (indirect effects). Finally, this

increase in demand increases employment and income, which stimulates the economy in general (induced effects).

At its simplest level, the estimated change in income and employment is the product of the demand change (in this case, an alternative) and a multiplier. Multipliers are specific to a region and industry. Multipliers have the ability to consider three interrelated factors. First, not all alternative-related income would be spent; some would be saved. Second, some alternative-related spending would occur outside the economic study region. Third, only some alternative-related income spent within the region may create more jobs. The IMPLAN approach considers these factors when it computes multipliers for the economic impact assessment presented in Chapter IV of this DEIS.

DEIS

DRAFT

Chapter III. Affected Environment

This chapter describes the areas within the Gulf of Alaska from Prince William Sound to the Alaskan archipelago directly affected by the *Exxon Valdez* oil spill (EVOS). Part A covers the physical and biological environment including the physical setting, marine, coastal, and terrestrial ecosystems, and individual biological resources. In addition to describing the fish and wildlife of the EVOS area, this section summarizes injury to the biota including results of the natural resource damage assessment studies. Part B covers the social and economic environment in the affected area before and after the spill. This section gives the historical background of the affected regions, as well as information about the socioeconomic and cultural impacts of the spill on affected communities.

A. Physical and Biological Environment

Figure III-A shows the location of the area oiled by the *Exxon Valdez* spill in relation to the rest of the State of Alaska. Within this area, Prince William Sound and the Gulf of Alaska were the areas most severely affected.

1. Physical Setting

The Exxon Valdez Oil Spill (EVOS) area is located in southcentral Alaska, north of the Gulf of Alaska, encompassing a surface area of approximately 75,000 square miles (125,000 km^2). At the northeastern edge of the EVOS area is Prince William Sound, an estuary about the size of Maryland's Chesapeake Bay or Washington State's Puget Sound (Mickelson, 1988). Southwest of PWS are the Kenai Peninsula and Kodiak Island. South of the Kenai Peninsula is the Shelikof Strait, which lies between Kodiak Island and the Alaska Peninsula. The Alaska Peninsula narrows into the Aleutian islands. The EVOS area contains 15 major islands, including Montague, Kodiak, and Afognak; 19 minor islands; and 150 lesser islands.

The geology of the region is young and relatively unstable; glaciers, earthquakes, and active volcanoes are common. In March 1964, an earthquake with an epicenter west of Columbia Glacier shook Prince William Sound for approximately 5 minutes destroying the towns of Valdez, Whittier, and Chenega. Winter winds in the Gulf of Alaska are generally easterly or southeasterly and interact with currents to push waters into Prince William Sound. This produces complex flow patterns resulting in strong downwelling and an outflow of surface waters to the southwest. The majority of the EVOS area has a maritime climate with heavy precipitation, averaging 150 inches (381 cm) annually in Prince William Sound. Much of the area is snow covered in the winter, with up to 21 feet (6.4 m) of snowfall per year in Valdez. In Prince William Sound, 15 percent of the total area, mostly in the mountains, is covered with permanent ice and snow. Temperatures in the region range from approximately 20° F (4° C) in January to a high of approximately 50° F (13° C) in the summer (Mickelson, 1988).

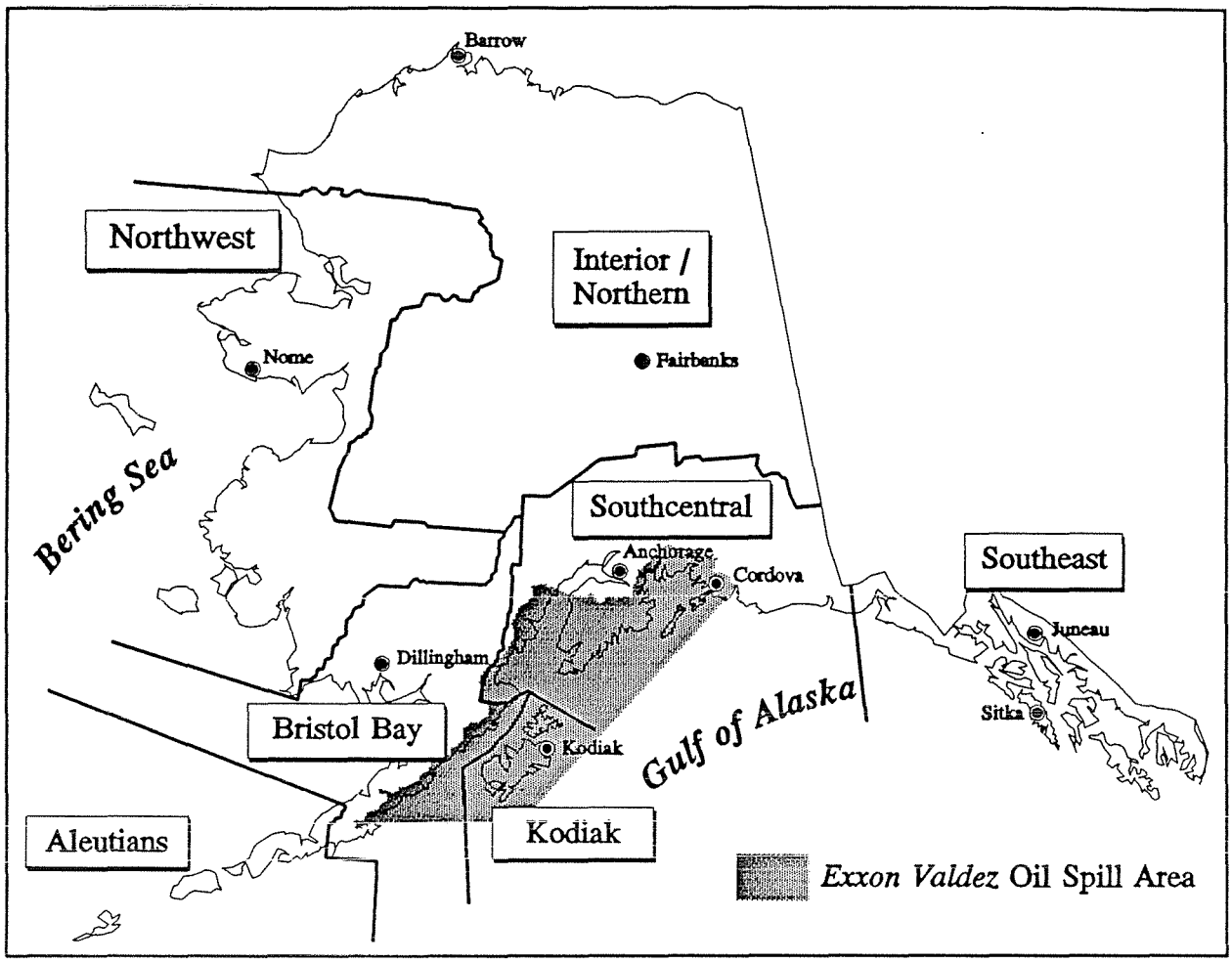


Figure III-A. *Exxon Valdez* oil spill in relation to Alaskan Census Regions.

2. Greater EVOS Ecosystem

The EVOS region contains a diverse system of marine, coastal, and terrestrial ecosystems that together constitute one of the largest and least developed regional ecosystems in the United States.

a. Marine Ecosystem

The marine ecosystem in the EVOS area is characterized by deep water (hundreds of meters) and cold temperatures. High winds and strong currents provide mixing of waters and can produce 20 m waves. Prior to the oil spill, water quality in the region was considered pristine. Total primary production in the region may be two to four times greater than in the open ocean. Phytoplankton (usually dominated by diatoms) are patchily distributed both horizontally and vertically depending on hydrographic and chemical conditions. In highly productive areas, such as Prince William Sound, a large phytoplankton bloom occurs in the spring and declines during the summer. Zooplankton follow the distribution of phytoplankton and peak 1 to 2 months later. Euphausiids, copepods, and other zooplankton are the major food source for many marine species, including whales and salmon.

Polychaete annelids and mollusks dominate a diverse benthic community of more than 200 species to depths of 200 m. Soft corals also occur throughout the region (USDOI BLM 1986).

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

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

b. Coastal Ecosystem

The coastal ecosystem is vital to the health of the greater EVOS area ecosystem. It connects the highly productive marine ecosystem to the rugged terrestrial ecosystem and provides food and shelter for marine and terrestrial organisms. Tectonic and glacial influences have produced an extremely irregular coast characterized by long beaches and dune ridges backed by high marine terraces. Short meltwater streams and large river deltas add to the diversity of the coastal topography. The supratidal zone is important for marine mammal haulout areas and many terrestrial species. The intertidal and subtidal zones contain diverse communities of their own and are critically important for maintaining the food chain to both marine and terrestrial organisms.

The intertidal zone is reaches from low to high tide and is intermittently inundated. Inhabitants of the intertidal zone include algae (e.g., *Fucus*), mussels, clams, barnacles, limpets, amphipods, isopods, marine worms, and certain fish species. The intertidal zone is used as a spawning area by many species of fish and as a feeding ground for a variety of marine organisms (e.g., sea otters, Dungeness crabs, juvenile shrimps, rockfish, cod, and juvenile fishes), terrestrial organisms (e.g., bears, river otters, and humans), and birds (e.g., black oystercatchers, harlequin ducks, numerous other species of ducks, and shorebirds) (Peterson, 1993). Because of the nature of the intertidal environment, the intertidal zone is especially vulnerable to initial and continued contamination in the event of an oil spill, as well as to the effects of cleanup operations (Exxon Valdez Oil Spill Trustees, 1992).

The subtidal zone extends from the low tide boundary of the intertidal zone into the open water area. Because the near coastal subtidal community is similar in many respects to the intertidal community, it is considered separately from the marine ecosystem. Inhabitants of the shallow subtidal zone

include amphipods, clams, eelgrass, crabs, juvenile cod, *Laminaria* plants, spot shrimp, and many other organisms. Like the intertidal zone, the subtidal zone is especially vulnerable to oil spills.

c. Terrestrial Ecosystem

The Exxon Valdez Oil Spill area falls almost entirely within the Oceanic Forest-Tundra Province of Bailey's (1989) ecoregional classification. This Province is part of the Marine Regime Mountains Division and Humid Temperate Domain. Within the EVOS area, three more specific biogeographic regions can be identified—Prince William Sound, Kenai Peninsula, and Kodiak Archipelago (Alaska Peninsula). The landforms and vegetation present in each region vary dramatically, but all are heavily influenced by a history of glaciation. Glaciers are still present at high elevations in all three regions. At lower elevations, ecological conditions vary between mountainous fjord and glacier-dissected rainforest areas and flat coastal deltas of the large rivers.

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

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

A wide range of bird and mammal species inhabit the terrestrial ecosystem of the EVOS area and many are more abundant there than anywhere else throughout their range. More than 200 species of birds occur in the EVOS area with more than 100 being shorebirds and seabirds. Approximately 100 species of these birds are year-round residents. Important nesting and breeding areas include the Copper River Delta, Kenai Peninsula, lower Cook Inlet, and the Kodiak and Afognak Island coasts. Moderate populations of bald eagle and peregrine falcon occur and the endangered Aleutian Canada goose and short-tailed albatross may be seasonal visitors to the area. The EVOS region contains 33 species of terrestrial mammals including brown and black bear, moose, Sitka blacktail deer, mink, and river otter. In addition to the five species of anadromous Pacific salmon (chinook, coho, pink, chum, and sockeye), many other fish contribute to the areas diverse inland aquatic communities including Dolly Varden char, rainbow and cutthroat trouts, lake trout, arctic grayling, whitefish, and turbot.

Of the 15 million acres within the oil spill area, 1.8 million are private lands (Figure III-B). Most of these lands were converted from public to private ownership during the last 20 years as a result of the Native Claims Settlement Act. Lands chosen for conversion to private uses were primarily commercially valuable timber lands. Publicly owned lands include a diverse number of designations, both state and federal. The USDA Forest Service manages Chugach National Forest predominantly for recreation and fish and wildlife. There have been no timber harvest on the forest since the mid to late 1970s, and no harvests are currently planned. The USDOI National Park Service administers [redacted] million acres in the Kenai Fjords National Park, Lake Clark National Park and Preserve, Katmai National Park and Preserve, and the Aniakchak National Monument and Preserve. Both the Kenai and Katmai Parks consist of large areas of federal designated wilderness or wilderness study areas. The western portion the Chugach National Forest is also a wilderness study areas. The USDOI Fish and Wildlife Service administers million of acres in the Kenai National Wildlife Refuge, Kodiak NWR, Alaska/Becharof NWR, and Alaska Maritime NWR. Numerous State classifications, including parks (including Kachemak Bay State Park), critical habitat areas, game refuges, and marine parks, exist in the oil spill area. All of these areas are afforded some degree of protection from land uses that could adversely affect or slow the recovery of injured resources and services. Wilderness areas in particular provide strict protection against future degradation of the ecosystem, but also preclude enhancement activities within their boundaries.

Land management activities, especially those that involve timber harvesting (either clear-cut logging or selective cutting), have important consequences for the recovery of injured resources in the EVOS area. Although timber harvesting is allowed on some Federal and State lands, it is the primary activity planned for the majority of forested private lands. Therefore, the proportion of sensitive EVOS area lands in private ownership is a measure of future adverse impacts to the ecosystem that may slow natural recovery of injured resources.

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

3. Biological Resources

The EVOS area supports a diverse collection of wildlife. The *Exxon Valdez* oil spill occurred in March, just before the most biologically active season of the year. The spill coincided with the migration of birds and the primary breeding season for most species of birds, mammals, fish, and marine invertebrates in the spill's path. Oil from the spill affected each species differently. For some

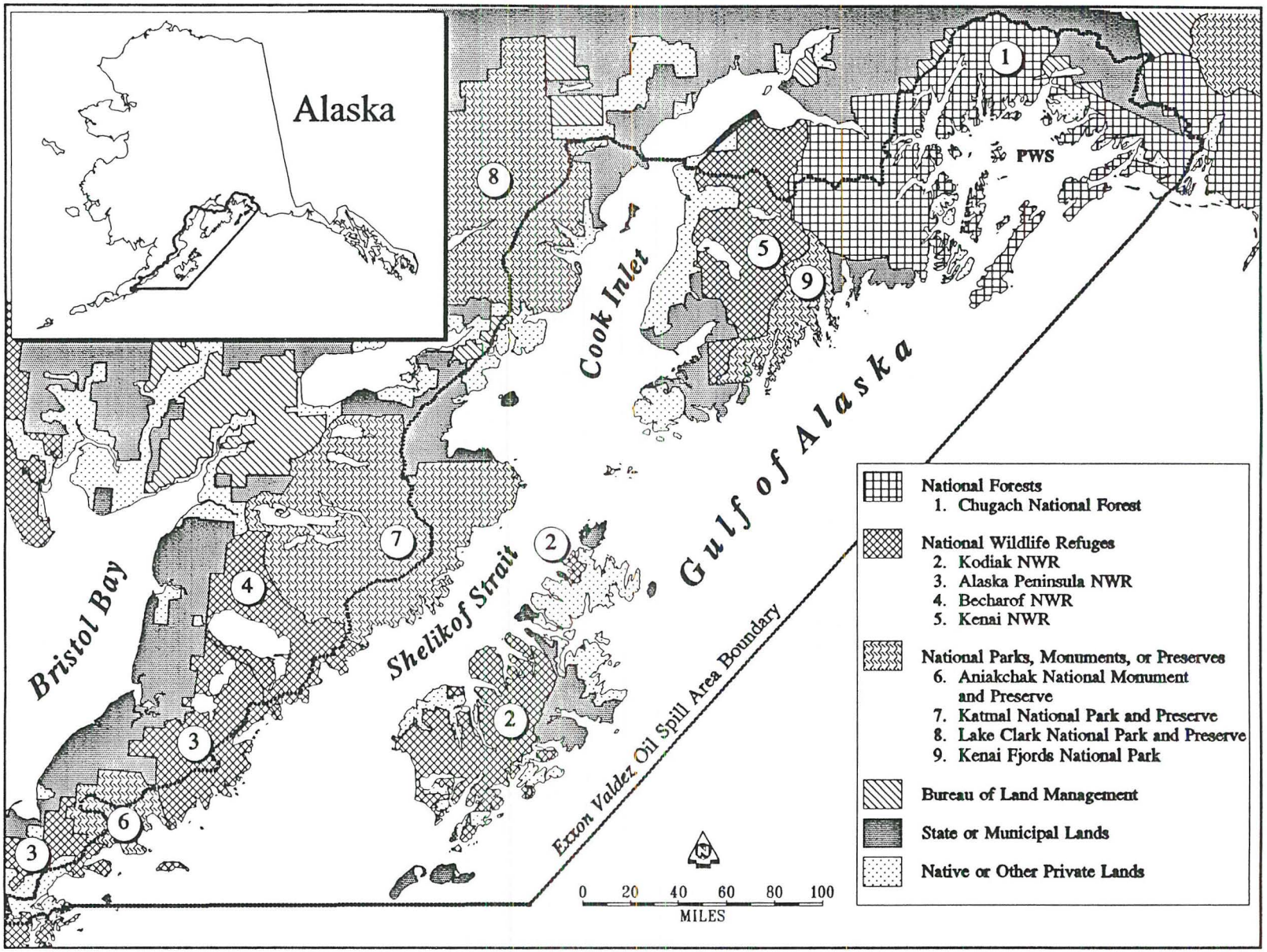


Figure III-B. General land status in the *Exxon Valdez* oil spill area.

species, the population measurably declined. For example, an estimated 3,500 to 5,000 sea otters were killed by the spill, and the population is not expected to recover for many generations. Other species were killed or injured by the spill, but the injury did not measurably decrease the overall population. The populations of some species, such as marbled murrelets, pigeon guillemots, and harbor seals, were declining before the spill. Their rate of decline was accelerated by the spill, but other factors such as variations in climatic conditions, habitat loss, or increased competition for food may also have influenced long-term trends in their health and populations. Still other species may have been indirectly affected by changes in food supplies or disruption of their habitats.

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

a. Marine Mammals

Harbor Seals

The harbor seal (*Phoca vitulina richardsi*) is a protected species under the Marine Mammal Protection Act of 1972, which placed a moratorium on the taking of harbor seals except for subsistence use by Native Alaskans. The harbor seal is under the management of the State of Alaska Department of Fish and Game, and the U.S. Fish and Wildlife Service.

Harbor seal pre-spill populations along the south coast of Alaska have been estimated at 125,000 (Lentfer, 1988). The harbor seal population has been declining by approximately 11-14 percent annually for unknown reasons (Frost and Lowry, 1993). In portions of its geographic range, the harbor seal was and is now in direct competition with human subsistence, recreational, and commercial resource users for fish. Bycatch of harbor seals from commercial fishing activity has been estimated to cause 2,800 seal deaths a year (Lentfer, 1988). The harbor seal is also harvested by Native Alaskans for subsistence use. Natural predators of harbor seals include killer whales and sharks.

Approximately 350 harbor seals were killed directly by the oil spill (Frost and Lowry, 1993). Following the spill, near-shore densities of harbor seals declined by 44 percent. In 1992, counts of harbor seals at molting sites in oiled regions were 34 percent lower than in 1988, while counts in un-oiled regions were 18 percent lower (Frost and Lowry, 1993).

Life cycle requirements of the harbor seal include sources of fish, octopus, squid and shrimp for food, and protected haulout sites for pupping and molting. During pupping and molting periods, harbor seals are very susceptible to disturbance and are prone to stampeding. Stampeding can cause injuries and deaths, as well as weaken the mother-pup bond, resulting in higher pup mortality (Johnson et al., 1989). Factors influencing the population recovery for harbor seals include high mortality in first year of life; the seal's annual reproductive rate (1 pup); and age to reproductive maturity (2-6 years).

Steller's Sea Lions

The sea lion (*Eumetopias jubatus*) has been classified as "threatened" under the Endangered Species Act of 1973. The sea lion is a protected species under the Marine Mammal Protection Act of 1972, which placed a moratorium on the taking of sea lions except for subsistence use by Native Alaskans. The sea lion is under the management of the State of Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service.

Pre-spill sea lion populations for the Gulf of Alaska have been estimated at 136,000 (Calkins and Pitcher, 1982). Approximately 70 percent of the world population of sea lions is located in Alaska (Johnson et al., 1989). The sea lion population has been in decline since 1980 (Johnson et al., 1989). In Alaska, the sea lion population declined 56 percent from 1985 to 1990 (Alaska Fisheries Science Center, 1991). The sea lion is in direct competition with human subsistence, recreational, and commercial resource users for fish. Natural predators of sea lions include killer whales and sharks.

After the oil spill, oiled sea lions were observed but injuries as a direct result of the oil spill are unknown. Due to pre-existing population declines and the seasonal migrations, post-spill studies on possible impacts of the oil spill to the sea lion population have been inconclusive (Frost et al., 1993).

Life cycle requirements for the sea lion include their age to reproductive maturity (4-7 years) and their annual reproductive rate (1 pup). Other causes of mortality are disturbance and stampeding during breeding season (August being the most critical period), and deaths incidental to commercial fishing (Johnson et al., 1989).

Sea Otters

The sea otter (*Enhydra lutris*) has been classified as "threatened" under the Endangered Species Act of 1973. The sea otter is a protected species under the Marine Mammal Protection Act of 1972, which placed a moratorium on the taking of sea otters except for subsistence use by Native Alaskans. The sea otter is under the management of the State of Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service. Pre-spill and post-spill management of sea otters by these agencies has focused on population monitoring through surveys and monitoring of Native harvest.

Sea otter pre-spill population for the entire State of Alaska was estimated at 150,000 animals (*Exxon Valdez* Oil Spill Trustees, 1992). The population in Prince William Sound prior to the oil spill was estimated at 10,000 animals (*Exxon Valdez* Oil Spill Trustees, 1992). The sea otter population within the oil spill zone was likely at or near an equilibrium density and was limited by prey availability when affected by the oil spill. The sea otter population in portions of its geographic range was and is now in direct competition with human subsistence, recreational, and commercial resource users for crabs, clams, and other benthic organisms. Natural predation of sea otters is limited.

More than 4,000 sea otters were killed directly by the oil spill (Frost et al., 1993). Following the spill, near-shore densities of sea otters declined by 35 percent (Frost et al., 1993). Near-shore densities appeared to have stabilized in 1991 in the oil spill area, but still remained below pre-spill population levels (Frost et al., 1993). Prior to the oil spill, the highest natural mortality levels for sea otters were for juveniles (ages 0-1 years). Monson and Ballachey (1993) report that mortality patterns after the spill have changed, with the highest mortality occurring in prime reproductive-aged sea otters (ages 2-8 years).

Life cycle requirements of the sea otter appear to be intertidal and subtidal invertebrates as food sources and protected areas for use as haulouts. An adequate food supply is critical for sea otters because they must eat large quantities in order to maintain the high metabolic rate necessary to survive in cold waters (Chapman, 1981). The importance of haulouts for sea otters is not fully understood. Sea otters appear to need haulouts for grooming to maintain their fur's insulating capabilities (Van Gelder, 1982) and also may use haulouts for pup rearing and weaning. Factors influencing the population recovery for sea otters are age to reproductive maturity (3-5 years); annual reproductive rate (1 pup); and low juvenile survivorship (Calkins and Pitcher, 1979). Adult sea otter survivorship is generally high in absence of outside mortality events (e.g., oil spills, disease, or harvest).

There are limited management opportunities to increase sea otter populations. Population management is restricted to protecting habitat and monitoring Native harvest.

Killer Whales

The killer whale (*Orcinus orca*) is protected under the Marine Mammal Protection Act of 1972, uunder which a moratorium was placed on harvesting killer whales. Killer whales are managed by the National Marine Fisheries Service (NMFS).

Prior to the Exxon Valdez oil spill, approximately 245 resident and 52 transient killer whales were known to be present in Prince William Sound (Frost, 1993). Detailed data on the population of killer whale pods in Prince William Sound existed at the time of the oil spill.

Population decline and other injuries have been documented in the AB pod in the oil spill area. There is debate about whether the oil spill caused these injuries. Thirteen whales out of 36 in one whale

pod in Prince William sound are missing and presumed dead. Circumstantial evidence links the whale disappearance to the oil spill. Additionally, several adult males have collapsed dorsal fins and social disruption of family units has been observed. In that pod, no new births were recorded in 1989 or 1990; one birth was recorded in 1991; and two births were recorded in 1992. These births suggest that the pod is beginning to recover.

The largest members of the dolphin family, killer whales live and migrate in groups of up to 50 individuals. There are two types of these groups, called pods: resident pods and transient pods. Because transient pods travel great distances throughout the year, resident pods were more likely to have suffered injuries from the EVOS. Resident pods have a more defined social structure, including a home range that may cover an area up to several hundred square miles (Matkin, Dahlheim, Ellis, and Saulitis, 1993). Another factor that may affect the ability of killer whales to recover is their low reproduction rate. The birthing rate of killer whales varies, with 5 years being the average time between calves. The gestation period is about 16 to 17 months and the cow gives birth to a single calf. Killer whales reach sexual maturity at approximately 7 years and have a life span of approximately 25 years. Analysts estimate that recovery of the AB pod to pre-spill numbers could take one to two decades.

Humpback Whales

Humpback whales (*Megaptera novaengliae*) are currently listed under the U.S. Endangered Species Act of 1973. They are also protected under the Marine Mammal Protection Act of 1972. Humpback whales are managed by the National Marine Fisheries Service (NMFS).

The estimated worldwide population of humpback whales is 10,000, with approximately 1,500 occurring in the North Pacific (Ziegesar and Dahlheim 1993).

The population of humpback whales in the Exxon Valdez oil spill area was not believed to be injured. No dead or stranded animals were found during or after the cleanup.

The humpback whale grows is a large whale (up to 48 feet and 50 tons) and eats vast amounts of krill and schooling fishes such as herring, anchovies, and sardines (Grzimek, 1990). Their preferred habitat is along shallow shelves and bank areas, rather than deeper ocean waters. During spring migration, the humpback whale travels well defined routes along the continental coastline to high latitude waters for feeding. In the Northern Hemisphere, the mating and calving season is October to March (Walker 1983). During the breeding season, humpback whales migrate to tropical waters. Like the killer whale, humpback whales have a low reproduction rate, reaching sexual maturity in 7 to 10 years and giving birth every 1 to 3 years.

b. Terrestrial Mammals

Sitka Black-tailed Deer

The Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) is an introduced game species under the management of the State of Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service.

Sitka black-tailed deer were introduced into Prince William Sound and the Kodiak Archipelago in the 1930s (Wallmo, 1978). The present population of deer in Alaska is approximately 350,000 to 400,000. Deer are hunted for sport and for subsistence use by Native Alaskans.

Deer tend to forage in the coastal intertidal areas during the lean winter months. When the oil spill occurred, the uplands were beginning to melt and deer had already begun moving up into the forested regions. No deaths were directly attributed to the oil spill. Slightly elevated hydrocarbon levels were found in some deer tested for human consumption, but the deer were determined to be safe to eat (Exxon Valdez Oil Spill Trustees, 1992).

Life cycle requirements of the Sitka black-tailed deer include old-forest habitat, herbaceous vegetation in the forest understory as food, and coastal vegetation during winter when uplands are snow covered.

Black Bear

The black bear (*Ursus americanus*) has been classified as threatened under the Endangered Species Act of 1973 in the states of Mississippi, Louisiana, and Texas. The black bear is under the management of the State of Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service.

The estimated black bear population in Alaska is more than 100,000. No studies on the impact of the oil spill on the black bear population were performed.

Life cycle requirements of the black bear include use of foraging habitat in coastline intertidal regions, riparian regions, and upland areas. Black bears are omnivorous; their main diet consists of grasses, berries, and assorted plant foods, but they also eat fish during salmon runs in Alaska. Factors influencing population growth of black bears include age to reproductive maturity (3-5 years) (Pelton, 1982); 2-year intervals between offspring production (Jonkel, 1978); and availability of large habitat as range areas.

Brown Bear

The brown bear (*Ursus arctos*) has been classified as "threatened" in the lower 48 states under the Endangered Species Act of 1973. The brown bear is under the management of the State of Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service.

The population of brown bears in Alaska is approximately 32,000 to 43,000. The brown bear competes with human subsistence, recreational, and commercial resource users for fish and clams. The opportunity to observe and photograph brown bears draws thousands of tourists to Katmai National Park and McNeil River State Park annually. In Alaska, brown bears are hunted for sport. On the Alaska Peninsula, approximately 250 bears are harvested annually by residents and non-residents (NRDA, 1990).

After the oil spill, petroleum hydrocarbons were found in brown bear fecal samples in the spill area. A yearling, dead of unknown causes, had a high concentration of petroleum hydrocarbon in its bile (*Exxon Valdez* Oil Spill Trustees, 1992). No brown bear deaths have been directly attributed to the oil spill.

Life cycle requirements of the brown bear include use of foraging habitat in coastline regions in the spring, riparian regions in the summer, and upland areas in the fall and winter (*Exxon Valdez* Oil Spill Trustees, 1992). Black bears are omnivorous. Their main diet consists of grasses, berries, and assorted plant foods. They also eat fish during salmon runs in Alaska. Factors influencing population growth of brown bears include high cub mortality; 2- to 3-year intervals between offspring production (Craighead and Mitchell, 1982); and availability of large range areas.

River Otters

The river otter (*Lutra canadensis*), has been found throughout North America except in the extreme southwest (Trustee, 1992). The river otter is one of the largest members of the weasel family. Found in marshes, wooded stream banks, and all types of inland waterways, river otters are almost completely aquatic, although they sometimes travel overland great distances to reach another stream (Forsyth, 1985).

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

The primary diet of the river otter is fish. They also eat crabs, mussels, clams, snails, and aquatic invertebrates (Walker, 1983), and occasionally birds and small land mammals such as rodents and rabbits. River otters are more prolific reproducers than bears, with a gestation period of 60 to 63 days (Toweill and Tabor, 1982) and females breeding more than once a year at age 2. Predators include bobcat, lynx, coyote, wolves, bald eagle and great horned owl when they are young.

Management and protection of habitat and harvest restrictions may be the only opportunities available to increase river otter population. Because no prespill population data are available, a monitoring program would be required to determine the effectiveness of implementing these programs.

c. Birds

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) lives only in North America, ranging from south of the arctic tundra in Alaska and Canada to the southern United States and Baja California in Mexico. In all States where it occurs, except Alaska, the bald eagle is classified as an endangered or threatened species and receives Federal protection under the Endangered Species Act (16 U.S.C. §1543 [1976 & Supp. V 1981]). Although the bald eagle in Alaska is classified as neither threatened nor endangered, the species is protected under the Bald Eagle Protection Act of 1940 (16 U.S.C. §§668-668d [1976 & Supp. V 1981]) and the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

Prior to the oil spill it was estimated that 4,000 bald eagles resided in the Prince William Sound area and 8,000 to 10,000 bald eagles resided along the northern Gulf of Alaska coast. A minimum of 200 to 300 eagles were estimated to have been killed by the spill. However, because population census techniques are not accurate enough to detect population changes this small, no measurable population decline has been recorded. Productivity in Prince William Sound was disrupted in 1989 but returned to normal in 1990. Exposure to oil and some sublethal injuries were found in 1989 and 1990, but no continuing effects were observed on populations. Bald eagles are recovering, or may already have recovered, from the effects of the oil spill.

Water is the feature common to bald eagle nesting habitat. Nearly all bald eagle nests are within two miles, and the vast majority are within a half mile, of a coastal area, bay, river, lake, or other body of water (Grubb, 1976; Lehman, 1979). Proximity to water reflects the dependence of bald eagles on fish, waterfowl, and seabirds as primary food sources. On National Forests in Alaska, protection measures for bald eagles and their nesting habitats are prescribed in the Memorandum of Understanding between the USDA Forest Service and the U.S. Fish and Wildlife Service. The Memorandum provides for the exclusion of all land-use activities within a buffer zone of 100 meter radius around all active and inactive bald eagle nests.

Abundant, readily available food resources are a primary characteristic of bald eagle wintering habitat. Most wintering areas are associated with open water, where eagles feed on fish or waterfowl, often taking dead or injured animals that are easy to find. Wintering bald eagles also use habitats with little or no open water if other food resources, such as carrion, are regularly present (Spencer, 1976).

Peale's Peregrine Falcon

Peale's peregrine falcon (*Falco peregrinus pealei*) is a very large, dark western form, or subspecies, of the peregrine falcon. In North America it nests from the Aleutians, occasionally the Pribilofs, south to Queen Charlotte Island. In winter it migrates to California (Brown and Amadon, 1968). Though some of the subspecies of peregrine falcon are on the Endangered Species List, the race

pealei has been considered stable and is apparently maintaining its population. This species is protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

Cade (1982) has estimated that the number of breeding pairs in Alaska prior to the spill may have consisted of 500 in the Aleutians and 200 in southeastern Alaska. There was no known mortality or population decline of this species associated with the oil spill. When compared with the results of a 1985 survey, a reduction in population and lower than expected productivity was measured in 1989 for Prince William Sound, but the cause of these changes is unknown.

During the breeding season, peregrines frequently inhabit offshore islands where bluffs provide suitable undisturbed nest sites and an abundance of food from nearby colonies of nesting seabirds. At all seasons, open country is preferred, particularly shores and marshes frequented by shorebirds and waterfowl.

Common Murre

The subspecies of common murre found in Alaska (*Uria aalge inornata* Salomonsen) breeds from the Commander Islands, Saint Matthew Island, and northwestern Alaska to Kamchatka, the Kurile Islands, southern Sakhalin, eastern Korea, and Hokkaido, and through the Aleutian and Pribilof Islands to southern British Columbia (Johnsgard, 1987). This species is protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

Data from the U.S. Fish and Wildlife Service's seabird colony catalog (Sowls *et al.*, 1978) indicate that prior to 1989 only 230,000 to 350,000 breeding-age murres occupied colonies in those areas of the Gulf of Alaska most exposed to oil. Assuming that the population was at equilibrium prior to the spill, and that survival rates of different age classes were similar to those in populations for which survival estimates have been obtained, the total population of adults and sub-adults would have been roughly 350,000 to 750,000 murres (Heinemann, 1993). With the 1989 oil spill, between 175,000 and 300,000 murres were killed. Measurable impacts on populations were recorded in 1989, 1990, and 1991. Breeding was still inhibited in some colonies in the gulf of Alaska in 1992. The degree of recovery varies between colonies, and some colonies show little evidence of recovery.

Breeding colonies of common murres are largely restricted to subarctic and temperate coastlines on rocky coasts that usually have steep seaward cliffs, though low-lying coasts may also be used if they are remote and predator-free. Stratified rock layers providing nesting ledges, or weathered pinnacles and similar promontories, are important habitat components (Tuck, 1961). Murres normally nest in dense colonies and breeding is synchronized so that all young hatch at the same time. Synchronized breeding helps satiate predators such as gulls and ravens. Murres are highly social birds on the breeding areas, with maximum densities of 28 to 34 birds per square meter reported by Tuck (1960), with some birds occupying no more than 500 cm^2 (about 0.5 square feet) of ledge. No nest is built, though a few pebbles or other materials may be dropped at the nest site, perhaps to reduce rolling of eggs early in incubation before the egg has become cemented to the substrate by excrement and

sediment (Johnsgard, 1987). Only one large pyriform (pear-shaped) egg is laid. If disturbed, the egg usually rolls in a small circle around its pointed end. There is often a fairly high loss of chicks to exposure or falls during the first 6 days after hatching, after which their clinging, hiding, and thermoregulation abilities have become better developed (Johnsgard, 1987).

Breeding success has been reported to be between 70 to 80 percent of young fledged per breeding pair (Birkhead, 1977; Hedgren, 1980). Birkhead (1974) estimated a 6 percent annual adult mortality rate and stated that most birds probably do not begin breeding until their fifth year. A 6 percent mortality rate results in an average life expectancy for adults of 16 years. Banded birds have been known to survive as long as 32 years, however.

Non-breeding habitats are coastal and pelagic areas. Typically, they are found in the offshore zone (at least 8 kilometers out to sea), and no more than a few hundred kilometers offshore at their southernmost breeding limits (Tuck, 1961). The common murre feeds predominantly on fish throughout the year. Prey are captured by extended dives, mostly at depths of 4-5 meters, but sometimes by bottom feeding at 8 meters (Madsen, 1957). Foraging tends to occur in flocks early in the breeding season, but as the year progresses, murres begin to forage individually.

The largest scale continuing injury to birds from the oil spill is with the common murre. Many young birds, apparently attempting to breed for the first time at age 4 or 5 years, have returned, but the courtship and egg laying patterns of the birds are poorly synchronized and occur nearly a month later than they should. This fragmented, late breeding has resulted in increased predation of eggs and chicks, and winter storms have swept more than 100,000 young chicks off the cliffs (Fry, 1993).

Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratum marmoratum*) breeds on islands and in coastal areas from southeastern Alaska to northwestern California. In Alaska, it is probably a common to abundant breeder in southeastern and south-coastal areas, a resident and probable local breeder in the Alaska Peninsula and also the Aleutians, and a casual summer visitor in western areas (Kessel and Gibson, 1976). The marbled murrelet is a species of concern in Alaska and is listed as threatened under the Endangered Species Act (16 U.S.C. §1543 [1976 & Supp. V 1981]) in Washington, Oregon, and California. This species is also protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

Islieb and Kessel (1973) estimated a total marbled murrelet population of several hundred thousands, possibly in the millions, in the north Gulf Coast and Prince William Sound region of Alaska. Marbled murrelet populations were declining prior to the oil spill. The 1989 spill caused population declines, but it is unknown if there were sublethal injuries. It is estimated that 8,000 to 12,000 birds died. Measurable population effects were recorded in 1989, 1990, and 1991 as a result of the oil spill. In 1992, recovery was uncertain and no signs of an increasing population had been observed, but the decline may since have stabilized.

The total breeding distribution of this species is poorly understood, but it apparently is limited to fairly warm waters of the west coast of North America. It is most closely associated with the humid coastal areas supporting wet-temperate coniferous forests with redwood, Douglas fir, and other ecologically similar species, but it also inhabits coastlines along tundra-covered uplands along the Alaska Peninsula and in the Aleutian Islands. In winter the birds move farther south, sometimes as far as southern California, but some wintering occurs on protected waters as far north as the Kodiak area of Alaska and as far west as the Aleutians (Forsell and Gould, 1981). For most of the year the birds seem to prefer semiprotected waters of bays and inlets, making only limited use of rock coastlines (Hatler, Campbell, and Dorst, 1978).

The murrelet eats small fishes it catches by diving in tide rips and other places where small fishes swim in schools. The major fish prey, sand lance (*Ammodytes*), belongs to a group of fish in which the young of the previous fall and winter tend to migrate to surface waters and move inshore in late spring, when they would become available to the murrelets. The murrelet's fall and winter diet is essentially unknown, but samples from a few birds suggest that sea perch (*Cymatogaster*) may be an important food item, and possibly also mysid and schizopod crustaceans (Sealy, 1975). Nearly all foraging is done in fairly shallow water close to shorelines. During the course of a study involving fishermen who salvaged dead birds for inspection, Carter and Sealy (1984) found that the marbled murrelet was the most frequently killed alcid. Marbled murrelets were killed almost exclusively at night and within 2 meters of the surface. They estimated that this accounted for 7.8 percent of the potential fall population, or 6.2 percent of the breeding birds. They also reported 600 to 800 murrelets killed annually in Prince William Sound.

Day, Oakley, and Barnard (1983) summarized data on eight known and one probable marbled murrelet nest. They ranged in elevation from 68 to 690 meters above sea level and from less than 1 kilometer to 24 kilometers from the coastline. The nest sites varied considerably in slope and directional aspect, though a possible preference for shady north-facing slopes has been suggested.

Storm Petrels

Storm petrels are among the smallest of the seabirds, measuring between 7½ and 9 inches [equivalent] in length and having a wingspan of 18 to 19 [equivalent] inches. With the exception of the breeding and nesting period, these birds spend their entire lives on the ocean. Two species of storm petrels are known to occur in Alaska. Those species are the fork-tailed storm petrel (*Oceanodroma furcata*), and Leach's storm petrel (*Oceanodroma leucorhoa*). The fork-tailed storm petrel occurs in the northern Pacific from the Bering Sea to southern California (Terres, 1980). The breeding range includes the Kurile, Komandorskie, and Aleutian Islands, southward along the North American Pacific coast to northern California. Leach's storm petrel occurs throughout the oceanic portion of the northern hemisphere. This species' breeding and nesting range includes coastal islands in the northern Pacific and northern Atlantic. In the Pacific, breeding occurs on the Kurile and Aleutian Islands, Alaska, and southeast along the Pacific Coast to Baja California (Godfrey, 1979;

Terres, 1980). Storm petrels are protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

Data from the U.S. Fish and Wildlife Service's seabird colony catalog (Sowls *et al*, 1978) indicate that approximately 150,000 storm petrels colonized the Barren Islands for breeding and nesting prior to the oil spill. Post oil spill studies (Fry, 1993) indicated that storm petrels were not directly impacted by the oil spill because they did not return to their breeding colonies until most of the oil had drifted away from the Barren Islands. However, 363 storm petrel carcasses were recovered after the spill, indicating that a number of individuals of this species were killed at sea. Injury assessments indicated that storm petrel reproduction was normal in 1989, although petrels had reportedly ingested oil and transferred that oil to their eggs. There has been no documented change in the current storm petrel population status, and no decline in population following the oil spill.

The petrel's primary food sources are small fishes, crustaceans, mollusks, small squids, and oily materials gleaned from the ocean (Terres, 1980).

Habitat requirements for storm petrels include the open ocean and coastal islands for nesting purposes. For breeding purposes, storm petrels prefer offshore islands. The preferred breeding and nesting habitats are burrows or rock crevices on marine islands and islets, although they have been known to nest up to 1 mile inland (Terres, 1980). The burrow is usually approximately 3 feet long, somewhat angled, and is excavated by the petrel. Some plant debris may accumulate at the nest site. Banding has shown that older breeding birds are the first to return to the nesting site in spring, and that pairs often return to the same nest burrow each year. It is thought that the species mates for life (Terres, 1980). As this species nests in burrows, primary predators in the oil-spill area included foxes that have been introduced to the islands.

The breeding season begins in late May for Leach's storm petrel and in June for the fork-tailed storm petrel. A single clutch consisting of one egg is produced. If that clutch is destroyed, storm petrels do not produce a second egg (Harrison, 1978). Incubation begins when the first egg is laid, usually in late May or early June for Leach's storm petrel and June to July for the fork-tailed storm petrel. Incubation lasts from 5½ to 7 weeks (Terres, 1980). The fledglings are usually deserted by the parents after 40 days. The young remain in the nest, living on fat reserves, and emerge at night to exercise as their feathers grow. The fledglings leave the nest for the sea 63 to 70 days after hatching (Harrison, 1978).

Black-legged Kittiwake

The black-legged kittiwake (*Rissa tridactyla*) is a marine bird occurring throughout the northern part of the northern hemisphere. With the exception of the breeding season, this species occurs almost exclusively in offshore waters. The nesting range includes islands and shores of the Arctic Ocean south to the Aleutian Islands and southern Alaska, southern Newfoundland, France, the Kurile Islands, and Sakhalin. The winter habitat range extends south to Baja California, southern New

Jersey, northwestern Africa, and Japan (Godfrey, 1979). This species is protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

Black-legged kittiwakes were among the most abundant colonially nesting seabirds in Prince William Sound (Irons, 1993). Additionally, the U.S. Fish and Wildlife Service's seabird colony catalog (Sowls *et al*, 1978) documented 46,600 kittiwakes utilizing the Barren Islands for breeding and nesting. Ten of the 27 colonies within Prince William Sound were subjected to the oil spill. In 1989, 1,225 carcasses were recovered from beaches after the oil spill. Post-spill monitoring has shown that overall, the number of breeding pairs did not substantially decline subsequent to the oil spill. However, the reproductive success of the kittiwakes at the oiled colonies was lower than expected in 1990, 1991, and 1992 when compared to previous years reproductive success (Irons, 1993). In 1989, kittiwakes built their nests using contaminated seaweed (i.e., *Fucus*). It is possible that reproductive failure of some kittiwake colonies may have been related to this oil exposure (Fry, 1993). Additionally, the brood size of fledglings decreased, suggesting less available food (Irons, 1993).

In 1989, contaminant analyses indicated that one out of 10 kittiwakes from oiled colonies contained hydrocarbon contaminated tissues. A follow-on study carried out in 1990 indicated that none of the birds collected in the oil spill area had contaminated tissues, but two out of five kittiwakes examined had ingested hydrocarbon contaminated material suggesting that oil may have persisted in the food chain (Irons, 1993).

The kittiwake's primary food sources are small fishes and small mollusks, crustaceans, and other plankton (Terres, 1980).

Black-legged kittiwakes often nest in dense colonies, usually on high cliffs overlooking the sea, and in sea caves. Their nest sites may be associated with murres and other seabirds. Their breeding season begins in May. Nests are deeply cupped and constructed of grass, mud, moss, and seaweed (Terres, 1980). Nests are often built on small projections or irregularities in the rock face. On the average, a single clutch consisting of two eggs is produced. Incubation lasts from 25 to 30 days (Harrison, 1978). Although black-legged kittiwakes are a single-brooded species, lost clutches are often replaced. The nestlings are tended by both adults, and are fledged between 38 and 48 days of hatching (Terres, 1980).

Pigeon Guillemot

Pigeon guillemots (*Cepphus columba*) have been documented as year-round residents of the Gulf of Alaska and the Aleutians. They are generally dispersed as single birds or small colonies of fewer than 1,000 individuals. In the winter, they move from exposed coastlines to sheltered bays and inlets. The winter range encompasses the Pribilof and Aleutian islands to the Kamchatka and the Kurile Islands, and south to California. During the nonbreeding season, the birds are nonpelagic and fairly sedentary. They rarely move into water more than [equivalent] 50 meters deep, and they tend to spread out thinly along coastlines in winter. Their breeding range extends from Chukotski Peninsula

and Diomede Islands to southern Kamchatka, and from Saint Lawrence and Saint Matthew islands and the Aleutians west to the Attu, Bogoslof, and Shumagin Islands, Kodiak, and southeastern Alaska south to Santa Barbara Island, California. The pigeon guillemot is protected under the Migratory Bird Treaty Act (16 U.S.C. §§703-711 [1976 & Supp. V 1981]).

Population estimates of the pigeon guillemot have suggested that approximately 200,000 lived in Alaskan waters in the late 1970s (Johnsgard, 1987). Boat surveys conducted in 1973 indicated that the Prince William Sound population was approximately 14,600. Subsequent to the oil spill, over 500 guillemot carcasses were recovered, and between 1,500 and 3,000 guillemots were estimated to have been killed by the spill. In 1989, population levels were found to be 25 to 36 percent lower than those documented in the early 1980s on Naked Island in Prince William Sound. Population estimates for this species in 1989, 1990, and 1991 were, respectively, 4,000, 3,000, and 6,600. The population has continued to show a decline through 1992 (Oakley and Kuletz, 1993).

Overall, data indicate that the pigeon guillemot population in Prince William Sound was declining prior to the spill, and post-spill declines were significantly greater in oiled areas. Post-spill surveys indicate a 40 percent decline in pigeon guillemots of the Naked Island group when compared to pre-spill surveys. Declines have corresponded to the degree of shoreline oiling (Oakley and Kuletz, 1993).

Pigeon guillemots suffered breeding losses as a result of oiling, disturbance from clean-up activities, or a combination of the two in 1989 and 1990 (Fry, 1993). In 1990, studies showed an increase in the number of active nests compared to 1989, suggesting that breeding in 1989 was disrupted either through decreased hatching success or because fewer pairs initiated nests. Although the number of active nests increased in 1990, reproductive success was poor due to low hatching success and predation. Oil was found on the surface of guillemot eggs that had failed to hatch in 1989 and 1990, suggesting decreased hatching success was directly related to the oil spill and that guillemots were still being exposed to oil one year after the spill.

There are limited management opportunities to increase pigeon guillemot populations. Identification, restoration, and protection of important nesting and feeding areas would facilitate population restoration.

The pigeon guillemot is a diving bird that feeds on bottom dwelling small fishes (e.g., blennies, sculpins, cods), schooling fish (e.g., sand lance, herring), mollusks, crustaceans, and marine worms (Oakley and Kuletz, 1993; Terres, 1980). This species is heavily dependent upon the nearshore and intertidal environments. Most of the guillemot's prey are found on or over rocky bottoms within the subtidal zone (Johnsgard, 1987). Dietary preferences may vary between individuals of this species.

The pigeon guillemot breeding season begins in mid-May to mid-June, depending on latitude. The pigeon guillemot nests either solitarily or in small colonies (Terres, 1980). Nesting distribution may be dictated by the availability of nesting sites rather than by any colonial tendency, and is thought to

be related to the use of inshore feeding areas. Breeding densities have been documented to range from 5 to 110 pair per colony (Johnsgard, 1987). Nests are often located in crevices or cavities under rocks, in crevices, or in similar cavity sites (Harrison, 1978). This species is also known to nest under railroad ties, use abandoned puffin and rabbit burrows, and nest on bridges and beneath wooden piers (Terres, 1980). In rocky habitats, the nests are usually close to water, often near the high-tide line. Throughout the breeding season, pigeon guillemots use the supratidal and intertidal areas in front of the nest sites for feeding and social activities (Johnsgard, 1987). Eggs are typically deposited on the bare cavity floor of the nest site, as no nest-lining materials are ever brought into the cavity. The female produces one clutch consisting of two eggs. This species is thought to be single-brooded, as the incidence of renesting after the loss of the initial clutch is still unproven (Johnsgard, 1987). Both sexes incubate, with incubation lasting from 30 to 32 days (Terres, 1980). Losses of eggs before hatching are sometimes fairly high. Causes of egg failure are diverse and include human disturbance, heavy rainfall causing nest desertion or chilling, and predation (Johnsgard, 1987). Egg survival may be affected by crow and gull predators. The northwestern crow (*Corvus caurinus*) has been identified as a serious guillemot egg predator (Bent, 1919).

The young are able to fly 29 to 39 days after hatching (Terres, 1980). At fledging time, the chicks are led from the nest to the water or, if necessary, fly or glide down from higher sites. The adults then either cease to tend the chicks, leaving them to feed in nearby kelp beds (Thoreson and Booth, 1958), or convoy the chicks to deeper water where they are tended by adults for about a month after leaving the nest (Johnsgard, 1987). It is thought that pigeon guillemots do not begin breeding until they are 3 to 5 years of age.

Glaucous-winged Gull

The glaucous-winged gull (*Larus glaucescens*) occurs primarily along the Pacific coast of North America. The summer range extends from Alaska and St. Lawrence Island, the Pribilofs, and the Aleutians south to northwestern Washington. The winter range extends from southeastern Alaska along the Pacific coast to Baja California (Terres, 1980). This species is protected under the Migratory Bird Treaty Act (U.S.C. §§703-711 [1976 & Supp. V 1981]).

Damage assessment reports indicate that 555 glaucous-winged gull carcasses were recovered from the beaches in the spill-affected area in 1989. However, there has been no evidence of population level impacts associated with the spill, when compared to historic population levels (1972 and 1973).

The glaucous-winged gull is oceanic in its habits, is most often found in the vicinity of salt and brackish water along the northern Pacific coast, and is rarely found more than a few miles offshore. This species is omnivorous, scavenging for garbage on docks, dumps, and shores near coastal cities. Glaucous-winged gulls follow boats and ships up and down the coast in search of food, and will eat carrion and fishes at sea. From the nearshore areas, this species gathers barnacles, mollusks, and sea urchins for food (Terres, 1980; Godfrey, 1979).

Glaucous-winged gulls breed on steep coastal cliffs and rocky islands offshore. They often nest colonially, usually on flat, low islands, rock ledges of higher islands, or on rock outcroppings. Nests are well-made bulky cups of grasses, seaweeds, feathers, fish-bones, and other debris built among tufts of plant life or left in the open on rocky ledges. The breeding season begins in late May. The female produces a single clutch of two to three eggs that are incubated for 26 to 28 days. The young are tended by both adults and leave the nest between 35 and 54 days. Glaucous-winged gulls are single-brooded, but usually replace lost clutches (Harrison, 1978; Terres, 1980).

Harlequin Duck

The harlequin duck (*Histrionicus histrionicus*) is a diving duck common to the northern coastal areas of North America and is a very familiar species along the coasts of the Aleutian Islands and Alaska. The harlequin duck occupies both an eastern and western range in the Northern Hemisphere. The western range includes northeastern Siberia north to the Arctic Circle, across the Bering Sea to the Aleutian Islands, much of the Alaskan interior, and south to northwest Wyoming and central California. The western population is much more abundant than the eastern population, with the main western stronghold located in Alaska. The greatest abundance of harlequin ducks is in the Alexander Archipelago, the Alaska Peninsula, and the Aleutian Islands (Bellrose, 1980; Johnsgard, 1978; Terres, 1980). This species is protected under the Migratory Bird Treaty Act (U.S.C. §§703-711 [1976 & Supp. V 1981]).

Fall and spring migration patterns consist of lateral movements from interior breeding grounds to coastal habitat. A number of ducks migrate from the Alaskan interior to the Aleutians each fall. Additionally, the harlequin duck population in the oil spill area consists of both resident and migratory birds. The migratory ducks spend the winter in Prince William Sound, leaving for their nesting areas in May. In the late 1960s, the May to August population estimates for the Aleutian Islands National Wildlife Refuge ranged from 100,000 to 150,000. Population estimates for this wildlife refuge peak during the winter season (September to April) and range from 600,000 to 1 million individuals (Bellrose, 1980). Currently, the summer population of resident harlequin ducks in the oil spill area has been estimated at approximately 2,000 individuals (Patten, 1993).

More than 200 harlequin duck carcasses were recovered after the oil spill. The total population loss due to the oil spill has been estimated at over 400 harlequin ducks.

Harlequin ducks were chronically exposed to oil remaining in the intertidal zone by direct contact to feathers and skin, and internally through preening and ingestion of contaminated food (e.g., blue mussels). Post-spill population levels have not recovered, and there has been a near total reproductive failure of this species in western Prince William Sound. Overall, studies have concluded that there are two potential causes of reproductive failure in this species: 1) oil exposure from contaminated intertidal food items ingested by ducks causing a cessation of reproduction; 2) human disturbance from the massive clean-up of contaminated shorelines through 1991. The primary cause

of reproductive failure, since failure has continued into 1992, is most likely ingestion of contaminated prey (Patten, 1993; Fry, 1993).

During the summer breeding season, the preferred habitat of the harlequin duck is cold, turbulent mountain streams, or ponds and lakes along rocky arctic shores in remote areas. The species favors forested mountain streams over non-forested streams. Patten and Crowley (1991) found that harlequin duck nesting sites in Prince William Sound were within 25 meters of streams or small tributaries to streams. Cassirer and Groves (1990) observed harlequin broods more often on undisturbed streams, away from human activity. Streams with adjacent logging activity within 50 meters would be unsuitable for harlequin duck breeding activity for more than 20 years after the initial logging cut. This species is sensitive to human disturbance (logging, near shore boating, research activities). Reduced disturbance at breeding and molting sites may increase productivity by allowing paired ducks to maintain their pair-bonds during the pre-nesting and nesting seasons. In winter, the harlequin duck's preferred habitat is heavy surf adjacent to a rocky coastline with shelves, reefs, and sunken rocks in remote areas (Terres, 1980).

Harlequin ducks are not known to breed until their second year. After reaching maturity, adults breed annually. Their breeding season begins in mid-May of each year. Adults congregate at the mouths of anadromous fish streams in spring, and most are paired by the time they leave the coastal wintering area for their interior breeding grounds. Harlequin ducks are primarily surface nesters and may use the same nest site each year. The nests are always well concealed by dense vegetation and are located along the rocky shores of turbulent mountain streams, often adjacent to rapids, in mature forests. Nests are composed of thin layers of grass, twigs, and leaves and are lined with white down (Bellrose, 1980).

The female produces one clutch consisting of three to seven eggs, laid at a rate of one every two days. The male leaves the breeding ground shortly after incubation begins, in preparation for the molt. The incubation period lasts from 27 to 33 days, although the time period has not been firmly established. The ducklings are tended by the female only, and are capable of flying in about 40 days (Johnsgard, 1978; Harrison, 1978; Terres, 1980). The female remains with the brood in the freshwater stream until late summer when they migrate to the coastal habitat.

Harlequin ducks feed by day, usually by themselves, and roost on rocks at night. They prefer water rich in aquatic life. The harlequin is a diving duck, and is well adapted to swimming in torrential currents. They often emerge at their points of entry, indicating an ability to walk along the bottom of the stream against the current. At times they feed by immersing their heads or upending like dabbling ducks (Terres, 1980; Bellrose, 1980).

The harlequin duck feeds primarily on crustaceans, mollusks, insects, echinoderms, and fishes. In the mountain streams during summer, the harlequin will prey on mayfly nymphs, stone flies, caddis fly larvae, and black flies. During the winter months, the duck will feed about sunken wrecks and rock breakwaters, and rocky underwater places. The primary prey in the coastal habitat are crustaceans

(crabs, amphipods, isopods) and mollusks (barnacles, limpets, snails, chitons, blue mussels) that are dislodged from rocks (Bellrose, 1980; Johnsgard, 1978; Terres, 1980).

During the fall, harlequin ducks can be legally harvested in Alaska. Management opportunities to increase harlequin duck populations include temporary restrictions on sport and subsistence harvesting of this species. Additionally, restoration of oiled mussel beds and adjacent anadromous streams; and identification, restoration, and protection of important nesting and feeding areas would facilitate population restoration.

Black Oystercatcher

The black oystercatcher (*Haemotapus bachmani*) is a large shorebird easily distinguishable by its long red bill used to open bivalves. The oystercatcher is often seen on rocky ledges along outer beaches where it preys on attached shellfish exposed by retreating tides. The black oystercatcher's range extends along the Pacific coast from Kiska Island, the Aleutians, Alaska, and south to Baja, California. The species is casual in winter on Pribilof Island and Yukon. The black oystercatcher does not migrate, and winter flocks seldom wander more than 30 miles [equivalent] from their nesting places (Terres, 1980). Observations from Alaska, however, indicate that some birds may disperse in the winter. The black oystercatcher prefers a rocky habitat. Outer saltwater shores and islands are most suitable (Godfrey, 1979). This species feeds in the intertidal zone, primarily on limpets, mussels, clams, and chitons (Terres, 1980). The black oystercatcher is protected under the Migratory Bird Treaty Act (U.S.C. §§703-711 [1976 & Supp. V 1981]).

In 1989, nine (9) black oystercatcher carcasses were recovered from beaches in the oil-spill area. From this number, it has been estimated that 120 adult oystercatchers may have been directly affected by the oil spill. Lost production of chicks from these mortalities was estimated at 1,290 over the expected life of the adults (Sharp and Cody, 1993). Additionally, oiling affected the reproductive success of the remaining black oystercatchers. In 1989, egg size was smaller in oiled areas than unoiled areas. Black oystercatchers may have laid smaller eggs in 1989 because a higher proportion of earlier clutches failed (second clutches tend to be small), or because they ingested oil which affected them physiologically. Oystercatcher feeding areas were surveyed in 1989, and noted to be contaminated with oil. Mussels collected within these feeding territories were severely contaminated with hydrocarbons. Currently, the black oystercatcher population appears to be recovering.

Black oystercatchers may take two to three years to reach sexual maturity. The oystercatcher breeds on coastal sites, preferring rocky shores, promontories, and islands. The highest breeding densities occur on low elevation, gravel shorelines with little wave action. Nests consist of hollows on gravel beaches above the tide line, or hollows of a rocky islet or reef. Nests are often unlined, or lined with a variable amount of small pebbles or bits of stone and shell chips. Nesting begins in late May or early June. This species is single-brooded, but renests to replace lost clutches. The female produces a single clutch of two to three eggs. Both sexes incubate the eggs for a period of 26 to 27 days. The chicks are usually fledged after 30 days but may continue to be fed by the adults. The young are

very active, drawing attention to their location, and are thus vulnerable to predation. Known predators include the river otter, mink, and gulls (Terres, 1980; Harrison 1978; Godfrey, 1979).

d. Fish

Pink Salmon

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

Pink salmon are the most abundant salmon in Cook Inlet, as well as in Prince William Sound. For the years 1973 to 1982, this species made up 39.6 percent of the total catch (numbers of fish) in Cook Inlet, with an annual average catch of 1.8 million. This was about 4.4 percent of the statewide catch of this species during those years. Major pink salmon producing streams that feed into Cook Inlet include the Kenai and Susitna Rivers located at the head of the inlet. The Talachulitna River, a tributary of the Susitna, is probably the most important pink producer, with as many as 1 million pink salmon spawners in some years (Alaska Geographic, 1983).

The extent of injury to pink salmon populations has not yet fully been assessed. However, immediate injury to eggs and larval were recorded. Approximately 75% of wild salmon spawn in the intertidal zone of Prince William Sound. Wild stocks did not shift spawning habitat after the oil spill and most salmon deposited eggs in oiled areas causing increased egg mortality compared to unoiled areas. Egg mortality was 15% in oiled areas and 9% in unoiled areas in 1989. in 1989. In 1991 egg mortality was 40 to 50% in oiled areas and 18% in unoiled areas. The increase in egg mortality in 1991 was hypothesized to be a result of genetic damage from oil contamination to the 1989 eggs and alevins (Bue et.al). In addition, fry growth was decreased and some larvae in oiled areas showed gross morphological abnormalities.

Pink salmon have the simplest and least variable life cycle of all salmon. Adults mature after 2 years and die after their first spawning. Because of this simple life cycle, populations spawning on odd number calendar years are effectively isolated from populations spawning on even number years, therefore, no gene flow occurs between the populations (Bonar et al., 1989). As adults, pink salmon return to their natal spawning grounds in the fall to reproduce, traveling several miles up their natal streams (Scott and Crossman, 1973). However, as much as 75 percent of Prince William Sound populations spawn in the intertidal zone (ADF&G, 1985a). Spawning generally occurs between June and mid-September, and hatching occurs between October and January.

Spawning success is dependent greatly on egg and larval survival. Certain environmental requirements must be met for successful reproduction to occur. Optimum water temperature for spawning is between [equivalent] 7.2 and 12.8 °C. Eggs and juveniles can withstand prolonged low temperatures if the initial temperature was greater than [equivalent] 6°C. Optimum incubation temperatures range from [equivalent] 4.4 to 13.3°C. Pink salmon eggs and alevins exposed to high salinities exhibit increased mortality (Bonar et al., 1989).

Eggs and alevins in the intergravel redd require a minimum of 6.0 mg/l [equivalent] of dissolved oxygen (DO) for successful incubation. Egg survival is dependent on chemical and physical characteristics of the gravel in which they are laid. Egg mortality usually results from oxygen deprivation, freezing, flow fluctuations, dewatering, predation, or microbial infestation (Bonar et al., 1989). Eggs can tolerate temporary decreases in DO, but cannot withstand oxygen concentrations of less than 5.0 mg/l [equivalent] for any length of time. Low DO can cause premature hatching, fry abnormalities, and impairment of swimming performance in adults. The preferred water velocity for successful spawning is 21 to 100 cm/s [equivalent]. Developing eggs and alevin are affected by water velocity through temperature changes, mechanical damage, or reduced intergravel DO concentrations. Although adult pink salmon can tolerate high turbidities during migration, their eggs can be suffocated from increased silt loads, and osmoregulation in young fish can be disrupted. Streams with low turbidities are preferred. Egg to fry survival is from 5 to 10 percent, and fry to adult survival is from 2 to 5 percent.

The diet of pink salmon fry consists primarily of invertebrate eggs, amphipods, and copepods. Juveniles feed primarily on larger invertebrates and small fishes, and adults feed mostly on euphausiids, squid, other invertebrates, and small fishes (Bonar et al., 1989 and ADFG, 1985a). Eggs, alevins, and fry are preyed upon by Dolly Varden, cutthroat trout, coho salmon, other fishes, and aquatic birds. During spawning migrations, juveniles and adults are consumed by terrestrial mammals such as bears and otters, and by marine mammals, predatory birds, and other fishes while at sea (ADFG, 1985a).

Sockeye Salmon

Both hatchery reared and wild stocks of sockeye salmon *(Oncorhyncus nerka)* are managed in freshwaters and within a three mile limit in marine waters by the Alaskan Department of Fish & Game (ADF&G). The North Pacific Fishery Management Council prepares management plans, which become Federal law, and applies them to marine waters from the 3 mile limit to the 200 mile limit. The International North Pacific Fisheries Commission (INPFC) provides conservation measures that limit location, time, and number of fishing days beyond the 200 mile limit.

Commercial harvest of sockeye salmon was reduced in portions of Cook Inlet, Chignik, and Kodiak in 1989 because of the oil spill. As a result, an unusually high number of adults returned to spawn in certain lake systems including Kenai, Skilak, Red, and Akalura lake systems, causing an overescapement define of salmon. The Kenai and red lake systems account for half of the sockeye

commercial harvest in Kodiak and Cook Inlet. This overescapement resulted in low smolt production in these lake systems and is predicted to result in return of adults less than needed for adequate production in 1993 and 1994.

Spawning usually occurs between July and October. The female builds several redds in sand or graveled areas that will provide sufficient oxygenation for the eggs and alevins. Egg survival is dependent on chemical and physical characteristics of the gravel in which they are laid. One of the most critical life stages of sockeye salmon are the egg to juvenile stages. Several environmental requirements must be met for successful reproduction. The optimum temperature range for spawning is 10.6 to 12.2°C [equiv.]. Lower mortality and faster growth rates during incubation occur when water temperatures are between 8.9 and 10.0°C [equiv.]. Water temperatures higher than 23.0°C [equiv.] and lower than 7.2°C [equiv.] cause increased mortality and poor growth. Sockeye salmon require a minimum of 5.0 mg/l [equiv.] of DO for successful spawning. Low DO can disrupt swimming efficiency during migration and stunt the growth of alevins and juveniles (Pauley et al., 1989; ADFG 1985b). Egg mortality usually results from oxygen deprivation, freezing, flow fluctuations, dewatering, predation, or microbial infestation (Bonar et al., 1989). Changes in velocity can effect developing eggs and alevin through mechanical damage, temperatures changes, or reduced DO concentrations (Pauley et al., 1989; ADFG 1985b). The alevins leave the gravel as fry in April or May (Pauley et al., 1989).

The fry move into their nursery lakes and remain for 1 to 2 years, 3 years in some Alaskan lakes, as smolts. This is a critical stage in their life cycle. Mortality is generally high as a result of predation from Dolly Varden, rainbow trout, and coho salmon. During this time, the sockeye salmon are pelagic schooling fish that feed primarily on zooplankton during the afternoon and avoid predators at other times. Migration as smolts from the nursery lakes to the sea is usually temperature dependent. They migrate to the ocean and remain in the inshore areas for the first few months before moving out to the Gulf of Alaska. Adults generally remain in the marine environment for 2 to 4 years before returning to freshwater to spawn (ADFG, 1985b, Pauley et al., 1989).

Adults feed primarily on euphausiids, amphipods, copepods, and young fishes. When returning to fresh water, the adults generally do not feed. Juveniles in streams feed primarily on small insects and insect larvae, and eat zooplankton in lakes. In the marine environment, they feed on small crustaceans, plankton, and fish larvae. Juveniles are important prey species for birds and other anadromous fish species such as Dolly Varden, coho salmon, cutthroat trout, arctic char, and sculpin. Adults are preyed on by marine mammals and predatory fishes (Pauley et al., 1989; ADFG 1985b).

Pacific Herring

Pacific herring (*Clupea harengus pallasi*) are managed in freshwaters and within a three mile limit in marine waters by the Alaskan Department of Fish & Game (ADF&G). The North Pacific Fishery Management Council prepares management plans, which become Federal law, and applies them to marine waters from the 3 mile limit to the 200 mile limit. The International North Pacific Fisheries

Commission (INPFC) provides conservation measures that limit location, time, and number of fishing days beyond the 200 mile limit.

This species is important to the Alaskan fishing industry and is a vital part of the food chain. Pacific herring are consumed by larger species of fish, such as salmon and halibut (Royce, 1991).

At the time of the oil spill Pacific herring were spawning in the shallow eelgrass and algal beds. As a result, a large percentage of abnormal embryos and larvae were found in the oiled areas in Prince William Sound. There was also evidence of hydrocarbon metabolites in the bile of adult fish. It is unclear whether or not the adult population was affected by the oil spill; only when the cohorts from 1989 and 1990 return to spawn in 1992 and 1993 will determination of effect be possible.

Pacific herring mature between 2 and 4 years of age and spawn annually. They live offshore, but spawn in nearshore coastal waters. Their greatest mortality occurs during the egg to juvenile stages, when mortality is 99 percent. Adults have a lifespan of approximately 19 years (Pauley et al., 1988).

In general, the herring live and spawn in water temperatures between [equiv.] 0 and 10°C throughout its life cycle, from egg to adult. Adults return to natal nearshore intertidal and subtidal areas between March and June to spawn in Prince William Sound. The eggs are highly adhesive and are laid on a variety of substrates including kelp, eelgrass, prominent rocks, and even artificial substrates. Egg incubation is dependent on water temperatures, but hatching usually occurs between 14 and 25 days. Salinity for successful spawning occurs between 3 and 29 parts per thousand (ppt), and larvae generally prefer salinities between 13 and 21 ppt. Excessive turbidity may hinder spawning and egg incubation, but higher turbidities associated with estuary nursery areas may enhance larval survival.

After hatching, herring larvae retain their yolk sac for approximately 2 weeks, depending on water temperature. Following absorption of the yolk sac, the herring undergo a critical period of feeding where the narrow margin between starvation and nutrition results in the highest mortality. They feed primarily on invertebrate eggs, nauplii, and diatoms. Feeding intensities were shown to be greater in turbidities between 500 and 1000 mg/l [equiv.] than the control of 0 mg/l [equiv.] (Pauley et al., 1988). As they increase in size, their diet expands to include barnacle larvae, mollusks, bryzoans, and rotifers. Juvenile herring congregate near shore in shallow waters during the summer and move offshore in the fall. In general, larval survival of herring depends greatly on timing in relation to predation and food supply (Pauley et al., 1988).

Juvenile herring feed on crustaceans, mollusks, and fish larvae, and adults feed on euphausiids, planktonic crustaceans, and fish larvae (Pauley et al., 1988). Herring eggs are preyed on by shorebirds, diving birds, gulls, invertebrates, and fish. Herring larvae are eaten by jellyfish, amphipods, and fish. Adults are a prey base for large finfish, sharks, and marine mammals and birds (Pauley et al., 1988).

Rockfish

The North Pacific Fishery Management Council prepares management plans, which become Federal law, and applies them to marine waters for the 3 mile limit to the 200 mile limit. The International North Pacific Fisheries Commission (INPFC) provides conservation measures that limit location, time, and number of fishing days beyond the 200 mile limit.

A small number of dead rockfish were found after the spill. Five of them were analyzed soon enough after death to establish that oil was the probable cause of death. The extent of injury to rockfish population is unknown.

There are over 50 species of rockfish (*Sebastes* spp. and *Sebastolobes* spp.), including yellow rockfish (*Sebastes ruberrimus*), quillback (*S. maliger*), and copper rockfish (*S. caurinus*), that are found in Prince William Sound, Cook Inlet, and the Gulf of Alaska. Their life histories are variable and not well understood. The following life history information is for the yellow rockfish.

The yellow rockfish range extends from Cook Inlet in Alaska south to Baja California (Hart, 1973). Rockfish grow very slowly and sexual maturity between 14 and 19 years of age and breeds annually thereafter. They grow slowly and produce few offspring. They can live up to 114 years. If is not known whether or how rockfishs migrate, but older fish tend to move to deeper water (Carlson and Straty, 1981).

Yellow rockfish are live bearers and release live planktonic larvae into the water column between April and June in southeastern Alaska (Carlson and Straty, 1981). Very little is known about the early life history of larvae and juveniles.

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

Dolly Varden

Dolly Varden (*Salvelinus malma*) are managed in freshwaters and within a three mile limit in marine waters by the Alaskan Department of Fish & Game (ADF&G). The Alaskan Board of Fisheries develops regulations governing sport harvest of fish in Alaska.

Dolly Varden are found in fresh and salt water in western North America and eastern Asia. Their range extends from northern California to the arctic coast of Alaska (Scott and Crossman, 1973). There are both anadromous and nonanadromous populations in Alaska.

Dolly Varden had the highest concentration of hydrocarbon metabolites in the bile of all fishes sampled in 1989. Tagging studies showed that adult mortality of Dolly Varden in oiled areas was 32% higher than in unoiled areas.

Dolly Varden mature between 4 and 7 years of age. As adults they live near their natal streams in nearshore areas of marine environments during the summer, and they migrate to freshwater lakes to overwinter. They are fall spawners that breed between September and December. Dolly Varden return to their natal streams to spawn and spawn each year from age 6 to 10 years. The young remain in their natal streams for 3 to 4 years. The average life span of the Dolly Varden is 12 years (Scott and Crossman, 1973; ADFG, 1985c).

Spawning occurs in the fall between September and December. The female builds the redd and is usually attended by 4 to 5 males during spawning. Fecundity is positively correlated with female size with females generally producing between 1,300 and 3,400 eggs. The eggs hatch in approximately 4 to 5 months. The alevin remain in the redd for approximately 18 days and then emerge as fry. The fry remain close to the bottom for the first few days but commence active feeding soon after and begin growing rapidly. The young remain in fresh water for 3 to 4 years before moving seaward. They are found near logs and undercut banks, where they seek protection from predation. Post-spawning mortality is usually high in adults (Scott and Crossman, 1973; ADFG, 1985c).

The primary diet for marine adult Dolly Varden consists of smelt, herring, juvenile salmonids, and other small fishes. In the freshwater habitat, juvenile salmonids, invertebrates, and other small fishes are the main diet. Juvenile Dolly Varden feed near the bottom and prey on aquatic insects, insect larvae, and fish eggs (Scott and Crossman 1973, ADFG 1985c).

Cutthroat Trout

Cutthroat trout (*Salmo clarki*) are managed in freshwaters and within a three mile limit in marine waters by the Alaskan Department of Fish & Game (ADF&G). The Alaskan Board of Fisheries develops regulations governing sport harvest of fish in Alaska.

Cutthroat trout range from northern California, Oregon, British Columbia to Prince William Sound, Alaska at the very northern edge of their range (Pauley et al., 1989). There are both anadromous and nonanadromous populations in Alaska.

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

Male sea-run cutthroat trout mature at 2 to 3 years, and females mature at 3 to 6 years. Unlike salmon they can spawn annually for up to ten years. They return to their natal streams to spawn in the spring between February and May, depending on the geographic area. After spawning, adults and smolts return to the sea between March and July. They remain in the vicinity of the natal stream to feed along its shores, and they return to freshwater lakes to overwinter. Cutthroat trout have a high survival rate between spawnings (Pauley et al., 1989).

Spawning occurs in the spring between February and May, depending on the geographic area. The female builds a redd in sand or graveled areas that will provide sufficient flow and oxygenation for the eggs and larvae. The most critical life stages of cutthroat trout are the egg to juvenile stages. Certain environmental requirements must be maintained for successful reproduction. The preferred water temperature for spawning ranges from [equiv.] 6 to 17°C. The optimum water temperature for egg incubation is [equiv.] 10° to 11°C. The optimal temperature for juveniles is [equiv.] 15°C, and water temperatures greater than [equiv.] 28°C can be detrimental. Low DO causes premature hatching, fry abnormalities, and swimming performance impairment in adults. Cutthroat trout generally avoid water with DO less than 5.0 mg/l [equiv.], but can tolerate temporary low DO conditions (Pauley et al., 1989).

Cutthroat trout are sensitive to high turbidity and its associated problems. They cease migration in streams with turbidity greater than 4,000 mg/l [equiv.] and may stop feeding and move to cover when turbidities exceed 35 mg/l [equiv.]. Excessive silt loads can affect DO concentrations, causing increased egg mortality in the redds, and can disrupt the emerging fry. The preferred water velocity for successful spawning is 11 to 90 cm/s [equiv.]. Fry are generally found in water velocities of less than 30 cm/s [equiv.], with an optimum velocity of 8 cm/s [equiv.]. Changes in flow can effect developing eggs and alevin in several ways, including mechanical damage, temperature changes, or reduced DO (Pauley et al., 1989).

The newly hatched alevins remain in the redd for 1 to 2 weeks until the yolk sac is absorbed. The emerging fry generally live in the shallow, low velocity stream margins close to where they were spawned, but their range increases with age. The time of smolting is variable and size dependent (Pauley et al., 1989).

Adult cutthroat trout feed primarily on small fish and shrimp and eat more fish as they increase in size. Fry and juveniles feed primarily on insects and crustaceans, but they also begin to feed on smaller fish such as sticklebacks and other salmonids as they increase in size. In the marine environment, they feed on gammarid amphipods, sphaeromid isopods, callianassid shrimp, immature crabs, and other salmonid fishes (Pauley et al., 1989). Fry and juveniles are preyed on by rainbow trout, brook trout, Dolly Varden, short head sculpins, and adult cutthroat trout, as well as a various bird species such as great blue herons and kingfishers. In the marine environment, cutthroat are preyed on by Pacific hake, sharks, marine mammals, and adult salmon (Pauley et al., 1989).

e. Coastal Communities

Coastal communities are protected under the Coastal Zone Management Act of 1972 (16 U.S.C. 1451-1464), the Alaska Coastal Management Act of 1977 (A6 46.40), and the Coastal Resource District Management Plans (6AAC 80 and 85).

Intertidal Organisms

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

The intertidal and subtidal zones were the habitats most affected by the Exxon Valdez oil spill and were therefore the focus of many of the Natural Resources Damage Assessment (NRDA) studies. More than 1,000 miles (1,609 km) of coastal shoreline was oiled. Zones exposed to wave and tidal action were most affected by the oil spill, and were in many cases re-oiled after the initial cleanup response. Surface oil contamination was greatest in the upper one-third to upper one-half of the intertidal zone, which resembled an oiled "bathtub ring." By fall 1989, the average depth of oil penetration in sediment[1] was approximately 50 cm (20 inches), and the persistence of subsurface oil became the major treatment issue during 1990 (Michel et al. 1991). Over time and through frequent winter storms in 1991 and 1992, oil has moved deeper into the sediments and has contaminated the seafloor of PWS to depths of over 20 m (60 feet). Measurements taken in the summer of 1992 indicate that the upper intertidal zones still have not recovered due to the continued presence of oil (Restoration Team, 1992 ii).

Following the oil spill, decreases in the populations of many intertidal organisms were observed along the oil-contaminated shorelines of Prince William Sound, Kodiak Island, and Cook Inlet. The intertidal habitat suffered from the effects of the spill and pressurized hot water treatments. Elevated concentrations of petroleum hydrocarbons were detected in intertidal and subtidal sediment samples in western Prince William Sound, as well as in intertidal mussels and other benthic marine invertebrates. Subsurface oil in the beaches has the potential for continued petroleum hydrocarbon contamination of intertidal organisms, and contamination continues to be evident in the intertidal mussels. Although increased densities of mussels in oil-contaminated areas have been documented, the mussels in the oil-

[1]Oil mixes with sediment particles and "sinks."

contaminated areas were smaller than those found in uncontaminated areas (Exxon Valdez Oil Spill Trustees, 1992). Some degree of recovery has been observed in the lower intertidal and the mid intertidal zones. Recovery of the upper intertidal zone, where the mussel beds are located, has not occurred (Restoration Planning Working Group, 1993).

In 1991, high concentrations of oil remained in mussels and the underlying mats of the mussel beds. Because the mussel beds were not cleaned or removed following the spill, they present sources of fresh oil for the organisms that feed upon mussels. The extent of the oil-contaminated mussel beds have not been determined; however, investigative studies are ongoing (Exxon Valdez Oil Spill Trustees, 1992). Studies have identified 31 mussel beds within Prince William Sound and 9 along the Kenai Peninsula and Alaska Peninsula that have sediment petroleum hydrocarbon levels greater than 1,700 μg/g wet weight oil equivalents. The contamination of mussels has the potential for continued food chain contamination (Babcock, et.al., 1993).

Populations of *Fucus*, the primary intertidal plant, were reduced following the oil spill and clean-up operations. The reduction in intertidal area covered by *Fucus* was accompanied by an increase in coverage of opportunistic plant species that thrive in disturbed habitats. In addition to the decrease in *Fucus* coverage, the size of the *Fucus* plants decreased, the number of reproductive-sized plants decreased, and the number of fertile receptacles per reproductive-sized plants were reduced. Therefore, not only was the actual coverage of *Fucus* reduced, its ability to replenish itself was decreased (Exxon Valdez Oil Spill Trustees, 1992). *Fucus* is the primary structural habitat in the Alaskan intertidal zone, and its reduction effects other intertidal zone inhabitants (Peterson, 1993).

Profiles of the following intertidal inhabitants are presented in subsequent paragraphs: blue mussel (*Mytilus trossulus*), common littleneck clam (*Protothaca staminea*), and Pacific razor clam (*Siliqua patula*). These organisms play important ecological and commercial roles within the EVOS area (e.g., mussels provide a source of food for many other organisms, and clams are harvested both recreationally and commercially).

Blue Mussel. Within the U.S., the subspecies of blue mussel called *Mytilus trossulus* is distributed from Oregon to Alaska (Moore, personal communication, 1993). It is found along rocky coastlines, in bays, and in estuaries. Blue mussels are harvested commercially for bait and for food. Blue mussels are suspension feeders and feed on dinoflagellates, organic particles, small diatoms, zoospores, ova and spermatozoa, flagellates, unicellular algae, and detritus. There is limited culturing of these mussels for food. These mussels are preyed upon by sea stars, gastropods, crabs, sea otters, black oystercatchers, and ducks (Shaw *et. al.*, 1988).

Blue mussels are subject to pollution and paralytic shellfish poisoning. Commercial harvest of another subspecies of the blue mussel in California has decreased immensely over the years, primarily due to the repercussions of paralytic shellfish poisoning. These mussels can also accumulate hydrocarbons in their tissues by taking hydrocarbons up through the gill tissues. Although oil is only

slightly toxic to mussels, it may prevent mussels from being marketed as food, as well as cause them to be toxic to predators (Shaw *et. al.*, 1988).

Common Littleneck Clam. The common littleneck clam is widely distributed along the coast of the Northwest region, but can be found from Mexico to the Aleutian Islands, Alaska. It serves as an important commercial and recreational species. This species is found in both intertidal and subtidal zones. Common littleneck clams are farmed in the intertidal zone in Puget Sound. It is a filter-feeder, feeding primarily on diatoms. Predators of the common littleneck clam in Prince William Sound include the sea star and the sea otter (Chew and Ma, 1987).

Studies show that the quantity of common littleneck clams landed in the U.S. Pacific Northwest have been decreasing yearly (these statistics did not include Alaska). Little recruitment of common littleneck clams occurred in Prince William Sound in 1967 to 1971 due to poor spawning and recruitment conditions. Harvest of abundant clams along the coast of Alaska is limited because of paralytic shellfish poisoning (i.e., toxic phytoplankton is filtered in and accumulated by shellfish and is fatal to humans, but not to the shellfish). It has been shown that common littleneck clams grow at a slower rate in oil-treated sediments, and they tend to burrow to a shallower depth, making them more accessible to predators (Chew and Ma, 1987).

Pacific Razor Clam. The Pacific razor clam is found on open sandy beaches from Pismo Beach, California to the Aleutian Islands, Alaska. Large razor clams tend to inhabit the lower intertidal zone, and razor clams found in the subtidal zone tend to be juveniles. The razor clam filters its food from the water it inhabits, and serves as prey for seagulls, sea ducks, and Dungeness crabs. This species supports an active sport fishery and limited commercial harvest. It has been suggested in the past that artificial propagation of razor clams is not feasible; however, the State of Washington has maintained a razor clam hatchery since 1980 (Lassuy and Simons, 1989).

The razor clam has been subject to disease in the past. Paralytic shellfish poisoning in razor clams was found in Alaskan razor clam populations between 1985 and 1987 (Lassuy and Simons, 1989).

Subtidal Organisms

The subtidal zone is the environment below the low tide. The shallow subtidal zone differs in community composition from deeper marine habitats and is especially vulnerable to oil spills. Inhabitants of the shallow subtidal zone consist of amphipods, clams, eelgrass, crabs, juvenile cod, *Laminaria* plants, spot shrimp, and many other organisms. As with the intertidal zone, oil-contaminated areas in the subtidal zone suffered declines in the populations of many of the organisms that inhabited them.

Evidence of ongoing subtidal oil contamination was documented in the winter of 1990-1991 through the use of sediment traps. The sediment traps collected elevated concentrations of petroleum hydrocarbons, indicating that, through beach cleaning and natural processes, oil was being withdrawn

from the beaches and transported to subtidal areas (Sale *et. al*, 1992). Between 1989 and 1991, oil concentrations remained the same and occasionally increased in shallow subtidal sediments at depths of 3-20 m. Further studies have indicated that petroleum hydrocarbons continue to present the potential for contamination of organisms that exist on or near the sea floor (Exxon Valdez Oil Spill Trustees, 1992).

Because of their ability to quickly take up petroleum hydrocarbons, and their inability to quickly metabolize the hydrocarbons, clams accumulate high concentrations of hydrocarbons. Therefore, clams inhabiting the shallow subtidal zone present an ongoing source of contamination to the many organisms that feed upon them (Exxon Valdez Oil Spill Trustees, 1992).

B. Social and Economic Environment

This section describes the social, cultural, and economic conditions of the EVOS region. Included are descriptions of the communities affected by the spill; a discussion of the impact of the spill on traditional Native and non-Native subsistence hunting and fishing; information about spill-related injury to cultural and anthropological resources; and a description of the economic base of the area.

1. Relevant State History

The Alaska Statehood Act (48 U.S.C. [VERIFY CITE]) admitted Alaska to the Union in January 1959. The act allowed the State to select 400,000 acres (161,880 ha) of National Forest and unreserved land for community use. In addition, the State was also empowered to choose 102.55 million acres (41.5 million ha) of public lands from other unreserved U.S. lands.

The Alaska Native Claims Settlement Act of 1980 YEAR? (33 U.S.C. § 1601-1624) settled aboriginal rights and established the legal claims for Alaska Natives. It also authorized formation of the Regional Native Corporations. This act addressed public land withdrawals and established a Joint Federal State Land Use Planning Commission, which began land selection procedures that resulted in the existing pattern of Federal, State, Native, and private ownership of lands in Alaska.

Oil exploration and development grew after statehood was declared. In 1968, a discovery well at Prudhoe Bay on the North Slope uncovered the largest known oil field in the United States. The North Slope oil lease, completed in 1969, granted oil rights to an oil consortium and brought more than $900 million in bonuses to Alaskans. To provide for transporting the oil from the North Slope to a shipping point, Congress passed the Trans-Alaska Pipeline Authorization Act in 1973. Construction of the pipeline was completed in 1977. Today, the pipeline moves almost 2 million barrels (84,000,000 gallons, or 317,940,000 liters) from Prudhoe Bay to Valdez every day. Since 1977, the Port of Valdez has shipped the bulk of crude oil taken from Prudhoe Bay (*Alaska Blue Book*, 1991).

In 1976, the first of USDOI's Minerals Management Service lease sales for outer continental shelf (OCS) oil and gas were completed in the eastern Gulf of Alaska. Sales followed in Lower Cook Inlet (1977 and 1981), the northeastern Gulf of Alaska (1980), and east of Kodiak Island (1980). Although Valdez and PWS have little or no known oil or gas potential, the area is part of Lease Sale 88.

The Alaska National Interest Lands and Conservation Act of 1980 (ANILCA, 16 U.S.C. 3111

et seq.) implemented the Alaska Native Claims Settlement Act and the Statehood Act. ANILCA instituted Alaska Native allotments and State land selections, and established the Alaska Land Bank. It also provided for the designation and conservation of Federal public lands, including the National Parks, National Wildlife Refuges, National Forests, Wild and Scenic Rivers, and the National Wilderness Preservation System. ANILCA also authorized the subsistence management system and allowed for the use of public resources, including the continued use of those resources in the National Parks and Forests.

2. Affected Communities

The communities affected by the *Exxon Valdez* spill are grouped into four regions: the Kenai Peninsula Borough (KPB), the Kodiak Island Borough (KIB), the Lake and Peninsula Borough, and the Valdez–Cordova Census Area. The effects of the spill differ for each region and its communities. In general, the communities that experienced the most disruption were the Native villages, which are mixed cash-subsistence hunting and fishing based economies.

a. Kenai Peninsula Borough

The Kenai Peninsula Borough, which is located south of Anchorage, includes both sides of Cook Inlet from the southern tip of the Kenai Peninsula north to the Knik Arm–Turnagain Arm split. The Kenai Peninsula holds 99 percent of the borough's population and most of the area's development because it is linked by roads to Anchorage. Sixty-three percent of the borough's population (27,338 people) lives in Kenai and Soldotna. The area is economically dependent on the oil and gas industry, as well as fishing and tourism. Communities within the central Kenai Peninsula region are the cities of Kenai, Soldotna, and Seward.

The southern Kenai Peninsula contains the cities of Homer and Seldovia and the Native villages of Port Graham and English Bay. Homer is the economic and population hub of the region, with revenues from commercial fishing, tourism, government and commercial offices, and agriculture. In contrast, the Native villages are largely dependent upon subsistence hunting and fishing. Within this region, Homer was least affected by the spill, both because it was least severely oiled and because its residents were relatively less dependent upon subsistence. Port Graham and English Bay were heavily oiled, yet these communities were farthest removed from the cleanup efforts. Residents of these communities who relied upon subsistence were adversely affected by actual contamination or perceived contamination of subsistence foods.

b. Kodiak Island Borough

The Kodiak Island region includes the city of Kodiak and the six Native villages of Port Lions,

Ouzinkie, Larsen Bay, Karluk, Old Harbor, and Akhiok. These communities are part of the Kodiak Island Borough (KIB). The KIB population is between 13,000 and 15,000 and includes Natives of Aleutic background and immigrants from the Philippines and from Central and Meso-America. As in other parts of Alaska, Kodiak Island's population grows significantly in the summer. The KIB provides some social services to villages, and the Kodiak Area Native Association (KANA) provides medical and social services through the tribal governments in each village.

Nearly two-thirds of the Kodiak Island shoreline was oiled. Oil in varying forms spread from the northern end of the island along the west coast and through the many passages, coves, and small islands that make up the Kodiak Island group. In addition to the physical effects of the oil on these communities' land, social effects were associated with the cleanup activities that followed the spill. Daily life in many Native villages was disrupted by the presence of outsiders and by changes in the local economy caused by the influx of visitors and cash. Local governments and relations with service providers were strained in many villages, and the introduction of provisional regulations added to the tension. The communities of Akhiok, Karluk, Kodiak, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions are located in the Kodiak Island Borough.

c. Lake and Peninsula Borough

The Lake and Peninsula Borough contains three communities, Chignik Bay, Chignik Lagoon, Chignik Lake, which were exposed to oil in the form of tar balls and oil sheen. Some remote beaches were also oiled. Residents of all three communities are ethnically mixed, Aleut, Russian, and Scandinavian. The economies of the communities are mixed cash-subsistence.

d. Valdez-Cordova Census Area

The Prince William Sound region covers an area of about 20,000 square miles [EQUIV] of water, ice, and land. For the purpose of this study, the region includes five communities: Valdez, Cordova, Whittier, Chenega Bay, and Tatitlek. Each is accessible by air or water, and all have dock or harbor facilities. Only Valdez is accessible by road.

The region has an abundant supply of fish, shellfish, and marine mammals. These and the other natural resources of PWS play an important part in the lives of area residents. In addition, the area is considered by many to be a unique, pristine wilderness, offering unparalleled opportunities for outdoor recreation, adventure, and travel.

The economic base of the five communities is diverse. Cordova's economy is based on

III Affected Environment
B. Baseline Socioeconomic Description
1990

Region	Community	Government Type	Total Population	Non-Native Population (%)	Native Population (%)	Subsistence Prevalence	Industry and Employment	Per Capita Income (1989)	Access	% of population over age 25 graduated from high school—1990 (all races)	
										Total	Native Americans
Kenai Peninsula Borough	English Bay	Unincorporated village	158	14 (8.9)	144 (91.1)	High	Fish	$12,615	Air, water		
	Homer	First-class city	3,660	3,530 (96.4)	130 (3.6)	Low	Fishery, tourism, recreation, agriculture	$19,182	Air, water, roadway		
	Kenai	Home-rule city	6,327	5,792 (91.5)	535 (8.5)	Low	Fishery, fish processing, oil and gas development	$17,877	Air, water, roadway		
	Port Graham	Unincorporated village	166	16 (9.6)	150 (90.4)	High	Fishery, fish processing	$17,265	Air, water		
	Seldovia	First-class city	316	268 (84.8)	48 (15.2)	High	Fishery, fish processing, logging, tourism	$14,052	Air, water		
	Seward	Home-rule city	2,699	2,289 (84.8)	410 (15.2)	Low	Fishery, logging, coal, tourism, local government	$16,615	Air, water, roadway		
	Soldotna	First-class city	3,482	3,324 (95.5)	158 (4.5)	Low	Sport fishery, tourism, recreation	$15,800	Air, water, roadway		
Kodiak Island Borough	Akhiok	Second-class city	77	5 (6.5)	72 (93.5)	High	Fishery, local government	$14,793	Air (infrequent), water		
	Karluk	Unincorporated village	71	6 (8.5)	65 (91.5)	High	Subsistence, fishery	$8,052	Air, water		
	Kodiak	Home-rule city	6,365	5,554 (87.3)	811 (12.7)	Low	Fishery, fish processing, tourism, logging/timber, government	$22,951	Air, water		
	Larsen Bay	Second-class city	147	23 (15.6)	124 (84.4)	Low	Fishery, fish processing, tourism	$19,222	Air, water		
	Old Harbor	Second-class city	284	32 (11.3)	252 (88.7)	Moderate	Fishery	$8,008	Air, water		
	Ouzinkie	Second-class city	209	31 (14.8)	178 (85.2)	High	Fishery	$16,530	Air, water		
	Port Lions	Second-class city	222	72 (32.4)	150 (67.6)	High	Fishery	$14,960	Air, water		

Region	Community	Government Type	Total Population	Non-Native Population (%)	Native Population (%)	Subsistence Prevalence	Industry and Employment	Per Capita Income (1989)	Access	% of population over age 25 graduated from high school—1990 (all races)	
										Total	Native Americans
Lake and Peninsula Borough	Chignik	Second-class city	188	103 (54.8)	85 (45.2)	Moderate	Fishery	$13,188	Air, water		
	Chignik Lagoon	Unincorporated village	53	23 (43.4)	30 (56.6)	High	Fishery	$19,604	Air, water		
	Chignik Lake	Unincorporated village	133	11 (8.3)	122 (91.7)	High	Fishery	$7,765	Air, water		
Valdez-Cordova Census Area	Chenega Bay	Unincorporated village	94	29 (30.9)	65 (69.1)	High	Fishery	$9,211	Air, water		
	Cordova	Home-rule city	2,110	1,873 (88.8)	237 (11.2)	Low	Fishery, aquaculture, fish processing	$23,408	Air, boat, N/A		
	Tatitlek	Unincorporated village	119	16 (13.4)	103 (86.6)	High	Fishery	$8,674	Air, water		
	Valdez	Home-rule city	4,068	3,829 (94.1)	239 (5.9)	Low	Oil, fishery, fish processing, government, transportation	$26,968	Air, water, roadway		
	Whittier	Second-class city	243	213 (87.7)	30 (12.3)	Low	Fishery, tourism, transportation	$17,032	Air, water, railway		

SOURCE: Alaska Department of Labor Research & Analysis, 1990 Census.

Enlarge to full page

Selected Labor Force

Total Employed Persons 16 Years and Over		Agriculture, Forestry, Fishing	Mining	Construction	Manufacturing Nondurable Goods	Manufacturing Durable Goods	Transportation	Communications	Wholesale Trade	Retail Trade	Finance, Insurance, Real Estate	Business and Repair Services	Personal Services	Entertainment and Recreation	Health	Education	Other Professionals	Public Administration
	Kenai Pen.																	
30	English Bay	2	--	--	---	2	3	--	---	--	--	--	--	--	5	13	4	1
1,634	Homer	142	46	178	64	75	92	55	34	296	66	37	110	20	136	78	109	108
2,738	Kenai	100	367	129	256	65	96	41	98	542	88	123	101	53	125	216	131	205
41	Port Graham	--	--	--	--	--	8	--	--	8	--	3	--	2	--	10	8	4
97	Seldovia	12	--	12	2	--	8	--	3	27	--	--	2	--	3	16	6	6
1,138	Seward	107	18	46	80	54	82	23	32	206	30	22	32	23	72	121	49	141
1,506	Soldotna	35	114	85	58	15	21	39	44	367	61	104	45	13	148	176	100	151
	Kodiak Borough																	
26	Akhiok	2	5	--	--	--	--	--	--	--	--	--	--	--	--	6	--	13
30	Karluk	--	--	2	--	--	14	--	--	--	--	--	--	--	--	7	2	5
3,607	Kodiak	646	3	202	582	62	178	89	83	542	73	106	87	18	184	269	198	282
36	Larsen Bay	--	--	2	1	--	7	1	--	8	--	--	3	1	3	8	--	4
42	Old Harbor	2	--	--	--	--	8	--	4	9	--	--	3	--	1	5	4	8
77	Ouzinkie	5	2	--	--	2	6	--	2	--	4	2	--	5	8	14	4	23
85	Port Lions	2	--	8	--	5	18	--	--	7	5	2	1	--	2	13	2	22
	Lake Penn																	
88	Chignik City	25	--	5	--	--	2	--	--	4	--	--	--	3	2	10	3	14
8	Chignik Lagoon	2	--	--	--	--	--	--	--	--	--	--	--	--	2	1	--	3
28	Chignik Lake	--	--	5	--	--	--	--	--	--	--	--	--	--	--	23	--	--
	Valdez—Cordova																	
36	Chenega Bay	20	--	--	3	2	--	--	--	--	--	2	3	--	--	5	2	4
1,109	Cordova	274	2	80	90	39	80	43	18	127	30	14	30	9	55	89	58	82
15	Tatitlek	--	--	--	--	--	--	--	--	--	--	--	--	--	1	6	--	8
2,206	Valdez	67	105	210	48	34	429	58	54	255	48	49	88	39	209	222	73	209
126	Whittier	14	4	12	3	--	33	--	--	10	9	--	3	--	4	18	2	14

-- No information
Alaska Department of Labor, Research and Analysis, *1990 Census*

commercial fishing, primarily for red salmon. As the terminus of the Trans-Alaska Pipeline, Valdez is dependent on the oil industry; but commercial fishing and fish processing are also important to the local economy. Whittier residents work as government employees, longshoremen, commercial fishermen, and service providers to tourists. The Alaska Native people of Chenega Bay and Tatitlek, by contrast, rely on subsistence fishing, hunting, and gathering for their livelihood.

3. Transportation

A major means of public transportation in the oil-spill region is the ferry service known as the Alaska Marine Highway. There are two major routes for the Alaska Marine Highway system: the Southeast system and the Southwest system (Figure III-C). The Southeast system serves almost every town in Southeast Alaska, and the Southwest system serves majority of the oil-spill area. The Southwest system runs as far east as Cordova and as far west as Dutch Harbor/Unalaska and serves the coastal towns in Southcentral, Kodiak Island, and the Kenai and Alaska peninsulas, and the Aleutian Chain (ADT 1990 Alaska Marine Highway System, 1989 Traffic Volume). The Southeast and the Southwest systems do not interconnect. The common way to transfer from the Southeast system to the Southwest system and vice versa is to take the Alaska Airlines flight between Juneau and Cordova (Castleman and Pitcher 1992).

The majority of the EVOS area cannot be reached via a road system. However, a few places in Kenai Peninsula and other Southcentral locations are served by highway systems. These highway systems include Sterling Highway (Route 1), Glenn Highway (Route 1), Richardson Highway (Route 4), and Route 9 (Figure III-C). Route 1 travels in northeast and southwest direction from Tok in the east to as far south as Homer passing through Glennallen, Palmer, Anchorage, and Soldotna. Route 9 connecting Seward to Route 1 is the most travelled highway in the state. Route 4 runs in north-south direction connecting Delta and Valdez. To transport between places that are connected by roads, private cars are a more popular means of transportation than public buses or vans. However, a public bus or van is also available between major cities connected by roads (Castleman and Pitcher 1992).

Portions of the oil-spill area are also served by the train, the Alaska Railroad, which runs 470 miles between Seward and Fairbanks passing through Portage and Anchorage. A seven-mile stretch of the railroad connects Portage to Whittier, where travelers transfer from cruise ships, ferries, and tour boats to the Alaska Railroad. Two express trains, one northbound and one southbound, run between Seward and Fairbanks daily. A shuttle train transports passengers between Portage and Whittier several times a day (Castleman and Pitcher 1992).

Transportation by aircraft is a popular between places not served by ferry or the road systems.

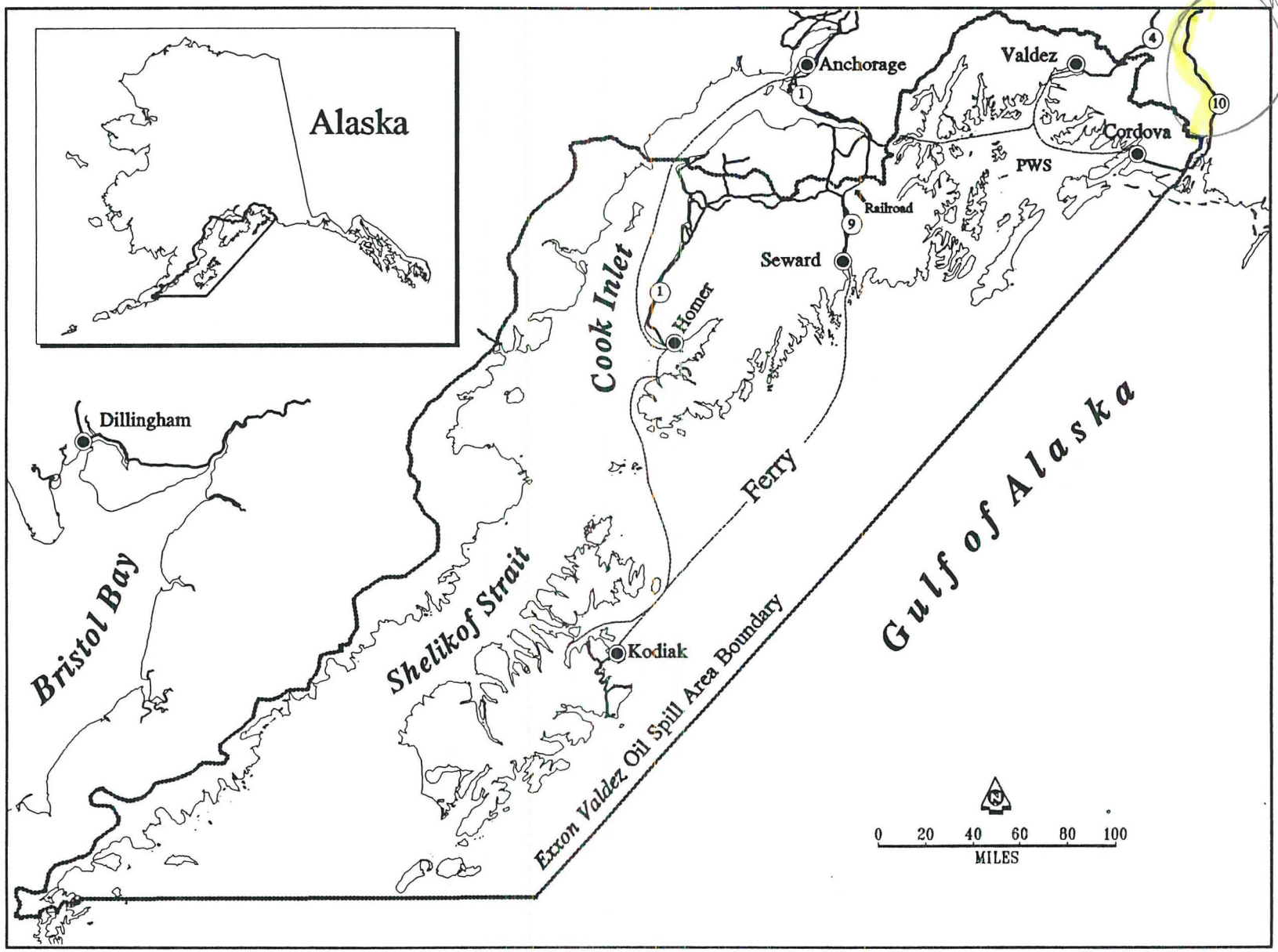


Figure III-C. Major land and water transporation paths in the *Exxon Valdez* oil spill area.

Besides the jets that fly between major cities, small aircraft fly to towns and tourist attractions throughout the state. The planes are usually 9 - 16 seaters, but in remote areas smaller planes, usually 2 - 4 seaters, are used (Castleman and Pitcher 1992).

4. Cultural and anthropological resources

Sites important to the Alaskan culture were injured by the oil spill and by the cleanup response, mainly by increasing human activity in and around PWS. At least 26 archaeological sites, including burial grounds and home sites, were injured to various degrees. Five of these sites were on private or State lands and 21 were located on Federal land—10 on national parks, six on national refuges, four within the Chugach National Forest, and one on Bureau of Land Management (BLM) land. Injuries included vandalism, erosion of beachfront sites, removal of artifacts, and oiled sites. With regard to the oil spill, the three major sources of potential impact were direct impacts resulting from oil in direct contact with artifacts or features; treatment methods employed to remove oil; and human activities incidental to the response actions.

Some Alaska Native sites in the PWS area are more than 11,000 years old (Clark 1984a. 1984b; Crowell 1988b). The sites affected by the oil spill fall within the larger ethnographic Pacific Eskimo region, which extends from the Copper River to the middle of the Alaska Peninsula and includes the outer reaches of Cook Inlet. Cook Inlet was originally occupied by the Tanaina Athapaskans. Trade, warfare, ceremonial exchange, and occasional intermarriage led to a sharing of many cultural traits among the Pacific Eskimo, Tanaina, Aleut, Eskimo, Athapaskan, Eyak, and Tlingit Indian tribes.

The types and locations of PWS archaeological and architectural sites made them particularly vulnerable to disturbances related to the oil spill. Sites found in the intertidal zone include stone and wooden fish weirs, petroglyphs, shipwrecks, piers and pilings associated with historical domestic and commercial facilities, and potentially the full range of features found in the uplands. Cultural resources were known to occur in adjacent uplands, where modified deposits, villages, rock shelters, culturally modified trees, historical domestic and commercial facilities, and other features are present. The range of physical materials incorporated into these sites includes stone, bone, shell, various metals, wood, textiles, leather, and other organic items.

The major potential physical impact of oiling is the obscuring of intertidal artifacts from observation, with the secondary possibility that solidification of oil could immobilize artifacts in the intertidal zone. Both of these effects would be temporary, as wave and tidal action would remove the oil over a period of months or years. The chemical impacts of oiling are not known. Some scientists have raised questions about whether contaminated organic items can still be dated using radiocarbon techniques, but others believe that the oil can be removed from crucial samples so that they may be successfully dated. (CRS 1989:103).

Several of the cleaning methods used on the beaches were particularly damaging to archaeological resources. Archaeological and architectural sites located in the uplands adjacent to treated shorelines were at risk only when people visited those uplands. Although a blanket restriction on upland access by cleanup crews was in effect throughout the shoreline treatment phase, some degree of access was required to efficiently undertake treatment activities. In addition, a variety of pedestrian upland crossings resulted in damage to cultural resources, especially surface features. Vandalism and looting of cultural sites occurred as a result of uncontrolled or unsupervised access to the immediate uplands, particularly where rock shelters, historic cabins, mine sites, and other surface features or subsurface deposits were exposed.

Eight methods of treatment were routinely combined and employed to remove oil from shorelines in PWS. Four more were developed and applied experimentally. The potential impacts to cultural resources varied depending on the type of application. These treatment methods and their potential impacts are outlined in the table below.

Treatment Methods and Potential Impacts

Method	Where used	Technique	Potential Impacts
Cold-water deluge	Crevices, interstices on rocky shores	Large volumes of ambient seawater at low pressure are used to wash surface oil to the water's edge.	Limited; comparable to normal wave action.
Cold-water, low-pressure washing	Rock surfaces, oil buried in shallow layers in sand and gravel-sized sediments	Low pressure (<50 psi) spray used to remove lightly adhering oil; also used to gently agitate substrate, expose buried oil, and move it downslope to a boomed area.	Limited; comparable to normal wave action. Improper application may drive oil farther into substrate.
Cold-water, high-pressure washing	Rock surfaces, buried oil in substrate, loose oil in tide pools and crevices	High-pressure ambient spray used to remove adhering oil and flush out loose oil.	Potentially destructive; severely agitated near-surface deposits. May drive oil deeper into substrate.
Warm-water, high-pressure washing	Heavily oiled boulder, cobble, and rock shoreline	High-pressure (up to 100 psi), heated seawater spray used to mobilize weathered oil.	As above; warm water may facilitate oil penetration to deeper levels of sediment.
Hot flush with hand wands	Inaccessible locations (e.g., narrow crevices)	Hand wands with pressurized water used to dislodge trapped oil.	Little sediment agitation lessens threat to artifacts; warm water may facilitate oil penetration.
Vacuum system	Shoreline surface	Vacuum pumps used to remove free oil.	Limited if used properly (i.e., little substrate removed).
Hot water injection	Shoreline sediments	Forces hot water below the sediment surface and flushes oil out through well points driven into the substrate.	Well point insertion may damage or displace buried artifacts; warm water may facilitate oil penetration.
Burying of oiled surfaces	Oiled logs and other materials	Used to remove oiled objects from areas of high recreational use.	Digging may damage existing buried artifacts.

Method	Where used	Technique	Potential Impacts
Disking (Experimental)	Lightly oiled sand beaches	Used to break up oiled layers and mix throughout the upper sediment profile.	High potential for damaging surface and near-surface artifacts.
Sediment removal (Experimental)	Oiled beaches	Manual or mechanical removal of oiled sediment, then disposal.	All features in the direct work area may be affected; buried features may be compressed or displaced by heavy equipment.
Shoreline removal, cleaning, and replacement (Experimental)	Oiled shoreline	Oiled sediments are removed, treated, and replaced.	Cultural materials in the removed sediment zone may be destroyed or crushed.
Relocation to surf zone (Experimental)	Shoreline, beach	Manually or mechanically removed sediments and placement in surf zone to allow natural wave action to clean sediments.	As above; potential for severe disturbance of cultural resources in the removal zone.

5. Subsistence [THIS SECTION TO BE REORGANIZED, CUT CONSIDERABLY.]

a. Overview

The term "subsistence" refers to a particular pattern of harvesting and using naturally occurring renewable resources. In a subsistence system, land and labor are allocated in accordance with kinship, political, or tribal rights and obligations. Subsistence systems define a relationship with the earth and its resources, shape the economy, provide material sustenance, and form the basis of community life. Subsistence systems depend on natural resources in a way that Western industrialized societies do not.

Alaska is the only State in which a significant proportion of the population lives off the land. The Alaska Lands Act defines subsistence as follows:

> . . . customary and traditional uses by Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for making and selling of handicraft articles out of non-edible by-products of fish and wildlife resources taken for personal or family consumption; for bartering or sharing for personal or family consumption; and for customary trade. (Alaska Lands Act, § 803)

Residents of communities legally defined as "rural" under State regulations may hunt and fish under subsistence regulations. Since there are only a few urban areas in Alaska, the majority of the State's 300 inhabited areas fall into the rural category.

Subsistence systems are characterized by four important attributes.

- Subsistence activities are seasonal. Fishing, hunting, and gathering follow the natural rhythm of the tides, wildlife and fish migration, and plant life cycles. The form of settlement and the pace of life in Alaskan villages depend upon the season.

- Subsistence activities are localized. Productive, accessible sites are established for various subsistence activities.

- Subsistence is regulated by a system of traditional, locally recognized rights, obligations, and appropriate behaviors. The use of sites, the division of the catch or harvest, and the assignment of responsibilities are determined by tradition. Villages that share overlapping territories for hunting and fishing occupy their individual niche and adhere to the rights and responsibilities traditionally assigned to them.

- Subsistence is opportunity-based. (MMS, [NEED YEAR])

b. Connection to Environment

We are expanding discussion/reference beyond PWS.

Subsistence implies a certain connection to the environment. Prior to the *Exxon Valdez* oil spill, PWS was considered a "pristine" wilderness with bountiful environmental riches. The abundant wildlife, scenic mountains, old-growth forests, clear waters, and other natural riches of PWS have made the area particularly valuable to Alaskans, both Native and non-Native. The unpolluted environment attributed to PWS was enriched individual lives, a perspective somewhat less common in the lower 48 States. For many Alaskans, the spill spoiled a pure and irreplaceable resource, a place that was fundamental to their identities and values. One resident explained it this way:

> . . . [H]ere in Homer most people don't really care all that much about money or material things. They care about a quality of life that in some cases they have traveled across the entire country to find. Some things are sacred. This country is sacred. The connection of these people to the country is sacred. And no amount of money can magically undo the damage, the sacrilege. (Oil Spill Commission, 1990)

Both Alaska Natives and non-Natives in PWS experience a relationship with the environment that is unique in the United States. Many of those who choose to live there, foregoing the

steady income a city job could provide, assign great value to the rural, subsistence-based way of life. When the environment is harmed, the basis of subsistence—the harmonious relationship of humans to their environment—is threatened.

c. Economic Implications

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

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

Subsistence pursuits supply important material goods, however. Although some food is imported into PWS, a vast subsistence harvest is hunted, fished, and gathered locally. For some residents, subsistence is the primary source of food and supplies. For others, subsistence supplements resources available from other sources.

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

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

Estimates vary widely on the percentage of subsistence foods in the diet, but studies indicate that subsistence may provide 70 to 80 percent of the total protein consumed within the households of PWS villages. Estimates place the share of subsistence meats and fish at 200 to 600 pounds [KG] per person per year. Among Alaska Natives, reliance on subsistence foods is greater still, with subsistence resources providing 80 to 100 percent of Natives' total protein intake, at an average of 500 pounds [KG] per person per year. Subsistence foods provide a large portion of the diet—a portion that families can ill afford to replace with imported substitutes. Fewer than

500 permits are given to subsistence fishermen each year, mostly residing in the Upper Copper River area and the southwestern area of PWS.

Besides making up part of the local diet, subsistence provides food for dog teams and is the only source for other material needs such as furs for clothing and seal hides for mukluk soles and uppers.

The PWS communities affected by the oil spill are small, relatively isolated, and economically dependent on local fish and wildlife. The noncommercial transfer and exchange of wildlife products are important institutions in PWS and in Alaska. The prevalence of direct consumption and nonmonetary transfer and exchange of fish, wildlife, and other natural resources and services makes it difficult to determine their economic value in terms of the value system of the cash economy.

d. Sociocultural Implications

Subsistence pursuits are tied to all aspects of life in the villages affected by the oil spill and are key to the Alaska Native sociocultural system. For at least 11,000 years, Alaska Native people have depended on the lands and water of PWS for their survival. Their traditional way of life is intimately tied to the harvesting, gathering, and use of subsistence foods.

The Alaska Native culture cannot easily be separated from the subsistence way of life and each person's relationship to the land, sea, and resources. The rules governing the harvesting and use of subsistence resources are derived from a combination of culture, tradition, and religious beliefs. Subsistence involves many social activities such as cooperative labor-sharing, the exchange of resources and information, transmission of knowledge and skills, and formation of values. The means of establishing prestige and maintaining peace traditionally involve the consumption, transfer, and exchange of fish, game, and their byproducts. These activities are necessary for the preservation of traditional family and community relationships that are essential to the physical and psychological well-being of Alaska Native communities. Continuous access to uncontaminated resources in a natural setting is also fundamental to the physical, spiritual, and psychological well-being of Alaska Native communities.

In Native villages, the hunt, the sharing of products of the hunt, and the beliefs surrounding the hunt tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Generous hunters are considered good men. Good hunters are often leaders. These are but some of the ways in which subsistence and beliefs about subsistence join with sociocultural values. The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and

subsistence activities that occur in Native society. Subsistence also shapes the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations, employment, sports activities, and membership in voluntary organizations. Language, culture, spiritual beliefs, customs, self-esteem, and respect for others are tied into a view of the world that is centered on the traditional hunting, fishing, and gathering way of life.

e. Effects of the Spill on Subsistence

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

The spill fouled waters and beaches used for subsistence hunting, fishing, and gathering by 18 rural communities, including 15 Native villages, with about 15,600 inhabitants. Destruction and contamination of subsistence resources contributed to the cultural disintegration and dislocation experienced by some Alaska Natives in the area.

> Livelihoods destroyed, emotional stability of people destroyed, tremendous stress—these things will be etched on my mind for the rest of my lifetime, and I think that I will be grieving for many, many years to come over what I saw in the summer of 1989. (The Day the Water Died, 1990)

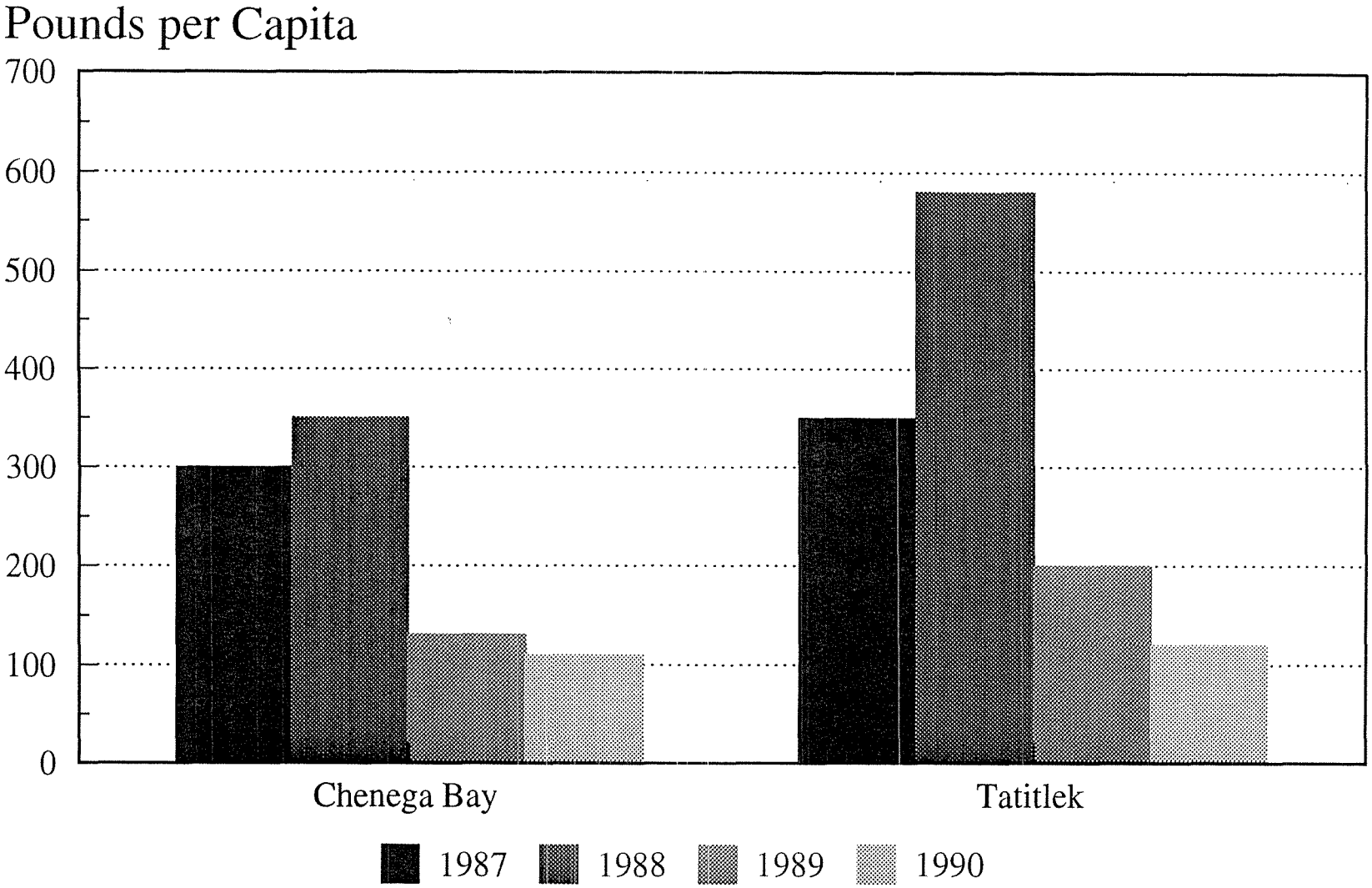
Subsistence harvesting was disrupted, which in turn disrupted the traditional cultural patterns of social interaction surrounding the harvesting of local natural resources. In 1989, subsistence fishery was banned as a precaution against possible health-threatening effects of the oil spill on fish in the Sound.

Resource and habitat contamination and destruction resulted in a 77-percent decline in subsistence resource harvesting. PWS residents had to seek food from outside the local environment. In Native villages, shortages of traditional foods resulted.

Table III# Permits Issued and Estimated Harvest Values, 1989 - 1990

City/village	Permits (1988)	Harvest Earnings (1988)	Permits (1989)	Harvest Earnings (1989)	Permits (1990)	Harvest Earnings (1990)
Cordova	411	$41,500,000	309	$29,949,000	412	$31,637,000
Valdez	55	$2,710,000	30	$1,436,000	54	$1,959,000
Chenega Bay	1	not applicable	1	not applicable	3	not applicable

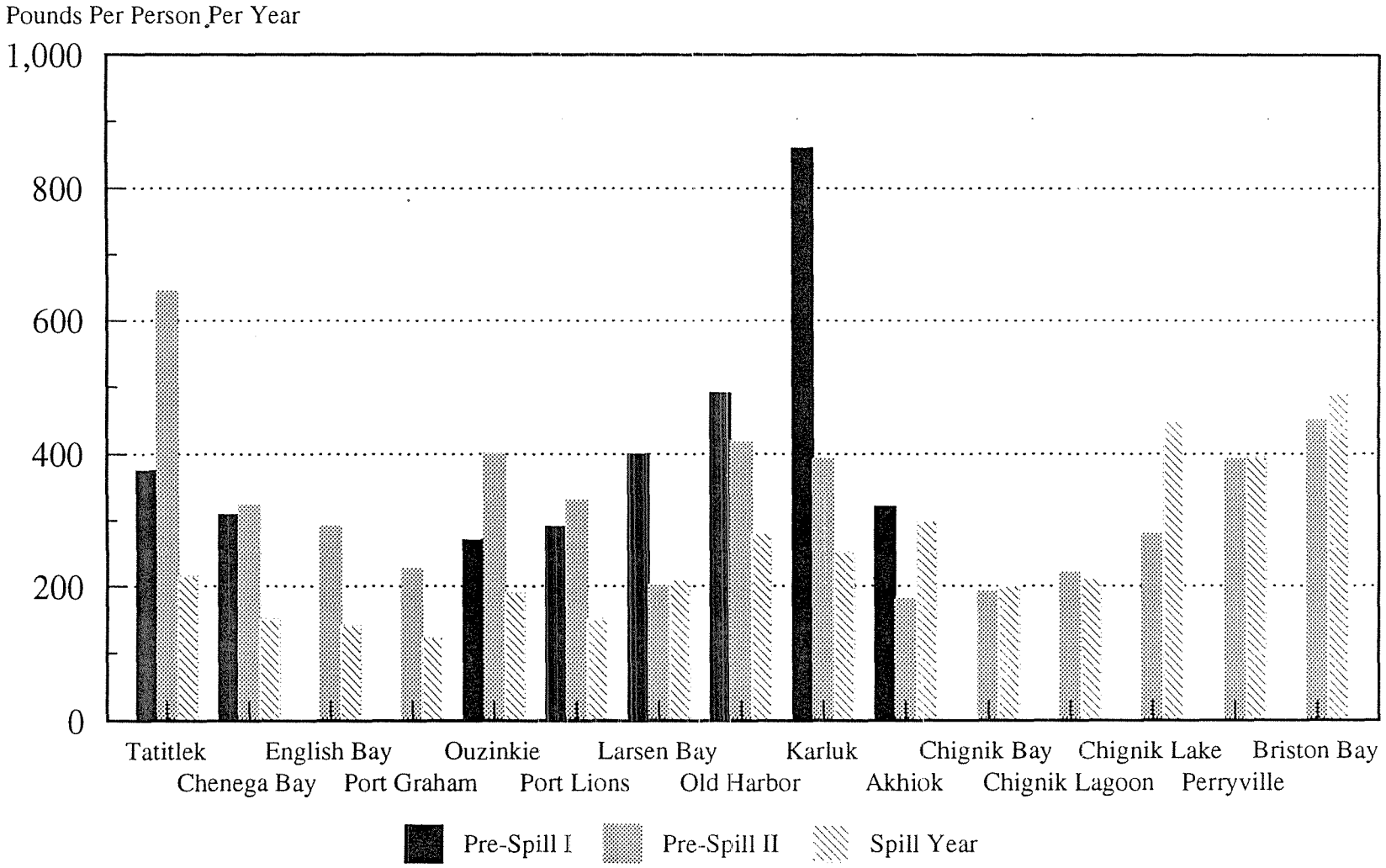
Pre- & Post Subsistence Harvest



Source: Alaska Department of Fish & Game

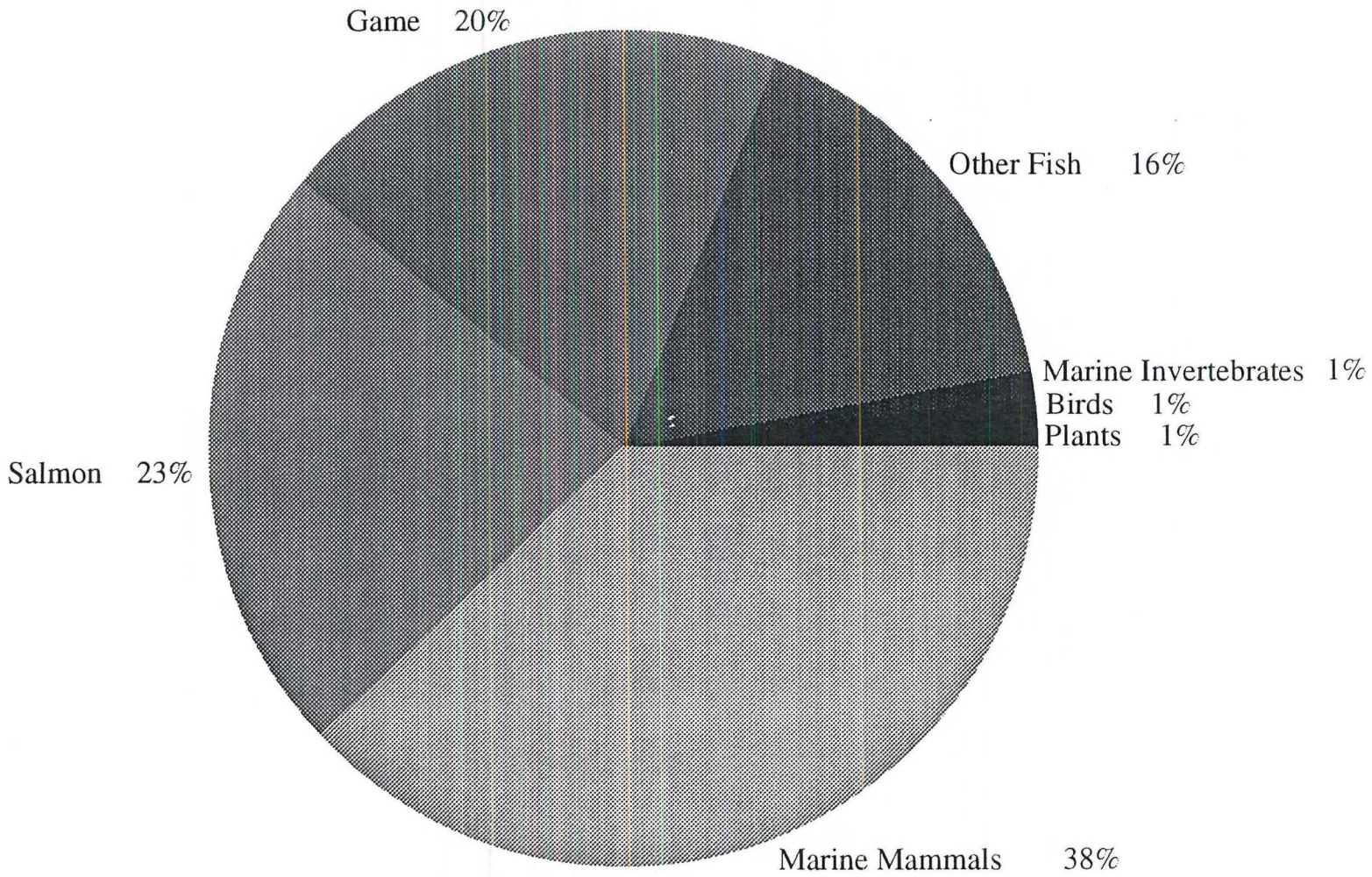
Per Capita Subsistence Harvests

Oil Spill Study Communities



Harvest Composition by Resource Category

Chenega Bay 1985-86



Post-Spill Change

Community	Per Capita Harvest in Pounds			Compared to Most Recent Previous Year	Compared to Average of all Previous years
	Year One	Year Two	Oil Spill Year[a]		
Chenega Bay	308.8	374.2	148.1	-60.4%	-56.6%
Tatitlek	351.7	643.5	214.8	-66.6%	-56.8%
English Bay	288.8	[b]	140.6	-51.3%	[b]
Port Graham	227.2	[b]	121.6	-46.5%	[b]
Akhiok	519.5	159.3	297.7	+86.9%	-12.3%
Karluk	863.2	381.0	250.5	-34.3%	-59.7%
Larsen Bay	403.5	200.9	209.9	+4.5%	-30.5%
Old Harbor	491.1	419.3	271.7	-35.2%	-40.3%
Ouzinkie	369.1	405.7	88.8	-78.1%	-77.1%
Port Lions	279.8	328.3	146.4	-55.4%	-51.9%
Chignik Bay	187.9	[b]	208.6	+11.1%	[b]
Chignik Lagoon	220.2	[b]	211.4	-3.7%	[b]
Chignik Lake	279.0	[b]	447.6	+60.1%	[b]
Ivanof Bay	455.6	[b]	489.8	+8.4%	[b]
Perryville	391.2	[b]	394.2	+1.0%	[b]

[a] For Prince William Sound and Kodiak communities, two pre-spill measurements are available. Pre-spill study years are as follows: Tatitlek, 1987–88 and 1988–89; Chenega Bay, 1984–85 and 1985–86; English Bay and Port Graham, 1987; Kodiak Island Borough, 1982–83 and 1986; Alaska Peninsula, 1984. The "spillyear" is 1989 for all communities but Chenega Bay and Tatitlek, for which it is April 1989 – March 1990. Source: Paige et al. 1991.

[b] Only one previous measurement.

City/village	Permits (1988)	Harvest Earnings (1988)	Permits (1989)	Harvest Earnings (1989)	Permits (1990)	Harvest Earnings (1990)
Tatitlek	11	$514,000	8	$196,000	6	$304,000
Whittier	16	$222,000	9	$42,000	14	$126,000
Total	494	$44,946,000	357	$31,623,000	489	$34,027,000

Source: Alaska Commercial Fisheries Entry Commission

Moreover, the sociocultural system on which the traditional Alaska Native lifestyle is based was threatened by the influx of cleanup crews and the unfamiliar demands of a cash economy. Contamination of traditional foods, and fear of contamination, led potential users to stop harvesting these resources. One Alaska Native had this to say:

> We depend on ourselves. . . And we depend on the seals, sea lions, butter clams, ducks, and sea life. Now they are disappearing. The sea life is disappearing. Even if they come around, we are staying away from them. (Alaska Oil Spill Commission, 1990)

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

6. Commercial Fishing

Commercial fishing within the oil spill area is divided among three census regions (Figure III-A): Southcentral, which includes PWS and the outer Kenai Peninsula area; Kodiak, which surrounds Kodiak and Afognak Islands; and Bristol Bay, which includes the area between Kodiak and the Alaskan Peninsula.

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

recovery status of rockfish, pink salmon, shellfish and herring are uncertain.

The fishing industry in the oil spill area is primarily a small-boat near shore fishery in contrast to the offshore highly capitalized fishery. The near shore fishery common in Prince William Sound, Cook Inlet, and Kodiak/Afognak Island area concentrate on seasonal salmon, herring, halibut, black cod and to a lesser extent on Dungeness, king, and tanner (snow) crab. The offshore fishery located in the western Gulf of Alaska is found well offshore, concentrating on groundfish, king, and tanner crabs. The nearshore fishery is dominated by Alaskan residents operating boats mostly in the 30 to 45 foot length. The offshore fishery is dominated by non Alaskan residents operating much larger vessels whose values range up to $40 million for the large factory trawlers.

In 1986, there were 28,663 permits purchased for the Alaskan commercial fisheries. Of these, 84% (24,059) were purchased by Alaskan residents; the remainder (4,604) were purchased by non-residents.

Alaska is considered the most important fishing state in the United States. In 1989 Alaska accounted for almost half the nation's catch in pounds, and 38% in value. The major species groups contributing to Alaska's commercial fisheries are salmon, shellfish (primarily crabs and shrimps), groundfish (mostly pollock, flatfishes, Pacific cod, black cod and rockfish), halibut and herring. No other state comes close to Alaska in either total harvest weight or value, according to statistics compiled by the U.S. Department of Commerce. Consequently, Alaska is a major exporter of fishery products.

The ex-vessel value of Alaska's commercial fishing industry ranks first among all U.S. states. The ex-vessel value of fishery landings in Alaska is more than twice the landed values of Washington, Oregon and California combined. In 1990, approximately 5.9 billion pounds of seafood worth $1.5 billion in ex-vessel value were landed into Alaskan ports. Salmon accounted for approximately 37% of the total value (Alaska Blue Book, 1991). In 1988, the value of the harvest in Prince William Sound (PWS) alone for salmon fisheries totalled $76 million; herring, $12.2 million; and shellfish, $2.4 million (AF&G, 1989).

The PWS Area combined commercial salmon harvest for 1989 was approximately 24.4 million fish. This catch exceeds the average harvest over the past 10 years. However, an exceptionally large portion of this catch (33%) was composed of hatchery sales fish from the private non-profit (PNP) hatcheries, leaving a common property portion of the catch below the 10 year average (ADF&G, 1991).

The value of the combined 1989 commercial salmon harvest in PWS was estimated at $41.3

million, excluding hatchery sales. The drift gill net catch was valued at $23.8 million, setting the average earnings for the estimated 480 permit holders that fished in 1989 at $49,470. Seiners harvested $18.9 million worth of fish setting the average earnings for the estimated 235 permit fleet at $80,610. Because the Eshamy district was closed for the season, set net fishermen had no opportunity to fish in the PWS area in 1989 (ADF&G, 1991).

The Kodiak area commercial fisheries are dominated by salmon harvests, primarily pink, sockeye and chum. There is also a joint venture trawl fishery for walleye pollock in Shelikof Strait, and a longline fishery for halibut, sablefish, and cod. Herring are also harvested in the Kodiak/Afognak area, primarily in the spring for sac roe, as well as fall and winter fisheries for shellfish, primarily crab.

The fishery in Cook Inlet is geared primarily for sockeye salmon in the vicinity of the Kenai River. Further south along the Kenai Peninsula, the Homer area commercial fishing fleets target all species of salmon, shellfish, and halibut (USDOI, 1986).**[reference is the 5-Year OCS lease EIS]**

Aside from the ex-vessel values of Alaska's fisheries and the economic activity (in terms of employment and personal income) generated from them, fishing generates revenues directly to the State of Alaska from taxes and licenses. State revenues generated in FY-86 from fisheries equalled $47.3 million, of which $43.4 million went to the general fund and $3.9 million went to the fish and game fund. Fishery revenues included fish taxes, marine fuel taxes, fishing permits, fishing licenses and other similar items.

Legal gear for the commercial harvest of salmon include purse seines, both drift and set gill nets, and trolling gear. Set and drift gill nets and purse seines are the most common gear type in the Kodiak area. Set and drift gill nets are also the most common gear for the Cook Inlet fishery. Drift gill net fishermen are the most numerous in PWS and are permitted to fish in the Bering River, Copper River, Coghill, Unakwik, and Eshamy districts (**Figure III-D**). During the 1989 season, 408 drift gill net permit holders participated in the PWS salmon fisheries. Set gill net gear is legal only in the Eshamy district. There are 30 total permits for this gear type. Purse seine gear is legal in the Eastern, Northern, Unakwik, Coghill, Northwestern, Southwestern, Montague and Southeastern Districts. Purse seiners, which catch most of the fish in the sound, fish all PWS districts, except Eshamy, usually beginning in early or mid-July, depending upon the strength of early pink salmon runs. Purse seine fishing continues usually into the first or second week of August. An estimated 243 purse seine permits were active during the 1989 season (ADF&G, 1991).

The seafood industry is the largest non-governmental employer in Alaska, providing

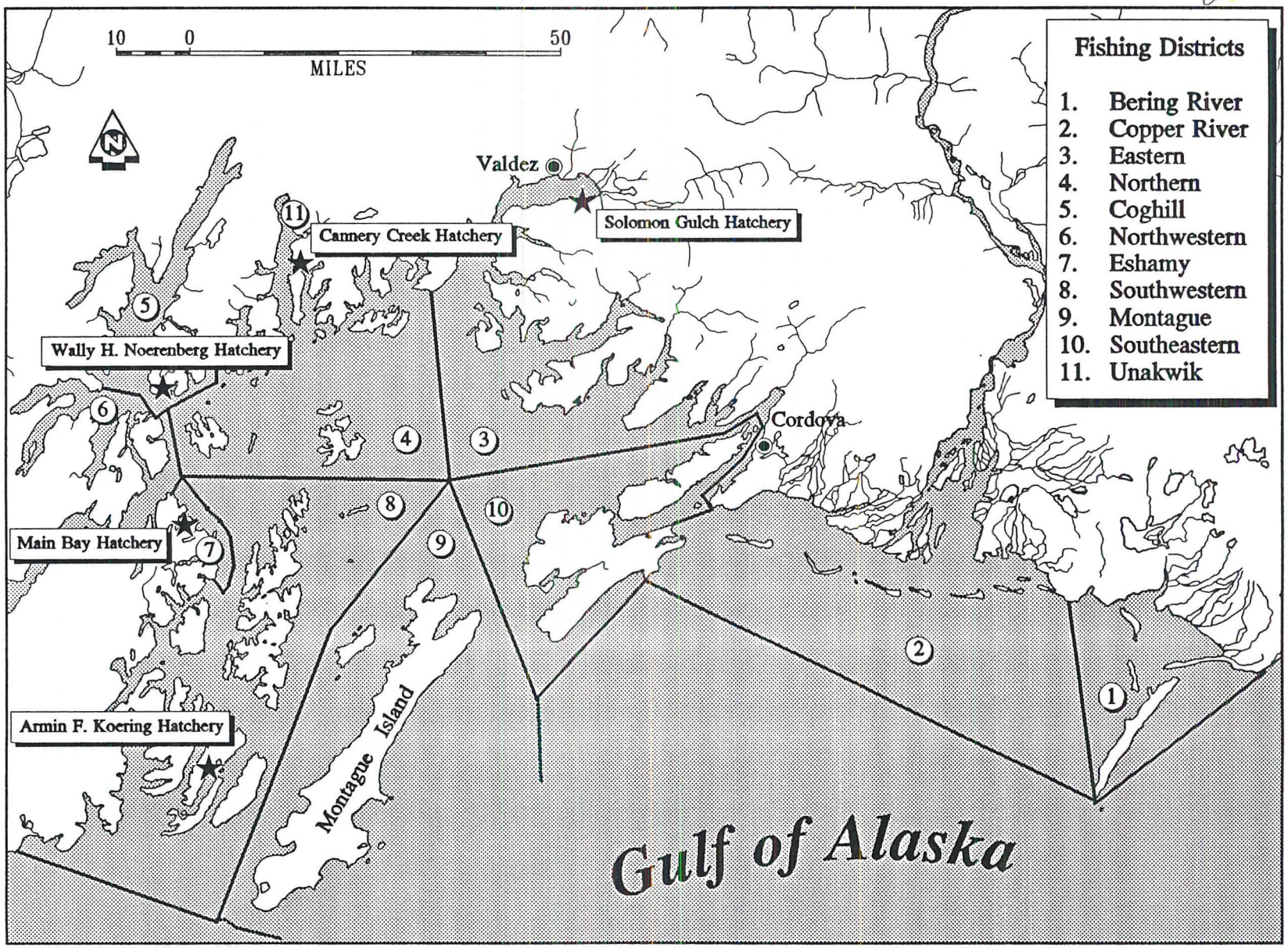


Figure III-D. Commercial Salmon Management Districts and hatcheries in the vicinity of Prince William Sound.

approximately 16.4% of the state's jobs. It has been estimated that the Alaskan seafood industry provides nearly 70,000 seasonal jobs, and as many as 33,000 direct, indirect and induced year-round jobs. Based on these figures, the 1987 estimated total seafood industry payroll was $596 million (Royce, 1991).

The seafood industry (harvesting and processing) in Southcentral Alaska employs approximately 4,000. Residents in Southcentral earn more from seafood harvesting than any other Alaska region. In the Kodiak region, the seafood industry is the dominant economic activity, employing over 2,500 residents. The Kodiak region is the only region completely within the oil spill area, and accounts for nearly 1/4 of the state's seafood processing jobs. Only the far eastern areas of the Bristol Bay region are within the oil spill area. This region is more dependent on the seafood industry than any other Alaska region. More than 70 percent of the region's private industry employment is in the seafood industry (McDowell Group, 1989).

Salmon Hatcheries and Management

Article VIII, Section 5 of the Alaska Constitution authorizes the state legislature to "provide for facilities improvements and services to assure further utilization and development of the fisheries". In 1974, the Private Nonprofit Hatcheries Act (Chapter III, SLA 1974) was enacted which "authorized private ownership of salmon hatcheries by qualified nonprofit corporations for the purpose of contributing by artificial means to the rehabilitation of the state's depleted and depressed salmon fishery."

Salmon hatcheries in the PWS area include the Solomon Gulch Hatchery at Valdez operated by the nonprofit corporation, Valdez Fisheries Development Association (VFDA); The Main Bay Hatchery operated by ADF&G Fisheries Rehabilitation, Enhancement and Development (FRED); and the Armin F. Koering (AFK), Esther, (now the Wally H. Noerenberg Hatchery), and Cannery Creek hatcheries operated by the Prince William Sound Aquaculture Corporation (PWSAC). Cannery Creek is a FRED facility under a 20 year management lease to PWSAC **(Figure III-D)**. Today, seven regional associations from Southeast Alaska to Kodiak produce salmon for common property fisheries (PWSAC, 1990).

The AFK and Cannery Creek Hatcheries produce primarily pink salmon; Noerenberg Hatchery produces all five species of Pacific salmon, the majority of which are pink, chum and coho. Main Bay Hatchery, in the western part of the Sound, currently produces pink salmon but is in the process of converting to sockeye salmon. The VFDA's Solomon Gulch hatchery in Valdez Arm produces pink, chum and coho salmon (PWSAC, 1990).

From the inception of the hatchery system the intent has been to protect the fisheries from

cyclical weaknesses. During the 1970's, salmon runs declined throughout the state. In PWS, seining did not open at all in 1972 and 1974 because the returning wild runs were below fisheries management escapement levels for reproduction and commercial harvest needs (PWSAC, 1990).

The importance of hatchery reared salmon was made apparent during the 1986 season, when approximately 11.5 million pink salmon were caught in PWS. Approximately 10.5 millon fish were harvested in common property fisheries, and 909,219 fish were harvested in the special harvest area sales harvests of the two major PNP hatcheries in the area. Approximately 5.8 million fish in the common property harvest were of hatchery origin. The combined common property and sales harvests of hatchery produced fish was 6.8 million fish. This marked the first time in the history of the fishery that hatchery fish constituted more than half of the pink salmon harvest (Sharr et al, 1988).

Because egg-to-fry survival is 80 percent or higher in hatcheries as opposed to 20 percent or less in natural spawning beds, hatcheries allow at least a 4-fold increase in production from a given number of spawners (PWSAC, 1990).

In an average year, the Prince William Sound hatcheries provide up to 40 percent of the salmon harvest in the Sound. In 1988, because of low natural runs of pink salmon, it is estimated that they contributed almost 90 percent of the Sound's total pink salmon harvest (AF&G, 1989).

Benefits from the introduction of the hatchery system have been achieved at some cost, not only financially, but in terms of fishery conditions, both perceived and real. Hatchery salmon production, intended to both increase catches and reduce harvest variability, has resulted in changes in the distribution of catches by species, the gear types used, seasonal opportunity to fish in historic and traditional areas, and fishing patterns.

Hatcheries have added new complexities to management of salmon returns. Generally, the major salmon returns to hatcheries overlap with the timing of adjacent wild stock systems. Hatchery fish are randomly mixed with wild stock fish, following the same migration routes to their respective points of origin. Unlike the wild stock pink systems distributed uniformly, hatchery stocks in PWS return in mass to a limited number of release sites. In these areas termed terminal areas, hatchery fish are concentrated which provides a management opportunity to specifically target the commercial harvest on the surplus production.

A shift in the composition of salmon in the harvest by the common property fishery can be attributed to the hatchery system. Since the inception of the hatchery program in 1978, the wild stock contribution has declined. In the 1988-89 harvest seasons only 10-15% of the PWS catch

was from wild stocks. Because recent wild stock returns have been quite small relative to hatchery returns, in order to achieve minimum escapement goals for wild stocks, it has been necessary to close the mixed stock areas of the general districts, and harvest a majority of the surplus hatchery returns in the hatchery terminal harvest areas (PWSAC, 1990).

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

In-season fisheries management is the responsibility of the Alaska Department of Fish and Game. The primary management tool used by ADF&G for regulating salmon returns is emergency order authority to open and close fishing areas. During years when the wild stock returns are strong, a liberal weekly fishing schedule may be permitted. However, when the wild stock returns are weak, fishing must be restricted to meet minimum spawning requirements.

The Alaska Board of Fisheries establishes the regulations that govern fisheries. Actions considered by the Board include changes in areas for the salmon fisheries, and the allocation of harvests among the various groups of fishermen. While ADF&G determines when and where fishery openings can occur, the Board of Fisheries regulations determine who can fish in the designated areas.

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

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

Along with FRED, the U.S. Forest Service and PNPs have been largely responsible for implementing management measures or in-stream projects to rehabilitate, if necessary, and increase salmon populations in the PWS area. Past rehabilitation efforts have been aimed at restoring wild stocks to former levels of abundance through stream improvements, fish ladders, and other activities that improve natural spawning conditions. Stream rehabilitation projects are carried out by the U.S. Forest Service in cooperation with the ADF&G. The Forest Service has this responsibility since many of the spawning streams are located in the Chugach National Forest which surrounds PWS and the mouth of the Copper River. Between 1963 and 1982 there

were 78 fish habitat improvement projects, 66 of which were completed by the Forest Service in PWS and Copper River delta areas.

Commercial Herring Harvest

The Pacific herring is also an important species to the Alaskan fishing industry because it eggs or roe are sold in large quantities, primarily to the Japanese market. Also, the herring is a vital part of the food chain, and it is consumed by larger commercial species of fish such as salmon and halibut (Royce, 1991).

In Alaska, there are four commercial herring fisheries. First, a small number of fish are caught for food and bait. Second, divers gather herring eggs or roe on kelp in shallow, open waters. Third, roe is gathered on kelp in man-made enclosures (this is known as the pound-kelp fishery). The fourth and most important commercial harvest is the "sac-roe" fishery, in which herring are netted to collect the mature female's egg filled membrane or sac. Each year the state limits the sac-roe harvest to 20% of the estimated herring stocks (Royce, 1991).

There are five different herring fisheries in the PWS management area, that all target on what is treated as a single major stock of herring in the Sound. Management of the PWS herring fishery involves a maximum exploitation rate of 20% for the PWS herring biomass for all fisheries combined. The food and bait fishery is the only one that occurs in the fall and winter, generally in the Knowles Head area. This fishery is not limited, but generally has fewer than 10 boats participating annually. The four spring fisheries usually occur in the month of April, coinciding with the spawn timing of the PWS herring stock. The spring fisheries include: 1) a purse seine sac row fishery, that accounts for a large portion of the harvest and limited to approximately 100 permit holders, 2) a gill net sac row fishery with 25 limited entry permit holders, 3) a roe on kelp produced in pounds fishery with approximately 125 limited entry permit holders, and 4) a wild harvest fishery of natural roe on kelp, that is open to entry and has annual participation between 100 to 200 (ADF&G, 1991).

A growing market has developed for bottomfish, particularly black cod and rockfish in the oil spill area. Little research as been completed to determine stock levels, and management initiatives are still developing. Throughout Alaska, the bottomfish fishery has grown, and recent plans for new bottomfish processing plants scheduled to come on line over the next few years are expected to add to harvests and associated employment for this portion of the commercial seafood industry (Alaska Blue Book, 1991).

7. Commercial Tourism

Tourism is Alaska's third-largest industry behind petroleum production and commercial fishing. Tourism was, and is, an industry of growing economic importance to the state. Once regarded as a stepchild of the major traditional resource industries, tourism's obvious growth in the 1980s gave it legitimacy as a major industry.

Although the nature and extent of injury varied, approximately 43 percent of the tourism businesses surveyed in 1990 felt they had been significantly affected by the oil spill. Millions of dollars were lost in 1989 due to reduced visitor spending in Southcentral and Southwest Alaska. By 1990, only 12 percent felt that their businesses were affected by the spill (McDowell 1990). Respondents also reported seeing less oil now than in 1989 and subsequent years; a slow but discernible increase in wildlife sightings; and each year a slight increase in people using the spill area for recreation activities (RPWG 1993).

A visitor survey conducted by the Alaska Division of Tourism under the Alaska Visitors Statistics Program II (AVSP) revealed important statistics on the tourism industry. The survey results indicated that more than 750,000 people visited Alaska in 1989 from around the world and of this number 521,000 people visited in summer generating $304 million in in summer revenue alone. The Southcentral region was the major beneficiary of visitor spending, capturing 44% of the $304 million (ADT 1989a). Sixty-nine percent of the total summer visitors were vacation/pleasure visitors. Southcentral Alaska accommodated more visitors per year than any other region but, among the vacation/pleasure visitors, Southeast was the most visited region, with nearly three out of every four vacation/pleasure visitors visiting the region. Southcentral was second with two-thirds of the vacation/pleasure tourism market (ADT 1989b). Southwest was visited by only 6% of the total vacation/pleasure visitors (ADT 1989a) and thus captured 5% of the $304 million (ADT 1989b).

Survey results indicated that Anchorage, Seward, Kenai/Soldotna, Homer, Valdez/PWS, and Whittier were among the most visited communities in the Southcentral region and that King Salmon, Kodiak, Bethel were among the most visited communities in the Southwest region. The most visited attractions on the Kenai Peninsula were Kenai River, Kenai National Wildlife Refuge, Resurrection Bay, Kachemak Bay, and Kenai Fjords National monument. In the Prince William Sound area the most visited attractions were Columbia Glacier, Valdez Pipeline Terminal, and College Fjord. In the Southwest region the most visited attractions were Kodiak Russian Orthodox Church, Katmai National Park, and Kodiak National Wildlife Refuge. In addition, cultural attractions and museums were popular among Southcentral visitors (ADT 1989b).

Among the wide variety of recreational opportunities offered in Alaska, wildlife viewing was the most common activity in every region among the vacation/pleasure visitors. Bird watching

was also common in all regions. Rafting was most popular in Southeast and Denali. Hiking was also popular, especially among the Southwest and Denali visitors. Fishing was most popular in the Southwest, with twice the participation of the next leading fishing region, Southcentral (ADT 1989b).

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

8. Recreation

The oil spill area offers tremendous opportunities for outdoor recreation. Much of land in the oil spill area is in public ownership and is designated as parks, refuges, or forest lands. These areas provide developed and non-developed recreational opportunities including hunting, fishing, hiking, camping, skiing, sightseeing, backpacking, climbing, dogsledding, snowmobiling, snowshoeing, kayaking, canoeing, power boating, sailing, flightseeing, photographing, and filming to the residents and visitors of the region (Castleman and Pitcher 1992). These recreational opportunities have helped create a growing tourism industry in the region.

The public land in the EVOS area include national parks and national forests, including Chugach National Forest, Kenai Fjords National Park, Katmai National Park and Preserve, Lake Clark National Park and Preserve, and Aniakchak National Monument and Preserve; national wildlife refuges including Alaska Maritime National Wildlife Refuge, Kenai National Wildlife Refuge, Kodiak National Wildlife Refuge, Alaska Peninsula National Wildlife Refuge, and Becharof National Wildlife Refuge; and state parks including Chugach State Park and Kachemak Bay State Wilderness Park (Figure III-B). Several other areas under State management, such as State Historic Sites, Marine Parks, Recreation Areas, and Recreation Parks also provide a variety of recreation. Besides the public lands and facilities, commercial recreational facilities exist in the oil spill area.

Hiking and camping, being relatively inexpensive and easily available, are by far the preferred mode of outdoor recreation for the majority of Alaska's residents and visitors. Although, there are very few trails, the vast taiga and tundra terrain (along with the perpetual daylight during hiking season) offers considerable flexibility to hikers (Castleman and Pitcher 1992). The abundant wildlife add the possibility of animal watching while hiking. Photography of the scenery, as well as the fauna and flora, go hand in hand with hiking and camping.

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

For the purposes of this section, the oil-spill area is divided into two regions: the Southcentral region which includes Anchorage, Kenai Peninsula, and Prince William Sound; and the Southwest region which includes Kodiak Island, Katmai, and other southwest locations. A brief description of recreational opportunities provided by each region is provided in the following sections.

Southcentral Alaska

Chugach National Forest, the second largest national forest, encompasses much of the Southcentral region. The Forest Service operates and maintains 37 public recreation cabins and 16 campgrounds within the Chugach National Forest. There are over 200 miles of trail, including two National Recreation trails. In addition, there are 149 recreation special use permit facilities, including one major ski resort and six other resort facilities. The Portage visitor center and the Russian River located in this area are among the three most heavily visited areas in the state. Approximately 90% of the recorded recreational activities in the Chugach National Forest occurs on the Kenai Peninsula. The most popular activities are, camping, hiking, skiing, and fishing. Alaska's second-largest state park, Chugach State Park, located within this region, encompasses nearly half a million acres. Hiking is the main recreational activity in this park with about a dozen well-maintained, well-used, moderate-to-difficult trails. Along with hiking, photography and wildlife-watching are popular recreational activities.

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

The Kenai Peninsula is the most popular all around destination for both Alaskans and visitors (Kenai 1993). It is the most often viewed landscape in Alaska with the Seward/Anchorage highway being the most heavily used travel route in the state (USDA 1984). Captain Cook State Recreation Area, Kenai National Wildlife Refuge, Kenai Fjords National Park, Alaska Maritime National Wildlife Refuge, Kachemak Bay State Park, and Chugach National Forest are some of the areas affording a variety of recreational opportunities in the Kenai Peninsula. The Kenai Fjords National Park, under the management of National Park Service, is an area with ice fields and a deep-water fjord coastline providing opportunities to see whales, sea otters, and various types of birds. At locations in the western and southern parts of the Peninsula, the Alaska Department of Natural Resources maintains public access and recreation sites (including the Kachemak Bay State Park) totaling several thousand acres (Kenai 1993).

Few refuges contain as diverse a landscape, as abundant fish and wildlife populations, or as varied recreational opportunities as the Kenai Refuge. Although not large compared to other refuges in Alaska, the Kenai Refuge supports more recreational use than any other refuge in the world. The wide array of facilities that support and encourage public use and protect refuge resources include, visitor centers, and 47 recreational sites including campgrounds, access areas, wayside, and trailheads. These facilities vary from small undeveloped sites to large campgrounds with tables, fire grates, parking-spurs, boat ramps, water wells, and sanitary facilities. Recreational opportunities in the Kenai Refuge include salmon fishing, camping in developed campgrounds along roads and trails to isolated and primitive areas, hunting, wildlife observation, sightseeing, canoeing, boating, horseback riding, crosscountry skiing, snowmobiling, and berry picking. Most visitors participate in several activities while on the refuge.

Besides the public lands, some cities also offer recreational opportunities on the Kenai Peninsula and their economy, to some extent, is based on recreation and tourism. The city of Seward, located at the head of a deep-water inlet known as Resurrection Bay, offers fishing and sightseeing opportunities. The city of Soldotna, located in the Central Peninsula region, offers salmon fishing in Kenai River and scenic views across Cook Inlet. The city of Kenai sits on a bluff where the Kenai River meets Cook Inlet and where some of the greatest tidal ranges occur, providing whale watching opportunities. Incoming tides actually reverse the flow of the river, influencing the movement of fish and the white beluga whales that follow them. Homer, located on the southern tip of the Kenai Peninsula provides charter boat tours to Gull Island and other locations for viewing thousands of birds. Homer is also visited for halibut fishing (Kenai 1993).

Prince William Sound (PWS), located within the Southcentral region at the northern-most point of the Gulf of Alaska, is a unique, pristine, wilderness abundant with land and marine wildlife.

The Sound is filled with deep fjords, snow-covered mountain ranges, tidewater glaciers, and hundreds of islands. Prince William Sound is primarily travelled by boat with some areas accessed by float-equipped aircraft. Prince William Sound covers over 2,700 miles of coastline, 4.4 million acres of National Forest and three of North America's major icefields. Prince William Sound offers tremendous opportunities for hiking, sightseeing, wildlife viewing, glacier viewing, and fishing (PWS 1993).

Several communities located within the Prince William Sound area offer recreational opportunities and services. The city of Cordova offers a variety of lodging options and recreational services including flightseeing, several boat charter services, and recreation centers. The city of Valdez, surrounded by mountains, provides a variety of local tours and sightseeing opportunities. Numerous scheduled cruises to Columbia and Shoup Glaciers start here. In addition, several guided walking and bus tours showing historic Valdez and the Alyeska Pipeline Terminal are also available (PWS 1993).

Outdoor recreation plays an important role in the lifestyles of many Alaskan residents. A public survey conducted on the lifestyles of southcentral Alaskans yielded information on the recreational activities that these residents engage in (Table I) (USDA 1984). The results of the survey indicated that driving, walking, and fishing were the most popular activities among the Southcentral Alaskans. Respondents also indicated that the important attributes of their favorite activities include getting away from usual demands, being close to nature, doing something exciting, experiencing new and different things, and being with family and friends. Attributes of favorite recreational places considered important by the respondents included fishing opportunities, scenery, and remoteness.

Recreation Participation of Southcentral Alaska Residents

Recreational Activities	Percent of Respondents who Engaged in Activity
Driving for pleasure	59
Walking/running for pleasure	53
Freshwater fishing	42
Attending outdoor sport events	37
Tent camping	31
Motor boating	30
Bicycling	29

Recreational Activities	Percent of Respondents who Engaged in Activity
Cross-country skiing	26
Target shooting	25
RV camping	24
Hiking with pack	22
Baseball/softball	19
Flying for pleasure	19
Sledding/tobogganing	17
Kayaking/canoeing	17
ORV winter	17
ORV summer	14
Outdoor tennis	17
Swimming/scuba diving	16
Alpine skiing	14

Southwest Alaska

The Southwest region includes the Kodiak Island group, the Alaska Peninsula, the Aleutian Islands, and Katmai. Katmai National Park and Preserve, Alaska Peninsula National Wildlife Refuge, Becharof National Wildlife Refuge, Kodiak National Wildlife Refuge, and Aniakchak National Monument and Preserve are located in this region.

Kodiak Island is the largest island in Alaska and the second largest island in the U.S. Kodiak has Alaska's largest fishing fleet and biggest brown bear population. Kodiak Refuge, established in 1941 to protect the habitat of brown bear and other wildlife, occupies about two-thirds of the island. Rearing and spawning habitat for five species of Pacific salmon is provided within the refuge. With over 200 species of birds, as well as large brown bear and bald eagle populations, the refuge is ideal for wildlife viewing. Other recreational activities include photography, rafting, canoeing, camping, backpacking, hiking, hunting, and fishing. A visitors center and a limited number of recreational cabins are also located within the refuge. The town of Kodiak, where the majority of the Kodiak Island population live, is accessible by air and is visited for

viewing commercial fishing operations. The communities of Larsen Bay and Ports Lion on the Kodiak Island are visited for hiking, fishing, and hunting opportunities and their economy to a large extent is dependent on tourism (U.S. FWS 1987).

9. Sport Fishing and Hunting

Sport fishing and sport hunting constitute an important and distinct segment of the recreational activities in the EVOS region.

Sport Fishing

Sport fishing is one of the most popular recreational activity for both residents and visitors of Alaska. Marine and freshwater systems provide a variety of sport fishing opportunities in the oil-spill region. Marine recreational fishing originates in all major towns on the Prince William Sound as well as Cook Inlet, Kodiak Island, and the Kenai Peninsula. Fishing trips are taken in several ways - from shore, from private boats, and from charter vessels. Several species of Pacific salmon, rockfish, and halibut inhabit salt water. Species of Dolly Varden, rainbow and cutthroat trout are found in freshwater streams and lakes. Although sport fishing is popular throughout the state, seventy percent of Alaska's sport fishing occur in the Southcentral region and majority of which occur in the Kenai Peninsula because access by car from Anchorage to Kenai Peninsula is relatively easy (Castleman and Pitcher 1992). The Kenai River is well known for king salmon fishing. Sport fishing throughout the state is conducted according to the Alaska Sport Fishing Regulations, formulated by the Alaska Board of Fisheries. The fishing regulations specify bag, possession, and size limits for the fishes to be taken from different streams/rivers/lakes etc. (ADF&G 1992a). In addition, there are management plans for king salmon on the Kenai River.

Historically (between 1984 and 1988), the number of anglers, fishing days, and fish harvest in the oil-affected area had been increasing at a rate of 10 - 16% per year.Since 1977, there has been a 4.5% average annual increase in the number of residents who sport fish, while the number of non-residents sport fishing has increased 16% annually. However, after the oil spill, between 1989 and 1990, a decline in sport fishing (number of anglers, fishing trips, and fishing days) was recorded for Prince William Sound, Cook Inlet, and the Kenai Peninsula. The decline occurred due to closures, fear of contamination, the unavailability of boats, and congestion at some sites outside the spill area (Carson and Hanemann 1992). The estimated number of anglers in the oil-affected region decreased 13% from 120,160 in 1988 to 104,739 in 1989, the number of days fished decreased 6% from 312,521 to 294,598, and the number of fish harvested decreased 10% from 352,630 to 318,981 (ADF&G 1992b). The area outside the oil spill, however, continued to experience the increase. In 1992, an emergency order restricting cutthroat

trout fishing was issued for western Prince William Sound due to low adult returns. The closure is expected to continue at least through 1993. Also the Kenai River sockeye salmon overescapement following the oil spill may severely affect sport fishing as early as 1994. An estimated 124,185 lost recreational fishing days were calculated for 1989 due to

Sport Hunting

Alaska has 12 species of big game, including several not found (muskox, Dall sheep), or very rare (wolf, wolverine, brown bear, caribou), in the other 49 states. Approximately 144,000 - 166,000 moose; 835,000 caribou; 60,000 - 80,000 Dall sheep; 32,000 - 43,000 brown bears; over 100,000 black bears; 5,900-7,900 wolves; 2,100 muskoxen; 13,000 - 15,000 mountain goats; 350,000 - 400,000 black-tailed deer; 1,400 - 1,600 elk and 850 bison inhabit the state. Also abundant are 19 species of furbearers, three species of ptarmigan, four species of grouse, two species of hares and many species of waterfowl, migratory birds, raptors and marine mammals (Castleman and Pitcher 1992). Hunting is conducted according to the Alaska State Hunting and Trapping Regulations formulated by Alaska Department of Fish and Game, Board of Game Members (ADF&G 1992c, 1992d). These regulations specify bag limits and season area-wise for hunting. The many wildlife refuges, parks, and national forests located within the oil-affected region provide tremendous opportunities for hunting.

Following the oil spill, sport hunting of harlequin ducks was reduced by restrictions imposed in 1991 and 1992 in response to damage assessment studies. It is likely that these restrictions will continue until the species shows signs of recovery.

DEIS

Chapter IV. Environmental Consequences

Chapter IV. Environmental Consequences

DRAFT

This chapter forms the scientific and analytic basis for the comparison of impacts among the proposed alternative implementation strategies (the alternatives) for the *EVOS* Restoration Plan. The environmental impacts or consequences that would occur from the implementation of each of the proposed alternatives are discussed in this chapter. The conclusions presented in this analysis are intended to guide decisionmakers in selecting the preferred alternative for the Restoration Plan. This chapter will also guide decisionmakers in developing a Record of Decision in compliance with the National Environmental Policy Act (NEPA) after comments are received from the public on the Draft Environmental Impact Statement (DEIS) and changes are incorporated as appropriate into the Final Environmental Impact Statement (FEIS).

The environmental consequences of the alternatives are the results of the application of different combinations of restoration options. Different mixes of options produce varying impacts on the human and natural environment. The title and number given each of the options, and the alternatives in which they would be included are presented in **Table 4-1**. A complete description of the activities included in the options, and their expected effectiveness in restoring resources and services damaged by the *EVOS* are presented in the Draft Restoration Plan.

This chapter first presents an assessment of the effects on resources and services from implementation of each of the possible restoration options, then summarizes the impacts of option implementation for each of the proposed Restoration Plan alternatives. An economic impact assessment is presented separately in the socioeconomic consequences section of this chapter because the economic impact assessment was conducted differently than the impact assessment of resources and services damaged by the *EVOS*. Following that analysis, there is a discussion of the nature and effect of alternative implementation on the issues identified through the EIS scoping process, which were presented in Chapter I of this DEIS. The remainder of the chapter is devoted to an a assessment of the cumulative impacts associated with Restoration Plan implementation, irreversible and irretrievable commitments of resources, unavoidable adverse environmental consequences of Restoration Plan implementation, and mitigation measures that may be appropriate for consideration when implementing Restoration Plan alternatives.

Option Descriptions

Table 4-1. List of alternatives and associated options.

Option	Alternatives				
	1	2	3	4	5
1.0 Archaeological Site Stewardship Program		.	✓	✓	✓
2.0 Intensify Fisheries Management to Protect Injured Stocks			✓	✓	✓
4.0 Reduce Disturbance at Marine Bird Colonies and Marine Mammal Haulouts and Concentration Areas Through Regulation			✓	✓	✓
8.0 Develop Sport and Trapping Harvest Guidelines for Injured Species					✓
9.0 Minimize Incidental Take of Marine Birds By Commercial Fisheries			✓	✓	✓
10.0 Preserve Archaeological Sites and Artifacts			✓	✓	✓
11.0 Improve Freshwater Wild Salmon Spawning/Rearing Habitats			✓	✓	✓
12.0 Creation of New Recreation Sites and Facilities			✓	✓	✓
13.0 Eliminate Oil From Mussel Beds			✓	✓	✓
14.0 Accelerate Recovery of Upper Intertidal Zone			✓	✓	✓
16.0 Increase Productivity and Success of Murre Colonies			✓	✓	✓
17.0 Increase Productivity and Survival of Marine Birds Through Predator Control			✓	✓	✓
18.0 Replace Fisheries Opportunities by Creating New Salmon Runs			✓	✓	✓
19.0 Protect Undocumented Anadromous Streams by Updating the ADF&G Anadromous Stream Catalogue					✓
30.0 Test Subsistence Foods for Hydrocarbon Contamination			✓	✓	✓

Option	Alternatives				
	1	2	3	4	5
33.0 Education: Public Information Program Through Visitor Centers					✓
34.0 Marine Environmental Institute and Research Foundation					✓
35.0 Negotiate with Museums and Agencies to Acquire Replacements for Artifacts Looted from the Spill Area				✓	✓
37.0 Habitat Protection and Acquisition		✓	✓	✓	✓
40.0 Special Designations		✓	✓	✓	✓
45.0 Facilitate Changes in Black Cod Fishery Gear			✓	✓	✓
46.0 Cooperative Program with Commercial Fishermen to Reduce Bycatch of Harbor Seals			✓	✓	✓
47.0 Cooperative Program with Subsistence Users to Assess Marine Mammal Harvest Levels			✓	✓	✓
48.0 Improve Survival of Salmon Eggs and Fry			✓	✓	✓
49.0 Provide Subsistence Users Access to Traditional Foods			✓	✓	✓
50.0 Replace Subsistence Harvest Opportunities for Bivalve Shellfish					✓
51.0 Relocate or Change Timing of Existing Hatchery Salmon Runs			✓	✓	✓

A. Physical and Biological Environment

None of the options would affect the physical environment on a large scale. Modifications to habitat structure in local environments would result from the construction of salmon spawning channels and instream improvements under Option 11 (Improve freshwater wild salmon habitat). Removal of vegetation and habitat on a very local scale would result from Option 12 (Creation of new recreation sites and facilities). Minor alterations of habitat structure would also result from mechanical removal of oil from mussel beds. None of these options would have a significant impact

on the physical environment.

1. Greater EVOS Ecosystem

The biological environment is better described as the Greater EVOS Area Ecosystem and includes the marine ecosystem, coastal ecosystem, and terrestrial ecosystem. All of the options would have some effect, although not always measurable or significant, on these ecosystems. Because the goal of the Restoration Plan is to benefit resources and services within the Greater EVOS Area Ecosystem, the cumulative effect of recovering resources constitutes a substantial benefit to the ecosystem. Indeed, restoration is one principal of ecosystem management stated in the recent Council on Environmental Quality (1993) document on the conservation of biodiversity. The specific effects on individual resources are discussed in later sections. For evaluation of impacts on the marine, coastal, and terrestrial ecosystems a specific set of biodiversity conservation criteria have been developed. These criteria are based on the definition of biodiversity given by the Council on Environmental Quality (1993) that includes regional ecosystem diversity, local ecosystem diversity, species diversity, and genetic diversity. Ten factors contributing to biodiversity, or ecosystem, protection were considered when evaluating the potential impacts of each option on the marine, coastal, and terrestrial ecosystems of the EVOS area.

1. Take a "big picture" or ecosystem view.

2. Protect communities and ecosystems.

3. Minimize fragmentation.
   Promote the natural pattern and connectivity of habitats.

4. Promote native species.
   Avoid introducing non-native species.

5. Protect rare and ecologically important species.

6. Protect unique or sensitive environments.

7. Maintain or mimic natural ecosystem processes.

8. Maintain or mimic naturally occurring structural diversity.

9. Protect genetic diversity.

10. Monitor for biodiversity impacts.
    Acknowledge uncertainty.
    Be flexible.

Where possible, each option was also evaluated in terms of its potential effect on the area of sensitive habitats, status of sensitive habitats, number of sensitive species, population status (including genetic composition) of sensitive species, and status of the landscape.

It is also important to remember that there are various degrees of linkage among the different species within the greater ecosystem. Although, some impacts may be small on individual resources, the combined impact on the ecosystem may be substantial. At the same time, the impacts of some options may be large for certain species within the ecosystems (as discussed below), but not significant for the ecosystem. Because of the complexity of interactions within an ecosystem, natural recovery should be encouraged wherever possible. This includes, however, diligent protection of the system from continuing and new impacts, especially those created by degrading land uses. In any case, long-term monitoring of the recovery process and effectiveness of restoration activities is essential.

separate nontarget resources

Option #2 (Intensify fisheries management)

This option involves the restricting or redirecting of existing fisheries. This option would contribute to population increases (improved species population status) of individual fish species. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine, coastal, and terrestrial (as defined to include anadromous migration into freshwater streams) ecosystems. These positive effects would be limited by their small magnitude (changes in populations numbers to only a few species) and moderate extent (expected changes in abundance only in targeted areas).

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

This option would be implemented through the establishment of buffer zones around these sensitive areas. This option would contribute to population increase of individual bird and mammal species. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine and coastal ecosystems. These positive effects would be limited by their small magnitude (changes in populations numbers to only a few species) and moderate extent (expected changes in abundance only in targeted areas). Creation of small buffer areas as planned would not have a significant affect on other organisms.

Option #8 (Develop sport and trapping harvest guidelines)

This option would involve imposing temporary restrictions or closure of sport harvest and trapping of this species in the oil-spill area. This option would contribute to population increases (improved population status) of individual bird and mammal species. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the coastal and terrestrial ecosystems. These positive effects would be limited by their small magnitude (changes in populations numbers to only a few species) and moderate extent (expected changes in abundance only in targeted areas).

Option #9 (Minimize the incidental take of marine birds)

Under this option, the extent of marine bird mortality by gillnets

and driftnets would be examined. If the mortality is found to represent a significant source of mortality for populations in the spill area, an effort would be made to develop new technologies or strategies for reducing encounters. This option would contribute to population increases (improved species population status) of individual bird species. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine and coastal ecosystems. These positive effects would be limited by their small magnitude (changes in population numbers to only a few species) and moderate extent (expected changes in abundance only in targeted areas).

Options #11 (Improvements to freshwater wild salmon habitats)

This option would involve a number of techniques designed to restore and enhance wild salmon populations in the oil-spill area including construction of salmon spawning channels and in-stream improvements, fertilizing lakes to improve rearing success, and improving access to spawning areas by building fish passes or removing barriers. This option would contribute to population increases (improved species population status) of individual salmon species. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine, coastal, and terrestrial (as defined to include anadromous migration into freshwater streams) ecosystems. These positive effects would be limited by their small magnitude (changes in population numbers to only a few species) and moderate extent (expected changes in abundance only in targeted areas). To the extent that habitats would be modified from natural conditions to benefit salmon, other native species would be adversely affected. In particular, nutrient sensitive species might decline. Achieving passage beyond manmade blockages would benefit all species and constitute a moderate, positive, direct, long-term impact on the freshwater terrestrial ecosystem.

Option #12 (Create new recreation sites and facilities)

This option would include construction of new public recreation facilities such as mooring buoys, boat ramps, picnic areas, campsites, and trails; and making public land available for commercial recreation facilities such as fuel stops, docks, and lodges. At this time, the specific proposed location of these new facilities is unknown. This option would remove natural habitat and alter ecological conditions at small sites. It is not

anticipated that enough new recreation facilities would be constructed to produce a large adverse effect on the marine, coastal, or terrestrial ecosystems. Therefore, a slight, negative, direct, long-term impact would occur.

Option #13 (Eliminate oil from mussel beds)

This option would determine the geographic extent of remaining oil and implement the most effective and least intrusive method of cleaning. Persistent oil in the mussel beds or anadromous streams continues to have adverse effects on the marine, coastal, and terrestrial (freshwater) ecosystems. The elimination of toxic effects to a variety of organisms and the return of spawning substrates and microhabitats to their natural condition (increase area of sensitive habitats) would greatly benefit the local aquatic communities. Lesser benefits would be reaped by species dependent on these beds and streams for food and habitat. In contrast, mechanical manipulation of mussel bed or stream bottom structure would have adverse effects on the aquatic communities. Assuming that intrusive methods of oil removal would be required, the positive and negative effects of this option would counteract each other and result in no significant impact on the marine, coastal, and terrestrial (freshwater) ecosystems.

Option #14 (Accelerate recovery of the upper intertidal zone)

This option would involve methods to remediate habitat heavily oiled and subjected to intensive clean-up measures. Implementation of this option would include installation of trickle irrigation systems designed to enhance moisture retention, use of biodegradable materials as additional substrate for germling attachment and cover, and transplanting adult plants attached to small rocks and cobble. The overall objective of this option is to facilitate recovery of the previously dominant brown algae *Fucus gardneri* (popweed). The loss of *Fucus* algae had a severe impact on the intertidal community that depends on this species for substrate attachment and physical shelter. Return of this algae would greatly benefit the intertidal community (increase area and improve status of sensitive habitats), and to a lesser degree those species that feed on intertidal organisms. Because of the degraded condition of the *Fucus* based community, it is assumed that intrusive methods of restoration would not have significant adverse effects on the ecosystem. Therefore, this option would have a moderate, positive, direct, long-term impact on the coastal ecosystem. Only the limited extent to which this option can be

implemented prevents it from having a larger positive impact.

Options #16 (Increase murre productivity and nesting ledges)

Enhancing social stimuli, such as using decoys and recorded calls to give the illusion of typical breeding densities may encourage a return to normal breeding patterns. Largely experimental techniques that provide breeding ledges with sills, add partitions and/or roofs on nesting ledges, enlarge nesting ledges, and clear debris from otherwise suitable nesting sites would be undertaken following determination of feasibility. If specific techniques were shown to be feasible, this option would contribute to populations increase of murres (improve species population status). To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine and coastal ecosystems. It is possible that intense management of these breeding areas may have negative affects on the coastal ecosystem through habitat alteration or disturbance, but it is assumed that these considerations would be taken into account during the determination of feasibility. The positive effects would be limited by their small magnitude (changes in populations numbers to only a few species) and moderate extent (expected changes in abundance only in targeted areas).

Option #17 (Removal of introduced predator species)

The primary goal of this option would be to remove introduced fox from islands along the Alaska Peninsula and Aleutians. A secondary goal would be to reduce avian predators. This option would contribute to population increases (improved species population status) in a number of species that face predation, and possibly competition from introduced foxes. To the extent that fox removal is accomplished and natural community composition is returned, the coastal and terrestrial ecosystems would improve. Where natural predators are controlled, natural ecosystems processes may be disrupted, adversely affecting the coastal and terrestrial ecosystems. Assuming that foxes are successfully removed from large areas, this option would result in a moderate, positive, direct, long-term impact on the coastal and terrestrial ecosystem.

Option #18 (Create new salmon runs)

This option would involve a combination of terminal hatchery runs and stream stocking. This option would not contribute to natural populations of native species, but might reduce harvest pressure on

these populations. In contrast, substantial increases in the number of salmon (as anticipated by new or expanded hatchery activities) may adversely affect predatory birds and mammals that feed on forage fish consumed by salmon. Overabundant salmon may also deplete the food source for these forage fish through interspecific competition. Therefore, this option would have a slight, negative, indirect, short-term impact on the coastal and terrestrial ecosystems.

Option #19 (Protect undocumented anadromous streams)

This option involves listing of undocumented anadromous streams in the state's catalogue to afford them legal protection under Alaska Department of Fish and Game (ADF&G) statutes to protect injured anadromous species and their habitats. This option would improve the understanding of natural ecosystem conditions in the EVOS area and could lead to better management decisions affecting the marine, coastal, and terrestrial ecosystems. This option would have a very slight, positive, indirect, long-term impact on these ecosystems.

Option #30 (Test subsistence foods for hydrocarbon contamination)

Testing subsistence foods for hydrocarbon contamination is assumed to be unrelated to toxic effects on native species. Therefore, this option would have no impact on the marine, coastal, or terrestrial ecosystems.

Option #33 (Visitor center)

This option involves construction and operation of a large visitor-center or expansion of an existing visitor center somewhere in the oil-affected area of Cordova, Valdez, Anchorage, Seward, Homer, or Kodiak. Information from the visitor center would also be available to other visitor centers, government agencies, and organizations in the spill area. This option would remove natural habitat and alter ecological conditions at a single site over an area too small to produce a significant adverse effect on the coastal or terrestrial ecosystems. At the same time, this option would improve the public understanding of natural ecosystem conditions in the EVOS area and could lead to more compatible human uses of the area. This option would have a slight, positive, indirect, long-term impact on the marine, coastal, and terrestrial ecosystems.

Option #34 (Establish a marine environmental institute)

This option involves construction of a new marine environmental institute in an easily accessible area, designated for the use, within the oil- spill region to study the marine environment and provide public education. This option would remove natural habitat and alter ecological conditions at a single site over an area too small to produce a significant adverse effect on the coastal or terrestrial ecosystems. At the same time, this option would improve the public understanding and scientific knowledge of natural ecosystem conditions in the EVOS area and could lead to better management decisions and more compatible human uses of the area. This option would have a slight, positive, indirect, long-term impact on the marine, coastal, and terrestrial ecosystems.

Option #37 (Habitat protection and acquisition)

This option involves private land acquisition, or acquisition of partial interests in private lands, for the purpose of protecting habitats linked to the resources injured by the oil spill or to prevent additional injury to those resources. Implementation of this option may include the acquisition of critical upland habitat for injured species including undisturbed riparian lands around anadromous streams and nesting areas in mature forests. This option directly addresses the conservation of coastal and terrestrial ecosystems, and by extension marine ecosystems (this ecosystem is not only linked through ecological processes, but also is vulnerable to degrading activities occurring in upland environments). Land acquisition addresses each of the factors designated as the criteria for biodiversity, or ecosystem, conservation.

1. Habitat acquisition takes a "big picture" or ecosystem view of EVOS restoration as evidenced by habitat acquisition evaluation criteria # 2—The parcel should function as an intact ecological unit or essential habitats on the parcel must be linked to other elements/habitats in the greater ecosystem.

2. Habitat acquisition directly protect communities and ecosystems by preserving land units rather than managing individual species. Evaluation criteria #4—The parcel should benefit more than one species or service—is consistent with community rather than single species management.

3. Habitat acquisition would minimize fragmentation by uniting private parcels with lands already in protected status. This

would promote the natural pattern and connectivity of habitats. Evaluation criteria #6—select vulnerable or potentially threatened areas—is evidence that without acquisition degradation through logging, or other incompatible human uses, is imminent.

4. Habitat acquisition would promote native species and avoid introducing non-native species by transferring private lands into management programs that follow these guidelines.

5. Habitat acquisition evaluation criteria #5—the parcel should contain critical habitat for depleted, rare, threatened, or endangered species—explicitly includes protection of rare and ecologically important species.

6. Habitat acquisition evaluation criteria #1 explicitly states that the parcel should contain essential habitats or sites (i.e., unique or sensitive environments). For example, old growth stands would be protected from logging with the acquisition of many forested parcels.

7. Habitat acquisition would maintain natural ecosystem processes through application of evaluation criteria #3—adjacent land uses will not significantly degrade the ecological function.

8. Habitat acquisition of prospective timber lands helps maintain naturally occurring structural diversity that would be lost through logging operations that simplify natural forest pattern by the reduction of age classes and the removal of snags and downed wood.

9. Habitat acquisition protects genetic diversity by maintaining the natural complement of subpopulations and individual variation. Problems with the dilution of genetic diversity often arise when intensive management and stocking programs are undertaken.

10. Habitat acquisition acknowledges the uncertainty inherent in ecosystem restoration. By maintaining a reservoir of natural areas, this option provides a benchmark for biodiversity monitoring and provides flexibility for future management decisions.

In summary, habitat acquisition would go the furthest toward promoting biodiversity by maintaining ecosystem integrity. It

would also enhance the recovery of injured resources, because their recovery may be substantially delayed or prevented by future development and land use changes on private lands. This option would have a strong positive, direct, long-term impact on the marine, coastal, and terrestrial ecosystems.

Option #40 (Special designations)

Marine, coastal, and terrestrial areas in public ownership can be placed into special State or Federal land designations that provide increased levels of regulatory protection. An important feature of special designations is that they can provide a regulatory basis for managing an area on an ecosystem level, with the primary objective of restoring spill injuries. Like the habitat acquisition option, this option would promote biodiversity by maintaining ecosystem integrity. It would also enhance the recovery of injured resources, because their recovery may be substantially delayed or prevented by future development and land use changes on private lands. Although the protection of ecosystem health and functioning would be limited to those lands already in public ownership, substantial benefits of precluding degrading activities such as logging would benefit the terrestrial, coastal, and by extension marine ecosystems (this ecosystem is not only linked through ecological processes, but also especially vulnerable to degrading activities occurring in upland environments). Ecosystem management inherent in the special designations option addresses each of the factors designated as the criteria for biodiversity, or ecosystem, conservation.

1. Take a "big picture" or ecosystem view.

2. Protect communities and ecosystems.

3. Minimize fragmentation.
   Promote the natural pattern and connectivity of habitats.

4. Promote native species.
   Avoid introducing non-native species.

5. Protect rare and ecologically important species.

6. Protect unique or sensitive environments.

7. Maintain or mimic natural ecosystem processes.

8. Maintain or mimic naturally occurring structural diversity.

9. Protect genetic diversity.

10. Monitor for biodiversity impacts.
Acknowledge uncertainty.
Be flexible.

In summary, this option would have a moderate positive, direct, long-term impact on the marine, coastal, and terrestrial ecosystems.

Option #45 (Facilitate Changes in Black Cod Fishery Gear)

This option is designed to prevent the harassment and shooting of the killer whales that strip cod from longline gear. This option would contribute to populations increases (improved population status) of individual killer whales. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine ecosystem. These positive effects would be limited by their small magnitude (changes in populations numbers of a single species).

Option #46 (Reduce the bycatch of harbor seals)

This option involves changing harvest methods and harvest areas to prevent incidental take. This option would contribute to population increases (improved species population status) of harbor seals. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine and coastal ecosystems.

Option #47 (Cooperative program with subsistence users)

This option has the potential to improve the information upon which marine mammal management decision are made. Because it is uncertain whether this option would be successful through implementation, the impact on the marine and coastal ecosystems is judged not to be significant.

Option #48 (Improve survival of salmon eggs and fry)

This option is designed to increase survival of salmon eggs and larvae through the rearing of wild salmon eggs in boxes, netpens, or hatcheries, and releasing them to native streams. This option

would contribute to population increases (improved species population status) of salmon species, and perhaps on predators feeding on salmon eggs and fry such as Dolly Varden. To the extent that these populations returned to natural levels, this option would have a very slight, indirect, long-term, positive effect on the marine, coastal, and terrestrial (as defined to include anadromous migration into freshwater streams) ecosystems. These positive effects would be limited by their small magnitude (changes in populations numbers to only a few species) and moderate extent (expected changes in abundance only in targeted areas).

Option #49 (Provide access to traditional subsistence foods)

This option would create greater opportunities for subsistence users from impacted areas to travel to unimpacted areas to harvest traditional subsistence resources. Implementation of this option would continue until the injured resources have recovered. It is assumed that subsistence use would not significantly affect resource populations, this option would not affect the marine, coastal, or terrestrial ecosystems.

Option #50 (Replace subsistence harvest opportunities for bivalve shellfish)

This option would provide the facilities and infrastructure to restore, replace, and/or enhance affected shellfish populations and in particular, the subsistence use of shellfish. Additionally, there is the potential to use hatchery shellfish to re-seed native species on beaches damaged by oiling or clean-up, once those beaches are no longer oiled. This option would not contribute to natural populations of native species, but might reduce harvest pressure on these populations. In addition, populations of species prey on bivalves may benefit. Therefore, this option would have a very slight, positive, indirect, short-term impact on the marine ecosystems.

Option #51 (Change or relocate existing hatchery runs)

This option would change the timing of hatchery run releases in PWS, or would release hatchery fish at remote locations to minimize the interaction of hatchery fish and wild salmon stocks during commercial harvest. This option would not contribute to natural populations of native species, but might reduce harvest pressure on these populations. In contrast, relocation of hatchery runs may upset the natural conditions in new habitats adversely affecting

native species. Assuming that new runs would only be undertaken in streams previously supporting salmon populations (e.g., those blocked by dams or other obstructions), this option would result in a very slight, positive, indirect, short-term impact on the marine, coastal, and terrestrial (freshwater) ecosystems.

2. Biological Resources

a. Marine Mammals

Harbor Seals

Option #2 (Intensify fisheries management to protect injured stocks)
Option #11 (Improve freshwater wild salmon habitats)
Option #48 (Improve survival of salmon eggs and fry)
Option #51 (Change or relocate existing hatchery salmon runs)

All of these options are designed to increase the abundance of salmon (and other fish) in the oil spill region. There would be a resulting indirect, positive effect on harbor seals because their main diet consists of the same fish affected by these options. By increasing fish numbers, harbor seals would have more to eat, be healthier due to steadier diet, and may slowly increase in abundance.

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

The purpose of this option is to designate buffer zones encircling important sites for the species in order to decrease disturbance. It is assumed that buffer zones would be established around known harbor seal haulout sites in the oil spill area, and that buffer zones would be maintained through the pupping and molting seasons from May until October. This option would decrease disturbance at harbor seal haulouts during times when seals are prone to panic, often stampeding and causing injuries/deaths and weakening mother-pup bonds. Weakening mother-pup bonds increases pup abandonment and leads to higher pup mortality. This option would have the indirect, positive result of decreasing harbor seal mortality caused by haulout disturbance.

Option #8 (Develop sport harvest guidelines)

This option would provide guidelines for limiting harvest of species still in recovery from the spill. Assuming that harbor

seals are included in this option, there would be an indirect, positive effect on the harbor seal population because the reduction or elimination of harvesting would decrease harbor seal mortality. Because the harvest reductions would be temporary, this option would have only a short-term effect on the harbor seal. The actual effect to population would probably be low, because the annual Native harvest in Alaska has been estimated at only 500 seals (Lentfer, 1988).

Option #18 (Create new salmon runs)

The purpose of this option is to start new salmon runs. Increasing salmon runs would indirectly result in more fish available in the long-term for consumption by harbor seals. This increase in food would have a positive effect on the health of the overall harbor seal population because the main diet of the seal is fish.

Option #30 (Test subsistence foods for hydrocarbon contamination)

The purpose of this option is to restore confidence in the safety of subsistence resources by testing traditional foods for contamination. In the short-term, this option would have a direct, negative effect on the harbor seal population due to use of seals for testing. In the long-term, there would be an indirect, negative effect on the population caused by increased use of seals by subsistence users if confidence in the safety of using the seals is restored. This option would have the negative result of decreasing the harbor seal population because of testing and subsistence use.

Option #37 (Habitat protection and acquisition)

This option would acquire land for the purpose of protecting habitat areas. Assuming that habitats important to the harbor seal are protected (e.g., coastal zones, haulouts) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on harbor seals because they would have larger ranges of their preferred habitat available for undisturbed use. Protection of habitat would decrease the number of harbor seals killed incidental to commercial fishing and by haulout disturbance. Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the harbor seal population.

Option #40 (Special designations)

This option would establish specially designated regions throughout the spill area to protect habitat. Assuming that important harbor seal habitats are protected (e.g., coastal zones, haulouts) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on harbor seals because they would have larger ranges of their preferred habitat available for undisturbed use. Protection of habitat would decrease the number of harbor seals killed incidental to commercial fishing and by haulout disturbance. It is assumed that the habitat areas would continue to be protected for a considerable time, thus this option would have long-term effects on the harbor seal population.

Option #46 (Reduce the bycatch of harbor seals)

The purpose of this option is to educate commercial fishermen on methods for reducing bycatch of harbor seals. It is assumed that the commercial fishermen would employ the new methods, thus this option would have the indirect, long-term effect of increasing harbor seal population by reducing mortality caused by commercial fishing.

Option #47 (Cooperative program with subsistence users)

This option involves voluntary reductions in harvesting by subsistence users to aid in the natural recovery of marine mammals. Because harbor seals are harvested by subsistence users, voluntary reductions would indirectly help the harbor seal population. This option would have a short-term, positive effect on the harbor seal population because harvesting would be reduced to allow the recovery of the injured population. Long-term, positive effects would result because there could be future voluntary reductions in use with evidence of over-harvesting. The result of this option would be a decrease in harbor seal mortality due to subsistence use.

Option #49 (Provide access to traditional subsistence foods)

This option would aid subsistence users in gaining access to traditional subsistence resources in areas unaffected by the oil spill. This option would continue until contamination in resources is eliminated and injured subsistence resources have recovered. Because harbor seals are a subsistence resource, this option would have an indirect, positive effect on local harbor seal populations. By subsistence users taking advantage of access to unaffected resources, less harvesting of local harbor seal populations would

occur. This option is only a temporary measure until resources recover, so the effects on harbor seals would be short-term.

Steller's Sea Lions

Option #2 (Intensify fisheries management)
Option #11 (Improve freshwater wild salmon habitats)
Option #48 (Improve survival of salmon eggs and fry)
Option #51 (Change or relocate existing hatchery runs)

All of these options are designed to increase the abundance of salmon (and other fish) in the oil spill region. There would be a resulting indirect, positive effect on sea lions because their main diet consists of the same fish affected by these options. By increasing fish numbers, sea lions would have more to eat. Food availability has been postulated as a possible cause of the sea lion population decline (Johnson et al., 1989). Increasing the sea lion food supply could have the positive, long-term effect of reducing the present population decline.

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

The purpose of this option is to designate buffer zones encircling important sites for marine mammals in order to decrease human disturbance of the animals. It is assumed that buffer zones would be established around known sea lion haulout/rookery sites in the oil spill area, and that buffer zones would be maintained through the breeding season from May until mid-October (August is the most critical month) to protect the mother-pup bond. This option would decrease disturbance at rookeries during breeding season when sea lions are prone to panic, often stampeding, resulting in sea lion injuries/deaths and weakening mother-pup bonds. Weakening mother-pup bonds increases pup abandonment and leads to higher pup mortality. This option would have the indirect, positive result of decreasing mortality caused by rookery disturbance.

Option #8 (Develop sport harvest guidelines)

This option would provide guidelines for limiting harvest of species still in recovery from the spill. Assuming that sea lions are included in this option, there would be an indirect, positive effect on the sea lion population by this option because the reduction or elimination of harvesting would decrease sea lion mortality. Because the harvest reductions would be temporary, this option would have only a short-term effect on the sea lion

population.

Option #18 (Create new salmon runs)

This option would start new salmon runs. Assuming that this option would be implemented in areas foraged by sea lions, increasing the number of salmon runs would indirectly result in more fish available for consumption. This increase in food supply would have a positive, long-term effect on the health of the sea lion population because their main diet is fish.

Option #37 (Habitat protection and acquisition)

This option would acquire land for the purpose of protecting habitat areas. Assuming that habitats important to the sea lion are protected (e.g., coastal zones, rookeries/haulouts) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on sea lions because they would have larger ranges of their preferred habitat available for undisturbed use. Protection of habitat would decrease the number of sea lions killed incidental to commercial fishing and by rookery/haulout disturbance. Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the sea lion population.

Option #40 (Special designations)

This option would establish specially designated regions throughout the spill area to protect habitat. Assuming that important sea lion habitats are protected (e.g., coastal zones, rookeries/haulouts) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on sea lions because they would have larger ranges of their preferred habitat available for undisturbed use. Protection of habitat would decrease the number of sea lions killed incidental to commercial fishing and by rookery/haulout disturbance. Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the sea lion population.

Option #47 (Cooperative program with subsistence users)

This option involves voluntary reductions in harvesting by subsistence users to aid in the natural recovery of marine mammal populations. Because sea lions are harvested by subsistence users,

voluntary reductions would indirectly help the sea lion population. This option would have a short-term, positive effect on the sea lion population because harvesting would be reduced to allow the recovery of the injured population. Long-term, positive effects would result assuming that there would be further voluntary reductions in use with future evidence of over-harvesting. The result of this option would be a decrease in sea lion mortality caused by subsistence harvesting.

Option #49 (Provide access to traditional subsistence foods)

This option would aid subsistence users in gaining access to traditional subsistence resources in areas unaffected by the oil spill. This option would continue only until contamination in resources is eliminated and injured subsistence resources have recovered. Because sea lions are a subsistence resource, this option would have an indirect, positive effect on sea lion populations in the oil spill region because, by taking advantage of access to unaffected resources, less harvesting of local sea lion populations would occur. Fewer sea lions would be killed for subsistence use. This option is only a temporary measure, so would effect sea lions only over the short-term.

Sea Otters

Option #4 (Reduce disturbance bird colonies, haulout sites, etc)

The purpose of this option would be to designate buffer zones encircling important sites for the species in order to decrease disturbance. There may be difficulties in implementing this option for sea otters because haulout site use is irregular. In addition, the importance of haulouts to sea otters is unknown. Sea otters appear to need haulouts to clean and maintain the insulating qualities of their fur (Van Gelder, 1982). By protecting haulout areas, this option would decrease disturbance to sea otters using the haulout. It is assumed that decreasing haulout disturbance would have the indirect, positive effect of increasing the health of the sea otter population.

Option #8 (Develop sport harvest guidelines)

This option would provide guidelines for limiting harvest of species still in recovery from the spill. Assuming that sea otters would be included in the guidelines proposed by this option, there would be an indirect, positive effect on the sea otter population

because the reduction or elimination of harvesting would decrease sea otter mortality. The Native harvest of sea otters has been increasing in the last decade (Lentfer, 1988), which may increase the positive effect of this option in aiding recovery of the sea otter population. Because the harvest reductions would be temporary, this option would have only a short-term effect on the sea otter population.

Option #13 (Eliminate oil from mussel beds)

The purpose of this options would be to eliminate oil from mussel beds and decrease the oil contamination in the intertidal zone. Mussels and other intertidal invertebrates are the primary food source for sea otters. This option would have an indirect effect on the sea otter because of alterations in their primary food source. Food availability is limiting to sea otter populations because they need to eat large quantities in order to maintain the high metabolism necessary to stay warm in cold waters (Chapman, 1981). The short-term effect of disturbance and cleaning of the intertidal areas would be negative because of the decrease in food sources. The long-term, positive effect would be clean, uncontaminated sources of food for the future.

Option #37 (Habitat protection and acquisition)

This option would acquire land for the purpose of protecting habitat areas. Assuming that habitats important to the sea otter are protected (e.g., coastal zones, haulouts) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on sea otters because they would have larger ranges of their preferred habitat available for undisturbed use. Protection of habitat would decrease the number of sea otters killed incidental to commercial fishing and reduce haulout disturbance. Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the sea otter population.

Option #40 (Special designations)

This option would establish specially designated regions throughout the spill area to protect habitat. Assuming that important sea otter habitats are protected (e.g., coastal zones, haulouts) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on sea otters because they would have larger ranges of their preferred habitat available for

undisturbed use. Protection of habitat would decrease the number of sea otters killed incidental to commercial fishing and by haulout disturbance. Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the sea otter population.

Option #47 (Cooperative program with subsistence users)

This option would involve voluntary reductions in harvesting by subsistence users to aid in the natural recovery of marine mammals. Because sea otters are used by subsistence harvesters, voluntary reductions would indirectly help the sea otter population. This option would have a short-term, positive effect on the sea otter population because harvesting would be reduced to allow the recovery of the injured population. Long-term, positive effects would result because there could be future voluntary reductions in use with evidence of over-harvesting. The result of this option would be a decrease in sea otter mortality due to subsistence use.

Option #49 (Provide access to traditional subsistence foods)

This option would aid subsistence users in gaining access to traditional subsistence resources in areas unaffected by the oil spill. This option would continue until contamination in resources is eliminated and injured subsistence resources have recovered. Because sea otters are a subsistence resource, this option would have an indirect, positive effect on local sea otter populations. By subsistence users taking advantage of access to unimpacted resources, less harvesting of local sea otter populations would occur. This option would be only a temporary measure until resources recover, so the effects on sea otters would be short-term.

Option #50 (Replace subsistence harvest opportunities for bivalve shellfish)

This option would involve developing mariculture sites for use by subsistence users to replace sites contaminated by the oil spill. This option could have an indirect effect on the sea otter population, because sea otters often interfere with mariculture projects by feeding on the shellfish themselves. A resulting positive effect would be more food available for the sea otters to maintain their crucial high metabolism, and therefore increase the health and abundance of the population. Once established, it is assumed that mariculture sites would be maintained far into the

future, resulting in long-term benefits to the sea otter population.

Killer Whales

Option #2 (Intensify fisheries management)

This option would implement fisheries management programs to control exploitation of injured species of fish that could provide a food source for the resident pods of killer whales in the Gulf of Alaska.

Restricting existing fisheries or redirecting them to alternate sites would have an indirect effect on killer whale populations. Injured species of fish could recover, and in the long-term provide an additional food source for the resident and transient pods in the Gulf of Alaska. An additional food source could assure the continued presence and growth of the killer whale population in the Gulf of Alaska.

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

This option could affect killer whale populations by creating buffer zones around rubbing beaches used by the killer whales. Buffer zones created to limit boat traffic and disturbance around beaches known to be used by killer whales for rubbing would have an indirect effect on the health and presence of killer whales by providing them with a safe habitat for rubbing. Rubbing is essential for killer whales, both for comfort and to remove dead skin and parasites. An increase in population could occur by allowing killer whales to use the rubbing beaches to maintain necessary health habits.

Option #40 (Special designations)

Option 40 could provide additional protection for killer whales by including rubbing beaches as part of National Marine Sanctuaries where they would be regulated to minimize disturbance.

Creating designated areas would have an indirect, long-term effect on the killer whales for the same reasons as identified in Option 4. Killer whales use rubbing beaches to remove dead skin and parasites, a necessary procedure for the killer whale to maintain health, which could reduce mortality and increase populations.

Option #45 (Change black cod fishery gear)

This option would affect killer whales by minimizing conflicts between the whales and fishermen. Historically, the gear type used in the Gulf of Alaska for black cod fisheries is the longline (baited hook and line). The killer whale is attracted to the black cod on the line and has learned to strip the cod from the lines. This has resulted in harassment and shooting of the killer whales. This option could have a direct, short-term positive effect on killer whale population by reducing the mortality that may result from these conflicts with fishermen.

Humpback Whales

Prince William Sound is a major feeding area for humpback whales in the North Pacific between spring and autumn. However, because no evidence of injury has been observed from the EVOS, no options have been proposed that impact humpback whales. There may be some indirect impacts to humpback food supplies or disturbances from recreational activities related to certain of the proposed restoration options, but the linkage between these impacts and the options is unclear and very speculative. Consequently, for the purposes of this impact assessment, no options are considered to effect humpback whales, and they will not be discussed in the impact assessment presented in the following sections of this Draft EIS.

b. Terrestrial Mammals

Sitka Black-tailed Deer

Option #8 (Develop sport harvest guidelines)

This option would provide guidelines for limiting harvest of species in recovery from the spill. Deer are not specifically mentioned in this option. Assuming that deer are included in this option, there would be an indirect, positive impact on the deer population because the reduction or elimination of harvesting would decrease deer mortality. Because the harvest reductions would be temporary, this option would have only a short-term effect on the deer population.

Option #13 (Eliminate oil from mussel beds)
Option #14 (Accelerate recovery of upper intertidal zone)

The purpose of these two options would be to eliminate oil from mussel beds and nearby contaminated areas. Coastal zones are important foraging areas for deer especially in winter and early spring when heavy snows limit foraging in upland regions. By increasing the health of the coastal ecosystem, these options would have an indirect, long-term, positive impact on the deer population because foraging habitat would improve.

Option #37 (Habitat protection and acquisition)

This option would acquire land for the purpose of protecting habitat areas. Assuming that habitats important to the deer are protected (e.g., old-growth forests, coastal intertidal areas) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on deer because of larger habitat ranges available for undisturbed foraging. Because preservation of old growth forest is necessary for maintenance of a healthy deer population (Smith and Trent, 1991), habitat protection would have positive impacts. Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the deer population.

Option #40 (Special designations)

This option would establish specially designated regions throughout the spill area to protect habitat. Assuming that important deer habitats are protected (e.g., old-growth forests, coastal intertidal areas) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on deer because of larger habitat ranges available for undisturbed foraging. Because preservation of old growth forest is necessary for maintenance of a healthy deer population (Smith and Trent, 1991), habitat protection would have positive impacts. Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term, positive effects on the deer population.

Black Bear

Option #2 (Intensify fisheries management)
Option #11 (Improve freshwater wild salmon habitats)
Option #48 (Improve survival of salmon eggs and fry)
Option #51 (Change or relocate existing hatchery runs)

All of these options are designed to increase the abundance of

salmon (and other fish) in the oil spill region. In the summer, a large portion of the black bear's diet consists of anadromous fish returning to spawn. Assuming that these options would increase available fish in areas used by black bears, there would be indirect, short-term and long-term, positive effects to black bears because of increases in important summertime food sources. By increasing fish numbers, black bears would have more to eat, resulting in better health of the population.

Option #13 (Eliminate oil from mussel beds)
Option #14 (Accelerate recovery of upper intertidal zone)

The purpose of these two options is to eliminate oil contamination and aid recovery of intertidal and anadromous stream areas. These options would have an indirect impact on the black bears assuming that they would be implemented in coastline areas used during autumn foraging. The short-term, negative effect of disturbance and cleaning of the areas would be a decrease in black bear foraging in these areas, resulting in less available autumn food. The long-term, positive effect of the options would be clean, uncontaminated areas for foraging in the future.

Option #18 (Create new salmon runs)

The purpose of this option would be to start new salmon runs. In the summer, a large portion of the black bear's diet consists of anadromous fish returning to spawn. Assuming that this option would be implemented in areas foraged by black bears, increasing the number of salmon runs would indirectly result in more fish available for consumption. This increase in food supply would have a positive, long-term effect on the health of the black bear population due to the reliance on fish as food in the summer months.

Option #37 (Habitat protection and acquisition)

This option would acquire land for the purpose of protecting habitat areas. Assuming that habitats important to the black bear are protected (e.g., coastal intertidal areas, riparian, upland forests) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on black bears because of larger habitat ranges available for undisturbed foraging. Larger foraging areas should increase the health of the population because being forced to leave preferred areas for food results in increased mortality (Pelton, 1982). Assuming that the

habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the black bear.

Option #40 (Special designations)

This option would establish specially designated regions throughout the spill area to protect habitat. Assuming that important black bear habitats are protected (e.g., coastal intertidal areas, riparian, upland forests) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on black bears because of larger habitat ranges available for undisturbed foraging. Larger foraging areas should increase the health of the population because being forced to leave preferred areas for food results in increased mortality (Pelton, 1982). Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term, positive effects on the black bear.

Brown Bear

Option #2 (Intensify fisheries management)
Option #11 (Improve freshwater wild salmon habitats)
Option #48 (Improve survival of salmon eggs and fry)
Option #51 (Change or relocate of existing hatchery runs)

All of these options are designed to increase the abundance of salmon (and other fish) in the oil spill region. In the summer, a large portion of the brown bear's diet consists of anadromous fish returning to spawn. Assuming that these options would increase available fish in areas used by brown bears, there would be indirect, short-term and long-term, positive effects to brown bears because of increases in important summertime food sources. By increasing fish numbers, brown bears would have more to eat, resulting in better health of the population.

Option #8 (Develop sport harvest guidelines)

This option would provide guidelines for limiting harvest of species still in recovery from the spill. Assuming that brown bears are included in this option, there would be an indirect, positive impact on the brown bear population because the reduction or elimination of harvesting would decrease bear mortality. Because the harvest reductions would be temporary, this option would have only a short-term effect on the brown bear population.

Option #13 (Eliminate oil from mussel beds)
Option #14 (Accelerate recovery of upper intertidal zone)

The purpose of these two options is to eliminate oil contamination and aid recovery of intertidal and anadromous stream areas. These options would have an indirect impact on the brown bears assuming that they would be implemented in coastal areas used for foraging. The short-term, negative effect of disturbance and cleaning of the areas would be a decrease in brown bear foraging in these areas, resulting in less available food. The long-term, positive effect of the options would be clean, uncontaminated areas for foraging in the future.

Option #18 (Create new salmon runs)

The purpose of this option is to start new salmon runs. In the summer, a large portion of the brown bear's diet consists of anadromous fish returning to spawn. Assuming that this option would be implemented in areas foraged by brown bears, increasing the number of salmon runs would indirectly result in more fish available for consumption. This increase in food supply would have a positive, long-term effect on the health of the brown bear population due to the reliance on fish as food in the summer months.

Option #37 (Habitat protection and acquisition)

This option would acquire land for the purpose of protecting habitat areas. Assuming that habitats important to the brown bear are protected (e.g., coastal intertidal areas, riparian, upland forests) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on brown bears because of larger habitat ranges available for undisturbed foraging. Larger foraging areas should increase the health of the population because disturbance and habitat alteration may cause local population decline (Exxon Valdez Oil Spill Trustees, 1992). Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term effects on the brown bear.

Option #40 (Special designations)

This option would establish specially designated regions throughout the spill area to protect habitat. Assuming that important brown bear habitats are protected (e.g., coastal intertidal areas,

riparian, upland forests) and not used for recreation purposes that would be disturbing, there would be an indirect, positive effect on brown bears because of larger habitat ranges available for undisturbed foraging. Larger foraging areas should increase the health of the population because disturbance and habitat alteration may cause local population decline (Exxon Valdez Oil Spill Trustees, 1992). Assuming that the habitat areas would continue to be protected for a considerable time, this option would have long-term, positive effects on the brown bear.

River Otters

Option #8 (Sport and trapping harvest guidelines)

This option would affect river otter populations by restricting trapping to subsistence use only, reducing bag limits for commercial trappers, or reduction and/or closure of both subsistence and commercial trapping.

Reducing or eliminating the number of river otter trapped would directly affect the river otter population by eliminating a source of mortality, and would allow a greater opportunity for river otter populations to increase. To the extent that the river otter population is declining due to trapping, this could have a long-term, positive impact on river otter populations.

Option #13 (Eliminate oil from mussel beds)

This option would affect river otters by investigating methods to improve the otter's food sources. This option would involve studying the extent of oil remaining in mussels and underlying substrate, and if necessary implementing the most effective and least intrusive method of cleaning oiled mussel beds.

Crustaceans and mollusks are an important part of the diet of river otters of coastal Alaska. Eliminating oil from mussel beds would have an indirect, long-term effect on the river otter by removing a source of oil contamination, which could improve the health of otters that use contaminated mussels as a source of food. A healthier population of river otters could lead to long-term increases in river otter populations.

Option #37 (Habitat protection and acquisition)

This option could affect river otters by acquiring and protecting

habitat necessary for otter survival. The option includes purchasing private land as a method of protecting river otter habitat. Suitable land would be purchased and managed by state or Federal agencies familiar with habitat requirements of river otter.

River otter of coastal Alaska live in abandoned burrows or lodges of other animals and in old growth forests along the shoreline and adjacent to suitable feeding areas. Acquiring and protecting suitable habitat could indirectly affect river otter by providing protected areas for breeding and resting when traveling along their ranges. Managing acquired habitat to provide favorable breeding grounds could promote long-term river otter population increases.

Option #40 (Special designations)

This option would affect river otter by providing additional protection from human disturbances. This option would involve designating some coastal shorelines as National Marine Sanctuaries where they would be regulated to minimize human disturbance of wildlife populations.

Designating areas could have long-term, indirect effects on the river otters by protection them from trapping, protecting otter food supplies, and providing safe, undisturbed areas for breeding. Otter populations could respond to this protection by increasing over the long-term.

c. Birds

Bald Eagle

Option #17 (Removal of predator species)

This option would affect bald eagles by reducing their occurrence around marine bird colonies. Young eagles would be removed and provided to the eagle reintroduction program in the lower 48 states.

This would have a direct, short-term, negative impact on bald eagles. The effect would be short-term because the number of young birds that can be handled through the reintroduction program may be a limiting factor and compliance with the Bald Eagle Protection Act of 1940 must be considered.

Option #37 (Habitat protection and acquisition)

This option would affect bald eagles by acquiring and protecting habitat required for breeding and nesting.

This option would have an indirect, long-term effect on bald eagles by reducing disturbances to nesting and wintering eagles. On National Forests in Alaska, protection measures for bald eagles and their nesting habitats are prescribed in the Memorandum of Understanding between the USDA Forest Service and the U.S. Fish and Wildlife Service. The Memorandum provides for the exclusion of all landuse activities within a buffer zone of 100 meter radius around all active and inactive bald eagle nests.

Peale's Peregrine Falcon

Option #37 (Habitat protection and acquisition)

This option would have an indirect, long-term effect peregrine falcons by preventing loss of habitat required for breeding and nesting.

Common Murre

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

This option would restrict the speed or prohibit navigation of vessels within 1/2 or 1 mile of protected bird colonies. These restrictions could be implemented in all areas of the oil spill area except Kodiak/Afognak. This option would affect the breeding and nesting success of common murres by reducing loud noises that can cause the adults to flush from the breeding ledges, kicking eggs off the cliffs and leaving eggs and young exposed to predators. The lower density and asynchronous nesting at the colonies within the oil-spill area have made the eggs and young more vulnerable to predation. Modifying boat traffic around these colonies may reduce additional disturbances.

This option would have a direct, long-term effect on common murre productivity by reducing the number of eggs loss and increasing the survival of chicks. While there is uncertainty regarding the exact level of disturbance that nearby boats have on nesting colonies, the decrease in potential disturbances could prevent additional loss of eggs and chicks during the recovery period. The effect of this option would be greatest during the initial recovery years while the proportion of young breeding birds is highest and additional measures are being undertaken to improve breeding

synchrony. The effect would be long-term because the buffer zones would stay in place for the entire recovery period for the impacted colonies and may be left in place afterward as a protective measure when the colonies have been fully restored.

Option #9 (Minimize the incidental take of birds)

Under this option, the extent of marine bird mortality by commercial fishing activities associated with gillnet (drift and set net) fisheries in PWS, Kenai, Alaska Peninsula and Cook Inlet, or the Kodiak/Afognak Island set net fishery would be examined. If the mortality is found to represent a significant source of mortality for populations in the spill area, an effort would be made to develop new technologies or strategies for reducing encounters. These could involve suspending nets below the surface, closure of certain areas, elimination of night fishing, or directing fishing away from injured marine bird habitats.

To implement this option a number of steps would have to be taken: (1) research and document the extent of marine bird mortality in the spill area, (2) research new technologies or strategies for reducing encounters, and (3) incorporate relevant methodologies and strategies in fishery management plans. Assuming that all steps have been completed, this option would have an indirect, long-term effect on reducing accidental mortality and increase the common murre population.

Option #16 (Increase productivity and success at murre colonies)

This option would affect common murres by developing and implementing two feasibility studies. One study would try to enhance social stimuli to promote breeding synchrony. This study would use decoys and recorded calls to give the illusion of typical breeding densities which may encourage a return to normal breeding patterns. The second study would try to improve the physical characteristics of the nesting ledges. This option would affect the breeding success by implementing techniques that are largely experimental, such as providing breeding ledges with sills, adding partitions and/or roofs on nesting ledges, enlarging nesting ledges, and clearing debris from otherwise suitable nesting sites.

The main effect of the first study of this option would be a direct, short-term increase in reproduction success since synchrony promotes earlier egg laying and increases the number of nesting birds to ward off predators. The effect would be short-term, in

regards to total recovery time, because breeding synchrony is a density effect. In addition, Heinemann (1993) supports the idea that it is probably a threshold phenomenon, which means that until densities climb above the threshold, reproductive rates would stay very low. Once the required density has been reached, however, efforts to promote synchrony would no longer be needed. Negative effects of this technique may include decoys displacing breeding pairs or causing gaps between pairs thus increasing susceptibility to predation, and are assumed to be minimal and compensated for by the increase in synchrony.

The second study of this option would have a direct, short-term effect by increasing murre reproduction. Techniques that can reduce the loss of eggs from falling off of ledges, or reduce the ability of predators to reach and takes eggs and chicks, would increase the productivity of the colony. This effect would diminish as the colony recovers and starts using sub-optimal breeding spaces and fills in the gaps between nesting pairs thereby increasing predator control. Negative effects due to construction and displacement of some traditional breeding birds from their preferred sites are assumed to be minimal.

Option #17 (Removal of predator species)

The primary goal of this option would be to reduce seabird egg and chick mortality by removing introduced fox from islands along the Alaska Peninsula and Aleutians. A secondary goal would be to reduce avian predation on eggs and chicks.

The removal of fox from the islands would result in an indirect, long-term increase in murre production. Foxes are voracious predators of chicks and eggs and their removal would allow the productivity of these islands to increase.

The reduction of avian predators would have an indirect, short-term increase in murre productivity. Glaucous-winged gulls, northern ravens, and bald eagles are effective predators on murre colonies with gulls sometimes accounting for 40% of the egg loss. Reducing avian predators at murre colonies is feasible, but would be difficult to implement for long-term effects because the reduction techniques would not totally remove the predator populations and would have to be done annually.

Option #37 (Habitat protection and acquisition)

Implementing this option could affect common murres by protecting breeding and fishing habitat throughout the oil spill area.

An assumption concerning the implementation of this option is that land containing these productive habitats is currently privately owned and consequently available for purchase or protection. This also assumes that the land area containing these habitats would meet the criteria necessary to make them a target for purchase or protection.

This option would have an indirect, long-term effect on increasing murre populations by further reducing disturbances to the birds during their nesting period.

Option #40 (Special designations)

Implementing this option could affect common murres by protecting breeding and fishing habitat throughout the oil spill area.

This option would have an indirect, long-term effect on increasing murre populations by further reducing disturbances to the birds during their nesting period.

Marbled Murrelet

Option #9 (Minimize the incidental take of birds)

Under this option, the extent of marine bird mortality by commercial fishing activities associated with gillnet (drift and set net) fisheries in PWS, Kenai, Alaska Peninsula and Cook Inlet, or the Kodiak/Afognak Island set net fishery would be examined. If the mortality is found to represent a significant source of mortality for populations in the spill area, an effort would be made to develop new technologies or strategies for reducing encounters. These could involve suspending nets below the surface, closure of certain areas, elimination of night fishing, or directing fishing away from injured marine bird habitats.

To implement this option a number of steps would have to be taken: (1) research and document the extent of marine bird mortality in the spill area, (2) research new technologies or strategies for reducing encounters, and (3) incorporate relevant methodologies and strategies in fishery management plans. Assuming that all steps have been completed, this option would have an indirect, long-term effect on reducing accidental mortality and increase the marbled

murrelet population.

Option #17 (Removal of predator species)

The primary goal of this option would be to reduce seabird egg and chick mortality by removing introduced fox from islands along the Alaska Peninsula and Aleutians.

The removal of fox from the islands would result in an indirect, long-term increase in murrelet production. Foxes are voracious predators of chicks and eggs and their removal would allow the productivity of these islands to increase.

Option #37 (Habitat protection and acquisition)

This option would affect marbled murrelets by acquiring and protecting upland habitats necessary for successful breeding and nesting.

An assumption concerning the implementation of this option is that land containing these productive habitats is currently privately owned and consequently available for purchase or protection. This also assumes that the land area containing these habitats would meet the criteria necessary to make them a target for purchase or protection.

This option would have an indirect, long-term effect on marbled murrelet populations. The marbled murrelet has a declining nesting habitat base throughout most of its range where it nests in trees. Continued logging operations can be expected to cause a decline in population numbers. Land acquisition would help this species assuming that the land bought was in danger of being logged and that it is suitable as nesting habitat.

Option #40 (Special designations)

Implementing this option could affect common murrelets by protecting breeding and fishing habitat throughout the oil spill area.

This option would have an indirect, long-term effect on increasing murrelet populations by protecting feeding and nesting locations. A large designation area that would limit development activities and pollution sources may have a positive effect on the prey base.

Storm Petrels

Option #12 (Creation of new recreation sites and facilities)

Implementation of this option involves construction of new public recreation facilities which would have a negative, indirect, long-term effect on the storm petrel populations if creation of these recreation sites and facilities would infringe on the habitat requirements of this species. If creation of these facilities were not to infringe on their habitat requirements, but rather would draw tourists away from the breeding and nesting areas, this option would result in a potential positive, indirect, long-term impact to the storm petrel.

Option #13 (Eliminate oil from mussel beds)

Persistent oil in the mussel beds represents a potential threat to the storm petrel as this species utilizes mussels for food. Implementation of this option would involve determination of the geographic extent of persistent oil as it pertains to the mussel beds and anadromous streams in Prince William Sound, and implementation of the most effective and least intrusive method of cleaning the beds and areas of contamination adjacent to anadromous streams.

This option would have a positive, indirect, long-term impact on the storm petrel because it would involve stripping or tilling of contaminated mussel beds and anadromous streams. This action would increase flushing of residual oil, resulting in a reduction of the amount of oil available for bioaccumulation by mussels and other invertebrates. Therefore, less oil would be available for ingestion by predator species such as the storm petrel. There would also be a negative, indirect, short-term effect on the storm petrel due to the cleaning of the oiled mussel beds. The proposed cleaning methods would result in a temporary direct loss of mussels and associated invertebrates and algae from this habitat, ultimately resulting in a temporary reduction in prey for the storm petrel.

Option #14 (Accelerate recovery of upper intertidal zone)

The overall objective of this option is to facilitate recovery of the previously dominant brown algae *Fucus gardneri* (popweed). This option would have a positive, indirect, and long-term effect on the storm petrel because this species utilizes the intertidal habitat

to feed on mollusks and crustaceans that would increase with recovery of this zone. By implementing this option, it is anticipated that additional seaweeds and invertebrates would recolonize the intertidal zone, thus providing the storm petrel with an additional food source.

Option #17 (Removal of predator species)

Implementation of this option would result in a positive, indirect, long-term effect on storm petrel reproduction from the removal of introduced fox from islands along the Alaska Peninsula and the Aleutians. Introduced fox have reduced and even eliminated some populations of these burrow-nesting birds. Foxes are voracious predators of chicks and eggs, and their removal would allow storm petrel reproduction on these island coasts to increase.

Option #37 (Habitat protection and acquisition)

Implementation of this option would have a positive, indirect, long-term effect on the storm petrel by providing protected habitat for breeding and nesting which could increase the population.

Option #40 (Special designations)

This option would have a positive, indirect, long-term effect on increasing storm petrel populations because, under this option, marine and intertidal areas, and uplands in public ownership can be placed into special State or Federal land designations that provide increased levels of regulatory protection. By providing protected habitat and further reducing disturbances to the birds during their nesting periods, populations may increase.

Black-legged Kittiwake

Option #12 (Creation of new recreation sites and facilities)

Implementation of this option would include construction of new public recreation facilities and making public land available for commercial recreation facilities such as fuel stops, docks, and lodges. The effects of implementing this option would be negative, indirect, and long-term on the black-legged kittiwake populations if creation of these recreation sites and facilities would infringe on the breeding, nesting, and feeding habitats of this species. If creation of these facilities were not to infringe on their habitat requirements, but rather would draw tourists away from the breeding

and nesting areas, this option would result in a potential positive, indirect, long-term impact to the black-legged kittiwake.

Option #13 (Eliminate oil from mussel beds)

Persistent oil in the mussel beds and anadromous streams represents a potential threat to the black-legged kittiwake as this species is dependent on these mussel beds for food. This option would involve determination of the geographic extent of persistent oil as it pertains to the mussel beds and anadromous streams in Prince William Sound, and implementation of the most effective and least intrusive method of cleaning the beds and areas of contamination adjacent to anadromous streams.

This option would have a positive, indirect, long-term impact on the black-legged kittiwake because it would involve stripping or tilling of contaminated mussel beds and anadromous streams. This action would increase flushing of residual oil, resulting in a reduction of the amount of oil available for bioaccumulation by mussels and other invertebrates. Therefore, less oil would be available for ingestion by predator species such as the black-legged kittiwake. There would also be a negative, indirect, short-term effect on the black-legged kittiwake due to the cleaning of the oiled mussel beds. The proposed cleaning techniques would result in a temporary, direct loss of mussels and associated invertebrates and algae from this habitat, ultimately resulting in a temporary reduction in prey for the species.

Option #14 (Accelerate recovery of the upper intertidal zone)

The overall objective of this option is to facilitate recovery of the previously dominant brown algae *Fucus gardneri* (popweed).

This option would have a positive, indirect, and long-term effect on the black-legged kittiwake because this species utilizes the intertidal habitat to feed on crustaceans and mollusks. By implementing this option, it is anticipated that additional seaweeds and invertebrates would recolonize the intertidal zone, thus providing the black-legged kittiwake with an additional food source.

Option #17 (Removal of predator species)

Implementation of this option would result in a positive, indirect, long-term effect on black-legged kittiwake reproduction from the

removal of introduced fox from islands along the Alaska Peninsula and Aleutians. Foxes are voracious predators of chicks and eggs, and their removal would allow the kittiwake reproduction on these islands to increase.

This option has a secondary goal of temporarily reducing avian predators. The reduction of avian predators would have a positive, indirect, short-term effect on the kittiwake productivity. Glaucous-winged gulls, northern ravens, and bald eagles are effective predators on these nesting colonies.

Option #37 (Habitat protection and acquisition)

Private land acquisition, or acquisition of partial interests in private lands, for the purpose of protecting habitats linked to the resources injured by the oil spill would be undertaken to prevent additional injury to those resources. Implementation of this option would have a positive, indirect, long-term effect on the black-legged kittiwake population by providing protected habitat for breeding and nesting which could increase the population of this species.

Option #40 (Special designations)

This option would have a positive, indirect, long-term effect on increasing the black-legged kittiwake populations because, under this option, marine and intertidal areas in public ownership can be placed into special State or Federal land designations that provide increased levels of regulatory protection. By providing habitat protection, and further reducing human disturbances to this species during nesting periods, the species population may increase.

Option #50 (Replace subsistence harvest opportunities for bivalve shellfish)

This option would have a positive, indirect, long-term effect on the black-legged kittiwake because it would provide additional food sources for this species. This option would provide the facilities and infrastructure to restore, replace, and/or enhance affected shellfish populations, and use hatchery shellfish to re-seed native species on beaches damaged by oiling or clean-up. Reseeding native species on damaged beaches would not only speed recovery of the beach, but also provide an additional food source for kittiwake.

Pigeon Guillemot

Option #12 (Creation of new recreation sites and facilities)

Implementation of this option would involve the construction of new public recreation facilities that could have a negative, indirect, long-term effect on the pigeon guillemot if creation of these facilities infringed on the habitat requirements of this species. If creation of these facilities were not to infringe on their habitat requirements, but rather would draw tourists away from the breeding and nesting areas, this option would result in a potential positive, indirect, long-term impact to the pigeon guillemot.

Option #13 (Eliminate oil from mussel beds)

Persistent oil in the mussel beds represents a potential threat to the pigeon guillemot as this species utilizes the intertidal mussel beds for food. Implementation of this options would involve determination of the geographic extent of persistent oil as it pertains to the mussel beds and anadromous streams in Prince William Sound, and implementation of the most effective and least intrusive method of cleaning the beds and areas of contamination adjacent to anadromous streams.

This option would have a positive, indirect, long-term impact on the pigeon guillemot because it would involve stripping or tilling of contaminated mussel beds and anadromous streams to increase flushing of residual oil, resulting in a reduction of the amount of oil available for bioaccumulation by mussels and other invertebrates. Therefore, less oil would be available for ingestion by predator species such as the pigeon guillemot. This could indirectly improve the health of this species by providing a healthy food source. There would also be a negative, indirect, short-term effect on the pigeon guillemot due to the cleaning of the oiled mussel beds. The proposed cleaning methods would result in a temporary, direct loss of mussels and associated invertebrates and algae from this habitat, ultimately resulting in a temporary reduction in prey for the species.

Option #14 (Accelerate recovery of upper intertidal zone)

The overall objective of this option is to facilitate recovery of the previously dominant brown algae *Fucus gardneri* (popweed). This option would have a positive, indirect, and long-term effect on the pigeon guillemot because this species utilizes the intertidal habitat for social activities (i.e., pair-bond maintenance) and to feed on mollusks, crustaceans, and marine worms that would increase

with recovery of this zone. By implementing this option, it is anticipated that additional seaweeds and invertebrates would recolonize the intertidal zone, thus providing the pigeon guillemot with suitable habitat and an additional food source.

Option #17 (Removal of predator species)

Implementation of this option would result in a positive, indirect, long-term effect on pigeon guillemot reproduction by removal of introduced fox from islands along the Alaska Peninsula, the coastlines with nesting pigeon guillemots, and the Aleutians. A secondary goal would be to reduce avian predators. Foxes are voracious predators of chicks and eggs, and their removal would allow the reproduction on these island coasts to increase.

The reduction of avian predators would have a positive, indirect, short-term effect on the pigeon guillemot productivity because glaucous-winged gulls, northern ravens, and bald eagles are effective predators on these nesting colonies and may be one cause of high chick mortality.

Option #37 (Habitat protection and acquisition)

Private land acquisition, or acquisition of partial interests in private lands, for the purpose of protecting habitats linked to resources injured by the oil spill, would be undertaken to prevent additional injury to those resources. Implementation of this option would have a positive, indirect, long-term effect on the pigeon guillemot by providing protected habitat for breeding and nesting which could increase populations.

Option #40 (Special designations)

This option would have a positive, indirect, long-term effect on pigeon guillemot populations because, under this option, marine and intertidal areas in public ownership can be placed into special State or Federal land designations that provide increased levels of regulatory protection. This option could increase pigeon guillemot populations by reducing disturbances to the birds during their nesting periods.

Option #50 (Replace subsistence harvest opportunities for bivalve shellfish)

This option would have a positive, indirect, long-term effect on

the pigeon guillemot because it would provide additional food sources for this species. This option would provide the facilities and infrastructure to restore, replace, and/or enhance affected shellfish populations, and to use hatchery shellfish to re-seed native species on beaches damaged by oiling or clean-up activities. Re-seeding native species on damaged beaches would not only speed recovery of the beach, but also provide a food source for the pigeon guillemot.

Glaucous-winged Gull

Option #13 (Eliminate oil from mussel beds)

Persistent oil in the mussel beds represents a potential threat to the glaucous-winged gull as this species utilizes mussels for food. This option would involve determination of the geographic extent of persistent oil as it pertains to the mussel beds and anadromous streams in Prince William Sound, and implementation of the most effective and least intrusive method of cleaning the beds.

This option would have a positive, indirect, long-term impact on the glaucous-winged gull because it would involve stripping or tilling of contaminated mussel beds and anadromous streams to increase flushing of residual oil. This would result in a reduction of the amount of oil available for bioaccumulation by mussels and other invertebrates, and ultimately, in less oil available for ingestion by predator species such as the glaucous-winged gull. There would also be a negative, indirect, short-term impact on the glaucous-winged gull due to the cleaning of the oiled mussel beds and anadromous streams. The proposed cleaning methods would result in a temporary direct loss of mussels and associated invertebrates and algae from this habitat, ultimately resulting in a temporary reduction in prey for the gull.

Option #14 (Accelerate recovery of upper intertidal zone)

The overall objective of this option is to facilitate recovery of the previously dominant brown algae *Fucus gardneri* (popweed) in the upper intertidal zone.

A positive, indirect, and long-term effect on the glaucous-winged gull would be realized by implementation of this option because this species utilizes the intertidal habitat to feed on mollusks and crustaceans. By implementing this option, it is anticipated that additional seaweeds and invertebrates would recolonize the

intertidal zone, thus providing the glaucous-winged gull with an additional food source.

Option #17 (Removal of predator species)

The objective of this option would be to remove introduced fox from islands along the Alaska Peninsula and the Aleutians, potentially having a positive, indirect, long-term impact on the glaucous-winged gull from removal of this predator species. Foxes are voracious predators of eggs and chicks, and their removal would allow glaucous-winged gull reproduction to increase on these islands.

This option has a secondary goal of temporarily reducing avian predators such as the glaucous-winged gull. Therefore, implementation of this option would also result in a negative, direct, short-term impact on the glaucous-winged gull population. Glaucous-winged gulls, northern ravens, and bald eagles are effective predators on common murre, black-legged kittiwake, and pigeon guillemot nesting colonies. The effect of this option would be considered short-term because the gulls are able to reproduce much more quickly than their prey (e.g., common murre), and a temporary population reduction would not constitute a threat to the gull population.

Option #37 (Habitat protection and acquisition)

Implementation of this option would have a positive, indirect, long-term effect on increasing glaucous-winged gull populations by providing protected habitat conducive to breeding and nesting for this species.

Option #40 (Special designations)

This option would have a positive, indirect, long-term effect on increasing glaucous-winged gull populations because, under this option, marine and intertidal areas, and uplands in public ownership can be placed into special State or Federal land designations that provide increased levels of regulatory protection. Glaucous-winged gull populations may increase through the provision of protected habitat and reduction in disturbances during nesting periods.

Harlequin Duck

Option #8 (Develop sport harvest/trapping guidelines)

Implementation of this option would involve imposing temporary restrictions or closure of sport harvest and trapping of this species in the oil-spill area. Post oil spill information indicates that the harlequin duck has suffered a decline in population and exhibited near total reproductive failure in the oil-spill area. Under this option, harvest pressure would be reduced or eliminated when it is shown to suppress the natural recovery rate of the harlequin duck.

It is not known how many ducks are harvested by sport hunters in the oil-spill area as harvest figures are reported for all of Southcentral Alaska. It is thought that the harvest is small. However, a harvest in September would take almost exclusively resident birds because migrants have not yet arrived from their breeding grounds further north.

Although the sport trapping and harvesting restrictions would be temporary, a reduction in harvest of this injured species would directly effect population levels by eliminating a source of mortality for resident birds, and providing additional opportunity for spill zone populations to reproduce. The effect would be long-term with regard to a potential recovery of the harlequin duck population in the oil-spill area if reproductive success is enhanced.

Option #12 (Creation of new recreation sites and facilities)

Implementation of this option would include construction of new public recreation facilities such as mooring buoys, boat ramps, picnic areas, campsites, and trails; and making public land available for commercial recreation facilities such as fuel stops, docks, and lodges. At this time, the specific proposed location of these new facilities is unknown, but it is assumed that facilities would be constructed in upland as well as tidal habitat.

The effects of implementing this option would be negative, indirect, and long-term on the harlequin duck population only if creation of these recreation sites and facilities would infringe on the pairing, breeding, and nesting habitat requirements of this species. If creation of these facilities were not to infringe on their habitat requirements, but rather would draw tourists away from the breeding and nesting areas, this option would result in a potential positive, indirect, long-term impact to the harlequin

duck.

Option #13 (Eliminate oil from mussel beds)

Persistent oil in the mussel beds or anadromous streams represents a potential threat to the harlequin duck, as the duck is dependent on these beds and streams for food and habitat. This option would involve determining the geographic extent of persistent oil as it pertains to the mussel beds and anadromous streams in Prince William Sound, and implementing the most effective and least intrusive method of cleaning the beds and areas of contamination adjacent to anadromous streams.

This option would have a positive, indirect, long-term effect on the harlequin duck because it would involve stripping or tilling of contaminated mussel beds and anadromous streams to increase flushing of residual oil, resulting in a reduction of the amount of oil available for bioaccumulation by mussels and other invertebrates. Therefore, less oil would be available for ingestion by predator species such as the harlequin duck. This could indirectly improve the health of this species by providing a healthy food source. There would also be a negative, indirect, short-term effect on the harlequin duck due to the cleaning of the oiled mussel beds and anadromous streams. The proposed cleaning methods would result in a temporary direct loss of mussels and associated invertebrates and algae from this habitat, ultimately resulting in a temporary reduction in prey for the duck.

Option #14 (Accelerate recovery of upper intertidal zone)

The overall objective of this option is to facilitate recovery of the previously dominant brown algae *Fucus gardneri* (popweed). Implementation of this option would include installation of trickle irrigation systems designed to enhance moisture retention, use of biodegradable materials as additional substrate for germling attachment and cover, and transplanting adult plants attached to small rocks and cobble.

By implementing this option, it is anticipated that additional seaweeds and invertebrates would be provided with suitable habitat for recolonization. Therefore, this option would have a positive, indirect, and long-term effect by providing the harlequin duck with an additional food source. This species utilizes the intertidal habitat, feeding on invertebrates.

Option #37 (Habitat protection and acquisition)

Private land acquisition, or acquisition of partial interests in private lands, for the purpose of protecting habitats linked to the resources injured by the oil spill, would be undertaken to prevent additional injury to those resources. Implementation of this option may include the acquisition of upland habitat and undisturbed riparian lands around anadromous streams. These habitats are conducive to the breeding and nesting of the harlequin duck.

Protecting harlequin ducks breeding and nesting habitat would have a positive, indirect, long-term effect because the protection of breeding and nesting habitat could lead to population increases.

Option #40 (Special designations)

Upland and intertidal areas in public ownership can be placed into special State or Federal land designations that provide increased levels of regulatory protection. An important feature of special designations is that they can provide a regulatory basis for managing an area on an ecosystem level, with the primary objective of restoring spill injuries.

This option would have a positive, indirect, long-term effect on increasing harlequin duck populations by providing habitat protection and further reducing disturbances to the birds during their nesting periods.

Option #49 (Provide access to traditional subsistence foods)

This option would provide funds for subsistence users from impacted areas to travel to unimpacted areas to harvest traditional subsistence resources such as the harlequin duck. Implementation of this option would continue until the injured resources have recovered.

This option would have a positive, direct, short-term effect on the harlequin duck by providing alternative hunting areas for the subsistence users of this species, thereby allowing the species to actively recruit and reproduce without suffering additional mortality in the oil-spill area.

Option #50 (Replace subsistence harvest opportunities for bivalve shellfish)

This option would provide the facilities and infrastructure to restore, replace, and/or enhance affected shellfish populations and, in particular, the subsistence use of shellfish. Additionally, there is the potential to use hatchery shellfish to re-seed native species on beaches damaged by oiling or clean-up, once those beaches are no longer oiled.

This option would have a positive, indirect, long-term effect on the harlequin duck by providing an additional food source for this species. This food source could improve the health of the species, allowing populations to rebuild in the oil spill area.

Black Oystercatcher

Option #12 (Creation of new recreation sites and facilities)

Implementation of this option involves construction of new public recreation facilities which would have a negative, indirect, long-term effect on the black oystercatcher populations if creation of these facilities infringed on the breeding, nesting, or feeding habitat of this species. If creation of these facilities were not to infringe on their habitat requirements, but rather would draw tourists away from the breeding and nesting areas, this option would result in a potential positive, indirect, long-term impact to the black oystercatcher.

Option #13 (Eliminate oil from mussel beds)

Persistent oil in the mussel beds represents a potential threat to the black oystercatcher as this species utilizes the intertidal mussel beds for food. Implementation of this option would involve determination of the geographic extent of persistent oil as it pertains to the mussel beds and anadromous streams in Prince William Sound, and implementation of the most effective and least intrusive method of cleaning the beds and areas of contamination adjacent to anadromous streams.

This option would have a positive, indirect, long-term impact on the black oystercatcher because it would involve stripping or tilling of contaminated mussel beds and anadromous streams to increase flushing of residual oil, resulting in a reduction of the amount of oil available for bioaccumulation by mussels and other invertebrates. Therefore, less oil would be available for ingestion by predator species such as the black oystercatcher. There would also be a negative, indirect, short-term effect on the

black oystercatcher due to the cleaning of the oiled mussel beds and anadromous streams. The proposed cleaning methods would result in a temporary direct loss of mussels and associated invertebrates and algae from this habitat, ultimately resulting in a temporary reduction in prey for the black oystercatcher.

Option #14 (Accelerate recovery of upper intertidal zone)

The overall objective of this option is to facilitate recovery of the previously dominant brown algae *Fucus gardneri* (popweed). Implementation of this option would have a positive, indirect, and long-term effect on the black oystercatcher because this species utilizes the intertidal habitat to feed on limpets, mussels, clams, and chitons that would increase with the recovery of this zone. By implementing this option, it is anticipated that additional seaweeds and invertebrates would recolonize the intertidal zone, thus providing the black oystercatcher with an additional food source.

Option #17 (Removal of predator species)

Implementation of this option would result in a positive, indirect, long-term effect on black oystercatcher reproduction from the removal of introduced fox from islands along the Alaska Peninsula and Aleutians. A secondary goal would be to reduce avian predators. Foxes are voracious predators of chicks and eggs, and their removal would allow black oystercatcher reproduction on these islands to increase.

The reduction of avian predators would have a positive, indirect, short-term effect on the black oystercatcher productivity because glaucous-winged gulls, northern ravens, and bald eagles are effective predators on these nesting colonies.

Option #37 (Habitat protection and acquisition)

Private land acquisition, or acquisition of partial interests in private lands, for the purpose of protecting habitats linked to resources injured by the oil spill, would be undertaken to prevent additional injury to those resources. Implementation of this option would have a positive, indirect, long-term effect on the black oystercatcher population by providing protected habitat for breeding and nesting which could increase the population.

Option #40 (Special designations)

This option would have a positive, indirect, long-term effect on increasing black oystercatcher populations because under this option marine and intertidal areas in public ownership can be placed into special State or Federal land designations that provide increased levels of regulatory protection. By providing habitat protection and further reducing disturbances to the birds during their nesting periods, populations may increase.

Option #50 (Replace subsistence harvest opportunities for bivalve shellfish)

This option would have a positive, indirect, long-term effect on the black oystercatcher because it would provide additional food sources for this species. This option would provide the facilities and infrastructure to restore, replace, and/or enhance affected shellfish populations, and use hatchery shellfish to re-seed native species on beaches damaged by oiling or clean-up activities. Re-seeding native species on damaged beaches would not only speed recovery of the beach, but also provide a food source for the black oystercatcher.

d. Fish

Pink Salmon

Option #2 (Intensify fisheries management)

This option could effect pink salmon by intensifying fisheries management of this species. This option would protect injured stocks from further fishing pressures, allowing for natural recovery. It is assumed that the intensified management of pink salmon would be designed to increase salmon populations, but not to exceed the carrying capacity of the stocks to avoid further damage to the wild stocks. This option would have a positive, direct effect on salmon populations by reducing commercial and sport fishing pressures on damaged stocks. This could increase the number of successful spawning adults which would increase overall spawning success. The long-term effect would be an increase of pink salmon populations.

Option #11 (Improve freshwater wild salmon)

This option could effect pink salmon by using two restoration techniques to increase populations: (1) construct salmon spawning channels and instream improvements and (2) improve access to salmon

spawning areas by building fish passes or removing barriers.

Construction of salmon spawning channels and instream improvements of streams in pink salmon lake systems would have a direct, positive effect by increasing the spawning habitat quality to insure that stream flow, substrate, and dissolved oxygen concentrations are sufficient for egg and larvae survival, therefore increasing spawning success, and thus increasing the populations. This effect would be long-term because the instream improvements could be maintained and last for many years.

Improving access to salmon spawning areas by building fish passages or removing barriers would have an indirect, positive effect on pink salmon populations by providing new or additional habitat for pink salmon spawning. This could improve spawning success and increase the population of pink salmon. This would be a long-term effect because this new habitat would be available for the life of the salmon fishery.

Option #12 (Create new recreational facilities)

This option would effect pink salmon by increasing sport fishing pressure and disruption of stream habitat by the construction of new public recreation facilities such as mooring buoys, boat ramps, picnic areas, campsites, and trails. This option could have an indirect, negative effect on pink salmon because it would increase public access to streams, causing disturbance to stream habitat. Increased public access could increase recreational fishing pressures on streams that are presently relatively undisturbed. Other habitat disturbances could include increased runoff from roads, trails, and campsites related to recreational facilities construction. This could result in increased turbidity and water temperature and reduce dissolved oxygen concentrations in streams which would adversely effect the survival of eggs and larvae. This could reduce spawning success of salmon, and the overall population in the effected areas. The effects would likely be long-term because of the long-term use of these facilities.

Option #14 (Recovery of upper intertidal zone)

The option would have a positive, indirect effect on pink salmon by improving habitat and the quantity of prey for juvenile salmon. Juvenile pink salmon use the nearshore areas to feed after leaving the streams. Improving the intertidal zone would increase the quantity of prey species utilized by pink salmon. This could have

a long-term effect on salmon populations by increasing growth rates and the survival rate of fish that may return to spawn. Increasing the number of spawning fish could ultimately increase populations.

Option #18 (Create new salmon runs)

This option could affect wild pink salmon stocks by providing new commercial, sport, and subsistence fishing opportunities to replace those opportunities lost from the spill. In addition, this would relieve fishing pressure on stocks damaged by the spill, assuming that timing and location of new fish runs would be managed in accordance with genetic and disease control guidelines to avoid further damage to natural stocks. This option could have an indirect, positive effect on pink salmon by reducing fishing pressure which allow damaged stocks to naturally recover and therefore increase populations. The effects could be long-term if populations are increased. There could be long-term, indirect, negative impacts on non-target species from introduction of salmon into vacant areas from increased competition for food and habitat and the introduction of disease. The effect would be short-term because the new salmon runs would be terminated after populations have recovered.

Option #19 (Protect undocumented anadromous streams)

This option could affect pink salmon by listing streams utilized by salmon in the ADF&G Anadromous Stream Catalogue. Streams listed in the catalogue are provided with certain level of protection to avoid further disturbance. It is assumed that new streams added to the catalogue are degraded in some way and are able to benefit from protection. This could have an indirect, positive effect on pink salmon by protecting existing spawning areas from further disturbance, thus increasing spawning success and therefore increasing populations. The option would have a long-term effect because the streams would be protected from future degradation, allowing pink salmon populations to increase.

Option #37 (Habitat protection and acquisition)

This option could affect pink salmon by protecting habitat throughout the spill area by acquiring damaged habitat and protecting it from further disturbance to allow for natural recovery. This would have a positive, indirect effect on the pink salmon by protecting spawning stocks so that reproductive success may increase. This would ultimately increase populations. The

long-term effects would be that pink salmon habitat would be protected from further disturbance.

Option #40 (Special Designations)

This option could affect pink salmon by giving special designations to uplands, coastal, and marine habitat that are utilized by salmon for spawning and rearing. This provides for a certain level of regulatory protection of these habitats. This could have an indirect, positive effect on pink salmon by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

Option #48 (Improve survival of salmon eggs and fry)

This option could affect pink salmon by rearing wild pink salmon eggs and fry in boxes, net pens, or hatcheries. Assuming that strict guidelines to prevent disease and overescapement are employed, this option could have a direct, positive effect on pink salmon by increasing the survival of eggs and larvae and improving spawning success. This would facilitate an increase in population. The effects would be long-term because it would restore wild pink salmon populations.

Option #51 (Relocate salmons runs)

This option would affect pink salmon by relocating or changing the timing of existing hatchery salmon runs in PWS. The concept is to minimize the interaction of hatchery reared fish and wild stocks during commercial harvests. This could have an indirect, positive effect on wild pink salmon in PWS because it would relieve fishing pressures on wild stocks. This could increase the number of spawning adults, thereby increasing spawning success. The effect would be long-term because the population of wild stocks could ultimately increase.

Sockeye Salmon

Option #2 (Intensify fisheries management)

This option would affect sockeye salmon by intensifying fisheries management of this species. This option would protect injured stocks from further exploitation and natural recovery. It is assumed that the intensified management of sockeye salmon would be

designed to increase salmon populations, but not to exceed the carrying capacity of the stocks. This option would have a positive, direct effect on salmon populations by reducing commercial and sport fishing pressures on damaged stocks. This could increase the number of successful spawning adults which would increase overall spawning success. The long-term effect would be an increase in sockeye salmon populations.

Option #11 (Improve freshwater wild salmon)

This option would affect sockeye salmon by using three techniques to increase populations: (1) construct salmon spawning channels and instream improvements, (2) fertilize lakes to improve sockeye salmon rearing success, and (3) improve access to salmon spawning areas by building fish passes or removing barriers.

Construction of salmon spawning channels and instream improvements of streams in sockeye salmon lake systems would have a direct, positive effect by increasing the spawning habitat quality to insure that stream flow, substrate, and dissolved oxygen concentrations are sufficient for egg and larvae survival. This habitat improvement would increase spawning success, and subsequently increase the population. This effect would be long-term because the instream improvements could be maintained for many years.

Fertilization of degraded rearing lakes would increase the primary food source of sockeye salmon by supplementing nutrients in the lake to increase primary productivity and zooplankton, the primary food source for young salmon. Fertilizing the lakes would have an indirect, positive effect on sockeye salmon by allowing an increased escapement, increasing the number of spawning adults, increasing survival of juvenile salmon, and therefore increasing the sockeye population. The effect would be short-term, lasting only as long as the lake fertilization is continued. The effect could be long-term if fertilization was continued and forage fish remained abundant as a food source for growing adult populations.

Improving access to salmon spawning areas by building fish passes or removing barriers would have a direct, positive effect on sockeye salmon populations by providing new or additional habitat for sockeye salmon spawning. This could improve spawning success and increase the population of sockeye salmon. This would be a long-term effect because this new habitat would be available for the life of the salmon fishery.

Option #12 (Create new recreational facilities)

This option would affect sockeye salmon by increasing sport fishing pressure and disruption of stream habitat by the construction of new public recreation facilities such as mooring buoys, boat ramps, picnic areas, campsites, and trails. This option could have an indirect, negative effect on sockeye salmon because it would increase public access to streams, causing disruption of stream habitat. Increased public access could increase recreational fishing pressures on streams that are presently relatively undisturbed. Other habitat disturbances could include increased runoff from roads, trails, and campsites related to recreational facilities construction. This could result in increased turbidity and water temperature and reduce dissolved oxygen concentrations in streams which would adversely affect the survival of eggs and larvae. This could reduce spawning success of sockeye, and the overall population in the affected areas. The effects would likely be long-term because of the long-term use of these facilities.

Option #14 (Recovery of upper intertidal zone)

The option would have a positive, indirect effect on sockeye salmon by improving habitat and the quantity and quality of prey for adult salmon. Adult sockeye salmon use the nearshore areas to feed after leaving the streams. Improving the intertidal zone would increase the quantity of prey species utilized by sockeye salmon. This could have a long-term effect on salmon populations by increasing the survival rate of fish that may return to spawn. Increasing the number of spawning fish could ultimately increase populations.

Option #18 (Create new salmon runs)

This option could affect wild sockeye salmon stocks by providing new commercial, sport, and subsistence fishing opportunities to replace those opportunities lost from the spill. In addition, this would relieve fishing pressure on stocks damaged by the spill, assuming that timing and location of new fish runs would be managed in accordance with genetic and disease control guidelines to avoid further damage to natural stocks. This option could have an indirect, positive effect on sockeye salmon by reducing fishing pressure which allow damaged stocks to naturally recover and therefore increase the populations. There could be long-term, indirect, negative impacts on non-target species from introduction of salmon into vacant areas, from increased competition for food and habitat, and from the introduction of disease.

Option #19 (Protect undocumented anadromous streams)

This option could affect sockeye salmon by listing streams utilized by salmon in the ADF&G Anadromous Stream Catalogue. Streams listed in the catalogue are provided with a certain level of protection to avoid further disturbance. It is assumed that new streams added to the catalogue are degraded in some way and would be able to benefit from protection. This could have an indirect, positive effect on sockeye salmon by protecting existing spawning areas from further disturbance, thus increasing spawning success and populations. The option would have a long-term effect because the streams would be protected from future degradation, allowing sockeye salmon populations to increase.

Option #37 (Habitat protection and acquisition)

This option could affect sockeye salmon throughout the spill area by acquiring damaged habitat and protecting it from further disturbance to allow for natural recovery. This would have a positive, indirect effect on the sockeye salmon by protecting spawning stocks so that reproductive success may increase. This would ultimately increase populations. The long-term effects would be that sockeye salmon habitat would be protected from further disturbance.

Option #40 (Special Designations)

This option could effect sockeye salmon by giving special designations to uplands, coastal, and marine habitat that are utilized by salmon for spawning and rearing. This provides a certain level of regulatory protection of these habitats. This could have an indirect, positive effect on sockeye salmon by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

Option #48 (Improve survival of salmon eggs and fry)

This option could affect sockeye salmon by rearing wild sockeye salmon eggs and fry in boxes, net pens, or hatcheries. Assuming that strict guidelines to prevent disease and overescapement were implemented, this option could have a direct, positive effect on sockeye salmon by increasing the survival of eggs and larvae and improving spawning success, thereby facilitating an increase in

population. The effects would be long-term because it would restore wild sockeye salmon populations.

Pacific Herring

Option #2 (Intensify fisheries management)

This option would affect Pacific Herring by intensifying fisheries management of this species. This option would protect injured stocks from further exploitation and allow natural recovery. The extent of damage to the herring population is unknown at this time. It is assumed that a damage assessment of the 1989 and 1990 year class of herring populations would be made, and that the results would indicate that recruitment of those year classes to the herring population was reduced and the population of herring has been reduced. This option would have a positive, direct effect on Pacific herring populations by reducing commercial and sport fishing pressures on damaged stocks. The effect would be long-term because the number of successful spawning adults would increase and thereby increase spawning success, which could ultimately lead to an increase in population.

Option #13 (Eliminate remove oil from the mussel beds)

This option could affect Pacific herring by cleaning the beds and areas of contamination adjacent to anadromous streams. This option could have an indirect, short-term, negative effect on eggs and larvae during the oil elimination process because of the release of some oil into the water column. The oil could temporarily decrease productivity, degrade the spawning habitat, and decrease the survival rate of eggs and larvae in PWS.

Option #14 (Recovery of upper intertidal zone)

The option would have a positive, indirect effect on Pacific herring by recovering the intertidal zone. Pacific herring use the intertidal zone for spawning and nursery grounds, therefore, improving the intertidal zone would increase spawning success. In addition, improving the intertidal zone would also increase productivity and increase the quantity and food available for larval Pacific herring. This would increase their survival rate, and subsequently increase the number of adults returning to spawn. The effect would be long-term because increasing the survival rate of larvae and the number of spawning adults could ultimately increase population.

Option #37 (Habitat protection and acquisition)

This option could affect Pacific herring populations throughout the spill area by acquiring damaged habitat and protecting it from further disturbance to allow for natural recovery. This would have a positive, indirect effect on the Pacific herring by protecting spawning stocks from excessive fishing pressure, thereby increasing the number of spawning adults so that reproductive success may increase. This would ultimately increase populations. The long-term effects would be that Pacific herring habitat would be protected from further disturbance.

Option #40 (Special designations)

This option could affect Pacific herring by giving special designations to uplands, coastal, and marine habitat that are utilized by herring for spawning and rearing. This provides a certain level of regulatory protection of these habitats. This could have an indirect, positive effect on Pacific herring by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

Rockfish

Option #2 (Intensify fisheries management)

This option would affect rockfish by intensifying fisheries management of this species. This option would protect injured stocks from further exploitation and allow for natural recovery. This option would have a positive direct effect on rockfish populations by reducing commercial and sport fishing pressures on damaged stocks. This could increase the number of adults for reproduction which would increase success. The long-term effect would be an increase of rockfish populations.

Option #14 (Recovery of upper intertidal zone)

The option would have a positive, indirect effect on rockfish by improving habitat and the quantity of prey species for adult rockfish. Improving the intertidal zone would increase productivity, increase cover, and increase the quantity of prey species utilized by rockfish. This could have a long-term effect on rockfish populations by increasing the survival rate of fish

that may reproduce, which would ultimately increase populations.

Option #40 (Special Designations)

This option could affect rockfish by giving special designations to coastal and marine habitat that are utilized by rockfish for spawning and rearing. This provides a certain level of regulatory protection of these habitats. This could have an indirect, positive effect on rockfish by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

An assumption concerning this option is that the designation of marine sanctuaries containing rockfish would be included.

Dolly Varden

Option #2 (Intensify fisheries management)

This option would affect Dolly Varden by intensifying fisheries management of this species. This option would protect injured stocks from further exploitation and allow for natural recovery. It is assumed that the intensified management of Dolly Varden would be designed to increase Dolly Varden populations, but not to exceed the carrying capacity of the stocks. This option would have a positive, direct effect on Dolly Varden populations by reducing commercial and sport fishing pressures on damaged stocks. This could increase the number of successful spawning adults which would increase overall spawning success. The long-term effect would be an increase of Dolly Varden populations.

Option #11 (Improve freshwater wild salmon)

This option could affect Dolly Varden by improving access to salmon spawning areas by building fish passages or removing barriers. Creating fish passage for salmon could also provide opportunities for other anadromous species to utilize the streams for spawning. Dolly Varden utilize some of the same streams as salmon. Therefore, this option could have an indirect, positive effect on Dolly Varden populations by creating fish passages and removing instream barriers. This would provide new and additional spawning habitat for Dolly Varden, which could increase spawning success and thereby increase populations. This could have a long-term effect on Dolly Varden because the new habitat could expand the current

spawning area of Dolly Varden for future reproduction. This effect would be long-term because the instream improvements could be maintained and last for many years.

Option #12 (Create new recreational facilities)

This option could affect Dolly Varden by increasing sport fishing pressure and disruption of stream habitat by the construction of new public recreation facilities such as mooring buoys, boat ramps, picnic areas, campsites, and trails. This option could have an indirect, negative effect on Dolly Varden because it would increase public access to streams, causing disturbance of stream habitat. Increased public access could increase recreational fishing pressures on streams that are presently relatively undisturbed. Other habitat disturbances could include increased runoff from roads, trails, and campsites related to recreational facilities construction. This could result in increased turbidity and water temperature and reduced dissolved oxygen concentrations in streams, which would adversely effect the survival of Dolly Varden eggs and larvae. This would reduce spawning success of Dolly Varden, and the overall population in the affected areas. The effects would likely be long-term because of the permanent nature of these facilities.

Option #14 (Recovery of upper intertidal zone)

The option would have a positive, indirect effect on Dolly Varden by improving habitat and the quantity of prey species for adult Dolly Varden. Adult Dolly Varden use the nearshore areas to feed after leaving the streams. Improving the intertidal zone would increase the quantity of prey species available to Dolly Varden. This could have a long-term effect on Dolly Varden populations by increasing the survival rate of fish that may return to spawn. Increasing the number of spawning fish could ultimately increase populations.

Option #19 (Protect undocumented anadromous streams)

This option could affect Dolly Varden by listing streams utilized by Dolly Varden in the ADF&G Anadromous Stream Catalogue. Streams listed in the catalogue are provided with a buffer strip for protection to avoid further disturbance. This could have an indirect, positive effect on Dolly Varden by protecting existing spawning areas from further disturbance, thus increasing spawning success and populations. The option would have long-term effect

because the streams would be protected from future degradation, allowing Dolly Varden populations to increase. It is assumed that new streams added to the catalogue are degraded in some way and are able to benefit from protection.

Option #37 (Habitat protection and acquisition)

This option could affect Dolly Varden populations throughout the spill area by acquiring damaged habitat and protecting it from further disturbance to allow for natural recovery. This would have a positive, indirect effect on the Dolly Varden by protecting spawning stocks so that reproductive success may increase. This would ultimately increase populations. The long-term effects would be that Dolly Varden habitat would be protected from further disturbance.

Option #40 (Special designations)

This option could affect Dolly Varden by giving special designations to uplands, coastal, and marine habitat that are utilized by Dolly Varden for spawning and rearing. This provides a certain level of regulatory protection of these habitats. This could have an indirect, positive effect on Dolly Varden by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

Option #48 (Improve survival of salmon eggs and fry)

This option could affect Dolly Varden by increasing survival of salmon eggs and larvae. Dolly Varden prey heavily on salmon eggs and larvae in the stream. An increase in the number of salmon eggs and larvae could have an indirect, positive effect on Dolly Varden by increasing the food supply for Dolly Varden. If salmon populations increase, this could have a long-term effect on the available food source for Dolly Varden, which would increase growth rates of Dolly Varden and thereby increase the number of adults that may return to spawn.

Cutthroat Trout

Option #2 (Intensify fisheries management)

This option would affect cutthroat trout by intensifying fisheries

management of this species. This option would protect injured stocks from further exploitation and allow for natural recovery. It is assumed that the intensified management of cutthroat trout would be designed to increase trout populations, but not to exceed the carrying capacity of the stocks. This option would have a positive, direct effect on trout populations by reducing commercial and sport fishing pressures on damaged stocks. This could increase the number of successful spawning adults, which would increase overall spawning success. The long-term effect would be an increase of cutthroat trout populations.

Option #11 (Improve freshwater wild salmon)

This option could affect cutthroat trout by improving access to salmon spawning areas by building fish passages or removing barriers. Creating fish passage for salmon could also provide opportunities for other anadromous species to utilize the streams for spawning. Cutthroat trout utilize some of the same streams as salmon. Therefore, this option could have an indirect, positive effect on cutthroat trout populations by creating fish passages and removing instream barriers. This would provide new and additional spawning habitat for cutthroat trout, which could increase spawning success and thereby increase populations. This could have a long-term effect on cutthroat trout because the new habitat could expand the current spawning area of trout for future reproduction. This effect would be long-term because the instream improvements could be maintained for many years.

Option #12 (Create new recreational facilities)

This option could affect cutthroat trout by increasing sport fishing pressure and disruption of stream habitat by the construction of new public recreation facilities such as mooring buoys, boat ramps, picnic areas, campsites, and trails. This option would have an indirect, negative effect on cutthroat trout because it would increase public access to streams, causing disturbance of stream habitat. Increased public access could increase recreational fishing pressures on streams that are presently relatively undisturbed. Other habitat disturbances could include increased runoff from roads, trails, and campsites related to recreational facilities construction. This could result in increased turbidity and water temperature and reduced dissolved oxygen concentrations in streams, which would adversely affect the survival of trout eggs and larvae. This could reduce spawning success of trout, and the overall population in the affected areas.

The effects would likely be long-term because of the long-term use of these facilities.

Option #14 (Recovery of upper intertidal zone)

The option would have a positive, indirect effect on cutthroat trout by improving habitat and the quantity of prey species available for adult trout. Adult cutthroat trout use the nearshore areas to feed after leaving the streams. Improving the intertidal zone would increase the quantity of prey species utilized by cutthroat trout. This could have a long-term effect on trout populations by increasing the survival rate of fish that may return to spawn. Increasing the number of spawning fish could ultimately increase populations.

Option #19 (Protect undocumented anadromous streams)

This option could affect cutthroat trout by listing streams utilized by trout in the ADF&G Anadromous Stream Catalogue. Streams listed in the catalogue are provided with a buffer strip for protection to avoid further disturbance. This could have an indirect, positive effect on cutthroat trout by protecting existing spawning areas from further disturbance, thus increasing spawning success and populations. The option would have a long-term effect because the streams would be protected from future degradation, allowing cutthroat trout populations to increase. It is assumed that new streams added to the catalogue are degraded in some way and are able to benefit from protection.

Option #37 (Habitat protection and acquisition)

This option could affect cutthroat trout populations throughout the spill area by acquiring damaged habitat and protecting it from further disturbance to allow for natural recovery. This would have a positive, indirect effect on the cutthroat trout by protecting spawning stocks so that reproductive success may increase. This would ultimately increase populations. The long-term effects would be that cutthroat trout habitat would be protected from further disturbance.

Option #40 (Special designations)

This option could affect cutthroat trout by giving special designations to uplands, coastal, and marine habitat that are utilized by trout for spawning and rearing. This would provide a

certain level of regulatory protection of these habitats. This could have an indirect, positive effect on cutthroat trout by protecting spawning habitats so that reproductive success could increase, thus increasing populations. The effect would be long-term because the habitat would be protected from future exploitation.

e. Coastal Communities

Intertidal Organisms

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

This option would establish or expand protective buffer zones to reduce disturbance at marine mammal haulout sites. It is assumed that implementation of this option would improve the population of marine mammals, such as sea otters. Because sea otters typically feed on clams and mussels in the intertidal zone, it is also assumed that an increased sea otter population would increase the degree of feeding on clams and mussels.

This option would have an indirect, short-term, adverse effect on clams and mussels in the intertidal environment by increasing feeding on these species and subsequently reducing the population. This effect would be short-term because the population increase in marine mammals would eventually stabilize, followed by stabilization of the increased feeding on clams and mussels.

Option #8 (Develop sport harvest guidelines)

It is assumed that implementation of this option would improve the populations and reduce mortality of the Harlequin duck and the river otter, both of which feed in the intertidal zone. If populations increase, it is also assumed that feeding on intertidal organisms, especially clams and mussels, would increase.

Because of the assumed increase in feeding on inhabitants of the intertidal zone, this option would have an indirect, short-term, adverse effect on clams and mussels by increasing the amount of clams and mussels that are eaten. The effect would be short-term because it would last only until the harvest-restricted species' population stabilizes.

Option #9 (Minimize the incidental take of birds)

It is assumed that this option would facilitate the reduction in mortality of marine birds that feed upon organisms in the intertidal environment. An indirect, short-term, adverse effect (for the length of catch restrictions) on intertidal organisms would occur because of increased feeding, which would reduce the population of the effected intertidal organisms.

Option #12 (Create new recreation sites and facilities)

It is assumed that new recreation areas associated with the implementation of this option were not previously areas of high activity. Consequently, construction of new recreational facilities could have an adverse, indirect, long-term effect on intertidal organisms because these facilities could contribute to increased use of a damaged areas that previously were little used or unused. This could slow the growth or reduce the number of organisms living in the damaged intertidal area.

Option #13 (Eliminate oil from mussel beds)

This option would produce a positive, direct, short-term effect on the mussel beds present on the intertidal environment by removing residual oil that is present in and adjacent to the mussel beds and reducing or eliminating the potential for further contamination of the mussels in the long-run. Consequently, less oil would be available for bioaccumulation by mussels and other invertebrates, and a positive, indirect effect would result to the health and safety of the predatory species (i.e., harlequin duck, black oystercatcher, sea otter, river otter) and humans (i.e., subsistence gatherers) that consume mussels. A direct, short-term, adverse effect would occur, in that, a minimal amount of mussels would be lost during the cleaning process; however, this effect would be a one-time event. This option would also include monitoring to assess the efficacy of stripping oil from mussel beds (i.e., the fate of oil in mussels and substrate, and the effects of oil on growth and reproduction of mussels). The effect from monitoring would be a positive, direct, long-term effect, because this knowledge would ensure more beneficial clean-up procedures in the event of future spills.

Option #14 (Accelerate recovery of upper intertidal zone)

This option would have a positive, direct, long-term effect on the intertidal zone because it would provide a mechanism to accelerate the recovery and increase the population of *Fucus* by providing

improved growing and attachment substrates (i.e., installing burlap for substrate), irrigation, and supplementing the population of adult, reproductive-sized plants. Because many organisms in the intertidal zone depend on *Fucus* for food and cover, this would have a positive, indirect, long-term effect on these intertidal organisms.

Option #17 (Removal of introduced predator species)

It is assumed that the elimination of introduced foxes and rodents would result in increased survival of seabirds (due to the removal of their main predators) that feed on organisms of the intertidal zone, especially clams and mussels. With the increased population of predator species, it is anticipated that feeding on clams and mussels would increase. This option would have an indirect, short-term, adverse effect on intertidal organisms (i.e., clams and mussels) by reducing their populations from increased feeding by seabirds, until the affected seabird population stabilizes.

Option #30 (Test subsistence foods for hydrocarbon contamination)

It is assumed that this option would restore subsistence uses of fish and wildlife damaged by the spill by reestablishing the confidence of subsistence users in the safety of the subsistence resources. A direct, short-term, adverse effect would occur because live animals would be removed, but only in small numbers. A potential indirect, long-term, adverse effect of this option to the intertidal zone would be greater use of subsistence foods such as mussels, due to increased confidence of subsistence users in the safety of subsistence resources (this effect assumes that monitoring determined that the mussels were safe for subsistence harvesting). This option could potentially produce a short-term, indirect, positive effect on mussel beds in that monitoring would determine the degree of contamination in the mussel beds and provide data to support continued restoration, if necessary.

Option #33 (Visitor centers)

It is assumed that the visitor centers and the associated informational materials would help the public to become better informed about the oil spill and how they can help to accelerate recovery. This option would have a positive, indirect, long-term effect on the intertidal zone and its organisms. The effect would be that recovery may be accelerated by public actions that result from knowledge obtained at the visitor center. Because the visitor

center would be a permanent facility, this indirect benefit would be long-term.

Option #34 (Marine environmental institute and research foundation)

The construction of a Marine Environmental Institute would have a positive, indirect, long-term effect on the intertidal environment and its organisms by educating the public. It is assumed that this knowledge would produce a more conservation- and safety-conscious public. Consequently, the intertidal organisms would potentially benefit from the prevention of spills and contamination long into the future. The funding of a marine research program or foundation to conduct restoration experiments would produce a positive, indirect, long-term effect on intertidal resources because scientists would have more extensive knowledge of how to restore damaged resources in the future.

Option #37 (Habitat protection and acquisition)

Implementation of this option would result in a positive, direct, long-term effect to intertidal organisms through the acquisition and long-term management of tidelands. This effect would result from restrictions on use and management of the protected habitat to reduce activities that might hinder the growth or reduce the population of intertidal organisms living in the selected areas.

Option #40 (Special designations)

Designation of new Alaska State Parks would result in a positive, indirect, long-term effect on injured intertidal organisms because it would potentially draw activities away from spill-damaged resources and allow for undisturbed recovery of these resources. Positive, direct, long-term effects would result to intertidal areas from special designations because these areas would be managed specifically to restore the damaged resources of the intertidal environment, provide for compatible uses and deter activities that may further disturb the recovery of damaged resources, and provide monitoring.

Option #47 (Cooperative program with subsistence users)

It is assumed that this option would result in a voluntary harvest reduction of sea otters, that the population of sea otters would then increase, and subsequent feeding in the intertidal zone (i.e., on clams and mussels) would increase. This option would have an

indirect, short-term, adverse effect on intertidal organisms by reducing the populations of clams and mussels, until the restrictions were lifted.

Option #49 (Provide access to traditional subsistence foods)

It is assumed that this option would redirect subsistence activities in spill-damaged areas to unimpacted areas. Consequently, this option would result in a positive, direct, short-term effect to spill-damaged areas of the intertidal environment because it would reduce activities in the spill-damaged areas that might slow the population growth of clams and mussels and deter recovery.

Option #50 (Replace subsistence harvest opportunities for bivalve shellfish)

It is assumed that the development of subsistence mariculture sites would reduce further disturbance of the oil-damaged intertidal organisms by subsistence users. Consequently, a positive, direct, long-term effect on the intertidal environment would result from this option because it would prevent collection activities that might slow the population growth and recovery of clams and mussels, thus allowing the clam and mussel population to increase. It is also assumed that hatchery-grown shellfish could be used to re-seed native oil-damaged beaches that are no longer oiled. Consequently, the option to develop a bivalve shellfish hatchery and research center would produce a positive, direct, long-term effect on the clams and mussels of the intertidal habitat by providing a mechanism for augmenting and accelerating the recovery and increasing the population of the native species.

Subtidal Organisms

Option #13 (Eliminate oil from mussel beds)

This option would produce an adverse indirect, short-term effect on organisms of the subtidal habitat because residual oil would be removed from the mussel beds and adjacent areas in the intertidal habitat and oil may temporarily become more available, in the water column, to the subtidal organisms. However, a positive, indirect, long-term effect would also occur because this oil would then be subject to more extensive weathering and eventually, less oil would be available for bioaccumulation by organisms of the subtidal environment.

Option #14 (Accelerate recovery of upper intertidal zone)

It is assumed that this option would improve the overall health of the intertidal zone and its organisms and that some subtidal organisms feed in the intertidal zone. This option would have a positive, indirect, long-term effect on organisms in the subtidal zone that might enter the intertidal zone for feeding purposes, by providing healthier prey.

Option #30 (Test subsistence foods for hydrocarbon contamination)

It is assumed that this option would restore subsistence uses of fish and wildlife damaged by the spill by restoring the confidence of subsistence users in the safety of the subsistence resources. A direct, short-term adverse effect would occur in that live animals would be removed, but only in small numbers. It is assumed that mussels may be collected from the shallow subtidal zone. Consequently, a potential indirect, long-term, adverse effect of this option would be to reduce the population of shallow subtidal mussels through increased subsistence harvesting, due to restored confidence of subsistence users in the safety of subsistence resources (assuming that monitoring would determine that the mussels were safe for subsistence harvesting).

Option #34 (Marine environmental institute and research foundation)

The construction of a Marine Environmental Institute would have a positive, indirect, long-term effect on the subtidal environment and its organisms by educating the public. It is assumed that this knowledge would produce a more conservation- and safety-conscious public. Consequently, the subtidal organisms would potentially benefit from the prevention of spills and contamination long into the future. The funding of a marine research program or foundation to conduct restoration experiments would produce a positive, indirect, long-term effect on subtidal resources because more data would be available for future restoration needs.

Option #37 (Habitat protection and acquisition)

This option would result in a positive, indirect, long-term effect on subtidal organisms through the acquisition and management of tidelands. Management would prevent activities that might slow the growth or reduce the population of subtidal organisms.

Option #40 (Special designations)

Positive, indirect, long-term effects would result to subtidal areas from special designations because these areas would benefit from management that would prevent activities that might slow subtidal organism growth or reduce populations.

Option #49 (Provide access to traditional subsistence foods)

It is assumed that subsistence harvests currently occur in the shallow subtidal areas. Consequently, this would result in a positive, direct, short-term effect on spill-damaged areas of the shallow subtidal environment because it would restrict further subsistence activities in spill-damaged areas, thus preventing activities that might slow the growth or reduce the population of subtidal organisms.

B. Services

1. Archaeology

Option #1.0 (Archaeological site stewardship program)

This option establishes an archaeological site stewardship program. Beach cleanup activities resulted in increased public knowledge of the exact locations of archaeological sites throughout the EVOS area. Archaeolgical sites and artifacts affected by looting and vandalism, directly attributable to the oil spill, has been occurring at disturbing levels. The site stewardship program will involve the recruitment, training, and coordination of a corps of local interested citizens to watch over threatened archaeological sites located within their home districts.

Although archaeological sites and artifacts cannot be restored, the site stewardship program is designed to stop additional damage to archaeological resources from looting and vandalism. Members of the citizen corps may receive small cash payments for their volunteer duties. These payments may benefit the local economy by introducing additional cash into the economy.

Option #10.0 (Preserve archaeological sites and artifacts)

This option addresses the need to repair archaeological sites that sustained injury from oiling, oil spill cleanup, or vandalism, as well as the need to recover information that can be salvaged from the area of an illegal excavation. It has been estimated that at least 113 archaeological sites located on State and Federal lands

within the EVOS pathway sustained injury. The initial focus wold include the 24 archaeological sites for which clear evidence of injury exists. The restorative actions taken would prevent additional injury and provide professional documentation on archaeological sites. This option is an effort to reduce additional degradation or decline of the resources and services associated with archaeological sites and artifacts.

Option #35 (Negotiate with museums and agencies to acquire replacements for artifacts looted from the spill area)

This option seeks to replace and/or recover those artifacts that have been lost as a result of oil spill cleanup activities or vandalism. It also seeks to place returned/recovered artifacts into public ownership for appropriate public display and scientific uses. Individuals and institutions with oil spill artifacts will be approached with offers of artifact purchase from the *Exxon Valdez* Oil Spill Trustees (member agencies). Acquired artifacts would be transferred to appropriate public institutions within the oil spill area for public display and appropriate scientific uses. This effort would provide replacement artifacts for those lost.

2. Commercial Fishing

Option #2 (Intensify fisheries management)

This option affects commercial fishing by restricting existing fisheries or redirecting them to alternative sites. The development and implementation of new fishing regulations may also be included in this option. In addition, this option may include research concerning commercial fisheries that would identify fish harvest levels, age and sex composition, natural mortality, seasonal movements, stock abundance, and recruitment. Commercial species that could be affected by this option include pink salmon and herring in PWS, sockeye salmon in central Cook Inlet, and rockfish in PWS, lower Cook Inlet and along the outer Kenai Peninsula.

Direct effects on commercial fishing from management actions aimed at protecting injured stocks would include the added cost of redirecting harvest activities to sites requiring longer travel times to and from port, and the loss, from regulatory constraints placed on harvest, of fisheries previously available for harvest. These effects would be direct, but would last for a short period of time, until the injured stock increased to levels determined by the

management agencies to be acceptable for harvest.

Indirect effects related to implementation of this option involve the increase in the long-term availability of salmon for harvest. Increased numbers of salmon resulting from the management activities would provide additional harvest opportunities, and a consequent increase in the income from the harvest. Additionally, indirectly through research activities included in the option, long-term viability of commercial fisheries would be enhanced by better information upon which to establish future management decisions that maintain stock availability and reduce harvest variability.

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

This option would affect commercial fishing operations by restricting the speed or prohibiting navigation of fishing vessels within 1/2 or 1 mile of protected bird colonies and haulout sites. These restrictions could be implemented in all areas of the oil spill area except Kodiak/Afognak, and would occur from May to September to encompass the affected species' molting and pupping seasons.

An assumption concerning the effects of implementing this option is that there are commercially harvestable fish populations that would be encompassed by the protected zone near the colonies and haulout sites.

The indirect effect to commercial fisheries from protecting these sites would be to reduce the available harvest locations, which may affect the volume of the harvest. If speed reductions restricted the type of fishing gear that could be used, this may also indirectly affect the ability to commercially harvest fish.

This option may result in long-term effects lasting until the injured species populations being protected recover.

Option #9 (Minimize the incidental take of birds)

This option would be directed at the commercial fishing activities associated with gillnet (drift and set net) fisheries in PWS, Kenai, Alaska Peninsula and Cook Inlet, or the Kodiak/Afognak Island set net fishery (i.e., could occur anywhere in the entire oil spill area). The option could involve suspending nets below the surface, closure of certain areas, elimination of night

fishing, or directing fishing away from injured marine bird habitats.

This option could directly affect the commercial fishing industry as a result of costs incurred to modify gillnets for use while suspended below the surface. If fisheries were closed, this may also cause direct, adverse economic effects by reducing the volume of fish caught, increasing the cost to travel to new harvest locations, and increasing competition for the available fishery, which would reduce fishing opportunity and the associated volume of the harvest for boats previously utilizing the closed areas.

The effects of implementing this option could be long-term, lasting for as many years as it may take for the injured species populations to rebound to preferred management levels.

Option #11 (Improve freshwater wild salmon habitats)

This option would affect commercial fishing by increasing the number of wild salmon stocks available for harvest. The numbers of fish made available would be the result of improvements in the availability of food in the PWS spawning and rearing habitats, and accessibility to spawning areas on Kodiak Island, which would increase fish survival and improve growth rates.

The indirect effect of implementing this option would be to increase the opportunities for harvest through an increase in the number of fish available for harvest. Consequently, the value of the harvest would increase (assuming prices did not commensurately decline), increasing the income of the fishermen participating in the harvest.

The effects of implementing this option would be long-term if wild salmon populations remained at high levels after the initial improvements were implemented.

Option #12 (Create new recreation sites and facilities)

This option could affect commercial fishing throughout the oil spill area by increasing the number of boat ramps, mooring buoys, and other facilities that increase the number of recreational boaters.

The effects of implementing this option would be indirect as a result of increased recreational boater traffic, which could

conflict with commercial fishing boats and gear. These conflicts could occur if recreational boaters accidently snagged commercial fishing gear causing the gear to fail, or by inhibiting the operation of the fishing vessel by operating to close to the vessel. In general, the greater the number of boats operating in the same area, the greater the potential for conflicts and collisions. Damage to gear or the fishing vessel would have an adverse economic effect on the commercial operator because of the costs of repair. The potential for injury in a collision could also have adverse effects on human health and safety.

Option #18 (Create new salmon runs)

This option could affect commercial fishing by creating new salmon runs on rivers in PWS, Cook Inlet and Kodiak/Afognak that currently do not support such runs. The option would involve the placement of a hatchery or remote release site at a river where a terminal harvest could occur.

The indirect effects on the commercial fishery from the creation of new salmon runs and the consequent increase in salmon populations would be to increase opportunities for harvesting salmon. An increase in the number of salmon harvested would have direct positive economic effects on commercial fishermen involved in the harvest. There may also be direct adverse economic effects on commercial fishermen if the distance traveled to the harvest site was further than previously required to harvest the same number of fish.

The effects of this option would be expected to be short-term because the runs would be terminated once the other target species had recovered.

Option #19 (Protect undocumented anadromous streams)

This option would affect commercial fishing by protecting streams in PWS and Kodiak/Afognak that contribute to the number of anadromous fish available for harvesting. This option would identify streams for inclusion in the Anadromous Stream Catalogue, which would automatically afford the stream protection. Under the State Forest Practices Act, any stream listed in the catalogue would be protected by a buffer zone to prevent stream encroachment (development close to the stream).

Assumptions concerning the implementation of this option include an

assumption that the streams not in the catalogue now, could add to the available fishery if they were included in the catalogue (i.e., there is some damage currently occurring to the stream that has reduced its productivity), and that harvesting is currently allowed in the area used during the migration of the adult fish.

Based on the assumptions, the commercial fishery would directly benefit from the increase in the number of fish available for harvest, and the consequent additional income that could result from that harvest.

The positive effects associated with the implementation of this option would be expected to be long-term because of the long-term protection afforded the stream once it is listed in the catalogue.

Option #37 (Habitat protection and acquisition)

Implementing this option could affect commercial fishing by protecting habitat throughout the oil spill area, that is necessary to ensure the productivity of estuaries, stream and lakes that produce the stocks of fish harvested commercially.

An assumption concerning the implementation of this option is that land containing these productive habitats is currently privately owned and consequently available for purchase or protection. This also assumes that the land area containing these habitats would meet the criteria necessary to make them a target for purchase or protection.

The effect to commercial fishing would be indirect, and fishing would benefit only if the stocks of commercially harvested fish increase, or the consistency of the harvest was ensured through the protection of productive fish spawning and rearing habitats. Additional stocks of fish for harvest would translate into additional income to commercial fishermen and commercial fish processing facilities. These benefits would be long-term assuming the habitat protection is afforded in perpetuity.

Option #40 (Special designations)

This option would affect commercial fishing by establishing special designations throughout the oil spill area to protect upland, coastal, and marine habitats that contain productive fish producing or harvesting areas.

An assumption concerning this option is that the designation of marine sanctuaries containing a commercially harvestable fishery would be included. Based on this assumption, commercial fishing would be directly affected by limiting the area available for commercially harvesting fish. This would have an adverse economic effect on the fishermen that rely on these area for all or portions of their catch.

Indirect, positive benefits to commercial fishing could occur from protecting productive spawning and rearing areas through special designations that increase the productivity of streams that currently are suffering some sort of stress. Increasing the number of fish available for harvest could increase the earnings of commercial fishermen and fish processors if harvest increase along with the increases in fish stocks. These effects would be long-term assuming that the areas remain under the special designation in perpetuity.

Option #45 (Change black cod fishing gear)

This option would affect commercial fishing by subsidizing the voluntary change in the way black cod fisheries are harvested in PWS and areas along the outer Kenai Peninsula. Instead of using long lines (hook & line), some other gear type such as "pots" like those used in the British Columbia black cod fishery would be used. The objective of the option is to find a method of fishing for black cod that does not attract or provide the opportunity for killer whales to strip the catch, in turn reducing the conflict between killer whales and commercial fishermen.

For analysis purposes, it is assumed that long lines would be replaced by the "pot" type gear, which requires a boat of a certain size (larger than many currently used) to place and retrieve the pots.

Direct effects to commercial fishing would occur as a result of the costs that would be incurred learning how to use the new gear types effectively. Costs may also be incurred by fishermen who choose to switch to the pot type gear but do not have boats large enough to use this gear type. Fishermen currently using small boats that cannot afford to acquire larger boats that would accommodate the new gear would not be able to participate in the fishery, and would either have to switch to a new fishery (assuming entry were permitted), or would not be able to participate in the harvesting of black cod. The economic consequences to the individual who

could no longer participate in the fishery could be severe.

Changing the gear types for the commercial black cod fishery would have short-term effects because it is assumed that changing the harvesting method would occur over a relatively short period of time, with a one-time cost for initially switching the gear, and a relatively short learning curve for determining the effective use of the new equipment.

Option #46 (Reducing the bycatch of harbor seals)

This option would affect commercial fishing in PWS, lower Cook Inlet, and Kodiak/Afognak Islands by changing the harvesting methods and harvest areas to prevent accidental take of harbor seals.

This option would have direct, adverse effects on commercial fishermen because of the costs that would be incurred to modify fishing methods and fishing gear to prevent the accidental take of harbor seals. Reduction in the number of fish harvested because of area harvest restrictions and the effectiveness of the modified harvest gear may also reduce the income of fishermen participating in the affected fishery.

The effects of implementing this option would be long-term assuming that once the gear restrictions have been implemented they would likely be difficult to repeal.

Option #48 (Improving survival of salmon eggs and fry)

This option would affect commercial fishing by rearing wild salmon eggs in boxes, netpens or hatcheries, and releasing them to native streams in PWS, central Cook Inlet, or Kodiak Island. This could increase the numbers of wild salmon available for harvest along the migration routes of the adult salmon.

An indirect effect on commercial fishing would occur from the improved survival of salmon eggs and fry because more fish would be available for harvest, and more harvest opportunities would be provided. An increase in the salmon catch would increase income for commercial harvesters and fish processors.

This option would have long-term effects because the additional fish provided by artificial rearing would increase the potential for long-term increases in the harvest of naturally produced

stocks.

Option #51 (Change or relocate existing hatchery runs)

This option would affect commercial fishing by changing the timing or location of commercial harvests. The option would involve changing the timing of hatchery run releases in PWS, or releasing hatchery fish at remote locations in an effort to minimize the interaction of hatchery fish and wild salmon stocks during commercial harvests. Ultimately, the objective of the option is to increase wild salmon stocks.

The short-term direct effect to commercial fishing from implementing this option could involve harvest area closures, changes in the time of year for harvesting, and possible increases in the distances traveled to reach open harvesting areas. These changes in harvest strategy could have economic consequences such as increases in the cost of harvest if the distance to the harvest area is greater than what had been previously required. Because the implementation of the option would require careful planning to ensure that interception of the wild stocks is avoided, consideration of the costs of the harvest would be an important part in the planning process. If fishermen are not willing to travel to the locations where the hatchery runs have been relocated, the objective of this option would be compromised.

The long-term, indirect effects from implementing this option would occur as a result of an increase in the wild salmon stocks. Once the stocks have recovered to a level where they can be sustained even with harvesting, an economic benefit to commercial fishing would be realized because of the additional fish available for harvest, and the associated value of those additional fish.

3. Commercial Tourism

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

This option involves designation of buffer zones around important marine birds and mammals habitats. The restrictions within buffer zones could include prohibiting boat or air traffic within a certain distance from the habitat. This could require tour or charter-boat companies to change their routes, and in critical conditions could prevent access to a favorite viewing or fishing location. Implementation of this option would have indirect,

short-term, negative and long-term, positive effects on commercial tourism. Short-term, negative effects would occur from temporary restrictions imposed on charter and tour-boat companies, and air traffic. However, these effects would be localized. Long-term positive effects to tourism would occur when the population of injured species recover creating additional wildlife viewing opportunities and consequently creating demand for additional charter and tour-boat services and cruises.

Option #9 (Minimize the incidental take of birds)

This option involves facilitating recovery of marine bird species (common murre and marbled murrelets) by employing measures to reduce encounters between these birds and gillnets, deployed in high seas and coastal fisheries. Implementation of this option would have indirect, long-term, positive effects on tourism industry because enhanced population of marine birds would create additional opportunities for bird watching and consequently demand for various tourism-related services such as tour boats, tour guides, cruises, etc.

Options #10 (Preserve archeological sites and artifacts)

This option involves restoration of archeological sites and artifacts injured by the oil spill from further degradation. Implementation of this option would have indirect, long-term, positive effects on the tourism industry because people would visit these archeological sites and resources and would create demands for tour guides, visitor information booths, etc.

Option #12 (Create new recreation sites and facilities)

This option involves construction of new recreational sites and facilities on public land. This option has two suboptions. Suboption 1 involves construction of additional backcountry public facilities such as mooring buoys, boat ramps, picnic area, outhouses, caches, cabins, campsites, and trails in National parks, wildlife refuges, forests, and state parks etc. Assuming that these new facilities are operated and managed by the Federal or State government, implementation of this suboption would have direct, long-term, positive and negative effects on commercial tourism. Positive effects would occur because additional facilities would attract additional tourists and these tourists in turn would create demand on tourism-related goods and services. On the other hand, commercial tourism could be negatively affected

because new facilities managed by government would attract more tourists than the privately owned recreational facilities.

Suboption 2 involves planning and marketing of public land for new commercial recreation facilities such as fuel stops, docks, campgrounds, and lodges. Implementation of this suboption would have direct, long-term, positive effects on commercial tourism because additional facilities would attract more tourists, create greater demand on goods and services, and enhance the tourism-related economy.

Option #16 (Increase productivity and success of murre colonies)

This option involves increasing common murre productivity and the success of murre colonies to enhance murre population. Common murres colonies are one of the most visited tourist attraction in the oil-spill area. Common murres suffered the greatest direct mortality from the oil spill of any bird species. It is assumed that some restrictions, similar to Option 4, would be imposed in and around the murre nesting sites to reduce human intervention in these areas. Implementation of this option would have indirect, short-term, negative and long-term, positive effects on tourism similar to Option 4.

Option #17 (Increase productivity and survival of marine birds through predator control)

This option involves reducing predator populations of marine birds especially, common murre, pigeon guillemot, and black oystercatcher colonies to enhance productivity and survival of these bird species. Implementation of this option would have similar effects on tourism as Option 9 by increasing bird watching opportunities.

Option #19 (Protect undocumented anadromous streams)

This option involves listing anadromous streams in the state catalog to increase protection of injured anadromous species and their habitat. Implementation of this option would have indirect, short-term, positive and long-term, negative effects on commercial tourism. Short-term, negative effects would result from regulations restricting or limiting use of these streams by tour boats and tourists in general. However, the positive benefits from this option would be derived after this ecosystem is restored and enhanced. Healthier ecosystems would attract more tourists for sport fishing and other recreational activities.

Option #33 (Visitor centers)

This option involves construction and operation of a large visitor center to provide information about the oil spill and the status of recovery. This option would have direct, long-term, positive effects on commercial tourism. Direct effects would result from tourists visiting the center and creating demands for goods and tourism-related services, such as tour buses, boats, etc.

Option #34 (Marine environmental institute and research foundation)

This option involves establishing a new Marine Environmental Institute within the oil-spill area. Live exhibits and marine aquaria would be an integral part of this institution. This option would have direct, long-term, positive effects on tourism similar to Option 33, by attracting tourist and creating demand for tourism-related goods and services.

Option #35 (Acquire archeological artifacts)

This option seeks to replace and/or recover archeological artifacts that have been lost subsequent to the oil spill and return them to public ownership for appropriate public display in museums. Implementation of this option would have indirect, long-term, positive effects on tourism similar to Option 10.

Option #37 (Habitat protection and acquisition)

This option involves acquisition of or partial interest in private lands associated with injured species and services for their protection. Implementation of this option would have indirect, short-term, negative and long-term, positive effects on commercial tourism. Long-term, positive effects would occur because healthier ecosystems resulting from enhanced protection would attract more tourists who in turn would create demand for tourism-related goods and services. Short-term, negative effects on tourism would occur because restrictions would limit human use of the area and fewer people would be visiting these areas.

Option #40 (Special designations)

This option involves placing nearshore, coastal, and upland habitats in public ownership into special State or Federal land designations to provide increased levels of regulatory protection

to injured resources and services supported by these lands. Several designations including Alaska State Parks, Alaska Department of Fish and Game Special Areas, National Marine Sanctuaries, Federal Wilderness Areas, and State Public Use Areas are considered. Implementation of this option would have indirect, long-term, positive and negative effects on commercial tourism. Positive effects would occur because special designations such as parks, public use areas, and sanctuaries would attract additional tourists. Negative effects on tourism would occur because restrictions imposed on designated lands would limit human use and recreational activities that were allowed prior to the designations.

4. Recreation

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

This option involves establishment of buffer zones as special designation areas around important murre colonies and harbor seal haulout sites to reduce human disturbance in these areas so that the injured species can recover. Design of buffer zones would vary considerably between sites and would take into account the needs of each species. Restrictions within the buffer zones can range from limiting the speed of boat traffic within a couple hundred feet of a specific site for a short time each year, to prohibiting boat or air traffic within a half mile or mile of the location. Less stringent regulations would require tour or charter boat companies to change their use patterns for part of the year, but would not prohibit access. The most restrictive buffer zones could prevent access to a favorite viewing or fishing location and should only be applied in critical situations.

Implementation of this option would have indirect, long-term, positive and short-term, negative effects on recreation. Short-term, negative effects on recreation would be localized and would occur due to restrictions imposed on boat traffic within the buffer zones which would limit opportunities for viewing murre colonies. It is assumed that the buffer zone restrictions would be removed once the population of injured species recover. This would have positive effects on recreation in the long-term by increasing wildlife viewing opportunities associated with the increase in population of these injured species.

Option #9 (Minimize the incidental take of birds)

This option would facilitate recovery of marine bird species (common murre and marbled murrelets) whose populations were reduced by the oil spill, by reducing encounters between these birds and gillnets deployed in high seas and coastal fisheries. Implementation of this option would have indirect, long-term, positive effects on recreation similar to Option 4 by enhancing marine bird watching opportunities associated with the gain in their population.

Option #10 (Preserve archeological sites and artifacts)

This option entails restoration of archeological sites and artifacts that were injured in the oil spill. It is assumed that the majority of the injured sites are located in easily accessible areas and artifacts salvaged from some the injured sites would be displayed in museums and other easily accessible public places. Implementation of this option would have indirect, long-term, positive effects on recreation because these preserved archeological sites and artifacts would attract visitors.

Option #12 (Create new recreation sites and facilities)

This option involves construction of new recreation sites and facilities on public land. This option has two suboptions, Suboption 1 involves construction of additional backcountry public facilities such as mooring buoys, boat ramps, picnic areas, caches, cabins, camping sites, and trails in National forests, monuments, parks, and wildlife refuges and state parks in the oil spill region. Suboption 2 consists of making public land available for commercial recreation facilities such as fuel stops, docks, campgrounds, and lodges. This option would provide funds for planning and marketing these sites in the oil-spill area. It is assumed that recreational sites and facilities would be developed in easily accessible areas.

Implementation of both these suboptions would have direct, short-term, negative and long-term, positive effects on recreation. Short-term, negative effects would be localized and would occur during construction activities that would limit or restrict temporary use of the site. Long-term, positive effects to recreation would occur because better sites and facilities would attract people and provide enhanced recreational opportunities. New sites and facilities would also enable the land managers to focus their information and education programs. Providing education on environmental awareness would enhance public knowledge

for a common goal of sustained, sensitive, high-quality interaction with the environment. Recreational facilities would confine public use, limit human intervention, preserve the wilderness quality, resulting in enhanced sight-seeing and other non-developed recreational opportunities. Indirect, long-term, negative effects to non-developed recreation would occur due to congestion and loss of perceived pristine environment associated with increased human use. These negative effects would be minimized if the facilities are constructed in areas of previous human activity.

Option #16 (Increase productivity and success of murre colonies)

This option involves enhancing murre productivity by enhancing social stimuli and improving the physical characteristics of murre nest sites to increase murre population in the oil-spill area. It is assumed that some restrictions, similar to Option 4, would be imposed in and around the murre nesting sites to reduce human intervention in these areas. Implementation of this option would have indirect, short-term, negative and long-term, positive effects on recreation. Short-term effects would occur due to restrictions limiting murre watching opportunities. Long-term effects would occur in terms of enhanced murre watching opportunities due to the increase in murre population.

Option #17 (Increase productivity and survival of marine birds through predator control)

This option involves enhancing the population of marine bird species especially common murres, black oystercatchers, and pigeon guillemots through terrestrial and avian predator control. Implementation of this option would have indirect, long-term, positive effects on recreation. These effects would occur because enhanced population of marine bird species would provide additional bird watching opportunities.

Option #19 (Protect undocumented anadromous streams)

This option involves listing of undocumented anadromous streams in the State's catalogue to afford them legal protection under Alaska Department of Fish and Game (ADF&G) statutes to protect injured anadromous species and their habitats. Implementation of this option would have indirect, short-term, negative and long-term, positive effects on recreation. Short-term, negative effects would occur due to restrictions of ongoing instream activities. However, long-term effects would be realized as healthier ecosystems,

resulting from enhanced resource protection, would provide increased recreational opportunities.

Option #33 (Visitors centers)

This option involves construction and operation of a large visitor center or expansion of an existing visitor center somewhere in the oil-affected area of Cordova, Valdez, Anchorage, Seward, Homer, or Kodiak. Information from the visitor center would also be available to other visitor centers, government agencies, and organizations in the spill area. Implementation of this option would have direct and indirect, long-term, positive effects on recreation. Direct effects would occur because new visitor centers would attract visitors and confine public use. Indirect effects would occur because visitor centers would educate the public of oil spill-related injuries and subsequently help them better utilize and enjoy the area.

Option #34 (Marine environmental institute and research foundation)

This option involves construction of a new marine environmental institute in an easily accessible area, designated for the use, within the oil spill region to study the marine environment and provide public education. Public exhibits and marine aquaria would be an integral part of the institute. Public exhibits would include living examples of Alaskan marine habitats, plants, animals, and seabirds. Implementation of this option would have direct and indirect, long-term, positive effects on recreation. Direct effects would occur because the facility would attract visitors. Public exhibits, especially the aquaria, would allow the public to closely observe marine creatures and habitats that they otherwise probably would never see. Indirect, long-term, positive effects to recreation would occur from environmental education programs developed and implemented by the institute to minimize additional human effects on injured resources and services.

Option #35 (Acquire archeological artifacts)

This option seeks to replace and/or recover archeological artifacts that have been lost subsequent to the oil spill and return them to public ownership for appropriate public display in museums. The implementation of this option would have indirect, long-term, positive effects on recreation because it would enhance opportunities for the public to see these artifacts.

Option #37 (Habitat protection and acquisition)

This option involves acquisition of or partial interests in private inholdings within Federal and State protected lands such as parks and refuges, to protect and better manage the habitat types linked to resources and/or services injured by the oil spill. Public ownership and enhanced protection of these lands would facilitate natural recovery by restricting activities stressful to already damaged populations, guard against future habitat degradation, and enhance the services provided. It is assumed that habitats for recreational sites would be acquired in visible areas readily accessible by roads.

Implementation of this option would have indirect, short-term, negative and direct and indirect, long-term, positive effects on recreation. Direct, long-term, positive effects would occur from habitat acquisitions for developing recreational sites. These sites would attract more people, concentrate public use, and enhance recreational opportunities provided in the area. Indirect, long-term, positive effects would occur from other habitat acquisitions which would protect the ecosystem and wilderness quality of the area. Healthier ecosystems resulting from enhanced protection would attract visitors, potentially providing increased non-developed recreational opportunities. Short-term, negative effects on recreation would occur because habitat protection would restrict and/or limit certain types of recreational activities on the protected lands.

Option #40 (Special designations)

This option involves placing nearshore, coastal, and upland habitats in public ownership into special State or Federal land designations to provide increased levels of legal protection to injured resources and services supported by these lands. Several designations including Alaska State Parks, Alaska Department of Fish and Game Special Areas, National Marine Sanctuaries, Federal Wilderness Areas, and State Public Use Areas would be considered.

Implementation of this option would have direct and indirect, long-term, positive effects and short-term, negative effects on recreation. Direct, long-term effects would occur from designations such as Alaska State Park and State Public Use Areas, which would provide additional recreational opportunities on these lands. Implementation of the other designations would have indirect, long-term, positive effects on recreation because the

designated lands would enhance protection of the habitat. Healthier ecosystems resulting from enhanced protection would create additional non-developed recreational opportunities on these lands. Indirect, short-term, negative effects would occur because special designations would impose certain restrictions on the use of the habitat.

5. Sport Fishing and Hunting

a. Sport Fishing

Option #2 (Intensify fisheries management)

This option involves intensifying fisheries management to speed the natural recovery of injured stocks of pink salmon, sockeye salmon, herring, rockfish, Dolly Varden, and cutthroat trout by restricting existing fisheries or redirecting them to alternative sites. It is assumed that temporary restrictions on sport fishing would be imposed until the injured stock increased to levels determined by management agencies to be acceptable for harvest. Implementation of this option would have indirect, short-term, negative and long-term, positive effects on sport fishing. Long-term, positive effects would occur because increased fisheries management would enhance fish population in the long-term, thereby creating additional opportunities for sport fishing. Short-term, negative effects to sport fishing would occur due to restrictions on sport fishing until the injured species recover.

Option #4 (Reduce disturbance at bird colonies, haulout sites, etc)

This option involves designation of buffer zones around important marine birds and mammal habitats. The restrictions within the buffer zone could include restricting the speed of boats or prohibiting boat traffic within a certain distance from the habitat for part of the year. This option could be implemented throughout the oil-spill region except for Kodiak/Afognak. It is assumed that the buffer zones may encompass favorite fishing locations and the restrictions would be in place during the fishing season. Implementation of this option would have indirect, long-term, negative effects on sport fishing. The effects would occur because of restrictions prohibiting boat access to sport fishing locations. The restrictions may last until the protected species' populations recover.

Option #11 (Improve freshwater wild salmon habitats)

The objective of this option is to restore and enhance the wild salmon populations by improving or supplementing its spawning and rearing habitats. This option would involve improvements in the availability of food in the Prince William Sound spawning and rearing habitats, and accessibility to spawning areas on Kodiak Island. Implementation of this option would have indirect, long-term, positive effects on sport fishing due to increases in wild salmon populations and associated sport fishing opportunities. The effects would be long-term assuming that the wild salmon populations would remain at high levels after the initial improvements were implemented.

Option #12 (Create new recreation sites and facilities)

This option involves construction of boat ramps, mooring buoys, docks, and campsites on public land throughout the oil spill area. Implementation of this option would have direct, long-term, positive effects on sport fishing. New facilities would provide additional sport fishing opportunities by providing easy access to fishing locations and enhanced services.

Option #18 (Create new salmon runs)

This option entails starting new salmon runs on rivers in Prince William Sound, Cook Inlet, and Kodiak/Afognak that currently do not support such runs, to replace fishing opportunities lost due to closures resulting from the oil spill. Implementation of this option would have direct, positive effects on sport fishing because new salmon runs would create additional opportunities for sport fishing. The effects could be short-term or long-term depending on how long the new salmon runs are employed. If the runs are terminated once the other target species recover, then the effect would be short-term. If the runs remain operational even after the species have recovered, then the effects would be long-term.

Option #19 (Protect undocumented anadromous streams)

This option involves listing undocumented anadromous streams in the Prince William Sound and Kodiak/Afognak area in the State's Anadromous Stream Catalog to afford the stream automatic protection, which would increase protection of injured anadromous species and their habitat. It is assumed that this option would involve placing additional restrictions on sport fishing on these

undocumented streams until the population of the injured species recover. Implementation of this option would have indirect, short-term, negative and long-term, positive effects on sport fishing. Short-term, negative effects would result from temporary regulations restricting or limiting use of these streams for sport fishing. The positive benefits from this option would be realized from enhanced population of anadromous species and associated sport fishing opportunities.

Option #37 (Habitat protection and acquisition)

This option involves acquisition of or partial interests in private inholdings within Federal and State protected lands such as parks and refuges throughout the oil spill area, to protect and better manage the habitat types linked to resources and/or services injured by the oil spill. It is assumed that habitats associated with fish rearing and spawning would be protected.

Implementation of this option would produce indirect, short-term, negative and long-term, positive effects on sport fishing. Short-term, negative effects would occur because habitat management regulations may place certain restrictions on sport fishing that did not exist prior to the acquisition, to facilitate recovery of the injured species of fish. The effects would be short-term because once the injured fish population is recovered and increases to levels determined by the management agencies to be acceptable for harvest, the restrictions may be removed. Positive effects would occur because habitat protection would enhance fish population and associated sport fishing opportunities. The positive effects would be long-term assuming that the habitat protection is afforded in perpetuity or until a self-sustaining population is reached.

Option #40 (Special designations)

This option involves designation of upland, coastal, and marine habitats in public ownership into special State or Federal land designations such as Alaska Department of Fish and Game Special Areas, Federal Wilderness Areas, and Marine Sanctuaries throughout the oil spill area. This option would affect sport fishing by protecting the habitat associated with fish rearing and spawning. It is assumed that certain designations would be subject to sport fishing restrictions that did not exist prior to the designation and that these restrictions would be removed once the populations recover.

Implementation of this option would produce indirect, short-term, negative and long-term, positive effects on sport fishing similar to Option 37. Short-term, negative effects would occur due to additional restrictions limiting sport fishing opportunities on the designated areas. Indirect, long-term benefits would be realized from protecting the habitat through special designations that would increase the population of fish available for sport fishing.

Option #48 (Improve survival of salmon eggs and fry)

This option involves improving survival of salmon eggs and fry to restore injured salmon runs to pre-spill levels or to enhance either injured or equivalent runs above pre-spill levels. Wild salmon eggs would be reared in boxes, netpens, or hatcheries and would be released in streams in Prince William Sound, Central Cook Inlet, or Kodiak Island. This option would have indirect, long-term, positive effects on sport fishing because increased salmon population from artificial rearing of salmon eggs and fry would provide additional sport fishing opportunities. The effects would be long-term because the additional fish provided by the artificial rearing would increase the potential for long-term increases in the harvest of naturally produced stocks.

Option #51 (Change or relocate existing hatchery salmon runs)

This option involves shifting the location and the timing of salmon runs released from hatcheries to decrease interception of injured, wild-stock pink salmon returning to spawning streams; thereby helping injured populations to recover more rapidly. The option would be implemented in the Prince William Sound area. Implementation of this option would have indirect, long-term, positive effects on sport fishing similar to Option 48 by providing additional salmon fishing opportunities.

b. Sport Hunting

Option #8 (Develop sport and trapping harvest guidelines for injured species)

This option would affect sport hunting by temporarily restricting or closing sport harvests and trapping of the injured species of harlequin duck and river otter in the Prince William Sound area and Outer Kenai (harlequin ducks only) areas of the oil spill region. Based population level data and harvest rates, the restrictions would include closure or reduction in sport harvest and commercial

trapping of the injured species. It is assumed that the restrictions would be in place for a maximum of two years. Implementation of this option would have direct, short-term, negative and long-term, positive, localized effects on sport hunting.

Direct, short-term, negative effects would occur due to the restrictions on sport hunting of the injured species. The magnitude of this effect would vary with the type of restriction. If the restrictions include complete closures of sport harvest, then the magnitude would be high. If the restrictions include reduction in bag limits or limited closure of the season, then the magnitude would not be high. However, overall effect to sport hunting would be low because it is assumed that the restrictions would be only for harlequin ducks and river otters and therefore, other game species would be available for sport hunting.

Long-term, positive effects on sport hunting would occur after the injured species population has recovered as a result of eliminating additional mortality. Enhanced population of these species would provide additional opportunities for sport hunting.

Option #12 (Create new recreation sites and facilities)

This option involves construction of recreational facilities such as cabins, campsites, caches and other facilities on public land throughout the oil spill area. It is assumed that the cabins and other facilities would be constructed in areas where these can be used by hunters during the hunting season. Implementation of this option would have indirect, long-term, positive and negative effects on sport hunting. Long-term, positive effects would occur because cabins and other facilities would provide hunters a place to stay while on a hunting trip.

Long-term, negative effects to sport hunting would occur because new facilities would attract additional recreationists, which might conflict with safety during the hunting season. Increased noise associated with recreationists may disturb the game species. In general, the greater the number of recreationists using the area, the greater the potential for conflicts. The effects could be minimized if facilities are constructed specifically for the hunters and are not used by the recreationists during the hunting season.

Option #37 (Habitat protection and acquisition)

This option involves acquisition of or partial interest in private lands associated with injured species and services for protecting these resources. This option would affect sport hunting by protecting habitat associated with game species throughout the oil spill area. It is assumed that these habitats under private ownership are available for purchase or protection and upon acquisition would be subject to more stringent regulations for sport hunting of injured game species until their populations recover.

Implementation of this option would have indirect, short-term, negative and long-term, positive effects on sport hunting. Long-term, positive effects would occur from long-term gain in hunting opportunities as a result of increase in population of game species inhabiting these habitats. Short-term, negative effects on hunting would occur due to additional restrictions that could temporarily close or restrict sport hunting on these lands.

Option #40 (Special designations)

This option involves designation of upland, coastal, and marine habitats in public ownership into special State or Federal land designations such as Alaska Department of Fish and Game Special Areas, Federal Wilderness Areas, and Alaska State Parks throughout the oil spill area. This option would affect sport hunting by protecting the habitat associated with game species. It is assumed that certain designations would be subject to sport hunting restrictions that did not exist prior to the designation and these restrictions would be removed once the species population recover.

Implementation of this option would produce indirect, short-term, negative and long-term, positive effects on sport hunting. Short-term, negative effects would occur due to additional restrictions limiting sport hunting opportunities on these lands. Indirect, long-term benefits would result from protecting the habitat through special designations that would increase the population of the game species available for sport hunting.

Chapter IV (section 2)

Comparison of Alternatives

A. Physical and Biological Environment

1. Greater EVOS Ecosystem

Alternative 1 - No Action Alternative

Under the No Action Alternative, ecosystem management activities within the EVOS area would be limited to existing programs, principally on public lands. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement habitat protection and acquisition Options 37 and 40. Option 37 (habitat acquisition) is the principal means for implementing ecosystem management within the restoration plan and would have a strong positive, direct, long-term effect on biodiversity conservation. Option 40 (special land designations) would also implement ecosystem management, albeit on the smaller scale of existing public lands, and would have a moderate positive, direct, long-term effect on biodiversity conservation. The large amount of funding allocated to these options (the entire budget minus 10 percent for administration and public information, and monitoring and research) under this alternative indicates that Alternative 2 would be implemented over a wide geographic extent and include many parcels totaling a large number of acres. Assuming that the acquisition of lands includes management in perpetuity for ecosystem integrity, the duration of this effect would be long-term. Because of these factors, the magnitude of the impact on biodiversity conservation of this alternative would be high.

Alternative 3 - Limited Restoration

Nearly all of the options in the restoration plan would affect biodiversity conservation to some extent. Options 2, 4, 8, 9, 16, 17, 45, 46, 48, 50, and 51 would have very slight positive, indirect effects on biodiversity by contributing to population enhancement of individual species. Options 11 and 14 would have a slightly greater positive effect on biodiversity by improving local habitat conditions for whole communities of organisms. Habitat alteration from the construction of recreational sites (Option 12) and the possible oversupply of salmon (Option 18) may have slight negative effects on biodiversity. Research and information dissemination into the ecosystem status of the EVOS area under Options 19, 33, and 34 would have a slight positive, indirect effect on biodiversity.

Under Alternative 3, the impacts of these general restoration

options would be overwhelmed by the strong positive effects of the habitat protection and acquisition Options (37 and 40). The large amount of funding allocated to the habitat protection and acquisition options (75 percent of the entire budget) indicates that, as in Alternative 2, this alternative would implement habitat protection and acquisition over a wide geographic extent and include many parcels totaling a large number of acres. Assuming that the acquisition of lands includes management in perpetuity for ecosystem integrity, the duration of this effect would be long-term. Because of these factors, the magnitude of the impact from this alternative on biodiversity conservation would be high.

Alternative 4 - Moderate Restoration

Nearly all of the options in the restoration plan would affect biodiversity conservation to some extent. Options 2, 4, 8, 9, 16, 17, 45, 46, 48, 50, and 51 would have very slight positive, indirect effects on biodiversity by contributing to population enhancement of individual species. Options 11 and 14 would have a slightly greater positive effect on biodiversity by improving local habitat conditions for whole communities of organisms. Habitat alteration from the construction of recreational sites (Option 12) and the possible oversupply of salmon (Option 18) may have slight negative effects on biodiversity. Research and information dissemination on the ecosystem status of the EVOS area under Options 19, 33, and 34 would have a slight positive, indirect effect on biodiversity.

Under Alternative 4, the impacts of these options would be added to the strong positive effects of the habitat protection and acquisition Options (37 and 40). The substantial amount of funding still allocated to the habitat protection and acquisition options (50 percent of the budget) indicates that this alternative would implement habitat protection and acquisition over a moderate geographic extent and include parcels totalling a lesser number of acres. Assuming that the acquisition of lands includes management in perpetuity for ecosystem integrity, the duration of this effect would be long-term. The combination of slight benefits from general restoration options and major benefits of habitat protection and acquisition would produce a moderate to high magnitude of the impact on biodiversity conservation for this alternative.

Alternative 5 - Comprehensive Restoration

Nearly all of the options in the restoration plan would affect biodiversity conservation to some extent. Options 2, 4, 8, 9, 16, 17, 45, 46, 48, 50, and 51 would have very slight positive, indirect effects on biodiversity by contributing to population enhancement of individual species. Options 11 and 14 would have a slightly greater positive effect on biodiversity by improving local habitat conditions for whole communities of organisms. Habitat alteration from the construction of recreational sites

(Option 12) and the possible oversupply of salmon (Option 18) may have slight negative effects on biodiversity. Research and information dissemination on the ecosystem status of the EVOS area under Options 19, 33, and 34 would have a slight positive, indirect effect on biodiversity.

Under Alternative 5, the impacts of these general restoration options would be added to the strong positive effects of the habitat protection and acquisition Options (37 and 40). The more limited amount of funding allocated to the habitat protection and acquisition options (35 percent of the budget) indicates that this alternative would implement habitat protection and acquisition over a limited geographic extent and include parcels totalling a moderate number of acres. Assuming that the acquisition of lands includes management in perpetuity for ecosystem integrity, the duration of this effect would be long-term. The combination of slight benefits from general restoration options and a lesser amount of major benefits of habitat protection and acquisition would produce a moderate magnitude impact on biodiversity conservation for this alternative. The greater emphasis on increased human uses under Alternative 5 may also reduce the positive impact on biodiversity conservation.

2. Biological Resources

a. Marine Mammals

Harbor Seals

Alternative 1 - No Action Alternative

Under the No Action Alternative, no changes to the present harbor seal population status as described by the options would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, the majority of the restoration funds would be used for the implementation of Options 37 and 40. These options would protect habitat areas used by harbor seals throughout the oil spill region. The impact of the implementation of Alternative 2 would be to secure undisturbed haulout sites and coastal habitat for harbor seals to use for pupping, molting, and foraging. Because the options described would protect habitat over a wide region for a long duration, there is some potential for increasing the harbor seal population under this alternative. However, because habitat protection would not have a direct influence, any harbor seal population growth would be gradual over a long interval of time.

Alternative 3 - Limited Restoration

Options 2, 4, 11, 37, 40, 46, 47, 48, 49, and 51 would impact harbor seal populations under this alternative. Options 2, 11, 48,

and 51 would indirectly impact harbor seals by increasing the short and long-term fish supply available in Central Cook Inlet and portions of Prince William Sound. Seventy-five percent of the restoration funds would be used for Options 37 and 40. These two options would protect habitat areas used by harbor seals throughout the oil spill region. Option 4 would also protect habitat, concentrating on areas used as haulouts for pupping, molting, and foraging. The main intent of Options 47 and 49 is to develop ways to keep subsistence users from over-harvesting harbor seals in order to maintain a healthy population for future use. Option 46 would establish a program to educate fishermen on methods to reduce bycatch of harbor seals. The long-term impact of the implementation of Alternative 3 on harbor seals would be larger areas of protected habitat, localized increases in food supply, and decreased mortality from bycatch. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact harbor seals, the potential for increasing the harbor seal population under this alternative would be moderate and occur only gradually because of the indirect nature of most of the options.

Alternative 4 - Moderate Restoration

Options 2, 4, 11, 18, 30, 37, 40, 46, 47, 48, 49, and 51 would impact harbor seal population under this alternative. Options 2, 11, 18, 48, and 51 would increase the long-term, local, fish food supply available to harbor seals. Options 2, 11, and 51 focus primarily on the Prince William Sound. Option 48 involves isolated areas of Central Cook Inlet and the Kodiak Archipelago. Option 18 includes five projects spread throughout the oil spill area. Options 37 and 40 would receive more than the half the funding and would protect haulout and coastal habitats used by harbor seals throughout the oil spill area. Option 4 would also protect habitat, concentrating on areas used as haulouts for pupping, molting, and foraging. Option 46 would establish a program to educate fishermen on methods to reduce bycatch of harbor seals. The main intent of Options 47 and 49 is to develop ways to keep subsistence users from over-harvesting harbor seals in order to maintain a healthy population for future use. Option 30 would test harbor seals for contamination to encourage subsistence use. The long-term impact of the implementation of alternative 4 on harbor seals would be larger areas of protected habitat, localized increases in food supply, and decreased mortality from bycatch. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact harbor seals, the potential for increasing the harbor seal population under this alternative would be moderate and occur only gradually because of the indirect nature of most of the options.

Alternative 5 - Comprehensive Restoration

Options 2, 4, 8, 11, 18, 30, 37, 40, 46, 47, 48, 49 and 51 would

impact harbor seal population under this alternative. Options 2, 11, 18, 48, and 51 would increase the long-term, local, fish food supply available to harbor seals. Options 2, 11, and 51 focus primarily on the Prince William Sound. Option 48 involves isolated areas of Central Cook Inlet and the Kodiak Archipelago. Option 18 includes five projects spread throughout the oil spill area. Options 37 and 40 would receive more than the half the funding and would protect haulout and coastal habitats used by harbor seals throughout the oil spill area. Option 4 would also protect habitat, concentrating on areas used as haulouts for pupping, molting, and foraging. The main intent of Options 47 and 49 is to develop ways to keep subsistence users from over-harvesting harbor seals in order to maintain a healthy population for future use. Option 30 would test harbor seals for contamination to encourage subsistence use. Option 46 would establish a program to educate fishermen on methods to reduce bycatch of harbor seals. The long-term impact of the implementation of alternative 5 on harbor seals would be larger areas of protected habitat, localized increases in food supply, and decreased mortality from bycatch. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact harbor seals, the potential for increasing the harbor seal population under this alternative would be moderate and occur only gradually because of the indirect nature of most of the options.

Steller's Sea Lions

Alternative 1 - No Action Alternative

Under the No Action Alternative, no changes to the present sea lion population status as described by the options would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, almost all of the restoration funds would be used for the implementation of Options 37 and 40. These options would protect habitat areas used by sea lions throughout the oil spill region. The direct impact of the implementation of alternative 2 would be to secure undisturbed rookery/haulout sites and coastal habitat for sea lions to use. Because the options described would protect habitat over a wide region for a long duration, there is some potential for increasing the sea lion population under this alternative. However, because habitat protection would not have a direct influence, any sea lion population growth would be gradual over a long interval of time.

Alternative 3 - Limited Restoration

Options 2, 4, 11, 37, 40, 47, 48, 49, and 51 would impact sea lion populations under this alternative. Options 2, 11, 48, and 51 would indirectly impact sea lions by increasing the short and long-

term fish supply available in Central Cook Inlet and portions of Prince William Sound. Seventy-five percent of the restoration funds would be used for Options 37 and 40. These two options would protect habitat areas used by sea lions throughout the oil spill region. Option 4 would also protect habitat, concentrating on areas used as rookeries and haulouts. The main intent of options 47 and 49 is to develop ways to keep subsistence users from over-harvesting sea lions in order to maintain a healthy population for future use. The long-term impact of the implementation of alternative 3 on sea lions would be larger areas of protected habitat and localized increases in food supply. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact sea lions, the potential for increasing the sea lion population under this alternative would be moderate and occur only gradually because of the indirect nature of the options.

Alternative 4 - Moderate Restoration

Options 2, 4, 11, 18, 37, 40, 47, 48, 49, and 51 would impact sea lion population under this alternative. Options 2, 11, 18, 48, and 51 would increase the long-term, local, fish food supply available to sea lions. Options 2, 11, and 51 focus primarily on the Prince William Sound. Option 48 involves isolated areas of Central Cook Inlet and the Kodiak Archipelago. Option 18 includes five projects spread throughout the oil spill area. Options 37 and 40 would receive more than the half the funding and would protect rookery/haulout and coastal habitats used by sea lions throughout the oil spill area. Option 4 would also protect habitat, concentrating on areas used as rookeries and haulouts. The main intent of Options 47 and 49 is to develop ways to keep subsistence users from over-harvesting sea lions in order to maintain a healthy population for future use. The long-term impact of the implementation of alternative 4 on sea lions would be larger areas of protected habitat and localized increases in food supply. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact sea lions, the potential for increasing the sea lion population under this alternative would be moderate and occur only gradually because of the indirect nature of the options.

Alternative 5 - Comprehensive Restoration

Options 2, 4, 8, 11, 18, 37, 40, 47, 48, 49 and 51 would impact sea lion population under this alternative. Options 2, 11, 18, 48, and 51 would increase the long-term, local, fish food supply available to sea lions. Options 2, 11, and 51 focus primarily on the Prince William Sound. Option 48 involves isolated areas of Central Cook Inlet and the Kodiak Archipelago. Option 18 includes five projects spread throughout the oil spill area. Options 37 and 40 would receive more than the half the funding and would protect rookery/haulout and coastal habitats used by sea lions throughout the oil spill area. Option 4 would also protect habitat,

concentrating on areas used as rookeries and haulouts. The main intent of Options 47 and 49 is to develop ways to keep subsistence users from over-harvesting sea lions in order to maintain a healthy population for future use. The long-term impact of the implementation of alternative 5 on sea lions would be larger areas of protected habitat and localized increases in food supply. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact sea lions, the potential for increasing the sea lion population under this alternative would be moderate and occur only gradually because of the indirect nature of the options.

Sea Otters

Alternative 1 - No Action Alternative

Under the No Action Alternative, no changes to the present sea otter population status as described by the options would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, almost all of the restoration funds would be used for the implementation of Options 37 and 40. These options would protect habitat areas used by sea otters throughout the oil spill region. The direct impact of the implementation of alternative 2 would be to secure undisturbed haulout sites and coastal habitat for sea otters to use. Because the options described would protect habitat over a wide region for a long duration, there is some potential for increasing the sea otter population under this alternative. However, because habitat protection would not have a direct influence, any sea otter population growth would be gradual over a long interval of time.

Alternative 3 - Limited Restoration

Options 4, 13, 37, 40, 47, and 49 would impact sea otter populations under this alternative. Option 13 would increase the long-term availability of healthy intertidal foraging areas for the sea otter. Seventy-five percent of the restoration funds would be used for Options 37 and 40. These two options would protect habitat areas used by sea otters throughout the oil spill region. Option 4 would also protect habitat, concentrating on areas used as haulouts. The main intent of Options 47 and 49 is to develop ways to keep subsistence users from over-harvesting sea otters in order to maintain a healthy population for future use. The long-term impact of the implementation of alternative 3 on sea otters would be larger areas of protected habitat and increased quality of food supply. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact sea otters, the potential for increasing the sea otter population under this alternative would be moderate and occur only gradually because of the indirect

nature of the options.

Alternative 4 - Moderate Restoration

Options 4, 13, 37, 40, 47, and 49 would impact sea otter populations under this alternative. Option 13 would increase the long-term availability of healthy intertidal foraging areas for the sea otter. Options 37 and 40 would receive more than the half the funding and would protect haulout and coastal habitats used by sea otters throughout the oil spill area. Option 4 would also protect habitat, concentrating on areas used as haulouts. The main intent of Options 47 and 49 is to develop ways to keep subsistence users from over-harvesting sea otters in order to maintain a healthy population for future use. The long-term impact of the implementation of alternative 4 on sea otters would be larger areas of protected habitat and increased quality of food supply. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact sea otters, the potential for increasing the sea otter population under this alternative would be moderate and occur only gradually because of the indirect nature of the options.

Alternative 5 - Comprehensive Restoration

Options 4, 8, 13, 37, 40, 47, 49 and 50 would impact sea otter population under this alternative. Options 13 would increase the long-term availability of healthy intertidal foraging areas for the sea otter. Options 37 and 40 would receive more than the half the funding and would protect haulout and coastal habitats used by sea otters throughout the oil spill area. Option 4 would also protect habitat, concentrating on areas used as haulouts. The main intent of Options 8, 47, and 49 is to develop ways to keep subsistence users from over-harvesting sea otters in order to maintain a healthy population for future use. Option 50 would increase the amount and quality of the sea otter food supply. The long-term impact of the implementation of alternative 5 on sea otters would be larger areas of protected habitat and localized increases in food supply. Short-term decreases in subsistence use would be an additional indirect effect of the alternative. Although the impacts described would positively impact sea otters, the potential for increasing the sea otter population under this alternative would be moderate and occur only gradually because of the indirect nature of the options.

Killer Whales

Alternative 1 - No Action Alternative

Under the No Action Alternative, none of the options affecting killer whales would be implemented. Therefore, none of the effects related to these options would occur.

Alternative 2 - Habitat Protection

The only option in Alternative 2 that affects killer whales is Option 40. This option could afford protection to rubbing beaches by designating the areas in which the beaches exist as marine sanctuaries. This would have an indirect impact on the health of killer whales, and could have positive impacts on increases in whale populations.

Alternative 3 - Limited Restoration

Under Alternative 3, Options 2, 4, 40, and 45 could impact killer whale populations. Option 2 does not affect PWS and would not have an impact on killer whales in the AB pod. Options 4, 40, and 45 do affect PWS and could have a positive long-term impact on killer whale populations by promoting better health, and reducing mortality related to conflicts with fishermen.

Alternative 4 - Moderate Restoration

Alternative 4 includes the same options affecting killer whales as Alternative 3 (Options 2, 4, 40, and 45). Under Alternative 4, Option 2 includes PWS, which was not included under Alternative 3. Consequently, in addition to the positive impacts associated with protecting whale rubbing beaches, Alternative 4 could increase the whale's food supply and potentially increase whale populations.

Alternative 5

Under Alternative 5, the same options identified under Alternative 4 would be implemented in the same general areas, and could potentially impact killer whales. Consequently, implementing Alternative 5 would have the same positive, long-term impact on killer whale populations as Alternative 4.

b. Terrestrial Mammals

Sitka Black-tailed Deer

Alternative 1 - No Action Alternative

Under the No Action Alternative, none of the options affecting the Sitka black-tailed deer population would be implemented. Therefore, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, almost all of the restoration funds would be used for the implementation of Options 37 and 40. These options would protect habitat areas used by deer throughout the oil spill region. The direct impact of the implementation of Alternative 2

would be to secure undisturbed foraging areas and ranges for the deer to use. Although the options described would be implemented over a wide area for a long duration, the potential for gradually increasing the deer population under this alternative is moderate because the deer themselves would not be directly impacted.

Alternative 3 - Limited Restoration

Options 13, 14, 37, and 40 would impact deer population under this alternative. Options 13 and 14 would increase the long-term availability of healthy intertidal foraging areas for the deer. Seventy-five percent of the restoration funds would be used for Options 37 and 40. These two options would protect habitat areas used by deer throughout the oil spill region. The direct long-term impact of the implementation of Alternative 3 on the deer would be larger areas of protected habitat. Although the impacts described would positively affect the deer, the potential for gradually increasing the deer population under this alternative is low because the deer themselves would not be directly impacted.

Alternative 4 - Moderate Restoration

Options 13, 14, 37, and 40 would impact deer population under this alternative. Options 13 and 14 would increase the long-term availability of healthy intertidal foraging areas for the deer. Options 37 and 40 would receive more than the half the funding and would protect habitat areas used by deer for foraging throughout the oil spill area. The long-term impact of the implementation of Alternative 4 on deer would be larger areas of protected habitat. Although the impacts described would positively affect deer, the potential for gradually increasing the deer population under this alternative is low because the deer themselves would not be directly impacted.

Alternative 5 - Comprehensive Restoration

Options 8, 13, 14, 37, and 40 would impact deer population under this alternative. The intent of Option 8 is to provide short-term guidelines for limiting deer harvest in Prince William Sound. Options 13 and 14 would increase the long-term availability of healthy intertidal foraging areas for deer throughout the spill area. Options 37 and 40 include almost half of the funding of this alternative and would protect habitat areas used by deer for foraging throughout the oil spill area. The long-term impact of the implementation of Alternative 5 on deer would be larger areas of protected habitat. Although the impacts described would positively affect deer, the potential for gradually increasing deer population under this alternative is low because deer themselves would not be directly impacted.

Black Bear

Alternative 1 - No Action Alternative

Under the No Action Alternative, no changes to the present black bear population status as described by the options would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, almost all of the restoration funds would be used for the implementation of Options 37 and 40. These options would protect habitat areas used by black bear throughout the oil spill region. The direct impact of the implementation of alternative 2 would be to secure undisturbed foraging areas and ranges for the black bear to use. Although the options described would be implemented over a wide region for a long duration, the potential for gradually increasing the black bear population under this alternative is moderate because the bears themselves would not be directly impacted.

Alternative 3 - Limited Restoration

Options 2, 11, 13, 14, 37, 40, 48, and 51 would impact black bear population under this alternative. Options 2, 11, 48, and 51 would indirectly impact black bears by increasing the short- and long-term fish supply available in Central Cook Inlet and portions of Prince William Sound. Options 13 and 14 would increase the long-term availability of healthy intertidal foraging areas for the bears. Seventy-five percent of the restoration funds would be used for Options 37 and 40. These two options would protect habitat areas used by black bears throughout the oil spill region. The direct long-term impact of the implementation of Alternative 3 on black bears would be larger areas of protected habitat and localized increases in food supply. Although the impacts described would positively affect black bears, the potential for gradually increasing black bear populations under this alternative is moderate because the bears themselves would not be directly impacted.

Alternative 4 - Moderate Restoration

Options 2, 11, 13, 14, 18, 37, 40, 48, and 51 would impact black bear populations under this alternative. Options 2, 11, 18, 48, and 51 would increase the long-term, local, fish food supply available to black bears. Options 2, 11, and 51 focus primarily on the Prince William Sound. Option 48 involves isolated areas of Central Cook Inlet and the Kodiak Archipelago. Option 18 includes five projects spread throughout the oil spill area. Options 13 and 14 would increase the long-term availability of healthy intertidal foraging areas for the bears. Options 37 and 40 would receive more than the half the funding and would protect habitat areas used by black bears for foraging throughout the oil spill area. The long-term impact of the implementation of Alternative 4 on black bears would be larger areas of protected habitat and localized increases in food supply. Although the impacts described would positively

affect black bears, the potential for gradually increasing black bear populations under this alternative is moderate because the bears themselves would not be directly impacted.

Alternative 5 - Comprehensive Restoration

Options 2, 11, 13, 14, 18, 37, 40, 48, and 51 would impact black bear populations under this alternative. Options 2, 11, 18, 48, and 51 would increase the long-term, local, fish food supply available to black bears. Options 2, 11, and 51 focus primarily on Prince William Sound. Option 48 involves areas of Prince William Sound, Central Cook Inlet and the Kodiak Archipelago. Option 18 includes five projects spread throughout the oil spill area. Options 13 and 14 would increase the long-term availability of healthy intertidal foraging areas for the bears throughout the spill area. Options 37 and 40 include almost half of the funding of this alternative and would protect habitat areas used by black bears for foraging throughout the oil spill area. The long-term impact of the implementation of Alternative 5 on black bears would be larger areas of protected habitat and localized increases in food supply. Although the impacts described would positively affect the black bears, the potential for gradually increasing the black bear population under this alternative is moderate because the bears themselves would not be directly impacted.

Brown Bear

Alternative 1 - No Action Alternative

Under the No Action Alternative, no changes to the present brown bear population status as described by the options would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, almost all of the restoration funds would be used for the implementation of Options 37 and 40. These options would protect habitat areas used by brown bears throughout the oil spill region. The direct impact of the implementation of alternative 2 would be to secure undisturbed foraging areas and ranges for the brown bear to use. Although the options described would be implemented over a wide region for a long duration, the potential for gradually increasing the brown bear populations under this alternative is moderate because the bears themselves would not be directly impacted.

Alternative 3 - Limited Restoration

Options 2, 11, 13, 14, 37, 40, 48, and 51 would impact brown bear populations under this alternative. Options 2, 11, 48, and 51 would indirectly impact brown bears by increasing the short and long-term fish supply available in Central Cook Inlet and portions of Prince William Sound. Options 13 and 14 would increase the

long-term availability of healthy intertidal foraging areas for the bears. Seventy-five percent of the restoration funds would be used for Options 37 and 40. These two options would protect habitat areas used by brown bears throughout the oil spill region. The direct long-term impact of the implementation of Alternative 3 on the brown bears would be larger areas of protected habitat and localized increases in food supply. Although the impacts described would positively affect the brown bears, the potential for gradually increasing the brown bear populations under this alternative is moderate because the bears themselves would not be directly impacted.

Alternative 4 - Moderate Restoration

Options 2, 11, 13, 14, 18, 37, 40, 48, and 51 would impact brown bear populations under this alternative. Options 2, 11, 18, 48, and 51 would increase the long-term, local, fish food supply available to brown bears. Options 2, 11, and 51 focus primarily on the Prince William Sound. Option 48 involves isolated areas of Central Cook Inlet and the Kodiak Archipelago. Option 18 includes five projects spread throughout the oil spill area. Options 13 and 14 would increase the long-term availability of healthy intertidal foraging areas for the bears. Options 37 and 40 would receive more than the half the funding and would protect habitat areas used by brown bears for foraging throughout the oil spill area. The long-term impact of the implementation of Alternative 4 on the brown bears would be larger areas of protected habitat and localized increases in food supply. Although the impacts described would positively affect the brown bears, the potential for gradually increasing brown bear populations under this alternative is moderate because the bears themselves would not be directly impacted.

Alternative 5 - Comprehensive Restoration

Options 2, 8, 11, 13, 14, 18, 37, 40, 48, and 51 would impact brown bear populations under this alternative. Options 2, 11, 18, 48, and 51 would increase the long-term, local, fish food supply available to brown bears. Options 2, 11, and 51 focus primarily on Prince William Sound. Option 48 involves areas of Prince William Sound, Central Cook Inlet and the Kodiak Archipelago. Option 18 includes five projects spread throughout the oil spill area. The intent of Option 8 is to provide short-term guidelines for limiting bear harvest in Prince William Sound. Options 13 and 14 would increase the long-term availability of healthy intertidal foraging areas for the bears throughout the spill area. Options 37 and 40 include almost half of the funding of this alternative and would protect habitat areas used by brown bears for foraging throughout the oil spill area. The long-term impact of the implementation of Alternative 5 on the brown bears would be larger areas of protected habitat and localized increases in food supply. Although the impacts described would positively affect the brown bears, the potential for gradually increasing brown bear populations under

this alternative is moderate because the bears themselves would not be directly impacted.

River Otters

Alternative 1 - No Action Alternative

Under the No Action Alternative, no changes to the present river otter population status as described by the options would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, river otter populations would benefit from the protection afforded by Options 37 and 40. This protection could lead to long-term increases in river otter populations due to an increased carrying capacity of the environment.

Alternative 3 - Limited Restoration

Alternative 3 includes Options 13, 37, and 40 that could impact river otter populations. Option 13 would study methods for removing oil contamination from mussel beds, which could increase food supplies for otters. Options 37 and 40 provide protection for otter habitat. Consequently, Alternative 3 would have positive indirect impacts on river otter populations by increasing the carrying capacity of the otters' environment, which could lead to increases in river otter populations.

Alternative 4 - Moderate Restoration

Alternative 4 would have the same positive indirect impacts on river otter populations as Alternative 3.

Alternative 5 -Comprehensive Restoration

Alternative 5 includes the same options and impacts as Alternatives 3 and 4, and in addition would protect river otters in PWS from over-harvest by subsistence and commercial trapping. Consequently, Alternative 5 would directly impact river otters by reducing mortality from trapping, while indirectly impacting otter populations by ensuring more and cleaner food supplies and habitat.

c. Birds

Bald Eagle

Alternative 1 - No Action Alternative

Under the No Action Alternative, bald eagles would be allowed to recover naturally. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

The primary protective measure for bald eagles designated under the Restoration Plan is Option 37, habitat acquisition and protection. Under this alternative the geographic extent of land acquisition for bald eagles would be greatest, but the impact would be limited because there is already mandatory protection for bald eagles.

Alternative 3 - Limited Restoration

Although land acquisition would likely still benefit bald eagles under this alternative, habitat protection is not specifically listed as a priority for this species under Alternative 3. The only option directly affecting eagles (Option 17) calls for their removal around seabird colonies (and reintroduction to other areas). Because this would be a very localized and short-term effect on the species, the magnitude of the impact would be very low.

Alternative 4 - Moderate Restoration

This alternative contains both Options 17 and 37. With the reduced allocation for land acquisition, the impacts on bald eagles would be less than under Alternative 2. The impact of controlling bald eagles as a predator on seabird colonies would still be low.

Alternative 5 - Comprehensive Restoration

This alternative contains both Options 17 and 37. With the reduced allocation for land acquisition, the impacts on bald eagles would be less than under Alternative 2. The impact of controlling bald eagles as a predator on seabird colonies would still be low.

Peale's Peregrine Falcon

Alternative 1 - No Action Alternative

Under the No Action Alternative, no options affecting the peregrine falcon would be implemented. Therefore, there would be no impacts to this species resulting from implementation of the options described in this chapter.

Alternatives 2 to 5

The peregrine falcon is not listed as a target species for habitat acquisition under any of the alternatives. Protection of their habitat from land acquisition would be incidental, and the effects on the species minimal.

Common Murre

Alternative 1 - No Action Alternative

Under the No Action Alternative, murre colonies would be allowed to recover naturally. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement Options 37 and 40. Both of these options, which protect and acquire habitat (Option 37), and establish special land designations (Option 40) would indirectly benefit common murres by protecting the nesting habitat.

Under this alternative there would be no direct effects on the common murre population. All indirect effects would be through the additional protection afforded the breeding colonies by regulations on public lands.

Alternative 3 - Limited Restoration

Under this alternative, common murres would be affected by Options 9, 16, 17, 37, and 40. For Option 16, only the study to promote synchrony would be done and for Option 17, only the avian predator reduction would be done. The emphasis of the options under this alternative is to stabilize the breeding synchrony and increase egg production at murre colonies. Breeding was still inhibited in some murre colonies in the Gulf of Alaska in 1992 and some colonies show little evidence of recovery. Consequently, murres appear to be becoming entrained to late breeding, possibly because young birds have established the wrong patterns. If this is permanent, the prospects for these colonies is poor, because a breeding failure will lead to the eventual decline and extinction of these colonies (Fry 1992). Because the geographic extent of the options in Alternative 3 covers the entire common murre breeding territory in the spill area, the magnitude of the combined impacts of the options could be high.

Alternative 4 - Moderate Restoration

Option affecting common murres under this alternative are the same as listed under Alternative 3. Less money is available for habitat acquisition, potentially resulting in increasing opportunities for human use of the area. The combined impacts on the common murre from these options could still be high.

Alternative 5 - Comprehensive Restoration

Under this alternative, common murres are affectd by Options 4, 9, 16, 17, 37, and 40. Both studies under Option 16 and all predator

control under Option 17 would be implemented. With the full implementation of these options, and the additional affect of Option 4 regulating boat traffic around the colonies, the intensity or magnitude of the effects would be greater than under the other alternatives.

Marbled Murrelet

Alternative 1 - No Action Alternative

Under the No Action Alternative, marbled murrelets would be allowed to recover naturally. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, marbled murrelets under are affected by Options 37 (Habitat Acquisition) and 40 (Special Designations). Given the high level of funding, habitat acquisition is likely to extend throughout the range of the marbled murrelet. The magnitude of the impact for this alternative on marbled murrelets would be high because habitat acquisition is the most effective option for preventing rapid population declines and ensuring populaton recovery.

Alternative 3 - Limited Restoration

Under this alternative, marbled murrelets are affected by Options 9, 37, and 40. As in Alternative 2, the emphasis would be on habitat acquisition and protection throughout the oil spill area. In localized areas, Option 9 (minimizing incidental take of marine birds) would provide additional help in stabilizing the population.

Alternative 4 - Moderate Restoration

This alternative has the same options as Alternative 3. However, with only 50 percent of the settlement funds would be available for habitat acquisition, the potential extent of this option would beless and the magnitude of the impact lower.

Alternative 5 - Comprehensive Restoration

This alternative has the same options as Alternative 3. However, with only 35 percent of the settlement funds would be available for habitat acquisition, the potential extent of this option would beless and the magnitude of the impact lower.

Storm Petrels

Alternative 1 - No Action Alternative

Under the No Action Alternative, none of the options effecting the storm petrel would be implemented. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, Options 37 and 40 would impact the storm petrel. Implementation of this alternative would have an indirect impact on the storm petrel population by providing protected habitat for breeding and nesting. Over 90 percent of the restoration funds for this alternative are allocated to the implementation of these two options. The geographic extent of the impact from implementing this alternative would be large, including the entire oil spill area. Assuming the habitat would remain under protected status, the duration of the impacts associated with this habitat protection would be long-term, potentially leading to increases in the species population. This alternative could create long-term positive benefits to the storm petrel by insuring the necessary habitat to maintain healthy populations in the oil spill area.

Alternative 3 - Limited Restoration

Under Alternative 3, Options 12, 13, 14, 17, 37, and 40 would indirectly impact the storm petrel. Option 12 would potentially have an indirect, negative impact on the storm petrel population through construction of new recreation facilities and sites in the coastal habitat utilized for breeding and nesting, resulting in human disturbance to this species during nesting. In constrast, if construction of these facilities would concentrate tourists away from the breeding and nesting areas, the indirect impact of this option on the reproduction potential of the storm petrel would be positive. Options 13 and 14 would be implemented throughout the oil spill area, with the exception of PWS north and east. These options would indirectly impact the storm petrel by increasing food supplies and restoring habitat. Implementation of Option 17 would result in a reduction in terrestrial predators of storm petrel chicks and eggs, having a positive impact on population. Options 37 and 40 would protect important breeding and nesting habitat, potentially resulting in a positive, indirect impact to the reproductive potential of the storm petrel. These options (37 and 40) would be implemented throughout the oil spill area, and would receive 75 percent of the restoration funds being allocated for these options.

Alternative 4 - Moderate Restoration

Alternative 4 would implement the same options affecting the storm petrel as Alternative 3 and result in the same impacts.

Alternative 5 - Comprehensive Restoration

With respect to the storm petrel, Options 12, 13, 14, 17, 37, and 40 would be implemented under Alternative 5, and each would have an indirect impact on the storm petrel. This alternative includes the most options affecting this species. The impacts of each option have been described previously in this chapter. Overall, Alternative 5 would utilize a larger amount of the restoration fund (48 percent) to implement general restoration options in addition to habitat acquisition and protection (35 percent).

The impacts associated with implementation of Alternative 5 would increase the storm petrel population through provision of additional food sources, habitat protection, and eradication of predator species. The options implemented under this alternative would be distributed throughout the spill zone, but would be of moderate magnitude because they would only be implemented in localized areas. Opportunities to increase the storm petrel population would be high in those localized areas, but the overall magnitude of the impact would be moderate.

Black-legged Kittiwake

Alternative 1 - No Action Alternative

Under the No Action Alternative, none of the options affecting the black-legged kittiwake would be implemented. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, over 90 percent of the restoration funds would be used to implement Options 37 and 40. Both of these options, which protect and acquire habitat (Option 37) and establish special land designations (Option 40), would indirectly benefit the black-legged kittiwake population by providing protected habitat and preventing disturbance in the coastal areas used for breeding and nesting. The geogrphic extent of the impact from implementing this option would be large, including the entire oil spill area. Assuming the habitat would remain under protected status, the duration of the impacts associated with this habitat protection would be long-term, potentially leading to increases in the species population. This alternative could create long-term positive benefits to the black-legged kittiwake by insuring the necessary habitat to maintain healthy populations in the oil spill area.

Alternative 3 - Limited Restoration

Under Alternative 3, Options 12, 13, 14, 17, 37, and 40 would indirectly impact the black-legged kittiwake. Option 12 would potentially have an indirect, negative impact on the black-legged kittiwake population through construction of new recreation facilities and sites in the coastal habitat utilized for breeding

and nesting, resulting in human disturbance to this species during nesting. In constrast, if construction of these facilities would concentrate tourists away from the breeding and nesting areas, the indirect impact of this option on the reproduction potential of the black-legged kittiwake would be positive. Options 13 and 14 would be implemented throughout the oil spill area with the exception of PWS north and east. These options would indirectly impact this species by increasing food supplies and restoring habitat. Implementation of Option 17 would result in a reduction in terrestrial and avian predators of black-legged kittiwake chicks and eggs, having a positive impact on population. Options 37 and 40 would protect important breeding and nesting habitat, potentially resulting in an indirect impact to the reproductive potential of the black-legged kittiwake. These options (37 and 40) would be implemented throughout the oil spill area, having major emphasis placed on them with 75 percent of the restoration funds allocated for implementation of these two options.

The primary emphasis of Alternative 3 is on the acquisition and protection of habitat as described in Options 37 and 40. Under this alternative, over 75 percent of the restoration funds have been allocated to implement the goals of these two options. Emphasis on this approach to restoration would have a long-term, positive impact on the black-legged kittiwake population by providing protected nesting, and breeding habitat.

Alternative 4 - Moderate Restoration

Alternative 4 would implement the same options, impacting the black-legged kittiwake, as Alternative 3. Therefore, the impacts associated with Alternative 4 would be the same as those associated with Alternative 3. As with Alternative 3, Alternative 4 devotes most of the available restoration funds (50 percent) to habitat acquisition and protection (Options 37 and 40). As noted previously, this would have a positive, long-term impact on the black-legged kittiwake population by providing protected nesting, and breeding habitats throughout the oil spill area.

Alternative 5 - Comprehensive Restoration

Under Alternative 5, Options 12, 13, 14, 17, 37, 40, and 50 would be implemented. Alternative 5 implements the most options affecting the black-legged kittiwake. As a consequence of a larger number of options affecting this species, a larger restoration funding allocation (48 percent) has been proposed for implementing restoration options in addition to habitat acquisition and protection than in Alternatives 2, 3, or 4. A major focus of Alternative 5 is still habitat protection (35 percent of funding), but there is a greater mix of options affecting the black-legged kittiwake to be implemented under this alternative.

The impacts associated with Alternative 5 would increase the black-legged kittiwake population through provision of additional food

sources and habitat acquisition and protection. The options implemented under this alternative would be distributed throughout the oil spill area, but would be of a moderate magnitude because they would only be implemented in localized areas. Therefore, the overall magnitude of the impact would be moderate.

Pigeon Guillemot

Alternative 1 - No Action Alternative

Under the no action alternative, none of the options affecting the pigeon guillemot would be implemented. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, Options 37 and 40 would impact the pigeon guillemot. Implementation of this alternative would have an indirect impact on the pigeon guillemot reproductive potential by providing protected habitat for breeding and nesting. Over 90 percent of the restoration funds for this alternative are allocated to the implementation of these two options. The geographic extent of the impact from implementing this alternative would be large, including the entire oil spill area. Assuming the habitat would remain under protected status, the duration of the impacts associated with this habitat protection would be long-term, potentially leading to increases in the species population. This alternative could create long-term positive benefits to the pigeon guillemot by insuring the necessary habitat to maintain healthy populations in the oil spill area.

Alternative 3 - Limited Restoration

Under Alternative 3, Options 12, 13, 14, 17, 37, and 40 would indirectly impact the pigeon guillemot. Option 12 would potentially have an indirect, negative impact on the pigeon guillemot population through construction of new recreation facilities and sites in the coastal habitat utilized for breeding and nesting, resulting in introduction of human disturbance to this species during nesting. In constrast, if construction of these facilities would concentrate tourists away from the breeding and nesting areas, the indirect impact of this option on the reproduction potential of the pigeon guillemot would be positive. Options 13 and 14 would indirectly impact this species by increasing food supplies and restoring habitat. These options would be implemented throughout the oil spill area, with the exception of PWS north and east. Implementation of Option 17 would result in a reduction in terrestrial and avian predators of pigeon guillemot chicks and eggs, having a positive impact on population. Options 37 and 40 would protect important breeding and nesting

habitat, potentially resulting in a positive indirect impact to the reproductive potential of the pigeon guillemot.

The primary emphasis of Alternative 3 is on the acquisition and protection of habitat as described in Options 37 and 40 (75 percent of the budget). Emphasis on this approach to restoration would have a long-term, positive impact on the pigeon guillemot population by providing protected nesting and breeding habitat.

Alternative 4 - Moderate Restoration

Alternative 4 would implement the same options, impacting the pigeon gillemot, as Alternative 3. Therefore, the impacts associated with Alternative 4 would be the same as those associated with Alternative 3. As with Alternative 3, Alternative 4 devotes most of the available restoration funds (50 percent) to habitat acquisition and protection (Options 37 and 40). As noted previously, this would have a positive, long-term impact on the pigeon guillemot population by providing protected nesting, and breeding habitats throughout the oil spill area.

Alternative 5

Alternative 5 would implement the most options impacting the pigeon guillemot. Those options, Options 12, 13, 14, 17, 37, 40, and 50 would have an indirect impact on the pigeon guillemot, and have been described previously in this chapter. As a consequence of a larger number of options affecting this species, a larger restoration funding allocation (48 percent) has been proposed for implementing restoration options in addition to habitat acquisition and protection than in Alternatives 2, 3, or 4. Habitat protection (allocated 35 percent of total funding) is still a major focus of this alternative, as with the previous alternatives, but there is a greater mix of options affecting the pigeon guillemot under Alternative 5.

The impacts associated with Alternative 5 would increase the pigeon guillemot population through provision of additional food sources and habitat acquisition and protection. The options implemented under this alternative would be distributed throughout the oil spill area, but would be of a moderate magnitude because they would only be implemented in localized areas. Therefore, the overall magnitude of the impact would be moderate.

Glaucous-winged Gull

Alternative 1 - No Action Alternative

Under the No Action Alternative, none of the options effecting the glaucous-winged gull would be implemented. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, over 90 percent of the restoration funds would be used to implement Options 37 and 40, having an impact on the glaucous-winged gull. Implementation of this alternative would have a direct impact on the glaucous-winged gull population by providing protected habitat for breeding and nesting. The geographic extent of the impact from implementing this alternative would be large, including the entire oil spill area. Assuming the habitat would remain under protected status, the duration of the impacts associated with this habitat protection would be long-term, potentially leading to increases in the species population. This alternative could create long-term positive benefits to the glaucous-winged gull by insuring the necessary habitat to maintain healthy populations in the oil spill area.

Alternative 3 - Limited Restoration

Under Alternative 3, Options 13, 14, 17, 37, and 40 would indirectly impact the glaucous-winged gull. Options 13 and 14 would be implemented throughout the oil spill area, with the exception of PWS north and east. These options would indirectly impact this species by increasing food supplies and restoring habitat, which would improve the health of the population and increase the carrying capacity of the ecosystem. Implementation of Option 17 would result in a reduction of terrestrial predators of glaucous-winged gull chicks and eggs, having a positive impact on population. However, Option 17 also pertains to temporary eradication of avian predators throughout the oil spill area (with the exception of PWS), of which the gull is one, and would therefore result in a direct, short-term, negative impact to the gull. Options 37 and 40 would be implemented throughout the oil spill area and would have a major emphasis placed on them with 75 percent of the restoration funds being used for these two options.

The primary emphasis of Alternative 3 is on the acquisition and protection of habitat as described in Options 37 and 40. Over 75 percent of the restoration funds would be used to implement these two options under this alternative. Emphasis on this approach to restoration would have a long-term, positive impact to the glaucous-winged gull population by providing protected breeding and nesting habitat.

Alternative 4 - Moderate Restoration

Alternative 4 would implement the same options, impacting the glacous-winged gull, as Alternative 3. Therefore, the impacts associated with Alternative 4 would be the same as those associated with Alternative 3. As with Alternative 3, Alternative 4 devotes most of the available restoration funds (50 percent) to habitat acquisition and protection (Options 37 and 40). As noted previously, this would have a positive, long-term impact on the

glacous-winged gull population by providing protected nesting, and breeding habitats throughout the oil spill area.

Implementation of Alternative 4 would be equivalent to implementation of Alternative 3. Therefore, impacts for Alternative 4 would be the same as those described for Alternative 3 (above). Alternative 4 devotes approximately 50 percent of the available restoration funds to the protection and acquisition of habitat (Options 37 and 40). As noted previously, this would have a positive, long-term impact to the glaucous-winged gull population by providing protected breeding and nesting habitat throughout the oil spill area.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes the most options affecting the glaucous-winged gull. Options 13, 14, 17, 37, and 40 would be implemented under this alternative, each of which have been described previously in this chapter. Each of these options would have an indirect impact on the glaucous-winged gull. Overall, Alternative 5 would utilize a larger amount of the restoration fund, approximately 48 percent, to implement restoration options in addition to habitat acquisition and protection (35 percent).

The impacts associated with implementation of Alternative 5 would serve to increase the glaucous-winged gull population through provision of additional food sources, habitat protection, and eradication of predator species. The options implemented under this alternative would be distributed throughout the spill zone, but would be of moderate magnitude because they would only be implemented in localized areas. Opportunities to increase the glaucous-winged gull population would be high in those localized areas, but the overall magnitude of the impact would be moderate.

Harlequin Duck

Alternative 1 - No Action Alternative

Under the No Action Alternative, none of the options effecting the harlequin duck would be implemented. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Options 37 and 40 would be implemented under Alternative 2. This alternative would apply over 90 percent to habitat protection. Implementation of Alternative 2 would have a indirect impact on the harlequin duck reproductive potential by providing protected habitat for breeding, nesting, and molting. The geographic extent of the impact from implementing this alternative would be large, including the entire oil spill area. Assuming the habitat would

remain under protected status, the duration of the impacts associated with this habitat protection would be long-term, potentially leading to increases in the species population. This alternative could create long-term positive benefits to the harlequin duck by insuring the necessary habitat to maintain healthy populations in the oil spill area.

Alternative 3 - Limited Restoration

With respect to the harlequin duck, implementation of Alternative 3 would include implementation of Options 12, 13, 14, 37, 40, and 49. Option 12 would potentially have an indirect, negative impact on the duck population because of human disturbance that could interrupt breeding, nesting, and molting. In constrast, if construction of these facilities would concentrate tourists away from the breeding and nesting areas, the indirect impact of this option on the reproduction potential of the harlequin duck would be positive. Options 13 and 14 would be implemented throughout the oil spill area with the exception of PWS north and east. These options would indirectly impact the harlequin duck by increasing food supplies which could improve the health of the population and increase the carrying capacity of the ecosystem. Options 37 and 40 would be implemented throughout the oil spill area and have major emphasis placed on them with 75 percent of the restoration funds being used for these two options. Option 49 would be implemented only in west PWS, and would have a positive direct impact on the harlequin duck population by temporarily relocating subsistence hunting. In constrast, if construction of these facilities would concentrate tourists away from the breeding and nesting areas, the indirect impact of this option on the reproduction potential of the harlequin duck would be positive.

The primary emphasis of Alternative 3 is on the acquisition and protection of habitat as described in Options 37 and 40. Under this alternative, over 75 percent of the restoration funds have been allocated to implement the goals of these two options. Emphasis on this approach to restoration would have a long-term, positive impact on the harlequin duck population by providing protected nesting, breeding, and molting habitat.

Alternative 4 - Moderate Restoration

Alternative 4 would implement the same options, impacting the harlequin duck, as Alternative 3. Therefore, the impacts associated with Alternative 4 would be the same as those associated with Alternative 3. As with Alternative 3, Alternative 4 devotes most of the available restoration funds (50 percent) to habitat acquisition and protection (Options 37 and 40). As noted previously, this would have a positive, long-term impact on the harlequin duck population by providing protected nesting, and breeding habitats throughout the oil spill area.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes the most options affecting the harlequin duck. Options 8, 12, 13, 14, 37, 40, 49, and 50 would be implemented under this alternative. The effects of each have been described previously in this chapter. As a consequence of the larger number of options affecting this species, a larger amount of restoration funding (48 percent) is being proposed for implementing restoration options in addition to habitat acquisition and protection than was allocated in Alternatives 2, 3, or 4. Habitat protection is still a major focus of this alternative (35 percent of total funding), as with the previous alternatives, but there is a greater mix of options affecting the harlequin duck to be implemented under Alternative 5.

The impacts associated with Alternative 5 would serve to increase the harlequin duck population through temporarily eliminating subsistence harvesting of this species in the oil spill area, provision of additional food sources, and habitat protection. The options implemented under this alternative would be distributed throughout the oil spill area, but would be of a moderate magnitude because they would only be implemented in localized areas. Opportunities to increase the harlequin duck population would be high in those localized areas, but the overall magnitude of the impact would be moderate.

Black Oystercatcher

Alternative 1 - No Action Alternative

Under the no action alternative, none of the options affecting the black oystercatcher would be implemented. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under Alternative 2, Options 37 and 40 would impact the black oystercatcher. Implementation of this alternative would have an indirect impact on the black oystercatcher population by providing protected habitat and preventing disturbance in the coastal areas used for nesting. Over 90 percent of the restoration funds for this alternative are allocated to the implementation of these two options. The geographic extent of the impact from implementing this alternative would be large, including the entire oil spill area. Assuming the habitat would remain under protected status, the duration of the impacts associated with this habitat protection would be long-term, potentially leading to increases in the species population. This alternative could create long-term positive benefits to the black oystercatcher by insuring the necessary habitat to maintain healthy populations in the oil spill area.

Alternative 3 - Limited Restoration

Under Alternative 3, Options 12, 13, 14, 17, 37, and 40 would indirectly impact the black oystercatcher. Option 12 would potentially have an indirect negative impact on the oystercatcher population through construction of new recreation facilities and sites in the coastal habitat utilized for breeding and nesting, resulting in introduction of human disturbance to this species during nesting. In constrast, if construction of these facilities would concentrate tourists away from the breeding and nesting areas, the indirect impact of this option on the reproduction potential of the black oystercatcher would be positive. Options 13 and 14 would be implemented throughout the oil spill area, with the exception of PWS north and east. These options would indirectly impact this species by increasing food supplies and restoring habitat. Implementation of Option 17 would result in a reduction in terrestrial and avian predators of black oystercatcher chicks and eggs, having a positive impact on this species' population. Options 37 and 40 would be implemented throughout the oil spill area and have major emphasis placed on them, with 75 percent of the restoration funds being used to implement these two options.

The primary emphasis of Alternative 3 is on the acquisition and protection of habitat as described in Options 37 and 40. Under this alternative, over 75 percent of the restoration funds have been allocated to implement the goals of these two options. Emphasis on this approach to restoration would have a long-term, positive impact on the black oystercatcher population by providing protected nesting and breeding habitat.

Alternative 4 - Moderate Restoration

Alternative 4 would implement the same options, impacting the black oystercatcher, as Alternative 3. Therefore, the impacts associated with Alternative 4 would be the same as those associated with Alternative 3. As with Alternative 3, Alternative 4 devotes most of the available restoration funds (50 percent) to habitat acquisition and protection (Options 37 and 40). As noted previously, this would have a positive, long-term impact on the black oystercatcher population by providing protected nesting, and breeding habitats throughout the oil spill area.

Alternative 5 - Comprehensive Restoration

Under Alternative 5, Options 12, 13, 14, 17, 37, 40,and 50 would be implemented. Alternative 5 implements the most options affecting the black oystercatcher. The effects of each option have been described previously in this chapter. As a consequence of a larger number of options affecting this species, a larger restoration funding allocation (48 percent) has been proposed for implementing restoration options in addition to habitat acquisition and protection than in Alternatives 2, 3, or 4. A major focus of Alternative 5 is still habitat protection (allocated 35 percent of

total funding), but there is a greater mix of options affecting the black oystercatcher under this alternative.

The impacts associated with Alternative 5 would increase the black oystercatcher population through provision of additional food sources and habitat acquisition and protection. The options implemented under this alternative would be distributed throughout the oil spill area, but would be of a moderate magnitude because they would only be implemented in localized areas. Therefore, the overall magnitude of the impact would be moderate.

d. Fish

Pink Salmon

Alternative 1 - No Action Alternative

Under the No Action Alternative, no options would be implemented to restore pink salmon. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement Options 37 and 40. Both of these options, which protect and acquire habitat (Option 37), and establish special land designations (Option 40) would indirectly benefit pink salmon by protecting the habitat required for spawning and rearing of fish in PWS, which could lead to an increase in population in PWS. The duration of the impacts would be long-term, assuming that the protected habitat is held by the public and managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts are large and wide-spread, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to pink salmon by insuring the necessary habitat to maintain healthy fish populations in PWS.

Alternative 3 - Limited Restoration

Options 14, 18, 37, 40, and 51 would indirectly increase pink salmon populations throughout the oil spill area. Option 14 would increase the quantity of food for young pink salmon, therefore increasing growth rates. Options 18 and 51 would reduce local fishing pressures on wild stocks. Options 37 and 40 would protect spawning areas from further exploitation and degradation, allowing for increased spawning and a gradual increase in pink salmon populations. Option 12 could indirectly impact pink salmon by disturbing spawning areas and adversely impacting spawning success. Under this alternative the majority of the funds would be used for habitat acquisition, resulting in a long-term, positive impact to pink salmon populations through habitat protection.

Alternative 4 - Moderate Restoration

Options 11, 14, 18, 37, 40 and 51 would indirectly increase pink salmon populations. Option 11 would improve the spawning habitat for pink salmon in PWS. Options 14 would increase the quantity of food for adult pink salmon in western PWS, Kenai/Cook Inlet, Alaskan Peninsula, and Kodiak. Options 37 and 40 would protect spawning areas from further exploitation and degradation, allowing for increased spawning. Options 18 and 51 would reduce commercial fishing pressure thus protecting wild stocks in PWS, lower and central Cook Inlet, and Kodiak/Afognak. Option 2 would directly impact pink salmon populations in central Cook Inlet by reducing commercial, sport, and subsistence fishing pressures, thus increasing spawning success in these areas. Option 48 directly impacts salmon populations by increasing the survival rate of eggs and larvae. Option 12 could indirectly impact pink salmon by disturbing spawning areas, having a potential adverse impact on spawning success. The majority of options would be implemented throughout spill area. The direct impact of Alternative 4 on pink salmon would be to increase spawning success in the spill area, resulting in gradual population increase. Because Options 2 and 48 are specifically designed to directly increase wild salmon populations, and the majority of the remaining options indirectly increase populations, the likelihood of increasing populations under this alternative is high.

Alternative 5 - Comprehensive Restoration

Options 11, 14, 18, 19, 37, 40 and 51 would indirectly increase pink salmon populations, and would be implemented under Alternative 5. Option 11 would benefit the pink salmon population by improving their spawning habitat in PWS. Options 14 would increase the quantity of food for juvenile pink salmon in western PWS, Kenai/Cook Inlet, Alaskan Peninsula, and Kodiak. Options 19, 37 and 40 would protect spawning areas from further exploitation and degradation allowing for increased spawning, with Option 19 being specifically for PWS and Kodiak. Options 18 and 51 would reduce commercial fishing pressure thus protecting wild stocks in PWS, lower and central Cook Inlet, and Kodiak/Afognak. Option 2 would directly impact pink salmon populations in central Cook Inlet by reducing commercial, sport, and subsistence fishing pressures, thus increasing spawning success in central Cook Inlet and Kodiak. Option 48 directly impacts salmon populations by increasing the survival rate of eggs and larvae. Option 12 could indirectly impact pink salmon by disturbing spawning areas which could have an adverse impact on spawning success. The majority of options would be implemented throughout spill area. The direct impact of Alternative 5 on pink salmon would be to increase spawning success in the spill area. Therefore, a gradual increase in population could occur. Because Options 2 and 48 are specifically designed to directly increase wild salmon populations, and the majority of the remaining options indirectly increase populations, the likelihood of increasing populations under this alternative is high.

Sockeye Salmon

Alternative 1 - No Action Alternative

Under the No Action Alternative, no options would be implemented to restore sockeye salmon. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement Options 37 and 40. Both of these options, which protect and acquire habitat (Option 37), and establish special land designations (Option 40) would indirectly benefit sockeye salmon by protecting the habitat required for spawning and rearing of fish in PWS, leading to an increase in population in PWS. The duration of the impacts would be long-term, assuming that the protected habitat is managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts is large and wide-spread, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term positive benefits to sockeye salmon by insuring the necessary habitat to maintain healthy fish populations in PWS.

Alternative 3 - Limited Restoration

Under this alternative, Options 11, 14, 18, 37, and 40 would indirectly increase sockeye salmon populations throughout the oil spill area. Option 11 would improve the spawning habitat for sockeye salmon only in northern PWS. Option 14 would increase the quantity of food for adult sockeye salmon in western PWS, Kenai/Cook Inlet, Alaskan Peninsula, and Kodiak, which could increase growth rates and ultimately increase spawning success in the effected areas. Option 18 reduce local fishing pressures on wild stocks in PWS, lower and central Cook Inlet, and Kodiak/Afognak. Options 37 and 40 would protect spawning areas from further exploitation and degradation, allowing for increased spawning throughout the spill area. Option 2 would directly impact sockeye salmon populations in central Cook Inlet by reducing commercial, sport, and subsistence fishing pressures; thus increasing spawning success in central Cook Inlet and Kodiak. Option 48 directly impacts salmon populations by increasing the survival rate of eggs and larvae in central Cook Inlet. Option 12 could indirectly impact sockeye salmon by disturbing spawning areas which could have an adverse impact on eggs and larvae.

Under this alternative the majority of the allocated funds (75 percent) would be used for habitat acquisition. This approach to restoration could have long-term, positive effect on sockeye populations by acquiring and protecting spawning habitat. Because Options 2 and 48 are specifically designed to directly increase

wild sockeye populations, and the majority of the remaining options indirectly increase populations, the magnitude of the impacts of this alternative would be high.

Alternative 4 - Moderate Restoration

Alternative 4 includes all options and effects under Alternative 3. Option 11 would additionally effect sockeye populations in Kodiak as well as northern PWS, increasing the impact of this option. As with Alternatives 2 and 3, the majority of restoration funds are allocated for Options 37 and 40, which provide habitat protection.

Alternative 5 - Comprehensive Restoration

This alternative includes all the options and associated effects documented in Alternatives 3 and 4, with the addition of Options 19 and 51. Options 11, 14, 18, 19, 37, and 40 would indirectly increase sockeye salmon populations and Options 37 and 40 would provide habitat protection throughout the spill area. Option 11 would improve the spawning habitat for sockeye salmon in northern PWS and Kodiak. Option 19 would provide habitat protection in PWS and Kodiak. Options 2 and 48 would directly increase wild sockeye populations in the Kodiak vicinity. Option 51 would reduce fishing pressure on wild sockeye populations in PWS by changing or relocating hatchery runs to other areas. The majority of the options would be implemented throughout spill area. The direct impact of Alternative 5 on sockeye salmon would be to increase spawning success and, ultimately, increase population in the spill area.

Pacific Herring

Alternative 1 - No Action Alternative

Under the No Action Alternative, no options would be implemented to restore Pacific herring. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement Options 37 and 40. Both of these options, which protect and acquire habitat (Option 37), and establish special land designations (Option 40) would indirectly benefit Pacific herring by protecting the habitat required for spawning and rearing of fish throughout the spill area, potentially leading to an increase in population. The extent of the impact from implementing this alternative would be relatively large, including the entire oil spill area. The duration of the impacts would be long-term, assuming that the protected habitat is managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts would be large and wide-spread, and a

large financial commitment would be made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to Pacific herring by insuring the necessary habitat to maintain healthy fish populations.

Alternative 3 - Limited Restoration

Under Alternative 3, Options 14, 37, and 40 would indirectly increase Pacific herring populations. Option 14 would increase the quantity of food for larval Pacific herring . Options 37 and 40 would protect spawning areas from further degradation, as described in Alternative 2, allowing for a natural increase in population. These options would be implemented throughout the spill area except in north and east PWS. Option 13 could have short-term, negative impacts on Pacific herring egg and larval survival during the oil elimination process. The results would be an ultimate increase in spawning success and Pacific herring population in the spill area.

Alternative 4 - Moderate Restoration

In addition to Options 13, 14, 37, and 40 described in Alternatives 2 and 3, Alternative 4 includes Option 2 which is to intensify fisheries management of Pacific herring. Option 2 would reduce commercial, sport, and subsistence fishing, potentially resulting in an increased number of spawning adults in PWS. Option 2 could overshadow any negative effects produced from implementing Option 13. Therefore, the likelihood of Alternative 4 to increase the Pacific herring population would be high.

Alternative 5 - Comprehensive Restoration

The effects of Alternative 5 on Pacific herring would be the same as the effects in Alternative 4.

Rockfish

Alternative 1 - No Action Alternative

Under the No Action Alternative, no options would be implemented to increase rockfish populations. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement Options 37 and 40. Because rockfish are open water fish, acquisition of inland and coastal habitat would not significantly impact this species. However, Option 40 would indirectly benefit rockfish by protecting through special designations (such as marine sanctuaries) the habitat required for

the spawning and rearing of fish, which could lead to increases in the numbers of fish. The magnitude of the impacts of this alternative on rockfish could be relatively high, creating long-term, positive benefits to rockfish by insuring the necessary habitat to maintain healthy fish stocks in the oil spill area.

Alternative 3 - Limited Restoration

There are two options under this alternative that could effect rockfish. Options 14 and 40 would indirectly increase rockfish populations. Option 14 would increase the quantity of food for adult rockfish throughout the spill area. This would increase growth rates as well as the number of healthy reproducing adults. Option 40 would protect habitat areas from further exploitation and degradation, allowing for natural recovery throughout the spill area. This would allow uninterrupted reproduction, which could ultimately increase population. Implementing this alternative for rockfish would gradually increase rockfish populations.

Alternative 4 - Moderate Restoration

In addition to Options 14 and 40, Alternative 4 includes Option 2, which intensifies fisheries management of rockfish. This would directly impact rockfish populations in the spill area by removing further fishing exploitation, thus increasing the number of reproducing adults in PWS, outer Kenai, and lower Cook Inlet. This could give greater potential for increasing the population of rockfish in the effected areas, as compared to Alternatives 2 and 3.

Alternative 5 - Comprehensive Restoration

The effects of Alternative 5 on rockfish would be the same as the effects in Alternative 4.

Dolly Varden

Alternative 1 - No Action Alternative

Under the No Action Alternative, no options would be implemented that would effect Dolly Varden. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement Options 37 and 40. Both of these options, which protect and acquire habitat (Option 37), and establish special land designations (Option 40) would indirectly benefit Dolly Varden by protecting the habitat required for spawning and rearing of fish in PWS, leading to an increase in

population in PWS. The extent of the impact from implementing this alternative would be moderate because the range of Dolly Varden only extends as far north as PWS. The duration of the impacts would be long-term, assuming that the protected habitat is managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts are large and wide-spread, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to Dolly Varden by insuring the necessary habitat to maintain healthy fish populations in PWS.

Alternative 3 - Limited Restoration

There are several options under this alternative that would effect Dolly Varden populations. Options 14, 37, and 40 could indirectly increase Dolly Varden populations. Option 14 would increase the quantity and quality of food for adult Dolly Varden in the marine environment. Options 37 and 40 would protect spawning areas throughout the spill area from further exploitation and degradation allowing for natural recovery. These two options have the greatest emphasis placed on them under this alternative, with 75 percent of the restoration funds being designated for these options, and only 12 percent of the funds for other restoration options. Option 12 (construction of recreational facilities) could indirectly impact Dolly Varden by decreasing populations in localized areas in PWS. The impacts associated with Option 12 would be short-term and relatively minor. The direct impact of Alternative 3 would be an increase in spawning success of Dolly Varden which would ultimately increase populations in PWS.

Alternative 4 - Moderate Restoration

The options implemented under Alternative 4 that would effect Dolly Varden include 2, 12, 14, 37, and 40. Options 14, 37, and 40 were described in Alternatives 2 and 3. Option 2 could directly impact Dolly Varden populations by reducing commercial, sport, and subsistence fishing pressures; thus increasing spawning success in PWS. The majority of options would be implemented throughout PWS. The direct impact of Alternative 4 on Dolly Varden would be an increase of spawning success in PWS and, therefore, a gradual increase in population in PWS.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes the greatest number of options that effect Dolly Varden. It includes the options described in Alternative 4 and three additional options: 11, 19 and 48. Option 11 could indirectly improve the spawning habitat for Dolly Varden in PWS. Like Options 37 and 40, Option 19 would provide further protection of spawning areas, allowing for increased spawning success in PWS. Option 48 like Option 14 would increase the food supply for Dolly Varden. The majority of options would be implemented in PWS. The direct impact of Alternative 5 on Dolly Varden would be an increase

of spawning success in PWS and, therefore, a gradual increase in populations.

Cutthroat Trout

Alternative 1 - No Action Alternative

Under the No Action Alternative, no options would be implemented to restore cutthroat trout. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement Options 37 and 40. Both of these options, which protect and acquire habitat (Option 37), and establish special land designations (Option 40) would indirectly benefit cutthroat trout by protecting the habitat required for spawning and rearing of fish in PWS, which could lead to an increase in population in PWS. The duration of the impacts would be long-term assuming that the protected habitat is managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts are large and wide-spread, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to cutthroat trout by insuring the necessary habitat to maintain healthy fish populations in PWS.

Alternative 3 - Limited Restoration

There are several options under this alternative that could effect cutthroat populations. Options 14, 37, and 40 could indirectly increase cutthroat trout populations. Option 14 would increase the quantity and quality of food for adult cutthroat trout in the marine environment. Options 37 and 40 would protect spawning areas throughout the spill area from further exploitation and degradation allowing for natural recovery. These two options have the greatest emphasis placed on them under this alternative, with 75 percent of the restoration funds being designated for them. Option 12 could indirectly impact cutthroat trout by decreasing populations in localized areas in PWS. The impacts would be short-term and relatively minor. All options would be implemented throughout PWS. The direct impact of Alternative 3 would be an increase in spawning success of cutthroat trout which could ultimately increase populations in PWS.

Alternative 4 - Moderate Restoration

The options under Alternative 4 that could effect cutthroat trout include 2, 12, 14, 37, and 40. Options 14, 37, and 40 were described in Alternatives 2 and 3. Option 2 could directly impact cutthroat trout populations by reducing commercial, sport, and

subsistence fishing pressures, thus increasing spawning success in PWS. The direct impact of Alternative 4 on cutthroat trout would be an increase of spawning success in PWS and, ultimately, an increase in cutthroat trout population in PWS.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes the most options that effect Cutthroat trout. It includes the options described in Alternative 4 and two additional options, 11 and 19. Option 11 could indirectly improve the spawning habitat for cutthroat trout in PWS. Like Options 37 and 40, Option 19 would provide further protection for spawning areas, allowing for increased spawning success in PWS. The majority of options would be implemented in PWS. The direct impact of Alternative 5 on cutthroat trout would be an increase of spawning success in PWS and, therefore, a gradual increase in cutthroat trout population.

e. Coastal Communities

Intertidal Organisms

Alternative 1 - No Action Alternative

Under the No Action Alternative, the intertidal habitat and its organisms would continue to recover naturally, to the extent possible under current conditions. None of the effects of the options described would be realized.

Alternative 2 - Habitat Protection

Options 37 and 40 would impact the intertidal zone, especially mussels and *Fucus*, by directly protecting habitat through acquisition of land and special designations. The benefits would be long-term, and these options would be implemented throughout the spill zone. The impacts associated with intertidal habitat recovery and protection would be of moderate magnitude because even though the actions would be implemented throughout the spill zone, they would only affect localized areas. The potential for recovery would be high in localized areas, but the overall magnitude of recovery would be moderate. Alternative 2 would allocate the greatest amount of funds to these options. Consequently, the positive impact to intertidal habitat recovery would be of greater magnitude for Alternative 2 than for Alternatives 3, 4, and 5.

Alternative 3 - Limited Restoration

Options 4, 9, 17, 47 would have an indirect, adverse impact on intertidal organisms, specifically clams and mussels, by increasing the size of predator populations and consequently reducing the mussel populations on a short-term basis until the predator population stabilizes. Option 4 would be implemented only in

Prince William Sound, and Options 9, 17, and 47 would be implemented throughout the spill zone. Option 30 would have a direct, short-term, adverse impact on mussels by reducing the mussel population on a one-time basis during sampling, and it would also indirectly reduce mussel populations on a long-term basis by restoring subsistence user confidence in the safety of the mussels for human consumption. Option 30 would be implemented throughout the spill zone. Options 13, 14, 37, and 40 would impact the intertidal zone, especially mussels and *Fucus*, by direct improvement of habitat through eliminating oil from mussel beds, augmenting *Fucus* recovery, and acquiring and protectively managing land. These options would be implemented throughout the spill zone. Option 49 would also protect habitat impact by drawing subsistence users away from oil-damaged areas to unimpacted areas, allowing undisturbed recovery of the oiled areas, albiet on a short-term basis that wouldbe implemented only in Prince William Sound. Option 12 would adversely impact the intertidal zone on a long-term basis by allowing activity in oil-damaged areas that were previously not high activity areas. This option would be implemented throughout the spill zone.

The impacts reducing mussel populations would not be of high magnitude because they would be indirect and temporary, lasting only until the predator population stabilizes. The impacts associated with habitat recovery and protection would be of moderate magnitude because even though the actions would be implemented throughout the spill zone, they would only affect localized areas. The potential for recovery would be high in the localized areas, but the overall magnitude of recovery would be moderate. In terms of impacts to the intertidal environment, Alternatives 3 and 4 encompass the same options, but Alternative 3 would allocate fewer funds to Option 17 and greater funds to Options 37 and 40. The differences in funding would not affect the relative magnitudes of Alternatives 3 and 4.

Alternative 4 - Moderate Restoration

Because Alternative 3 and Alternative 4 include the same options that would impact the intertidal environment, the impacts to the intertidal habitat and its organisms from Alternative 4 would be nearly identical to those of Alternative 3, except that Alternative 4 would allocate more funds to Option 17 and fewer funds to Options 37 and 40. The differences in funding would not constitute a difference in impacts magnitude between Alternative 3 and Alternative 4.

Alternative 5 - Comprehensive Restoration

Options 4, 8, 9, 17, 47 would produce indirect, adverse impacts on intertidal organisms, specifically clams and mussels, by increasing the size of predator populations and consequently reducing the mussel populations on a short-term basis until the predator population stabilizes. Options 4 and 8 would be implemented only

in Prince William Sound, and Options 9, 17, and 47 would be implemented throughout the spill zone. Option 30 would have a direct, short-term, adverse impact on mussels by reducing the mussel population during sampling, and it would also indirectly reduce mussel populations on a long-term basis by restoring subsistence user confidence in the safety of the mussels for human consumption. Option 30 would be implemented throughout the spill zone. Options 13, 14, 37, 40, and 50 would impact the intertidal zone, especially mussels and *Fucus*, by direct improvement of habitat through eliminating oil from mussel beds, augmenting *Fucus* recovery, acquiring and protectively managing land, and supplementing damaged mussel populations by re-seeding beaches through mariculture operations. These options would be implemented throughout the spill zone, except Option 50 which would only be implemented on the Kenai Peninsula. Option 49 would have a similar direct habitat protection impact by drawing subsistence users away from oil-damaged areas to unimpacted areas, allowing undisturbed recovery of the oiled areas; however, this would be a short-term impact that would only be implemented in Prince William Sound. Options 33 and 34 would indirectly impact intertidal habitat by providing the public with the knowledge of how they can help speed recovery of the impacted areas. This impact would be long-term because these options would produce permanent facilities throughout the spill zone to disseminate this information. Option 12 would adversely impact the intertidal zone throughout the spill zone on a long-term basis by allowing activity in oil-damaged areas that were previously not high activity areas.

The impacts that would reduce mussel population would be indirect and short-term, lasting only until a stable predator species population is reached. The impacts associated with habitat recovery and protection would be of moderate magnitude, occuring throughout the spill zone, but only affecting localized areas. The potential for recovery would be high in the localized areas, but the overall magnitude of recovery would be moderate. Alternative 5 would implement more options than the other alternatives, at an equal or greater level of funding, except for Options 37 and 40 which would be allocated fewer funds than would be allocated to these options in the other alternatives. However, the funding for Options 37 and 40 (in Alternative 5) would be much greater than the funding for any of the other options in Alternative 5, and as a result, the magnitude of the impacts of Alternative 5 would remain moderate.

Subtidal Organisms

Alternative 1 - No Action Alternative

Under the No Action Alternative, the subtidal habitat and its organisms would continue to recover naturally. None of the effects of the options described would be realized.

Alternative 2 - Habitat Protection

Options 37 and 40 would impact the subtidal zone through habitat acquisition and protection and special land designations. Although Alternative 2 allocates more funds to habitat protection and acquisition than the other alternatives, the impacts would be of low magnitude because the subtidal zone is believed to have already recovered and it is unlikely that habitat acquisition and protection would further enhance the subtidal zone.

Alternative 3 - Limited Restoration

Option 13 would indirectly impact subtidal organisms in an adverse manner because more oil may temporarily be available to subtidal organisms during the mussel bed cleaning process. Option 13 would also have an indirect, positive impact on subtidal organisms by cleaning up the mussel beds and making less oil available for bioaccumulation in the long-term. This impact would be long-term and would be implemented throughout the spill zone. Option 14 would have a similar positive, indirect impact by accelerating the recovery of *Fucus* and improving the intertidal habitat, and thus providing a healthier feeding grounds for certain subtidal organisms. Option 30 would produce an indirect, adverse impact on the shallow subtidal mussel population from greater subsistence use. Option 30 would be implemented throughout the spill zone. Options 37 and 40 would impact the subtidal zone through habitat acquisition and protection and special land designations. These options would be implemented throughout the spill zone. Option 49 would also protect habitat impact by drawing subsistence users away from oil-damaged areas to unimpacted areas, allowing undisturbed recovery of the oiled areas, albiet on a short-term basis that wouldbe implemented only in Prince William Sound. The indirect impact from Option 13 would have a low magnitude because even though the option would be implemented throughout the spill zone, it would affect only localized areas. The impacts that result from habitat acquisition, protection, and recovery would be of low magnitude because the subtidal zone appears to have recovered from the spill damage; therefore, it is unlikely that further recovery would occur.

Alternative 4 - Moderate Restoration

The options in Alternative 4 that could impact the subtidal environment would be identical to those in Alternative 3. Alternative 4 differs from Alternative 3 only in the amount of funding dedicated to habitat protection and acquisition in Options 37 and 40 (less funding in Alternative 4). Consequently, the impacts that result from habitat acquisition, protection, and recovery would be of low magnitude because the subtidal zone is believed to have recovered from the spill, and it is unlikely that further enhancement would occur.

Alternative 5 - Comprehensive Restoration

Option 13 would have an indirect, adverse impact on subtidal organisms because more oil may temporarily be available to subtidal organisms during the mussel bed cleaning process. Option 13 would also have an indirect, positive impact on subtidal organisms by cleaning up the mussel beds and eventually making less oil available for bioaccumulation. This impact would be long-term and would be implemented throughout the spill zone. Option 14 would have a similar positive, indirect impact by accelerating the recovery of *Fucus* and improving the intertidal habitat, and thus providing a healthier feeding grounds for subtidal organisms that may feed in the intertidal zone. Option 30 would produce an indirect, adverse impact on the shallow subtidal mussel population by reducing the population from greater subsistence use. Option 30 would be implemented throughout the spill zone. Option 34 would indirectly impact the subtidal habitat by providing the public with the knowledge to help speed recovery of the impacted areas. Option 34 would produce a long-term impact because it would establish permanent facilities throughout the spill zone to disseminate this information. Options 37 and 40 would impact the subtidal zone through habitat acquisition and protection and special land designations. These options would be implemented throughout the spill zone. Option 49 would have a similar direct habitat protection impact by drawing subsistence users away from oil-damaged areas to unimpacted areas, allowing undisturbed recovery of the oiled areas; however, this would be a short-term impact that would only be implemented in Prince William Sound.

The indirect impact from Option 13 would have a low magnitude because even though the option would be implemented throughout the spill zone, it would only be implemented in localized areas. The impacts that would result from habitat acquisition, protection, and recovery would also be of low magnitude because the subtidal zone is believed to have already recovered from spill damage, making further recovery unlikely. Alternative 5 includes the greatest amount of options that could impact the subtidal zone in a positive, indirect manner; however, most of the funding would be allocated to habitat protection and acquisition.

B. Services

1. Subsistence

Alternatives 3,4, & 5

Option #18 (Replace Subsistence Opportunities by Creating New Salmon Runs)

This option entails starting new salmon runs to replace fishing opportunities lost due to closure resulting from the oil spill. This option restores services by providing replacement harvests, but does not restore injuries by providing replacement, but does not restore injuries suffered by impacted fish species.

Potentially, commercial, sport, and subsistence fishermen could benefit.

Terminus runs originating from and returning to hatcheries or remote release sites would be started. Returning fish would be harvested and brood stock would be used to artificially propagate the next generation. Alaska Department of Fish and Game standards and requirements for genetic and disease screening and brooding stock selection would be met. Planning concerns include avoiding harmful interactions with wild stock and interceptions of existing stock.

The goal of this option is to minimize additional injury to user groups by providing alternative fishing opportunities when historical fishing areas are restricted. Fishing pressures could be redirected to target these new runs until injured stocks recover. In addition, this option could enhance fishing opportunities above pre-spill levels.

Alternatives 3,4, & 5

Option #30 (Test Subsistence Foods for Hydrocarbon Contamination)

This option addresses the need to restore the confidence of subsistence suers in the safety of subsistence resources. To date, there is a continued reluctance of subsistence harvesters to harvest and consume food resources perceived as contaminated by the oil spill. As a result, only limited recovery of pre-spill subsistence levels has occurred. This option involves the monitoring of hydrocarbon levels in selected subsistence species, communicating findings to subsistence harvesters, and integrating the findings of other studies of oil-spill related injuries into previously developed health advice.

Community participation in all aspects of this option is necessary to ensure its credibility and results. The goal of this option is to restore the confidence of subsistence users in the safety of traditional foods. Although the overall restoration monitoring may serve to scientifically define the "edibility" of subsistence foods, involvement of the impacted community representatives in the sampling, testing, and analysis processes may help to overcome the hydrocarbon contamination health risks perceived by subsistence harvesters. The results of tests and findings from the full range of damage assessment and restoration studies will be interpreted by the Oil Spill Health Task Force and reported to the communities in an informational newsletter and by community visits.

Only limited recovery to pre-spill subsistence harvest levels has occurred. Communities continue to be concerned about the long-term health effects of using resources from the spill area. By involving the community in subsistence resource recovery monitoring and then presenting the results of monitoring at the community level, it is hoped that this option will stimulate the return of

subsistence harvest to pre-spill levels and will reduce subsistence harvesters' anxiety about the safety of these resources.

Alternatives 3,4, & 5

Option #49 (Provide Subsistence Users Access to Traditional Foods)

This option would provide transportation funds for subsistence harvesters from areas that have experienced declines in the subsistence resources or suspect contamination of these resources due to the oil spill. In addition, funds would be provided to allow people in other subsistence communities to assist the impacted communities by gathering, preserving, and sending subsistence foods.

The continuation of subsistence harvest activities would help ensure that traditional hunting skills and culturally important harvesting and sharing practices would not be diminished. The option would improve subsistence recovery by providing traditional subsistence foods to villages for which they are not readily available. The provision of transportation funding would continue until subsistence resources are no longer contaminated, populations have recovered from oil spill-related injuries, and foods are no longer perceived to be contaminated.

Alternative 5

Options 50, 50.1, and 50.2 involve interrelated and interdependent activities.

Option #50 (Subsistence Harvest Opportunities for Bivalve Shellfish)

This option would provide the facilities and the infrastructure to restore, replace, and/or enhance affected bivalve shellfish populations, such as mussels and clams, affected by the oil spill and the cleanup efforts. Facilities and infrastructure to restore, replace, and/or enhance affected shellfish populations would be provided. Particular emphasis would be placed on the replacement and/or enhancement of shellfish used for subsistence.

Option #50.1 (Develop Subsistence Mariculture Sites)

This option funds the development of shellfish mariculture in subsistence communities. Cultivated species would include oysters, mussels, scallops, and a variety of clams. The cultivated shellfish would be used to supplement subsistence harvests as a replacement for traditional foods contaminated by the spill.

Some villages have begun to develop oyster mariculture, using imported oyster seed. Existing operations could be expanded to include more sites. In addition, Alaskan species of clams, mussels, and scallops could be cultivated if readily available

shellfish seed and knowledge of species growing requirements could be acquired. The lack of available shellfish seed and cultivation knowledge could prove an impediment to the success of this option. Option 50.2 proposes a shellfish hatchery and research center that would complement this option.

Option #50.2 (Bivalve Shellfish Hatchery and Research Center)

This option uses concepts already developed for the Seward shellfish hatchery and the Alaska Fish and Game Mariculture Technical Center. Engineering and biological expertise will be retained to conduct a feasibility analysis of the project. If construction funds are approved at a later date, direct restoration, replacement, and/or enhancement of bivalve shellfish will be accomplished via an onshore production hatchery operated by the private sector using technology developed at a State-operated research center. The hatchery will provide seed stock for mariculture operations or the re-seeding of beaches.

Shellfish farming in subsistence communities will provide a food source to replace traditional food sources that were contaminated or reduced by the oil spill, or are perceived to be unsafe to eat. Farmed shellfish can be a replacement for contaminated shellfish or for other types of traditional foods that are less available because of the spill. The replacement of wild shellfish by cultivated shellfish might help to speed recovery of beach ecosystem and provide a food source for multiple species.

2. Commercial Fishing

Alternative 1 - No Action Alternative

Under the No Action Alternative, commercial fishing would continue as it is currently practiced. Consequently, none of the effects related to the various options described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, over 90 percent of the restoration funds would be used to implement Options 37 and 40. Both of these options, which protect and acquire habitat (Option 37), and establish special land designations (Option 40) would indirectly benefit commercial fishing by protecting the habitat required for the spawning and rearing of fish, which could lead to increases in the numbers of fish harvested commercially. The extent of the impact from implementing this alternative would be large, including the entire oil spill area. The duration of the impacts would be long-term, assuming that the protection afforded habitat acquired for the public domain is held by the public and managed to promote healthy ecosystems in perpetuity. Because the extent and duration of the impacts are large and wide-spread, and a large financial commitment is being made, the magnitude of the impacts of this

alternative could be high, creating long-term, positive benefits to commercial fishing by insuring the necessary habitat to maintain healthy fish stocks in the oil spill area.

Alternative 3 - Limited Restoration

Options affecting commercial fishing in this alternative include Options 2, 4, 9, 11, 12, 37, 40, 45, 46, 48, and 51. Options 2, 11, 37, 40, 48, and 51, would benefit commercial fishing either directly or indirectly by ultimately increasing the number of fish available for commercial harvest. Option 2 would affect only central Cook Inlet, and 11, only north PWS. Options 37 and 40 would be implemented throughout the oil spill area and would have a major emphasis places on them, with 75 percent of the restoration funds being used for these two options. Option 48 would involve relatively few projects (possibly 4), and only in central Cook Inlet (Kenai River system), and Kodiak Island (Red Lake system). Option 51 would affect commercial fishing only in PWS. Options 9, 45, and 46 would have direct, adverse impacts on commercial fishing because of potential regulatory controls that would have economic consequences associated with changing existing methods of fishing. Option 4, and 12 would have an adverse, indirect impact on commercial fishing because of restrictions placed on areas where fishing can occur, or because of conflicts with recreational boaters.

By far the greatest emphasis of Alternative 3 is on the habitat acquisition and protection, Options 37 and 40. As in Alternative 2, this emphasis can have long-term, positive impacts to commercial fishing by increasing fish populations available for harvest. This in turn increases the potential to increase income for commercial harvesters and processors.

Alternative 4 - Moderate Restoration

The options included in Alternative 4 that affect commercial fishing are Options 2, 4, 11, 12, 18, 37, 40, 45, 46, 48, and 51. Options 2, 11, 18, 37, 40, 48, and 51 have either direct or indirect, positive impacts on the commercial fishery by increasing the number or availability of fish for harvesting. Option 2 would lead to increases in the stocks of herring and pink salmon in PWS, rockfish in PWS and in lower Cook Inlet and outer Kenai Peninsula, and sockeye salmon in central Cook Inlet. Option 11 would lead to increases in the number of sockeye for harvest in north PWS and Kodiak Island. Option 18 would be geared toward increasing salmon available for harvest in PWS, Kodiak/Afognak, and in Cook Inlet, while 37 and 40 would lead to increases in harvestable fish throughout the oil spill area. Option 48 would ultimately lead to increases in the number of salmon available for harvest in central Cook Inlet, and 51 would increase salmon harvest opportunities in PWS. Options 4, 9, 12, 45 and 46 would have either direct or indirect, adverse economic impacts on commercial fisheries in various locations throughout the oil spill area. However, as with

Alternatives 2 and 3, Alternative 4 devotes most of the available restoration funds (approximately 50 percent) to the protection and acquisition of habitat. As noted previously, this can have positive, long-term impacts to commercial fishing through long-term maintenance of spawning and rearing habitat necessary to maintain fish stocks throughout the oil spill area.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes the most options affecting commercial fishing. It includes Options 2, 4, 9, 11, 12, 18, 19, 37, 40, 45, 46, 48, and 51. The effects of each of these option has been described previously in this chapter. As a consequence of the larger number of options affecting commercial fishing, a larger amount of the restoration fund (48 percent) is being proposed for implementing restoration options in addition to habitat acquisition and protection (Options 37 and 40), than in Alternatives 2, 3, or 4. Habitat protection is still the major focus of Alternative 5 (35 percent of total funding), as it is with all the alternatives, but there is a greater mix of options affecting commercial fishing in 5 than in any other Alternative.

Because of the greater mix of options in Alternative 5, the intensity or magnitude of impacts to commercial fishing would be distributed among a greater number of resources and services affecting a larger portion of the oil spill area. Alternative 5 is more proactive than any of the other alternatives, and has the greatest number of options that have indirect, positive impacts on commercial fishing.

3. Commercial Tourism

Alternative 1 - No Action Alternative

The No Action Alternative does not involve implementation of any option. Under this alternative, commercial tourism would continue as it is currently practiced. None of the effects related to the various options as described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, only Options 37 and 40 would be implemented. Over 90 percent of the funds would be used to implement these options. Both of these options entail acquisition of habitat for enhancing the ecosystem in the oil spill region. Implementation of these options would indirectly benefit commercial tourism because healthier ecosystems resulting from enhanced protection would attract more tourists who, in turn, would create demand for tourism-related goods and services. The extent of impact from implementing this alternative would be large, including the entire oil spill area. The duration of the impacts would be long-term, assuming that the habitat protection through special designation and acquisition is continued in perpetuity. Because

the extent and the duration of the impacts are wide-spread and large, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to commercial tourism.

Indirect, negative impacts would also occur on commercial tourism from implementation of this alternative because habitat protection and special designations would limit human use of the area and, consequently, fewer people would be visiting these areas. This would create lesser demand on tourism-related goods and services. The extent of this impact would be wide-spread, occurring throughout the oil spill region. However, the duration of the impact would be short-term, assuming that the restrictions would be removed after the ecosystem is restored. Therefore, the magnitude of the short-term impact would be low.

Alternative 3 - Limited Restoration

Options affecting recreation under this alternative include Options 4, 9, 10, 12, 16, 17, 37, and 40. Options 4, 9, 16, and 17 would indirectly benefit tourism throughout the oil spill area by ultimately increasing the population of marine birds and associated bird watching opportunities which, in turn, would create demand for additional charter and tour-boat services and cruises. Option 10 would benefit tourism by creating demands for tour guides, visitor information booths, and other tourism-related services associated with visiting archeological attractions. Option 12 would have direct, positive impacts on commercial tourism by constructing new commercial recreational facilities that would attract more tourists throughout the oil spill area. By far the greatest emphasis of Alternative 3 is on the habitat acquisition and protection, Options 37 and 40, with 75 percent of the restoration funds being used to implement these two options. As in Alternative 2, emphasis on this approach to restoration could have a long-term, positive impact to commercial tourism by protecting habitat that would result in healthier ecosystems and ultimately attract more tourists.

Alternative 4 - Moderate Restoration

This alternative includes Options 4, 9, 10, 12, 16, 17, 35, 37 and 40. The impacts on commercial tourism from implementation of this alternative would be direct and indirect, long-term, positive and short-term, negative as described previously. In addition to all the options identified in Alternative 3, Option 35 is included in this alternative. Option 35 would produce indirect, long-term, positive impacts on tourism. As with Alternatives 2 and 3, Alternative 4 devotes most of the available restoration funds (approximately 50 percent) to the protection and acquisition of habitat. This would have long-term, positive benefits to commercial tourism as discussed previously.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes implementation of all the options (4, 9, 10, 12, 16, 17, 19, 33, 34, 37, and 40) affecting commercial tourism. Options 19, 33, and 34 are the options that are not included in other alternatives. Option 19 would be implemented in PWS and Kodiak/Afognak areas and would produce indirect, long-term, positive impacts on commercial tourism. Options 33 and 34 would have direct, positive impacts on commercial tourism by attracting tourists and creating demands for tourism-related goods and services. Since a larger number of options (Options 4, 9, 10, 12, 17, 19, 33, 34, and 35), in addition to the habitat protection options (Options 37 and 40), affect commercial tourism under Alternative 5, as compared with Alternative 2, 3, or 4, a larger amount of the restoration funding (48 percent) is being proposed for implementing these options under Alternative 5. Habitat protection is still the major focus of Alternative 5 (35 percent of total funding), as it is with all the alternatives, but there is a greater mix of options affecting commercial tourism in Alternative 5 than in any other alternative.

4. Recreation

Alternative 1 - No Action Alternative

The No Action Alternative does not involve implementation of any option. Under this alternative, recreation would continue as it is currently practiced. None of the effects related to the various options as described in this chapter would occur.

Alternative 2 - Habitat Protection

Under this alternative, only Options 37 and 40 would be implemented. Over 90 percent of the funds would be used to implement these options. Both of these options entail habitat protection for providing enhanced recreational opportunities throughout the oil spill region and directly benefit recreation by acquiring habitats for developing recreational sites. The extent of impact from implementing this alternative would be large, including the entire oil spill area. The duration of the impacts would be long-term, assuming that the habitat protection through special designation and acquisition is afforded in perpetuity. Because the extent and the duration of the impacts are wide-spread and large, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to recreation by protecting the necessary habitat to promote developed and non-developed recreation.

Indirect, negative impacts to recreation would also occur from implementation of this alternative because habitat protection and special designations may involve posing restrictions on certain recreational activities that otherwise occurred on these lands. The extent of this impact would be wide-spread, occurring throughout the oil spill region. However, the duration of the

impact would be short-term, assuming that the restrictions would be removed after the population of the targeted injured species have recovered. Therefore, the magnitude of the short-term impact would be low.

Alternative 3 - Limited Restoration

Options affecting recreation in this alternative include Options 4, 9, 10, 12, 16, 17, 37, and 40. Options 4, 9, 16, and 17 would indirectly benefit recreation throughout the oil spill area by ultimately increasing the population of marine birds and associated bird watching opportunities. Option 10 would benefit recreation by preserving archeological sites and artifacts that would attract visitors. Option 12 would have direct, positive impacts on recreation by constructing new recreational facilities throughout the oil spill area. By far the greatest emphasis of Alternative 3 is on habitat acquisition and protection, Options 37 and 40, with 75 percent of the restoration funds being used to implement these two options. As in Alternative 2, emphasis on this approach to restoration would have long-term, positive impacts to recreation.

Alternative 4 - Moderate Restoration

This alternative includes Options 4, 9, 10, 12, 16, 17, 35, 37, and 40. The impacts on recreation from implementation of this alternative would be direct and indirect, long-term, positive and short-term, negative as described previously. In addition to all the options identified in Alternative 3, Option 35 is included in this alternative. Option 35 would produce indirect, long-term, positive impacts on recreation. As with Alternatives 2 and 3, Alternative 4 devotes most of the available restoration funds (approximately 50 percent) to the protection and acquisition of habitat. This would have long-term, positive benefits to recreation as discussed previously.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes implementation of all the options (4, 9, 10, 12, 16, 17, 19, 33, 34, 37, and 40) affecting recreation. Options 19, 33, and 34 are the only options under this alternative that are not included in other alternatives. Option 19 would be implemented in PWS and Kodiak/Afognak areas and would produce indirect, long-term, positive impacts on recreation. Options 33 and 34 would have direct, positive impacts on recreation by attracting visitors. Since a larger number of options (Options 4, 9, 10, 12, 17, 19, 33, 34, and 35), in addition to the habitat protection options (Options 37 and 40), affect recreation under Alternative 5 as compared with Alternative 2, 3, or 4, a larger amount of the restoration funding (48 percent) is being proposed for implementing these options under Alternative 5. Habitat protection is still the major focus of Alternative 5 (35 percent of total funding), as it is with all the

alternatives, but there is a greater mix of options affecting recreation in Alternative 5 than in any other alternative.

5. Sport Fishing and Hunting

Sport Fishing

Alternative 1 - No Action Alternative

The No Action Alternative does not involve implementation of any option. Under this alternative, sport fishing would continue as it is currently practiced. None of the effects related to the various options described in the above section would occur.

Alternative 2 - Habitat Protection

Under this alternative, only Options 37 and 40 would be implemented. Over 90 percent of the restoration funds would be used to implement these options. Both of these options entail habitat protection associated with rearing and spawning of fish species that could potentially increase the population of these species in the long-term and, therefore, indirectly benefit sport fishing. The extent of the impact from implementing this alternative would be large, including the entire oil spill area. The duration of the impacts would be long-term assuming, that the habitat protection through special designation and acquisition is afforded in perpetuity or until a self-sustaining population is reached. Because the extent and the duration of the impacts are wide-spread and large, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to sport fishing by protecting the necessary habitat to maintain a healthy population of fish.

Indirect, negative impacts would also occur on sport fishing from implementation of this alternative because habitat protection and special designations may involve posing additional sport fishing restrictions (that did not exist prior to the acquisition or designation) on these lands in an effort to increase the injured species population. The extent of this impact would be wide-spread, occurring throughout the oil spill region. However, the duration of the impact would be short-term, assuming that the restrictions would be removed after the population of the injured species reached levels determined by the management agencies to be acceptable for harvest. Therefore, the magnitude of the short-term impact would be low.

Alternative 3 - Limited Restoration

Options affecting sport fishing under this alternative include Options 2, 4, 11, 12, 18, 37, 40, 48, and 51. Options 2, 11, 18, 37, 40, 48, and 51, would benefit sport fishing either directly or

indirectly by ultimately increasing the population of fish. Option 2 would affect only central Cook Inlet, and Option 11, only north PWS. Options 37 and 40 would be implemented throughout the oil spill area and would have a major emphasis placed on them, with 75 percent of the restoration funds being used for these two options. Option 18 would involve 5 projects throughout the oil spill area. Option 48 would involve 4 projects, only in central Cook Inlet (Kenai River system) and Kodiak Island (Red Lake system). Option 51 would affect commercial fishing only in PWS. Option 4 would have an adverse, indirect impact on sport fishing because of restrictions placed on areas where fishing can occur, and Option 12 would have a direct, positive impact on sport fishing because of construction of new facilities that would improve access to sport fishing locations.

By far the greatest emphasis of Alternative 3 is on the habitat acquisition and protection, Options 37 and 40, with 75 percent of the restoration funds being used to implement these two options. As in Alternative 2, emphasis on this approach to restoration can have long-term, positive impacts to sport fishing by increasing species population available for fishing. The short-term, negative impacts from implementation of these options would occur because of increased temporary restrictions on sport fishing.

Alternative 4 - Moderate Restoration

This alternative includes Options 2, 4, 11, 12, 18, 37, 40, 48, and 51, and is similar to Alternative 3. The impacts on sport fishing implementation of this alternative would be direct and indirect, long-term, positive and long- and short-term, negative as described previously. In Alternative 4, the affects of Option 2 would be realized in PWS and Kenai/Cook Inlet areas. As with Alternatives 2 and 3, Alternative 4 devotes most of the available restoration funds (approximately 50 percent) to the protection and acquisition of habitat. This can have long-term, positive benefits to sport fishing by enhancing the population of fish and associated sport fishing opportunities.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes implementation of all the options (2, 4, 11, 12, 18, 19, 37, 40, 48, and 51) affecting sport fishing. Option 19 is the only option under this alternative that is not included in other alternatives. Option 19 would be implemented in PWS and Kodiak/Afognak areas and would produce indirect, long-term, positive impacts on sport fishing by enhancing the population of anadromous fish species. Since a larger number of options (Options 2, 4, 11, 12, 18, 19, 48, and 51) besides the habitat protection options (Options 37 and 40) affect sport fishing under Alternative 5, as compared with Alternative 2, 3, or 4, a larger amount of the restoration funding (48 percent) is being proposed for implementing these options under Alternative 5. Habitat protection is still the major focus of Alternative 5 (35 percent of total funding), as it

is with all the alternatives, but there is a greater mix of options affecting sport fishing in Alternative 5 than in any other alternative.

Sport Hunting

Alternative 1 - No Action Alternative

The No Action Alternative does not involve implementation of any options. Under this alternative, sport hunting would continue as it is currently practiced. None of the effects related to the various options described in the above section would occur.

Alternative 2 - Habitat Protection

Under this alternative, only Options 37 and 40 would be implemented. Over 90 percent of the funds would be used to implement these options. Both of these options entail habitat protection associated with game species that could potentially increase the population of these species in the long-term and, therefore, indirectly benefit sport hunting. The extent of impact from implementing this alternative would be large, including the entire oil spill area. The duration of the impacts would be long-term, assuming that the habitat protection through special designation and acquisition is afforded in perpetuity. Because the extent and the duration of the impacts are wide-spread and large, and a large financial commitment is being made, the magnitude of the impacts of this alternative could be high, creating long-term, positive benefits to sport hunting by protecting the necessary habitat to maintain a healthy population of game species.

Indirect, negative impacts would also occur on sport hunting from implementation of this alternative because habitat protection and special designations may involve posing additional sport hunting restrictions (that did not exist prior to the acquisition or designation) on these lands in an effort to increase the injured game species population. The extent of this impact would be wide-spread, occurring throughout the oil spill region. However, the duration of the impact would be short-term, assuming that the restrictions would be removed after the population of the injured species have reached a significant management level. Therefore, the magnitude of the short-term impact would be low.

Alternative 3 - Limited Restoration

Options affecting sport hunting in this alternative include Options 12, 37, and 40. All of these options would be implemented throughout the oil spill area. Option 12 would have indirect, long-term, positive impacts on sport hunting by making cabins and other facilities available for use by the hunters. This option would also have an indirect, long-term, negative impact on sport hunting because of conflicts with increased recreationists in the same area. By far the greatest emphasis of Alternative 3 is on the

habitat acquisition and protection, Options 37 and 40, with 75 percent of the restoration funds being used to implement these two options. As in Alternative 2, emphasis on this approach to restoration can have a long-term, positive impact to sport hunting by increasing game species population available for hunting. The short-term, negative impacts from implementation of these options would occur because of increased temporary restrictions on sport hunting of certain game species.

Alternative 4 - Moderate Restoration

This alternative also include Options 12, 37, and 40 similar to Alternative 3. The impacts on sport hunting from implementation of this alternative would be indirect, long-term, positive and long- and short-term, negative as described previously. As with Alternatives 2 and 3, Alternative 4 devotes most of the available restoration funds (approximately 50 percent) to the protection and acquisition of habitat. This can have long-term, positive benefits to sport hunting by enhancing the population of game species and associated sport hunting opportunities.

Alternative 5 - Comprehensive Restoration

Alternative 5 includes implementation of all the options (8, 12, 37, and 40) affecting sport hunting. All the options would have indirect or direct, long-term, positive impacts on sport hunting. In addition, Options 8, 12, 37, and 40 would produce short- or long-term, negative impacts on recreation as described previously. Since a larger number of options (Options 8 and 12), besides the habitat protection options (Options 37 and 40) affect sport hunting under Alternative 5, as compared with Alternative 2, 3, or 4, a larger amount of the restoration fund (48 percent) is being proposed for implementing these options under Alternative 5. Habitat protection is still the major focus of Alternative 5 (35 percent of total funding), as it is with all the alternatives, but there is a greater mix of options affecting sport hunting in Alternative 5 than in any other alternative. Alternative 5 is also the only alternative that includes Option 8, that has direct, positive impacts on sport hunting.

Economic Impacts

As noted in the Analytical Tools section of Chapter II, the Forest Service's IMPLAN economic computer model was used to perform an economic impact assessment identifying the economic impacts of implementing each of the proposed *EVOS* Restoration Plan alternatives. Because Alternative 1 is the No Action Alternative, it is reflected in the "baseline" condition against which the impacts of Alternatives 2-5 are compared.

IMPLAN estimates change in income and employment as the product of the demand change (e.g., and alternative) and a multiplier. Estimating multipliers requires data and a description of the regional economy. The data are the national input-output matrices that show the dollar volume of transactions among industries and final demand. The national matrices are stepped-down to the county/borough level by using county population and employment data, and ratios of employment to output. The boroughs and census areas included in this assessment are the Municipality of Anchorage, Kenai Peninsula Borough, Kodiak Island Borough, Lake and Peninsula Borough, and the Valdez-Cordova Census Area. At present, the benchmark national data is for 1990.

The key assumptions in the IMPLAN economic assessment are that there is one output for each industry and each industry has one output; there is a fixed formula for making commodities and there can be no substitutions; there are only constant returns to scale (i.e., to make twice as much of something all inputs are doubled); adjustments are instantaneous and timeless and technology does not change.

IMPLAN's output classification system is based on systems defined by the Bureau of Economic Analysis (BEA-Department of Commerce) and the Standard Industrial Classification (SIC) used by the Office of Management and Budget. The analysis is conducted using 528 industries and the results are aggregated into 10 sectors. The 10 sectors are as follows:

1. Agriculture, Forestry and Fishing - These businesses engage in agricultural production, forestry, commercial fishing, hunting and trapping and related services. Agricultural production firms produce crops and livestock. Forestry firms operate timber tracts, tree farms, forest nurseries or perform forestry services. Fishing, hunting and trapping covers commercial fishing, fish hatcheries, fish and game preserves and commercial hunting and trapping.

2. Mining - These businesses extract minerals occurring naturally. Mining includes quarries, wells, milling and other preparations commonly done at mine site.

3. Construction - These businesses build new work, additions, alterations and repairs.

4. Manufacturing - These businesses mechanically or chemically transform materials or substances into new products. The materials and substances are produced by other sectors (e.g., agricultural, forests and fisheries) or other manufacturers.

5. Transportation, communication and utilities - These businesses provide to the public or to other businesses passenger and freight transportation, communication services, electricity, gas, steam, water or sanitary services. The U.S. Postal Service is included here.

6. Trade - These businesses retail merchandise to households or wholesale it to retailers; other wholesalers; to other businesses; or act as agents or brokers in buying or selling goods.

7. Finance, Insurance and Real Estate - These businesses engage in the fields of finance, insurance and real estate.

8. Services - These businesses provide a variety of services for individuals, businesses, governments, and other organizations. Examples include hotels, amusements, health, legal, engineering and other professional services.

9. Government - This sector includes the legislative, judicial, administrative and regulatory activities of Federal, State, local and international governments. Government-owned businesses are classified according to the activity in which they are engaged.

10. Misc. Special Services - These cannot be classified in any other industry.

For each Restoration Plan alternative, the amount of funds allocated for each expenditure is divided among restoration activities and the economic sector participating in those activities, as follows:

Administration and public information - Federal and State and local government

Monitoring and research - Federal and state and local government and universities

General restoration - State and local government, private fisheries and construction

Habitat protection - Forestry, real estate, households

Respending of Habitat Protection - Securities, social services, construction, households

The last category "Respending of Habitat Protection" does not appear in the Summary. It is part of the modeling exercise. Habitat purchases put dollars in the hands of resource owners. This category specifies a spending pattern for these funds that saves/invests part (securities, construction) and consumes part (social services).

By inputing the various allocation of expenditures into the IMPLAN model, different measures of economic performance (output) are produced. For the purposes of this economic impact analysis, six measures of economic performance are reported. Final demand represents regional purchases of goods and services. Industry output represents the regional supply of goods and services. The difference between regional supply and demand is accounted for by regional imports and exports. Value added represents the costs added within the region to produce industry output. Employee compensation and property income are its two key components. Employment is the number of man-year equivalents to produce industry output.

Table IV-B represents the "baseline" condition of the regional economy, which depicts the No Action Alternative. Tables IV-C, D, E, and F show the economic impact on the regional economy from the implementation of the *EVOS* Restoration Plan Alternatives 2 through 5.

Alternatives 2-5 show decreases in the agricultural, forest and fishery sector and increases in the construction, trade, finance, services and government sectors. The sectoral changes reflect (1) the purchase of commercial timberland for habitat preservation, (2) the spending of the sale proceeds, and (3) the spending of the remainder of the settlement for other goods and services. Thus, the results indicate that the spending alternatives may change the economy's reliance on specific sectors.

A limitation of these results and those from any economic analysis is that only market commodities are included and they are valued at market prices. Non-market activities such as barter; subsistence fishing/hunting; experiences whose price is essentially zero; or the willingness-to-pay for the simple existence of wilderness is not addressed. The implication of this is simply that economic analysis should be supplemented with other, non-market analyses.

Table IV-B. Baseline economic conditions used for the economic impact assessment of *EVOS* Restoration Plan alternatives implementation.

Base	Analysis of Alternatives 1990$ Millions					
Economic Sector	Final Demand $	Industry Output $	Employee Comp. $	Property Income $	Value Added $	Employment #
Agriculture, Forest and fisheries	340.7	462.1	28.1	151.3	189.6	8,091
Mining	6,061.0	6,199.0	502.4	2,835.3	4,745.4	6,335
Construction	1,246.1	1,420.3	495.1	363.9	861.9	11,751
Manufacturing	948.6	1,072.4	226.5	82.0	319.5	7,655
Transportation, communication and Utilities	1,933.3	2,265.9	543.7	768.5	1,405.1	13,795
Trade	1,125.7	1,252.6	752.6	138.2	1,035.4	33,790
Finance, insurance, and real estate	988.3	1,137.4	245.4	337.3	734.1	11,329
Services	2,018.0	2,514.4	944.9	546.2	1,507.8	48,779
Government	2,105.6	2,151.5	1,934.2	76.5	2,010.7	46,428
Misc. Special sectors	44.5	12.3	0.0	33.4	33.4	0
Total	16,811.8	18,487.9	5,673.1	5,332.7	12,843.0	187,953

Table IV-C. Economic impact on the regional economy from the implementation of *EVOS* Restoration Plan Alternative 2.

Alternative 2	Change from Base for direct, indirect and induced effects from 10 yrs of: Administration, monitoring, restoration, habitat purchase w/respending.					
Economic Sector	Final Demand $	Industry Output $	Employee Comp. $	Property Income $	Value Added $	Employment #
Agriculture, Forest and fisheries	-31.9767	-38.8218	-8.219	-5.2829	-14.6414	-440.02
Mining	0.0652	-0.0427	-0.0034	-0.0197	-0.0328	-0.04
Construction	8.0662	7.3758	2.7049	1.0998	3.8239	64.66
Manufacturing	0.0616	-0.6096	-0.0972	-0.0279	-0.1422	-1.32
Transportation, communication and Utilities	0.1525	0.1721	0.0474	0.0728	0.1219	1.24
Trade	0.5303	0.2352	0.1158	0.0241	0.1489	9.08
Finance, insurance, and real estate	2.5531	2.3244	0.5857	0.1628	0.7877	52.09
Services	6.0367	2.8359	4.6217	-1.1249	3.5008	959.44
Government	0.8094	0.6767	0.7299	-0.0189	0.7109	13.75
Misc. Special sectors	0	0	0	0	0	0
Total	-13.7017	-25.854	0.4858	-5.1148	-5.7223	658.88

Table IV-D. Economic impact on the regional economy from the implementation of *EVOS* Restoration Plan Alternative 3.

Alternative 3	Change from Base for direct, indirect and induced effects from 10 yrs of: Administration, monitoring, restoration, habitat purchase w/respending.					
Economic Sector	Final Demand $	Industry Output $	Employee Comp. $	Property Income $	Value Added $	Employment #
Agriculture, Forest and fisheries	-26.5006	-32.6154	-7.2206	-4.1676	-12.4089	-329.49
Mining	0.0580	0.0007	0.0001	0.0003	0.0005	0
Construction	8.4277	7.8589	2.9088	1.1774	4.1068	69.56
Manufacturing	0.0546	-0.338	-0.0522	-0.0113	-0.0730	-0.67
Transportation, communication and Utilities	0.1355	0.2274	0.0674	0.0847	0.1555	1.85
Trade	0.4721	0.3111	0.1675	0.0367	0.2287	9.90
Finance, insurance, and real estate	2.0637	1.8532	0.4635	0.1320	0.6307	41.33
Services	5.1646	2.5365	3.7855	-0.8371	2.9552	766.79
Government	1.5449	1.438	1.4781	-0.0141	1.4637	27.58
Misc. Special sectors	0	0	0	0	0	0
Total	-8.5795	-18.7276	1.5981	-3.599	-2.9408	586.85

Table IV-E. Economic impact on the regional economy from the implementation of *EVOS* Restoration Plan Alternative 4.

Alternative 4	Change from Base for direct, indirect and induced effects from 10 yrs of: Administration, monitoring, restoration, habitat purchase w/respending.					
Economic Sector	Final Demand $	Industry Output $	Employee Comp. $	Property Income $	Value Added $	Employment #
Agriculture, Forest and fisheries	-19.6192	-24.7403	-5.8949	-2.8028	-9.5563	-196.74
Mining	-0.0049	-0.0071	-0.0006	-0.0033	-0.0055	-0.01
Construction	9.8829	9.4421	3.5334	1.4229	4.9813	84.53
Manufacturing	-0.0043	-0.0838	-0.0118	-0.0005	-0.0150	-0.35
Transportation, communication and Utilities	-0.0111	0.1149	0.0395	0.0411	0.0812	1.24
Trade	-0.0396	-0.0274	-0.0181	-0.0025	-0.0243	-0.62
Finance, insurance, and real estate	0.9571	0.6805	0.1185	0.0569	0.1801	17.08
Services	0.8213	-1.1042	-0.2672	-0.4726	-0.7336	-11.42
Government	3.1135	3.0314	3.0877	-0.0204	3.0674	57.09
Misc. Special sectors	0	0	0	0	0	0

Table IV-F. Economic impact on the regional economy from the implementation of *EVOS* Restoration Plan Alternative 5.

Alternative 5	Change from Base for direct, indirect and induced effects from 10 yrs of: Administration, monitoring, restoration, habitat purchase w/respending.					
Economic Sector	Final Demand $	Industry Output $	Employee Comp. $	Property Income $	Value Added $	Employment #
Agriculture, Forest and fisheries	-10.8969	-14.4444	-3.9257	-1.221	-5.7457	-53.27
Mining	0.0141	0.0792	0.0063	0.0363	0.0606	0.08
Construction	9.5556	9.3257	3.5227	1.4124	4.9598	84.31
Manufacturing	0.0131	0.2471	0.0450	0.0238	0.0739	0.69
Transportation, communication and Utilities	0.0328	0.2939	0.0952	0.0925	0.1937	2.79
Trade	0.1147	0.2920	0.1763	0.0411	0.2579	6.39
Finance, insurance, and real estate	0.7365	0.6119	0.1365	0.0486	0.1993	13.82
Services	1.2018	0.3652	0.2312	-0.0244	0.2187	13.31
Government	4.0410	4.0056	4.0223	-0.0059	4.0162	74.46
Misc. Special sectors	0	0	0	0	0	0
Total	4.8127	0.7762	4.3098	0.4034	4.2344	142.58

Summary of Issues Addressed by Alternatives

The No Action Alternative (Alternative 1) would not change the existing activities in the EVOS region and therefore does not address the issues presented in Chapter I. The following discussion describes how each of the eight issues is addressed by the remaining alternatives (Alternatives 2-5).

Issue 1. Describe the effect of implementation of Alternatives 2 through 5 on local economies and communities.

Under Alternative 2, habitat acquisition would entail precluding substantial parts of the EVOS area from resource exploitation, principally logging. This would have a severe negative, short-term impact on local economies dependent on timber harvesting. In contrast, local economies dependent on tourism and marine resource exploitation (fishing) would benefit from protection of the ecosystem and recovery of fisheries services. In the long-term, sustainable development of EVOS area natural resources would be enhanced by protection of critical habitat areas.

Under Alternative 3, habitat acquisition would have a moderate to severe negative, short-term impact on local economies dependent on timber harvesting. In contrast, local economies dependent on tourism and marine resource exploitation (fishing) would benefit. General restoration activities might involve short-term disruption of some fishing activities, but the long-term recovery of the ecosystem and fisheries services would have a positive impact on all local economies.

Under Alternative 4, habitat acquisition would have a moderate negative, short-term impact on local economies dependent on timber harvesting. In contrast, local economies dependent on tourism and marine resource exploitation (fishing) would benefit. General restoration activities might involve short-term disruption of some fishing activities, but the long-term recovery of the ecosystem and fisheries services would have a positive impact on all local economies.

With implementation of Alternative 5, habitat acquisition would have a moderate negative, short-term impact on local economies dependent on timber harvesting. In contrast, local economies dependent on tourism and marine resource exploitation (fishing) would benefit. General restoration activities might involve short-term disruption of some fishing activities, but the long-term recovery of the ecosystem and fisheries services would have a positive impact on all local economies.

Issue 2. Describe the degree or rate of recovery due to implementation of Alternatives 2 through 5.

Through implementation of Alternative 2, habitat acquisition would not directly increase the rate of recovery beyond the natural rate, but would do the most toward assuring that the natural rate of recovery was achieved for all injured resources combined.

Alternative 3 would enhance the degree or rate of recovery documented under Alternative 2. In addition, general restoration activities would increase the rate of recovery in selected species.

Under Alternative 4, the degree or rate of recovery as documented under Alternatives 2 and 3 would be enhanced, and general restoration activities would substantially increase the rate of recovery in selected species.

In addition to the documented degree or rate of recovery documented in Alternatives 2 through 4, general restoration activities implemented under Alternative 5 would substantially increase the rate of recovery in selected species, in some instances beyond natural levels.

Issue 3. Describe the changes in land use due to implementation of Alternatives 2 through 5.

Acquisition of private land for habitat protection and the special designation of public lands, under Alternative 2, would eliminate existing land uses in areas managed for resource exploitation and preclude future development in a large number of areas.

Under Alternative 3, acquisition of private land for habitat protection and the special designation of public lands would eliminate existing land uses in areas managed for resource exploitation and preclude future development in a moderate to large number of areas.

Acquisition of private land for habitat protection and the special designation of public lands would eliminate existing land uses in areas managed for resource exploitation and preclude future development in a moderate number of areas under Alternative 4.

Under Alternative 5, acquisition of private land for habitat protection and the special designation of public lands would eliminate existing land uses in areas managed for resource exploitation and preclude future development in a small to moderate number of areas.

Issue 4. Describe the effect on non-target resources (biodiversity) and services from implementation of Alternatives 2 through 5.

Habitat acquisition is the principal means for implementing ecosystem management and considering non-target species within the restoration plan for Alternatives 2 through 5.

At the Alternative 2 funding level, there would be a strong positive, direct, long-term effect on biodiversity conservation.

Under the Alternative 3 funding level, there would be a moderate to strong positive, direct, long-term effect on biodiversity conservation.

At the Alternative 4 funding level, a moderate positive, direct, long-term effect on biodiversity conservation would be noted.

At the funding level for Alternative 5, a small to moderate positive, direct, long-term effect on biodiversity conservation would be noted.

Issue 5. Characterize the ecological changes in the spill area resulting from implementation of Alternatives 2 through 5.

Acquisition of private land for habitat protection and placing public lands into special State and Federal land designations would greatly enhance the ecological integrity of the EVOS area and therefore promote only beneficial ecological change under Alternatives 2 through 5.

Additional general restoration activities implemented under Alternatives 3, 4 and 5 would enhance recovery of selected species toward natural ecological conditions.

Issue 6. Describe changes to subsistence uses resulting from implementation of Alternatives 2 through 5.

Acquisition of private land for habitat protection or placing public lands into special State and Federal land designations might restrict subsistence uses on certain lands under Alternative 2.

Under Alternative 3, acquisition of private land for habitat protection or placing public lands into special designations might restrict subsistence uses. However, in contrast, general restoration activities implemented under this alternative would benefit subsistence hunting and fishing through increases in populations of selected species and enhancement of opportunities for subsistence use.

Under Alternative 4, acquisition of private land for habitat protection or placing public lands into special State and Federal land designations might restrict subsistence uses on certain lands. General restoration activities at this funding level would provide benefits to subsistence hunting and fishing that exceed land

restrictions through increases in populations of selected species and enhancement of opportunities for subsistence use.

Acquisition of private land for habitat protection or placing public lands into special State and Federal land designations might restrict subsistence uses on certain lands under Alternative 5. General restoration activities at this funding level would provide benefits to subsistence hunting and fishing that exceed land restrictions through increases in populations of selected species and enhancement of opportunities for subsistence use.

Issue 7. Describe the effects on human health and safety resulting from implementation of Alternatives 2 through 5.

There would be no effects on human health and safety resulting from implementation of these alternatives.

Issue 8. Characterize the effects of implementing Alternatives 2 through 5 on the volume and quality of scientific information used to monitor recovery and manage resources and services.

The budget for Alternative 2 includes 5 percent for monitoring and research.

The Alternative 3 budget includes 7 percent for monitoring and research.

The budget for Alternative 4 includes 8 percent for monitoring and research.

Lastly, the budget for Alternative 5 includes 10 percent for monitoring and research.

Environmental effects as listed on discussed in effects section

Cumulative Impacts

According to CEQ regulations (40 CFR 1508.6), cumulative impacts are the results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes the other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

At the "programmatic" EIS level cumulative impacts are mainly the result of management actions, regulations, and policy decisions by other agencies (i.e., effects of programs on other programs) than effects from site specific projects. For site specific projects proximity to other actions are an important determinant in assessing the cumulative impact and this component is generally missing at the programmatic level where general types of actions are considered.

To assess the cumulative impacts of other agencies on the Restoration Plan's proposed alternatives Walcoff & Associates, Inc. sent out a letter on April 21, 1993 to Federal, State and local agencies, and native entities in or managing lands within the oil spill area. Among the agencies that received letters were those that could have cumulative impacts at the programmatic level such as the Federal Highway Administration, U.S. Soil Conservation Service, U.S. Bureau of Mines, U.S. Army Corps of Engineers, Environmental Protection Agency, Federal Aviation Administration, Alaska Marine Highway System, Alaska Department of Transportation, Alaska Department of Commerce, and Alaska Energy Authority.

There are several programmatic management actions taking place in the oil spill area and many of these actions have been the subject of NEPA documentation. EIS's have been completed for the Chugach National Forest Plan and the Kenai National Wildlife Refuge. In addition, NEPA documentation is occurring at the site specific level and will continue as specific projects are proposed for implementation in response to the Restoration Plan. An example of this is the EIS currently in progress for the expansion of the Main Bay Hatchery in Prince William Sound.

In lieu of a finalized Restoration Plan, several projects that are similar to those proposed have already been implemented under annual work plans or have been proposed by the State and acted on by the Trustee Council. Alaskan House Bill No. 269 has already appropriated funds from the Exxon Valdez Oil Spill Restoration Fund for acquiring inholdings to the Kacheak Bay State Park for the protection and restoration of resources damaged by the spill, to enhance sport fishing services lost or diminished by the oil spill, and to restore, replace, or enhance subsistence resources. The Chenega Bay IRA Council is planning on dock and port improvements and the development of a Chenega Bay Marine Service Center and is requesting matching funds from the Trustee Council.

With the exception of construction projects to promote recreational opportunities, the majority of activities in the Restoration Plan would be implemented by regulation or through land acquisition. Cumulatively, land acquisition could have an effect on the amount of timber available for harvest, but until specific properties are targeted for purchase, the cumulative effects are unknown.

Irreversible and Irretrievable Commitment of Resources

Irreversible use of a resource results in the loss of the option of use in the future. Irreversible commitment applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity that are renewable only over long periods of time.

Identifying a resource as irretrievable refers to the loss of production, harvest, or use of natural resources. For example, some or all of the timber production from an area is lost irretrievably while an area is serving as a recreational facility. The production lost is irretrievable, but the action is not irreversible. If the use changes, it is possible to resume timber production.

The alternatives proposed for implementation in the *EVOS* Restoration Plan do not involve any irreversible or irretrievable commitments of resources. Some options would ultimately involve construction of recreational facilities or in-stream physical habitat improvements (e.g., fish ladders). No site specific plans for construction activities were included for review in this DEIS. Upon proposal of detailed construction plans, an environmental analysis will be performed that will determine whether resources would be irreversibly or irretrievably affected.

Mitigation

Mitigation, as defined by the Council on Environmental Quality (CEQ) in 40 CFR 1508.20, includes impact avoidance through choosing not to implement an action, or parts of that action; minimizing impacts through limiting the degree or magnitude of the action and its implementation; correcting impacts by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and compensating for the impact by replacing or providing substitute resources or environments.

At a programmatic level, mitigation would be comparable to implementation of planning activities as documented in Forest Service Management Plans, State or Federal highway administration management plans, and State or Federal resource management plans (e.g., Alaska State Hunting Regulations). Standards specified in Federal and State regulations are intended to provide a level of protection for all managed resources that is adequate to mitigate significant adverse environmental impacts from implementation of the proposed *EVOS* Restoration Plan. For example, the National Forest Management Act regulations and Forest Service Directives System would be used as a guideline for standard procedures and appropriate mitigation pertaining to the use and future development of wilderness areas for recreational purposes, including construction of backcountry sanitation facilities. The Alaska State Hunting Regulations specify bag limits and hunting seasons by species and game management unit to protect these resources from overharvesting.

On a programmatic level, all practical means to minimize any adverse environmental effects resulting from implementation of the proposed *EVOS* Restoration Plan would be employed. The following Federal and State laws and regulations would provide protection to affected resources and services, serving as mitigation measures to prevent adverse effects from implementation of the proposed *EVOS* Restoration Plan:

- Endangered Species Act of 1973 (16 U.S.C. 1531)
- Marine Mammal Protection Act of 1972 (16 U.S.C. 1361 *et seq.*)
- Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712)
- Bald Eagle Protection Act of 1940 (16 U.S.C. 668)
- Alaska Coastal Management Act of 1977 (A.S. 46.40)
- Coastal Resource District Management Plans (6 AAC 80 & 85)
- ADF&G Anadromous Stream and Fishway Acts (A.S. 16.05.870)
- Clean Water Act of 1977 (33 U.S.C. 1251 & 1344)
- National Historic Preservation Act of 1966 (16 U.S.C. 470 *et seq.*)
- Section 22 (g) of Alaska Native Claims Settlement Act of 1972

- State and local zoning regulations.

Site specific mitigation measures will be included in future environmental documents prepared for specific projects proposed pursuant to the *EVOS* Restoration Plan.