A DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE *EXXON VALDEZ* OIL SPILL RESTORATION PLAN

MAY 2010

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ABSTRACT:
NOAA, as a member of the *Exxon Valdez* Oil Spill Trustee Council (Council), has prepared a draft supplement to the existing environmental impact statement (EIS) on the Council's restoration efforts, in accordance with the National Environmental Policy Act of 1969, (NEPA). This supplemental EIS (SEIS) is necessary to respond to significant new circumstances bearing on the Council's restoration efforts as assessed in the original EIS. Specifically, as the restoration funds remaining from the *Exxon Valdez* settlement diminish, the Council seeks a more discrete and efficient funding mechanism by which to direct the remaining funds. The SEIS assesses the environmental impacts of the Council's proposal to narrow and refine the scope of the Council's restoration efforts to five defined restoration categories: herring; lingering oil; long-term monitoring of marine conditions and injured resources; harbor protection, marine restoration, and lessons learned/outreach; and habitat acquisition and protection.

PUBLIC COMMENTS ON THE DRAFT SEIS MUST BE RECEIVED BY MONDAY JULY 19, 2010

EXECUTIVE SUMMARY

NOAA, as a member of the *Exxon Valdez* Oil Spill Trustee Council has prepared this Draft Supplemental Environmental Impact Statement. It presents and analyzes alternative proposals for the *Exxon Valdez* Trustee Council's management of the remaining joint trust funds resulting from the civil settlement of civil claims brought as a result of the 1989 *Exxon Valdez* Oil Spill. Following a required 30-day period of no action, the three federal trustees (U.S. Departments of Interior, Agriculture and Commerce) are expected to sign a Record of Decision in October 2010. This Record of Decision will represent the conclusion of the planning process and provide guidance for the Trustee Council's future actions.

The Council, recognizing that the remaining joint trust funds are limited and that is it becoming increasingly difficult to distinguish between spill impacts and other effects in measuring recovery, is considering a strategic and organized transition to a more modest restoration program, which would focus the remaining funds on a few specific programs and reduce administrative costs. Specifically, the Council proposes to narrow and refine the scope of the Council's monitoring efforts to five defined restoration categories: herring, lingering oil, long-term monitoring of marine conditions and injured resources, harbor protection, marine restoration, and lessons learned/outreach, and habitat acquisition and protection. Under this approach, the remaining Council funds would be expended with an emphasis on producing information to support the future management and natural restoration of the injured species and, thus, the human services that depend upon them. In addition, the information produced by such activities can enable management consistent with long-term restoration.

This SEIS assesses the environmental impacts of the Council's proposal. In 1994, the Council adopted a Restoration Plan and an EIS was issued that analyzed the Council's actions under that Plan. The five focus areas the Council currently proposes to pursue are consistent with the existing EIS and the 1994 Restoration Plan.

In developing its proposed action alternative of focused restoration, the Council issued a Notice of Intent summarizing its proposals and subsequently held public meetings in six spill-area communities to encourage public comment. Throughout this deliberative process, the Council and its staff also consulted with scientists, Trustee Agency Liaisons, counsel, the Council's Public Advisory Committee, and reviewed numerous public comments received through the public meetings and those submitted directly to the Council.

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CHAPTER 1 – INTRODUCTION

1.1 Background

More than twenty years ago, on March 24, 1989, the tanker *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska, causing the largest tanker oil spill in U.S. history. Approximately 11 million gallons of North Slope crude oil subsequently moved through southwestern Price William Sound and along the western coast of the Gulf of Alaska, causing injury to both natural resources and services (the functions performed by a natural resource for the benefit of another natural resource and/or human uses) in the area. During the summer of 1989, oil from the spill was found as far away as 600 miles from Bligh Reef.

The State of Alaska and the United States brought claims against Exxon Corporation and related companies for the natural resources damage resulting from the spill and the resolution of the civil claims resulted in a $900 million civil settlement. The *Exxon Valdez* Oil Spill Trustee Council (EVOSTC or Council) was formed in 1991 to oversee the use of these funds to work to restore the natural resources and ecosystem damaged by the 1989 spill. The Council consists of three state (AK Departments of Law, Environmental Conservation and Fish and Game) and three federal trustees (U.S. Departments of the Interior, Agriculture and NOAA) (or their designees) and is advised by members of the public and by members of the scientific community. As part of their efforts, the Council adopted a Restoration Plan (Plan) in 1994 to guide restoration through research and monitoring, habitat protection and general restoration.

The *Exxon Valdez* Oil Spill Trustee Council originally approved and released a *Draft Restoration* Plan in 1993, followed by a *Draft Environmental Impact Statement* in June 1994, which reviewed the potential effects of implementing the plan. In September 1994, the Council issued a *Final Environmental Impact Statement*, followed by their signing of a Record of Decision in October 1994 and adoption of the *Restoration Plan* in November 1994. The Council has prepared this supplement to the existing environmental impact statement (EIS) issued in 1994, in accordance with the National Environmental Policy Act of 1969, 42 U.S.C. § 4321 *et seq.* (NEPA).

1.2 Proposed Action

Of the approximately $780 million of joint trust funds initially managed by the Council, which consisted of payments by Exxon Companies and interest and earnings on those payment, more than $180 million has been used for research, monitoring and general restoration and more than $375 million has funded habitat protection. Council annual program development, implementation and administration costs have totaled more than $45 million Approximately $15 million will be needed to fund the ongoing and final stages of EVOSTC administration. Approximately $65 million is currently contractually-committed to multi-year projects, habitat purchases and other previously approved projects. Therefore, as of spring 2010, approximately

$81 million remain available for research, monitoring and general restoration, and $25million remain available for habitat acquisition and protection. These joint trust funds are invested in State of Alaska investment accounts which have produced additional income for restoration activities. The proposed funding of future restoration activities must allow for annual flexibility in order to respond to market fluctuations which affect the income produced by these investment accounts. Accordingly, the monetary amounts proposed by the Council are approximate figures and represent proportional allocations of remaining restoration funds.

Recognizing that funding for future restoration is limited and that it is becoming increasingly difficult to distinguish between spill impacts and other effects in measuring recovery, the Council is considering an organized and strategic transition to a modest program which would focus the remaining funds on a few specific programs and habitat protection. Long-term management of species and resources initially injured by the spill lies with the agencies and entities that have the mandate and resources to pursue these long-term goals. To advance long-term resource management of injured resources, the Council has increasingly directed funds toward research that provides information critical to the support of and healthy functioning of the spill ecosystem.

The Council proposes to narrow the scope of its future restoration work. Building on its past efforts, the Council has identified five areas of focus for its remaining work: (1) herring; (2) lingering oil; (3) long-term monitoring of marine conditions and injured resources; (4) harbor protection, marine restoration, and lessons learned/outreach; and (5) habitat acquisition and protection.

1.3 Purpose and Need

The purpose of the proposed action analyzed in this Supplemental Environmental Impact Statement (SEIS) is to continue to restore the injured natural resources and services affected by the spill. The Federal and State governments, acting as Trustees for natural resources, are responsible for taking actions necessary to restore resources and the services they provide that were injured by the spill. The Federal Water Pollution Control Act (Clean Water Act) (33 U.S.C. § 1321[f] and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)(42 U.S.C. § 9607[f]) provide the legal basis for these responsibilities. This SEIS also responds to significant new circumstances bearing on the Council's restoration efforts as assessed in the original EIS. Specifically, as the restoration funds remaining from the *Exxon Valdez* settlement diminish, the Council seeks a more discrete and efficient funding mechanism by which to direct the remaining funds. This SEIS assesses the environmental impacts of the Council's proposal to narrow and refine the scope of the Council's restoration efforts to five defined restoration categories: 1) herring; 2) lingering oil; 3) long-term monitoring of marine conditions and injured resources; 4) harbor protection and marine restoration; and 5) habitat acquisition and protection. Each of these focus areas falls within the original 1994 *Restoration Plan*. *See Restoration Plan* at pp. 19 – 28.

1.4 Action Area

The spill area is located in Southcentral Alaska, including the northern and western portions of the Gulf of Alaska, and encompasses a surface area of approximately 75,000 square miles. The spill area is divided into three regions: Prince William Sound, Cook Inlet/Kenai Peninsula, and the Kodiak Archipelago and the Alaska Peninsula. *See also*, The *Exxon Valdez* Oil Spill Area General Land Status Map, 1994 Restoration Plan at pg. V.

1.5 Public Participation Process

1.5.1 Notice of Intent

As part of the process to develop the Draft Supplemental Environmental Impact Statement, NOAA, on behalf of the Council, solicited the input of stakeholders and the public on the scope and scale of the Draft SEIS. NOAA began the formal scoping process by publishing a Notice of Intent (NOI) in the *Federal Register* on Friday January 22, 2010 (75 FR 3706).

1.5.2 Scoping Process

NOAA also released public notices of six public meetings in February and March 2010 in the following locations:

Table 1: Scoping Process, Public Meeting Locations and Times

February 16, 2010 - Homer, Alaska 6:00 PM - 8:00 PM Alaska Islands and Oceans Visitor Center 95 Sterling Highway Homer, AK 99603	**March 16, 2010 - Seward, Alaska** 6:00 PM - 8:00 PM K.M. Rae Building 125 Third Avenue Seward, AK 99664
February 17, 2010 - Anchorage, Alaska 6:00 PM - 8:00 PM Dena'ina Civic & Convention Center- Kahtnu Room #1 600 West 7th Ave. Anchorage, AK 99501	**March 17, 2010 - Valdez, Alaska** 6:00 PM - 8:00 PM Valdez Civic Center 110 Clifton Drive Valdez, AK 99686
February 18, 2010 - Cordova, Alaska 7:00 PM - 9:00 PM Cordova Public Library 622 First Street Cordova, AK 99574	**March 18, 2010 - Kodiak, Alaska** 6:00 PM - 8:00 PM Kodiak Refuge Visitor Center 402 Center Street Kodiak, AK 99615

These notices were sent though email distribution lists, posted on the Council website, mailed to municipalities and tribal governments, and published in local and state newspapers. Through both the NOI and the public meetings, NOAA requested comments from the public regarding potential environmental concerns or impacts, additional categories of impacts to be considered, measures to avoid or lessen impacts, and suggestions on restoration priorities and projects.

At the six public meetings a representative from NOAA, as the Lead Administrative Trustee, gave an overview of the NEPA process and discussed the direction the Council plans to take with regard to streamlining its administrative structure. The Council website was updated so that it contained much of the same information released through the NOI and the public meetings.

For more information on the comments gathered through the scoping process, visit the EVOSTC website at http://www.evostc.state.ak.us/NEPA/Comments.cfm

1.6 Environmental Justice

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. While not a part of NEPA itself, EO 12898 (Environmental Justice, 59 FR 7629 [1994]) requires each federal agency to achieve environmental justice by addressing "disproportionately high and adverse human health and environmental effects on minority populations and low-income populations." The Council will take these matters into consideration when making decisions with regard to future restoration activities. This type of determination is further described in Chapter 4, sections 4.1 and 4.2 for this case.

CHAPTER 2 – ALTERNATIVES, INCLUDING THE PROPOSED ACTION

2.1 Introduction

This chapter describes the management alternatives considered by the Council in their proposal to narrow and refine the scope of their restoration efforts and concurrently to implement a more discrete and efficient funding mechanism by which to direct the remaining funds. The Council has considered two management alternatives: (1) no action – a continuation of the current program; and (2) a narrowing of the Council's scope to five defined restoration categories. The analysis in this SEIS pertains to the broadly defined alternatives, and as such, does not consider specific restoration projects. Project- and site-specific analyses will be conducted by the appropriate agencies for all future actions.

2.2 Program Elements Common to both Alternatives

Both alternatives share the common elements outlined in the September 1994 *Final Environmental Impact Statement* (FEIS, Ch. 2, pg. 2-5). These elements include policies that:

- take an ecosystem approach to restoration;

- require that restoration projects designed to restore or enhance an injured service must have a sufficient relationship to an injured resource;

- encourage competition and efficiency in restoration efforts;

- require that restoration projects be subject to open, independent scientific review before Council approval;

- require that restoration must include meaningful public participation in planning, project design, implementation and review; and

- specify that government agencies will be funded only for restoration projects that they would not have conducted had the spill not occurred.

2.3 Alternative 1: No Action

The "no action" alternative consists of the Council continuing its activities in research, monitoring, general restoration and habitat protection, as it has done for the last twenty-one years, pursuant to the Preferred Alternative (5) in the FEIS. This current practice involves approximately $2 million in administrative costs annually for funding of Trustee Agency Liaisons, science support, Restoration office administration, Public Advisory Committee operations, and project management. These funds also support numerous meetings by the Council, researchers, stakeholders and the public to review and approve individual projects of a limited length, typically one to three years.

As outlined in the September 1994 *Final Environmental Impact Statement* (FEIS, Ch. 2, pg. 6-7), agency monitoring of natural recovery would remain at present levels and agency responsibility

would remain unchanged. In addition, under this alternative, the remaining funds from the civil settlement would be spent as they have in the past until they were fully depleted. This includes the Council considering individual projects under their own project management and current methods of Council administration, as described above. Under this scenario, it is likely the administrative costs would remain similar or slightly below their present levels, despite the diminishing expenditures on restoration by the Council.

2.4 Alternative 2: The Proposed Action - Focused Restoration

This alternative addresses the same policies, locations, restoration goals, assumptions used for impact assessment, as outlined for the FEIS Proposed Action Modified Alternative 5: FEIS, Ch. 2, pg. 14-16. However, the General Restoration list of FEIS Alternative 5 is supplanted by the Council's proposed five focus areas: herring, lingering oil, long-term monitoring of marine conditions and injured resources, harbor protection, marine restoration, and lessons learned/outreach; and habitat acquisition and protection, which are discussed in detail below. In addition, instead of considering individual, discrete projects that were typically one year in length, the Council proposes to fund longer-term, integrated programs. The Council would also shift many of its current administrative functions, such as scientific and technical review and planning, peer review, and the solicitation and management of individual projects, to the entity responsible for the funded focus area. By narrowing its focus areas and by delegating many of its existing administrative functions to a select number of entities, the Council would streamline and reduce administrative functions and allow the funded entities to design and implement longer-term, integrated programs supporting restoration goals and objectives.

2.4.1 Herring

The Council has classified the Prince William Sound (PWS) population of Pacific herring (*Clupea pallasi*) as a resource that has not recovered from the effects of the 1989 oil spill. The PWS herring population was increasing prior to 1989 with record harvests reported just before the spill. The 1989 year class was one of the smallest cohorts of spawning adults recorded and by 1993 the fishery had collapsed with only 25 percent of the expected adults returning to spawn. The PWS fishery was closed from 1993 to 1996, but reopened in 1997 and 1998, based on an increasing population. Numbers again declined in 1999, and the fishery remains closed today. The 1993 collapse can be explained by several competing hypotheses; however, data uncertainties make it unlikely that the true reasons will ever be known.

The Council recognizes the uncertainty with regard to the role of the 1989 spill and the current depressed state of the PWS herring population. However, herring are considered a keystone species in the marine ecosystem and play a vital role in the food chain of many injured species. Thus, rebuilding the herring population has the potential to support the restoration of these injured species. In addition, supporting a healthy herring population may compensate for some of the losses in fishing opportunities that resulted from the spill and its damage to salmon and species other than herring. In April 2006, prompted by public comments about the continuing

impacts to human communities and commercial fishermen from herring losses, the Council convened scientists and researchers, commercial and subsistence fishermen, and natural resource managers for a herring workshop. One of the most important outcomes of the workshop was the consensus that a long-term strategic herring restoration program was needed if viable herring recovery activities were to be implemented. From 2006 to 2008, Council representatives met with natural resource managers, commercial fishers, scientists, the Public Advisory Committee (PAC) and Alaska Native residents of spill area communities to gain sufficient input to draft a cost-efficient, scientifically credible, and coordinated program. This effort produced the first draft of the Integrated Herring Restoration Program (IHRP) in December 2008. The IHRP is currently undergoing its final revision and will inform the final *Invitation for Proposals FY 2012* that may be issued by the Council in October 2010 if Alternative 2 of this SEIS is chosen for implementation.

The goal of the IHRP is to determine what, if anything, can be done to successfully restore PWS herring; to determine what steps can be taken to examine the reasons for the continued decline of herring in the Sound; to identify and evaluate potential recovery options; and to recommend a course of action for restoration. The Council is currently funding a package of multi-year proposals that are focused on factors limiting recovery.

The Council proposes funding a long-term herring program that focuses on core monitoring at a level that allows detection of population change, at a precision meaningful to restoration objectives, and that focuses on identifying limiting factors for the continued decline of herring in Prince William Sound (PWS), to identify and evaluate potential recovery options and to recommend a course of action for restoration of PWS herring.

The Council has proposed to use approximately 11% to 21% of the available funding for research in this area over a twenty-year period. The program would conduct studies that may include monitoring of herring population, disease, predators, habitat and related oceanographic conditions.

2.4.2 Lingering Oil

One of the most surprising revelations from two decades of research and restoration efforts since the 1989 spill is the persistence of subsurface oil in a relatively unweathered state. This oil, estimated to be around 97.2 metric tons (or 23,000 gallons), is contained in discontinuous patches across beaches that were initially impacted by the spill. The patches cannot be visually identified on the beach surface, but their presence may be a source for continued exposure to oil for sea otters and birds that seek food in sediments. The survey work completed to date indicates that the oil is decreasing at a rate of zero to four percent per year, with only a five percent chance that the rate is as high as four percent. As a result, it may persist for decades.

Subsistence, recreational, commercial fishing and passive uses were significantly impacted by the spill and this has affected the overall health of the communities in Prince William Sound.

Lingering oil may also discourage the public from resuming full use of some natural resources, in part to avoid patches of oil that still persist and, probably, in part due to uncertainty about exactly where oil patches remain (and, conversely, where the oil has fully degraded) and the extent to which it continues to affect edible aquatic organisms and other resources. It may be appropriate to devote additional resources to evaluate, monitor, and redress the impact of lingering oil on recreational and subsistence uses in the spill area. An important function of this effort would be to pass this information back to the communities and the general public.

In an effort to address the issue of lingering oil, the governments developed a restoration plan in 2006 under the terms of the Reopener provision in the Consent Decree with Exxon (http://www.evostc.state.ak.us/facts/reopener.cfm). Efforts to date include the development of a spatial probability model to identify beach segments with a high likelihood of persistent oil, and investigations of the reasons for the persistence of oil as a means to consider options that may accelerate the oil degradation. The Council has also funded a number of studies to determine the effects of lingering oil on the nearshore environment and the species that forage there, including sea otters, harlequin ducks and Barrow's goldeneyes.

It is possible that the results of currently funded and ongoing projects, or information developed by the research of other entities, will identify information gaps that will need to be filled. Under the lingering oil initiative, the Council envisions completion of the studies underway to reach a decision point on further efforts for active remediation. Upon receiving additional lingering oil information from these current lingering oil studies and the resolution of the Reopener, the Council will evaluate the need for restoration of services that may be affected by lingering oil, and thus no prospective funding amount has been proposed. If there is a need for additional projects, these may include proposals to measure the exposure of recovering or not recovered resources to lingering oil and the effects of such exposure, in addition to direct restoration of impacted services if practical and feasible, particularly in the nearshore ecosystem.

2.4.3 Long-term monitoring of marine conditions and injured natural resources

In the twenty-one years since the *Exxon Valdez* oil spill, it has become apparent that the ocean ecosystem can undergo profound changes naturally and such changes likely preclude a return to pre-spill conditions. The 1994 *Restoration Plan* (Plan) recognized that recovery from the spill would likely take decades. A Restoration Reserve was created from the Plan in part to provide for long-term observation of injured resources and services and provide for appropriate restoration actions into the future. To further this effort, in 1999 the Council also supported the development of a long-term research and monitoring program, which did not progress to implementation.

Long-term monitoring has two components: monitoring the recovery of resources from the initial injury and monitoring how factors other than oil may inhibit full recovery or adversely impact recovered resources. This second type of monitoring collects data on environmental factors that drive ecosystem-level changes. Monitoring factors such as temperature, salinity, turbidity, and

zooplankton availability can play an important role in determining the overall health of the ecosystem. Data produced from this type of monitoring is increasingly valuable in illuminating the larger ecosystem shifts that impact and influence a broad variety of species and resources injured by the spill. In addition, by monitoring such changes, agencies and interested parties may be able to adjust their own activities and management strategies to adapt to what may lie ahead and to further support injured resources in these quickly-shifting marine ecosystems. The Council has a history of supporting oceanographic monitoring by helping to establish and fund long-term data collections.

With regard to the monitoring of individual species, the Council also proposes to monitor some key indicator species. While it would be virtually impossible to monitor every injured resource and service in the entire geographic area of the oil spill, it is possible to select key indicator species that will provide an overview of the health of the ecosystem. Examples of these key species may include forage fish, killer whales, seabirds, bivalves, and sea otters. Monitoring these indicator species in two trophic levels (pelagic and benthic) as well as the environmental drivers (oceanographic conditions) of the system can provide a combination of data that can greatly contribute to an understanding of the state of recovery in the spill areas.

In this initiative, the Council envisions seeking partnerships with scientific entities or consortiums able to maintain those collections, demonstrate an ability to leverage this support, and develop science-based products to inform the public of environmental changes and the impacts of these changes on injured resources and services. The Council proposes to fund this effort with approximately 15% to 25% of the available funding, to be spent over a twenty-year period. As a part of this effort, the Council seeks to monitor ocean and nearshore conditions such as current, temperature, and the climate of those areas that influence the spill area, as well as injured resources.

2.4.4 Harbor protection, marine restoration, and lessons learned/outreach

a. Waste disposal and harbor projects

Many coastal communities in the spill area have a limited ability to collect and properly dispose of waste, such as oily bilge water, used engine oil, paints, solvents, and lead-acid batteries. Improper disposal of these wastes in landfills adversely affects the quality of nearby marine waters through runoff and leaching. In some cases, these wastes are discharged directly into marine waters. Chronic marine pollution stresses fish and wildlife resources, possibly delaying recovery of resources injured by the oil spill. For example, with regard to the worldwide mortality of seabirds, the effects of chronic marine pollution are believed to be at least as important as those of large-scale spills.

The Council has approved the funding of several projects to prepare waste management plans and has contributed to their implementation. These projects resulted in the acquisition of waste oil management equipment and the construction of environmental operating stations for the drop-

off of used oil, household hazardous waste and recyclable solid waste in Cordova, Valdez, Chenega Bay, Tatitlek and Whittier, Kodiak and lower Cook Inlet. The Council seeks to further reduce pollution in the marine environment to facilitate the recovery of injured natural resources or services and is considering funding this effort with approximately 3% to 13% of the available funding.

b. Marine debris removal

Marine debris is an issue in the marine and near-shore environment in Alaska, where it is likely that thousands of tons of marine debris exist within three nautical miles of the Alaska coastline. Marine fish and wildlife become entangled in and ingest debris from foreign and domestic sources that may be a day or decades old and that range from small plastic items to very large fishing nets. Approximately 175 metric tons of debris was collected from Alaska coasts by citizen cleanup projects in 2007. Marine debris removal projects can result in an immediate improvement to the coastal habitat.

Coastal communities are effective in marine debris cleanups due to their intimate knowledge of the locations of debris accumulation. In addition, when communities participate in marine debris cleanups, they often alter the common practices that led to marine debris as their awareness of the effects of the debris on their coastline and the fisheries upon which they depend increases. Marine debris removal reduces marine pollution affecting injured resources and services and, thus, further supports natural restoration. The Council proposes to fund marine debris removal with up to 7% of the available funding.

c. Lessons Learned/Outreach

Damage to natural resources occurs not only with an initial oil spill, but also potentially through spill response efforts. Damage assessment from the 1989 spill has yielded information that can assist in mitigating damage from spill response activities in future spills. Skilled damage assessment also quantifies the extent of injury and allows for the accurate monitoring and measurement of restoration after a spill. Organizing, preserving, and passing on such information will help responders and those conducting future damage assessments. These efforts ensure that restoration efforts are truly effective. Outreach efforts could include a conference or series of papers sharing information to be used by future responders, including natural resource assessment, the long-term costs of high-pressure washing, use of dispersants in the near-shore, sub-arctic environment, and the effects of potential burning scenarios. The Council proposes to fund this effort with up to 5% of the available funding.

2.4.5 Habitat acquisition and protection

The protection of habitat is an important component of the *Exxon Valdez* oil spill restoration program. The acquisition of private lands or partial interests in private lands promotes the natural recovery of spill-injured resources and associated services by removing the threat posed by additional development impacts. The program is implemented by state and federal resource agencies, often in partnership with non-governmental organizations. The habitat program has

protected approximately 650,000 acres of valuable habitat through a variety of purchases of various property rights, ranging from fee simple acquisition to conservation and timber easements. The goals of the habitat protection program remain viable. Resource and land management agencies, such as the Alaska Department of Natural Resources, Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, National Park Service and U.S. Forest Service, continue to receive parcel nominations for Council consideration. Approximately $25 million remains within the habitat subaccount for future habitat protection efforts. The Council is considering alternatives for allocation of these funds. For example, half of the funds remaining may be allocated to protect large parcels within a period of two to three years, and the remaining half to a program spanning a 12-year period focused on the protection of small parcels less than 1,000 acres or $1 million in price. The Council proposes to utilize the approximately $25 million remaining to continue the habitat program. A variety of administrative options, funding allocations, time frames, and management strategies will be considered.

2.5 Other Alternatives Considered and Rejected

In their deliberations, the Council has considered alternatives that consisted of expending the remaining funds in a short time frame, transferring the monies to agencies to administer, and reallocating habitat monies to other restoration uses. Each of these alternatives was rejected without detailed consideration, as noted below.

2.5.1 Expending funds in the immediate future

Expending the funds in a very short time frame, for example within three years, as a method to decrease the overall expenditure in administrative costs that accrue over time was rejected. While it could possibly achieve some measure of purely economic efficiency with regard to overall administrative expenditures and might be appropriate for some projects, e.g. marine debris removal, it would not necessarily represent the most effective way to pursue restoration of injured resources and services. For example, it would not serve the considerable long-term scientific needs of monitoring and long-term herring research; nor would it benefit habitat protection, where taking the time to develop sensitive negotiations with willing sellers are required.

2.5.2 Funds Transferred to Agencies

Transferring the remaining funds to agencies to be expended as limited and required by the *Exxon Valdez* settlement, was rejected as unnecessary and inhibits the opportunity to allow non-governmental organizations to propose creative collaborations and participation that could result in an efficient and creative use of resources.

2.5.3 Reallocation of Habitat Funds:

Reallocating habitat monies to other restoration uses was rejected because the Council supports using the remaining funds (approximately $24 million) currently designated for habitat protection for that valuable use. In addition, the Council noted that this allocation of funds is mandated by federal law. *See*, Public Law 106-113, 113 Stat 1501A-207 (1999). An effort to

amend the legal requirement would entail an additional and unnecessary use of administrative resources and time.

2.5.4 Funds used for an Endowment

Using the remaining funds for a permanent endowment was rejected without detailed consideration due to legal issues which could hinder a permanent endowment.

2.6 Comparison of Alternatives

2.6.1 Alternative 1

This alternative would vary in terms of the scope of restoration activities proposed, as it would not be limited to the five focus areas. Without reducing the array of restoration activities, restoration efforts for species that would benefit from activities under one of the five focus areas could experience diminished benefits or benefits of a shorter duration than they would under Alternative 2, as Alternative 1 allows the remaining funds to be spent on a broad variety of proposals without a strategic focus or comprehensive plan to guide the spending. In addition, under this alternative, the Council would remain the sole administrator of the funds, thus requiring funds that could be used for restoration activities to be allocated toward administration (approximately an additional $10–$25 million, depending upon the duration of the Council). This alternative also does not envision an organized or strategic end to the expenditure of funds, thus potentially creating an abrupt end to the Council's funding of restoration activities when the funds are fully depleted.

2.6.2 Alternative 2

This option envisions actions focused on the five proposed restoration areas that would aid in the recovery of a broad spectrum of injured resources and services. Focus areas such as long-term monitoring of oceanographic conditions and injured resources and herring research can also produce information that can be used by a wide variety of researchers, members of the public, stakeholders, state and federal agencies. Under this approach, the remaining Council funds would be expended in a strategic and organized manner, with an emphasis on producing information to support the future management and natural restoration of injured species and, thus, the human services that depend upon them. In addition, the information produced by such activities can enable management consistent with long-term restoration. This important data can assist those agencies and entities that have the mandate and resources to pursue long-term restoration goals for these injured species and services and which will exist beyond the life of the Council.

The Council's restoration effort has been evolving over time and the current proposal represents this progression. With regard to research and restoration proposals, this alternative refines the Council's efforts in these five areas, rather than funding individual projects that typically lasted for one year and typically focused on a singular injured resource. The single-species perspective has been driven largely by the original listing of injured resources and species. Consistent with

this, the September 1994 FEIS and the 1994 Plan were largely organized by individual species. The 1994 Plan also acknowledged the importance of the ecosystems in the spill area, and this perspective has grown with time and as science has illuminated the complex and interdependent relationships of ecosystems.

Under Alternative 2, the Council contemplates restoration activities for specific species which serve the focus areas. For example, the Council includes herring as a single-species focus area in its current proposed alternative. However, this species is considered a keystone species in the marine ecosystem and herring play a vital role in the food chain of many injured species. Thus, rebuilding the herring population has the potential to support the restoration of a broad range of injured species. Supporting a healthy herring population also has the potential to compensate for some of the losses in fishing opportunities that resulted from the spill and its damage to species other than herring. In this way, the Council's focus on this single species may serve a broad range of injured species and services. In addition, as discussed with regard to long-term monitoring, the Council contemplates monitoring a number of key species in the spill-affected ecosystems in order to contribute to the overall understanding of the spill-affected ecosystem.

Alternative 2 also emphasizes an effort to reduce administrative spending through funding long-term proposals administered largely by third parties which have exiting infrastructure that can accommodate administering such a program and therefore potentially allowing a higher allocation of funds (approximately an additional $10–25 million, depending upon the duration of the Council) to be used for restoration activities. By narrowing its focus to provide benefits for a broad range of injured species over the long-term, the Council increases the opportunity for continuing research to support the future management and long-term restoration goals for individual species and benefit the ecosystems hosting numerous species originally injured by the spill.

Chapter 3 – Affected Environment

3.1 Introduction

This Chapter provides a current summary of the status of the environment affected by the spill. As discussed above, the Council's research has been largely organized by individual injured species, consistent with the *Injured Resources and Services List* (List) which it adopted in November 1994 as part of its *Restoration Plan* and updated in 1996, 1999, 2002, 2006 and 2010. The List served three main purposes in the Restoration Program:

1. Initially, the List identified natural resource and human service injuries caused by the oil spill and clean-up efforts.

2. The List helped guide the Plan and was especially important in 1994 when the plan was first adopted. The List was created as guidance for the expenditure of public restoration funds under the Plan, and assisted the Council and the public to ensure that money was expended on resources that needed attention. The List continues to serve that purpose today.

3. Finally, the status of injured resources on the List provides the Council and the public a way to monitor recovery of individual species, and the related ecological functions and human services that depend on those resources.

Although the fish and wildlife resources that appear on the List experienced population-level or chronic injury from the spill, not every species that suffered some degree of injury was included. For example, carcasses of about 90 different species of oiled birds were recovered in 1989, but only 10 species of birds were included on the List.

Moreover, it should be noted that the analysis of resources and services in relation to their recovery status only pertains to amelioration of effects from the 1989 oil spill. When the Plan was first drafted, the distinction between effects of the oil spill and the effects of other natural or anthropogenic stressors on affected natural resources was not clearly delineated. At that time, the spill was recent; the impact to the spill area ecosystem was profound and adverse effects of the oil on biological resources were apparent. As time passes, the ability to distinguish effects of oil from other factors affecting fish and wildlife populations diminishes. Currently, natural and human perturbations may be hindering recovery of some resources initially injured by the spill. However, the passage of time and the evolution of science from the listing of species to an ecosystem approach have shifted the purpose and utility of the Injured Resources and Species List. The Council recognizes that the complexities and the difficulties in measuring the continuing impacts from the spill result in some inherent uncertainty in defining the status of a

resource or service through a specific list and the Council's focus has accordingly expanded to a more ecosystem approach. The 1994 Plan also outlined an ecosystem approach to restoration and this more integrated view has become increasingly recognized as essential and the original organization of efforts through a list of species in the Update is no longer a viable approach.

Recognizing that funding for future restoration is limited and that it is becoming increasingly difficult to distinguish between spill impacts and other effects in measuring recovery, the Council's efforts are now focused on making an organized and strategic transition to a modest program which focuses the remaining funds on a few specific programs. Building on its past efforts, the Council has identified the following areas of focus: (1) herring; (2) lingering oil; (3) long-term monitoring of marine conditions and injured resources; (4) harbor protection, marine restoration, and lessons learned/outreach; and (5) habitat acquisition and protection.

The Council also recognizes that long-term management of species and resources initially injured by the spill lies with the agencies and entities that have the mandate and resources to pursue these long-term goals. To support natural restoration and to enable management consistent with this long-term restoration, the Council has increasingly directed funds toward research that provides information that is critical to monitor and support the healthy functioning of the spill ecosystem.

3.2 Ecosystem Perspective and Recovery

Recognizing the difficulties inherent with the listing of individual species, as discussed above, the Council has moved towards an ecosystem approach. In practice, and through the Plan, the Council has increasingly adopted an ecological approach to restoration, and, consistent with this, the studies and projects the Council sponsors have been progressively more ecologically-based.

The 1994 Plan defines ecosystem recovery as follows:

Full ecological recovery will have been achieved when the population of flora and fauna are again present at former or pre-spill abundances, healthy and productive, and there is a full complement of age classes at the level that would have been present had the spill not occurred. A recovered ecosystem provides the same functions and services as would have been provided had the spill not occurred.

Although significant progress has been made using this definition of recovery, some of the coastal and marine ecosystems in the oil spill region have not fully recovered at this time from the effects of the oil spill. For example, harlequin ducks still show signs of oil exposure and may be negatively affected by such exposure. A number of other species and communities are showing signs of recovery, but are still not fully recovered from the effects of the oil spill. Although full ecological recovery has not been achieved, the spill area ecosystem is making progress towards recovery 21 years after the *Exxon Valdez* oil spill.

Consistent with the Council's shift from individual species to an ecosystem approach, in this chapter we will discuss each injured resource and service as part of its larger system, including the nearshore, offshore, and human services.

3.3 Recovery Status Determination

The information contained in this Chapter, drawn from the Injured Resources and Services List, also provides the List's recovery status for each species.[1] The recovery goal for injured resources is a condition that would exist in the absence of the *Exxon Valdez* oil spill (EVOS). It is important to understand that ecosystems are dynamic and the spill-affected area would have changed even without the spill. Given the limited ability to predict multi-year changes in marine ecosystems, it is difficult to know precisely what changes were inevitable had the spill not occurred. However, it is still possible to assess the recovery status of a particular resource by reviewing multiple sources of applicable information.

Types of information that were used to assess the recovery status of a particular resource or service included:

- initial magnitude of oil impacts to a population in the spill area
- comparisons of population demographic in oiled and reference areas
- survey data of community members in oiled and reference areas
- continued exposure to residual oil in the spill area as measured by the biomarker cytochrome P450 or tissue concentrations of petroleum hydrocarbons
- exposure potential as evaluated by the distribution of lingering oil; overlap in spatial distribution of lingering oil and a resource; and identification of an exposure pathway
- persistence of sublethal or chronic injuries
- intrinsic ability of the population to recover
- other natural or human-caused stressors

Even with such an evaluation, direct links cannot always be drawn between effects from the oil spill and the observed, current condition of a particular resource: in most cases the amount or type of data is insufficient to complete a cause and effect relationship. Specifically, there is little pre-spill data for many of the injured resources. Moreover, the physiological effects of oil on key species of wildlife and subsequent population consequences were not well understood at the time of the spill. As a result, few species exist for which there is complete knowledge of the impacts of the oil spill.

[1] The *Exxon Valdez* Oil Spill Trustee Council 2010 Update of Injured Resources and Services (May 14, 2010), available on the Council's website at http://www.evostc.state.ak.us, provides the information presented in this Chapter and may be consulted for additional detail and annotations.

3.3.1 Uncertainties in Evaluating Recovery Status

To mitigate the uncertainties inherent in evaluating recovery the Council reviewed current, relevant scientific information while acknowledging the limitations of assigning an ultimate cause and effect relationship using the existing data. The current List combines the available literature and limitations of data into one document using best professional judgment. The types of uncertainty found in the published literature include:

1. Variability in population estimates. Because the patterns of animal distribution present challenges in getting accurate counts (especially of highly mobile fish, birds and marine mammals), most estimates of population size have wide ranges of variability associated with the data.

2. Lack of pre-spill data. For many of the resources affected by the spill there was limited or no recent data on their status in 1989. Additionally, some of the available pertinent data were the result of limited sampling, which consequently produced wide confidence intervals around the population estimates.

3. Interaction of spill and natural factors. It is increasingly difficult to separate what may be lingering effects of the spill from changes that are natural or caused by factors unrelated to the oil spill.

4. Scale and scope. The geographic scale and scientific scope of studies conducted over the years has varied among resources and this disparity must be considered when interpreting data and applying results to recovery status. Some studies were conducted at the large spatial scale to address population and ecosystem concerns, while other studies focused on localized exposure and effects of oil. In addition, some studies examined one characteristic over multiple species while other studies investigated many characteristics in a focused number of species.

For some species, no further actions have been taken with regard to future funding of studies to assess recovery. This may be based upon the factors discussed above and may also include a consideration of the following:

1. Additional studies are expensive. More study, with sufficient effort and scope to achieve powerful tests of the impacts of lingering oil, would be relatively expensive.

2. Unable to definitively demonstrate an effect. Natural variability, confounding effects, and lack of tools to estimate important metrics make it unlikely that an effect could be detected with a high degree of confidence.

3. Effects are likely undetectable. Based on available data, mechanistic principles, and knowledge of past spill impacts on processes of recovery, the likely effects are deemed to be minimal.

4. Effects unlikely to be of ecological importance. Based on available data, understanding of ecological interactions, and the expected small size of lingering impacts, it is unlikely that the effect (if any) will impair function of the ecological system.

5. No effective restoration options available. Even if a demonstrated need exists, there are no reasonable options for restoration of the injured resource.

6. More effective uses of funds. Other projects provide promise of more definitive results, greater significance to the ecosystem, or more potential for restoration.

More information on the recovery status of impacted species is available in the following section. The species listed are separated by nearshore and offshore designations but many can traverse the designations during life stages, time of year, or in response to predation.

3.4 Nearshore: Recovering

More than 1,400 miles of coastline were oiled by the spill in Prince William Sound, on the Kenai and Alaska peninsulas, and in the Kodiak Archipelago. Heavy oiling affected approximately 220 miles of this shoreline. It is estimated that 40–45 percent of the 11 million gallons of crude oil spill by the *Exxon Valdez* washed ashore in the intertidal zone. For months after the spill in 1989, and again in 1990 and 1991, both oil and intensive clean-up activities had significant impacts on the flora and fauna of this environment.

Initial impacts to the nearshore occurred at all tidal levels and in all types of habitats throughout the oil spill area. Direct assessment of the spill effects included sediment toxicity testing, documenting abundance and distribution of nearshore organisms and sampling ecological parameters of community structure. Dominant species of algae and invertebrates directly affected by the spill included common rockweed, speckled limpet, several barnacle species, blue mussels, periwinkles, and oligochaete worms. At lower elevations on gravel and mixed sand/gravel beaches, the abundance of sediment organisms and densities of clams declined. Large numbers of dead and moribund clams were documented on treated beaches, but these effects were likely due to a combination of oil toxicity and hot water washing. Nearshore fish were also affected. In a study conducted in different habitats, density and biomass of fish at oiled sites showed declines relative to reference sites in 1990.

The Nearshore Vertebrate Predator (NVP) project was a six-year study (1995-2001) of factors limiting recovery of four indicator species that use the nearshore environment. The possible

factors included: food availability, continued damage from oil, and population demographics. The $6.4 million project focused on two fish-eaters, river otters and pigeon guillemots, and two species that feed on shellfish and other invertebrates, harlequin ducks and sea otters. Nearshore areas were the hardest hit by the *Exxon Valdez* oil, which clung to beaches and polluted waters on each succeeding tide. When this project was designed, all four predators exhibited signs of stress in oiled areas. For sea otters and harlequin ducks, long-term effects continued in the oiled areas, as shown by the lack of population recovery in these areas, and symptoms of oil exposure in harlequin ducks. At the time, researchers predicted that food was the most likely factor limiting recovery, but their studies proved that it was not. When large quantities of lingering oil were discovered in 2001, it became clear that there was linkage between known effects and the remaining oil.

3.4.1 Bald Eagles: Recovered

Productivity (or reproductive success as measured by chicks per nest) was back to pre-spill levels in 1990 and 1991, and an aerial survey of adults in 1995 indicated that the population had returned to or exceeded its pre-spill level in the Sound. In September 1996, the Council classified the bald eagle as recovered from the effects of the oil spill.

3.4.2 Barrow's Goldeneyes: Recovering

Prince William Sound is an important area for this species as the area is within their wintering range and supports between 20,000 and 50,000 wintering individuals. Survey data from the U.S. Fish and Wildlife Service indicated that winter numbers of goldeneyes on oiled areas were stable from 1990–1998, in contrast to significantly increasing numbers on unoiled areas during that same time period That was interpreted as evidence of lack of recovery, as the prediction would be that lack of continued injury would result in parallel population trajectories and that recovery would be indicated by more positive trajectories on oiled areas. In the most recently published survey (through March 2007), slopes were parallel and stable over time, although this was due primarily to a decrease in goldeneye abundance on unoiled areas. A study of Barrow's goldeneye habitat use in oiled and unoiled portions of Prince William Sound found that densities of birds in oiled areas were at expected levels, given the habitat; food limitations in the intertidal are not restraining recovery. Lingering oil still remains in intertidal habitats used by Barrow's goldeneyes, maintaining the possibility of continued exposure and chronic effects.

Interpretation of surveys and habitat selection is constrained by lack of full understanding of Barrow's goldeneye demography, particularly rates of site fidelity and dispersal. These values have important implications for understanding the process of population recovery. Lack of elevated CYP1A measured in oiled areas in 2009 relative to unoiled areas suggests that exposure to lingering oil has ceased in the Barrow's goldeneyes, and thus, that at least part of the recovery objective has been met. Barrow's goldeneyes are considered to be recovering from the effects of the oil spill.

3.4.3 Black Oystercatchers: Recovering

Black oystercatchers are long-lived (15+ years) and territorial, occupying nests in rocky areas close to the intertidal zone and returning in successive years to nest again in the same vicinity. In the early 1990s, elevated hydrocarbons in feces were measured in chicks living on oiled shorelines. Deleterious behavioral and physiological changes including lower body weights of females and chicks were also recorded. Because foraging areas are limited to a few kilometers around a nest, contaminations of mussel beds in the local vicinity was thought to provide a source of exposure. In 1998 the Council sponsored a study to reassess the status of this species in Prince William Sound. The data indicated that oystercatchers had fully reoccupied and were nesting at oiled sites in the Sound. The breeding phenology of nesting birds was relatively synchronous in oiled and unoiled areas, and no oil-related differences in clutch size, egg volume, or chick growth rates were detected. However, a higher rate of nest failure occurred on oiled Green Island: at the time this was thought to be the result of predation, not lingering effects of oil. Because the extent of shoreline with persistent contamination was limited and lingering oil was patchy, it was concluded that the overall effects of oil on oystercatchers in the Sound had been minimal. However, the reasons that predation was higher at oiled Green Island than at Montague were not investigated. It is not clear whether predation was higher because there were higher numbers of predators, lower number of nests initiated or a behavioral change in the parents that would have led to lower nest protection.

Based on this study and one year of boat-based surveys (2000) of marine birds in Prince William Sound indicating that there were increases in numbers of oystercatchers in both the oiled and unoiled areas for that year, the black oystercatcher was identified as recovered. Since 2002, however, additional information has come to light indicating that designation may have been premature. A long-term (1989–2007) evaluation of marine bird population trends suggest that populations of black oystercatchers in the Sound have likely not recovered to pre-spill conditions.

Further, ongoing oil exposure to oystercatchers was documented in 2004 using a biochemical marker of exposure, cytochrome P450IA. Given the more recent understanding of the persistence of oil in sediments along shorelines that initially received heavy or moderate oiling, it is likely that black oystercatchers in oiled areas have suffered chronic exposure as has been shown for sea otters and harlequin ducks. Hydrocarbon exposure in 2004 is likely considerably less than in the early 1990's, but at this time, we do not know if there are any significant physiological or population level consequences from chronic exposure.

Black oystercatchers will have recovered when population levels, reproduction rates, productivity and oil exposure biomarkers have reached levels that would have existed without the spill. Evidence, however, still shows a high rate of nest failure and the continued exposure to oil. Population trends indicate a continued status of "recovering."

3.4.4 Clams: Recovering

Studies have indicated that abundances of some species of clams were lower on treated beaches through 1996. Densities of littleneck and butter clams were depressed through 1997 on cleaned mixed-sedimentary shores where fine sediments had been washed down the beach during pressured water treatments.

As part of an investigation of sea otter populations conducted from 1996-1998, researchers compared clam densities between oiled sites on Knight Island and unoiled sites on Montague Island. They reported an increase in mean size of littlenecks and butter clams at Knight Island, where numbers of sea otters, a major predator of clams were significantly reduced. Absolute densities of littlenecks and butter clams were not different between oiled and unoiled sites; however, oiled sites had fewer juvenile clams and lower numbers of other clam species. In 2002, differences in species richness, diversity and abundance of several species were still measurable between cleaned (oiled and treated) and untreated (oiled but untreated) beaches. Moreover, as of 2007, several wildlife species that use the intertidal zone and feed on clams (e.g., harlequin ducks and black oystercatchers) are still being exposed to oil. These resources are included on the List and although the exact route of oil contamination has not been established for these birds, it is likely they are ingesting oil with their prey.

Some overlap occurs between areas where lingering oil and populations of littleneck and butter clams co-exist. Given the burrowing behavior of these animals, it is likely they would be exposed to oil as they dig into the subsurface sediments known to contain oil. In fact, it has been demonstrated that littleneck clams exposed for a year to the surface layer of contaminated sediments did not accumulate oil, but if the clams were buried in sediments mixed with oil, accumulation did occur.

Clam populations found on oiled but untreated beaches have likely recovered from the effects of the spill. However, several factors continue to impact clam populations on oiled and treated beaches: abundances and distribution differences are still measurable between cleaned and untreated sites; a lingering oil occurs in habitats with clams, and exposure of clams to oil could result in upper trophic level predators eating contaminated prey; and other species on the List are still being exposed to oil and are known to forage on clams.

Clams are continuing to recover in the Sound, but there still exists a difference in abundance between oiled and washed, oiled and unwashed, and unoiled sites. Data have suggested that disturbance of the rock armor of beaches continues to impede recovery. If this is true then recovery may require geological re-armoring processes that operate on decadal scales. Current population trends indicated a status of recovering.

3.4.5 Common Loons: Recovered

Boat-based surveys of marine birds in Prince William Sound give some insight into the recovery status of the loons affected by the oil spill. Pre-spill counts of loons exist only for 1972–1973 and 1984–1985. After the spill, contrasts between oiled and unoiled areas of the Sound indicated that loons as a group were generally doing better in unoiled areas than in oiled areas. Thus, the survey data suggested that the oil spill had a negative effect on numbers of loons (all species combined) in the oiled parts of the Sound.

Common loons exhibited declines in population numbers and habitat usage in oiled areas in 1989 but not in 1990. There was a weak negative effect of oiling on population numbers again in 1993, but not in 1996 or 1998. Based on the boat surveys carried out through 2000, there were indications of recovery, because in that year the highest counts ever recorded for common loons in PWS. In addition, July 2000 counts were the third highest of the 11 years since 1972, although these increases were limited to the unoiled portion of the Sound. Loons are a highly mobile species with widely variable population numbers and the pre-spill data were limited, thus this one year of high counts in the unoiled areas was insufficient to indicate that recovery had started.

Population surveys conducted from 1989–2007 found increasing winter population trends in common loon densities in oiled areas. The summer counts do not show a consistent positive relationship, however the summer counts of loons are usually low and variable because they are predominately found on their breeding grounds in other areas during the summer. Common loons have an intrinsically low population growth rate and relatively large numbers of carcasses were recovered after the spill, yet post spill winter population counts of common loons have met or exceeded available pre-spill counts for all years measured since the spill, except 1993. Given the long-term positive changes in winter population information, common loons are considered recovered from effects of the oil spill.

3.4.6 Common Murres: Recovered

Post-spill monitoring at the breeding colonies in the Barren Islands indicated that productive success was within normal bounds by 1993, and it has stayed within these bounds each breeding season since then. During the period 1993–1997, the murres nested progressively earlier by two to five days each year, suggesting that the age and experience of nesting birds were increasing, as might be expected after a mass mortality event. By 1997, the numbers of murres at the Barren Island had increased, probably because three- and four-year old nonbreeding sub-adult birds that were hatched there in 1993 and 1994 were returning to their natural nesting colony. Although counts were low in 1996, the counts in 1997 at this index site brought the colony size to pre-spill levels. The population size coupled with normal reproductive success (productivity), indicate that recovery has been achieved for common murres.

3.4.7 Cormorants: Recovered

Marine bird surveys were conducted during ten of the 16 years during1989–2005. For cormorants, trends for both summer and winter populations were increasing in the oiled area of Prince William Sound. Moreover, population estimates for cormorants in summer 2004 ranged from 9,000–11,000 birds, which falls within the range of 10,000–30,000 estimated in 1972. Therefore, although population estimates of cormorants are highly variable throughout their range, the recovery objectives have been met and cormorants are considered to be recovered.

3.4.8 Cutthroat Trout: Very Likely Recovered

Limited information exists regarding the current status of cutthroat trout. Recent exposure to lingering oil is unlikely, because most of the bioavailable oil appears to be confined to subsurface intertidal areas, and not dissolved in the water column. Distribution of cutthroat trout is patchy throughout the Sound,however populations are known to occur in areas directly impacted by the spill The Sound is the northern edge of cutthroat trout range and dispersal during marine migration is restricted, thereby increasing their susceptibility to habitat alteration and pollution. Resident cutthroat trout populations in the Sound are small and geographically isolated from each other: These characteristics suggest that recovery of a population would depend less on mixing with nearby aggregates than on the productivity of the endemic population and the extent to which it was injured by the spill. However, anadromous forms are also present. Confounding factors such as sport fishing and habitat alteration of spawning streams (e.g., through logging) may also inhibit successful recruitment of young into a population and subsequent increase in numbers.

Given the ecological similarities in summer diet and foraging ecology along shorelines between cutthroat trout, and Dolly Varden, and the absence of ongoing injury to Dolly Varden, further research would be very unlikely to demonstrate any evidence of continuing differences due to the spill between oiled and unoiled areas. Thus, funding the additional research necessary to provide current growth rate and abundance data for this species is not a cost-effective scientific priority.

The Council considers cutthroat trout to be very likely recovered. Additional study, with sufficient effort and scope to achieve powerful tests of the impacts of lingering oil, would be relatively expensive, would likely be unable to definitively demonstrate an effect, and any effects would likely be minimal. For these reasons, it is unlikely that additional research will clarify this species' injury status.

3.4.9 Dolly Varden: Recovered

The growth differences between Dolly Varden in oiled and unoiled streams did not persist into the 1990–91 winter, but no growth data have been gathered since 1991. In addition, by 1990 the concentrations of hydrocarbons in bile had dropped substantially and a biochemical marker of oil exposure had a diminished.

In a 1991 restoration study sponsored by the Council, some tagged Dolly Varden moved considerable distances among streams within Prince William Sound, suggesting that mixing of overwintering stocks takes place during the summer in saltwater. Follow up studies indicate that Dolly Varden are abundant throughout the Sound, and genetically similar among geographically different aggregates. Frequent genetic exchange among groups of fish implies that mixing occurs, and outside populations are available to enhance depleted stocks. Moreover, fishing pressure on Dolly Varden is likely not as intense as that on coastal cutthroat trout. Populations are larger, the fish are more widely spread throughout the Sound and larger numbers can better tolerate harvest. Finally, current exposure to lingering oil is unlikely because most of the bioavailable oil is confined to subsurface intertidal areas and not dissolved in the water column. The recovery status of Dolly Varden is recovered.

3.4.10 Harbor Seals: Recovered

Harbor seal populations in the Sound were declining before the oil spill and the decline continued after the spill occurred. Factors contributing to this decline may involve environmental changes that occurred in the 1970s in which the amount and quality of prey resources were diminished. It is possible that the changes in the availability of high quality forage fish such as Pacific herring and capelin altered the ecosystem such that it may now support fewer seals than it did prior to the late 1970s. Other sources of mortality that may be contributing to lower seal numbers could include predation, subsistence hunting, and commercial fishery interactions (e.g., entanglement and drowning in nets).

Satellite tagging studies sponsored by the Council and genetic studies carried out by the National Marine Fisheries Service indicate that harbor seals in the Sound are largely resident throughout the year and have limited movement and interbreeding with other subpopulations in the northern Gulf of Alaska. This suggests that recovery must come largely through recruitment and survival within resident populations.

Based on annual counts from haulouts concentrated in the south-central region of the Sound, seal numbers stabilized from 1996–2005 and likely increased between 2001–2005. From 1990–2005, seal numbers at sites that were not oiled decreased at a greater rate than oiled sites, indicating no localized effects of the spill. However, the entire spill zone was not surveyed, and trends may have been influenced by movements of seals from oiled to unoiled sites after the spill and a return to more oiled sites in recent years. This hypothesis has not been studied directly. Harbor seals are considered recovered due to collective evidence from the last ten years indicating that harbor seal population numbers are stabilizing or increasing.

3.4.11 Harlequin Ducks: Recovering

Winter populations of harlequin ducks in Prince William Sound have ranged from a high of 19,000 ducks in 1994 to a low of around 11,000 ducks in March of 1990, one year after the spill. The 2000 estimate of wintering harlequin ducks in the Sound was approximately 15,000.

Several post-spill studies were designed to measure the extent and severity of injuries to the Prince William Sound harlequin duck population from the oil spill and assess recovery. Through 1998, oil spill effects were still evident although the extent and magnitude of the injury remained unclear. Supporting studies provided evidence of continuing injury to harlequins through the following mechanisms: 1) invertebrate recovery in upper intertidal and subtidal areas remained incomplete for some species, thereby impacting potential prey base for harlequins; 2) oil persisted in intertidal areas of Prince William Sound where it was identified as a source of contamination of benthic invertebrates; 3) the possibility of external oiling of feathers remained due to lingering surface oil; 4) a biochemical marker of oil exposure (cytochrome P450) was greater in tissues of harlequin ducks captured in oiled areas than in reference areas and 5) overwinter female survival was lower in oiled than reference areas.

More recent studies indicate improving conditions. From 1997–2007, age composition and population trends were compared in harlequin ducks between oiled and unoiled areas of the Sound. No difference in population trends was observed between areas. Although populations in the oiled area were no longer declining as they were in the mid 1990s, a positive trend was not observed. Overall, more males than females occurred Sound-wide which is consistent with other Pacific populations of harlequin ducks. The ratio of immature to adult males was similar between areas, thus indicating similar recruitment into both populations. However, there remains a disproportionately lower number of female ducks in the oiled areas. From 2000–2002, measurements of cytochrome P450 activity and female survival rates were converging between oiled and unoiled areas. However, in 2005 through 2009 the P450 biomarker was elevated in ducks from the oiled areas. Finally, lingering oil still remains in habitats used by harlequins, thereby maintaining the possibility of chronic effects related to continued exposure.

Recent analyses still show a pattern of higher cytochrome P450 induction in oiled than unoiled areas. A temporal trend towards convergence between oiled and unoiled populations in over-winter survivorship indicate that harlequin ducks are in the process of recovering. However, a sustained increase in abundance numbers is needed in oiled areas for full recovery. Harlequin ducks are considered to be recovering, as indications of negative effects (reduced survival and declining numbers) in oiled areas have abated, although the recovery objective has not been fully realized.

3.4.12 Mussels: Recovering

The primary route by which mussels accumulate oil is through ingestion of petroleum hydrocarbons in the water. Much of the lingering oil in the Sound and the Gulf of Alaska is

sequestered in the subsurface sediments. Mussels are found both as epibiota, attached to the surface substrates, and also partially embedded in coarse sediment, where they could come into close contact with oiled sediments. It is possible that mussels could filter particulate and dissolved hydrocarbons from the water if the oil is re-suspended during storm surges, wave action or when underlying sediments are disturbed by predators. The current distribution of oil within a mussel bed is determined by water flow, amount of oil present, sediment grain size, and disturbance history.

After the spill, hydrocarbons accumulated in mussels for about a decade at sites where oil was retained in sediments. Remaining oil was biologically available for many years after the spill, but the frequency of occurrence and average hydrocarbon concentrations in mussel tissue has declined with time. In most instances concentrations of oil in mussels from the most heavily oiled beds in Prince William Sound were largely indistinguishable from background by 1999. However, concentrations in sediment underlying the mussel beds remained elevated.

Recent data indicate that hydrocarbon concentrations in mussels are declining, even in armored beaches where elimination has been slow, and at many sites concentrations are not different from background. While a decrease in tissue concentration addresses part of the recovery objective, in order to be fully recovered mussels must provide uncontaminated food to top predators, including human subsistence users. As recently as 2008, some bird species which rely exclusively on the intertidal zone (harlequin ducks, Barrow's goldeneye and black oystercatchers) were still being exposed to hydrocarbons. The route of oil exposure has not been established for these birds, however, it is possible that they are consuming contaminated prey or foraging in contaminated sediment during feeding. For many of these species mussels are a known prey item, and they could be foraging in contaminated sediments underlying mussel beds. Because it cannot be verified that predators are not being exposed to oil while foraging in mussel beds, mussels are considered to be recovering from the effects of the oil spill.

3.4.13 Pink Salmon: Recovered

In the years preceding the spill, returns of wild pink salmon in Prince William Sound varied from a maximum of 23.5 million fish in 1984 to a minimum of 2.1 million in 1988. Many factors, such as the timing of spring plankton blooms and changes in water circulation patterns throughout the Gulf of Alaska are likely to have a great influence on year-to-year returns in both wild and hatchery stocks of pink salmon. Since the spill, returns of wild pinks have varied from a high of about 12.7 million fish in 1990 to a low of about 1.9 million in 1992. In 2001 the return of wild stock fish was estimated to be 6.7 million fish.

The decade preceding the oil spill was a time of peak productivity for pink salmon in the Sound. In 1991 and 1992, it appears that wild adult pink salmon returns to the Sound's Southwest District were reduced by 11 percent; however wild salmon returns are naturally highly variable. Furthermore, the methods used to estimate this decrease could not be used to produce reliable

injury estimates across multiple generations of salmon. An analysis of escapement data from 1968-2001 did not show any differences in annual escapements between oiled and unoiled parts of the Sound. Therefore, population-level effects from the spill did not impact wild pink salmon or were short-lived.

Sound-wide population levels appear to be within normal bounds. In addition, reduced juvenile growth rates in Prince William Sound occurred only in the 1989 season. Since then, juvenile growth rates have been within normal bounds. Higher embryo mortality persisted in oiled streams when compared to unoiled streams through 1993: these differences were not detected from 1994–1996, but higher embryo mortality was again reported in 1997. It could not be determined if the reemergence of elevated embryo deaths was due to the effects of lingering oil (perhaps newly exposed by storm-related disturbance of adjacent beaches), or due to other natural factors (e.g., differences in the physical environment). Although patches of lingering oil still persist in or near intertidal spawning habitats in a few of the streams used by pink salmon in southwestern Prince William Sound, the amounts were considered negligible based on 1999 and 2001 studies. In 1999, dissolved oil was measured in six pink salmon streams that had been oiled in 1989. Only one of the six streams had detectable concentrations of oil, and they were about a thousand times lower than concentrations reported as toxic to developing pink salmon embryos.

Based on these results, continuing exposure of pink salmon embryos to lingering oil is negligible and unlikely to limit pink salmon populations. Given the fact that pink salmon population levels and indicators such as juvenile growth and survival are within normal bounds, pink salmon were considered recovered from the effects of the oil spill in 1999.

3.4.14 River Otters: Recovered

Although some of the differences (e.g., values of blood characteristics) between river otters in oiled and unoiled areas in Prince William Sound were apparent through 1996, they did not persist in 1997 and 1998. In 1999, the Council considered river otters to be recovered, because the recovery objectives had been met and indications of possible lingering injury from the oil spill were not present.

3.4.15 Sea Otters: Recovering

No apparent population growth occurred for Prince William Sound sea otters through 1991. After 1993, the population in the western Sound began increasing at a rate approximately one-half of the pre-spill rate of increase. From 1993–2000, the number of otters increased by 600 animals which represents an annual growth rate of 4 percent. However, in areas that were heavily oiled, such as northern Knight Island, sea otter populations have remained well below pre-spill numbers, and population trends continued to decline through 2005.Moreover, the demographics within this group apparently are not stable as many of the females are below reproductive age and young non-territorial males have moved into and out of the population.

The lack of recovery may reflect the extended time required for population growth for a long-lived mammal with a low reproductive rate, but likely reflects the effects of chronic exposure to hydrocarbons, or a combination of both factors. Food limitation does not appear to be a factor limiting recovery in the Knight Island group, because food resources are at least as plentiful there as they are at unoiled Montague Island. Productivity is also similar between oiled and unoiled sites. Exposure of sea otters to lingering oil is plausible because their foraging sites and prey species occur in habitats harboring oil. Additionally, biochemical responses (cytochrome P450) of oil exposure were elevated in animals from oiled sites through 2002. By 2004–2005, the response of this biomarker was similar in animals from oiled and unoiled areas. However, additional years of data are needed to determine if the similarity is true convergence, and the apparent diminishing exposure to oil is a long-term trend.

Sea otters will have recovered when population levels, reproduction and productivity are within normal bounds in oiled and unoiled areas and have reached levels that would have existed without the spill. Recovery will also be substantiated when the biochemical indicators of hydrocarbon exposure are similar within the oiled and unoiled areas.

Although there has been a slow increase since 2005 in the sea otter population within the heavily-oiled areas, there has been a greater rate of overall increase in the population within Prince William Sound. Therefore, sea otters are considered to be recovering.

3.5 Sediments: Recovering

Approximately ten acres of *Exxon Valdez* oil remains in surface sediments of Prince William Sound, primarily in the form of highly weathered, asphalt-like or tar deposits. In 2003, it was estimated that 20 acres of unweathered, lingering oil may still be present in subsurface, intertidal areas of the Sound, which could represent up to 100 tons of remaining oil. Most of this oil is found in protected, unexposed bays and beaches. Subsurface oil was not subjected to the original clean-up activities, and because this oil is trapped beneath a matrix of cobbles, gravel and finer sediments, it is not easily exposed to natural weathering processes.

The most recent studies documenting residual oil occurred on those beaches that were considered heavily or moderately oiled in 1989: beaches reported as lightly oiled were not surveyed. Moreover, beaches outside of the Sound were not included, so the amount and extent of residual oil in the entire spill zone is not known, but one estimate suggests as much as 200 tons of oil may still exist. Several studies have evaluated the extent of lingering oil on armored oiled beaches along the outer Kenai Peninsula coast, the Alaska Peninsula, and Kodiak Archipelago: These studies looked at the same sites repeatedly at intervals from 1992–2005. By 1995, little visible oiling was observed in the study area on Kodiak. Overall, by 1995, hydrocarbon concentrations in sediments at the Gulf of Alaska sites were generally lower than for sites in Prince William Sound, but at some locations substantial concentrations persisted. Through 2005, surface oil was

not frequently observed in these areas, and subsurface oil was present as mostly unweathered mousse.

In 1989, chemical analysis of oil in subtidal sediments was conducted at a small number of index sites in Prince William Sound. In the subtidal areas, petroleum hydrocarbon concentrations were highest at depths of 1– 60 feet (below mean low water) and diminished out to depths of 300 feet. It is likely that oil in subtidal sediments have decreased substantially since the spill. In 2001, several sites that were sampled after the spill were revisited, and no oil was found in the subtidal sediment from these locations.

Twenty-one years after the spill, lingering oil has persisted in the intertidal zones of Prince William Sound and on northwest shorelines of the spill area. The presence of subsurface oil continues to compromise wilderness and recreational values, expose and potentially harm living organisms, and offend visitors and residents, especially those who engage in subsistence activities along still-oiled shorelines. Although much of the oil has diminished over time, pockets of unweathered oil exist, and natural degradation of this oil is very slow. Moreover, some obligate intertidal foraging bird species are still being exposed to oil. Therefore, sediments are considered to be recovering.

3.6 Offshore - Recovering

Subtidal habitats encompass all of the seafloor below the mean lower low water tide line to about 800 meters, although deeper habitats are often referred to as the deep benthos. For purposes of evaluating oil spill effects, the impacted subtidal zone generally ranges from the lower intertidal zone to a depth of about 20 meters. Communities in the near subtidal areas are typically characterized by dense stands of kelp or eelgrass and comprise various invertebrate species, such as amphipods, polychaete worms, snails, clams, sea urchins and crabs. Subtidal habitats provide shelter and food for an array of nearshore fishes, birds, and marine mammals.

It is estimated that up to 13 percent of the oil that was spilled deposited in the subtidal zones. The direct toxicity of the oil, as well as subsequent clean-up activities caused changes in the abundance and species composition of plant and animal populations below lower tides. Initial injuries were evident for several oil-sensitive species. Infaunal amphipods, a prominent prey species in subtidal communities, were consistently less abundant at oiled than at unoiled sites. Reduced numbers of eelgrass shoots and flowers were also documented and may have resulted from increased turbidity associated with clean-up activities. Two species of sea stars and helmet crabs also were less abundant at oiled sites when compared to oiled areas. However, stress tolerant organisms, including polychaete worms, snails and mussels were more abundant at oiled sites. It has been suggested that these species may have benefited from organic enrichment of the area from the oil or from reduced competition or predation because other, more sensitive species were depleted.

3.6.1 Killer Whales: Recovering (AB Pod), Not Recovering (AT1 Population)

From 1990–1995 seven calves were born within the AB pod: however, additional mortalities occurred and by 2005, the number of whales was only 27. Killer whales are long-lived and slow to reproduce. Female killer whales give birth about every five years, and are likely to produce only four to six calves throughout their life. Moreover, a disproportionate number of females were lost at the time of the spill, and population modeling has demonstrated that the spill impacted the AB pod primarily through the loss of young and reproductive females. Unexpected mortalities in the years since the spill have also impacted this group. These factors indicate that the recovery rate of this population after a large loss of individuals will be slow.

Transient killer whales, such as the AT1 population, largely prey on marine mammals, especially harbor seals. From data collected at haul-outs in the south-central region of the Sound, it appears that harbor seals numbers may have increased over the past five years. It is unclear how the population dynamics of harbor seal influence transient whale populations, but changes in the availability of such an important prey species could impact survival of individuals and reproductive success within groups. Research sponsored by the Council on contaminants in killer whales in the Sound indicates that individuals of the AT1 population are carrying elevated levels of PCBs, DDT, and DDT metabolites in their blubber. Although the presence of these contaminants is not related to the oil spill, the high concentrations found in these transients are comparable to levels that cause reproductive problems in other marine mammals. Accordingly, it is likely that the population dynamics of this population are being influenced by factors other than residual oil which may further hinder their ability to rebound from the initial injury from the spill.

Killer whales will have recovered when population levels, reproduction and productivity are within normal bounds in spill-affected pods of killer whales, as would have existed without the spill. The weighted average annual productivity rate of the AB resident pod is 3.3 percent. This pod is considered recovering. The AT1 transient population of killer whales, however, continues to decline, and therefore, is considered not recovering. The progress toward recovery is slow as key breeding females have been lost. The AB killer whale pod is considered to be recovering due to the stabilized reproduction rate of the pod. The recovery status of the AT1 killer whale population is considered to be not recovering due to the population's continuing decline.

3.6.2 Pigeon Guillimot: Not Recovered

As of 1999, adult pigeon guillemots in the oiled areas were still being exposed to oil as indicated by elevation of a biochemical marker of exposure, cytochrome P450. No differences were found between P450 activity in chicks from oiled and unoiled sites. The difference in P450 activity between adults and chicks is probably due to the fact that pigeon guillemot chicks are fed primarily fish, while adults eat a combination of fish and invertebrates. Invertebrates are more likely to sequester petroleum compounds, whereas fish metabolize them. Data collected in 2004

indicated that there was no difference in P450 activity in adult pigeon guillemots collected in oiled and unoiled parts of the Sound.

Lingering oil occurs in habitats used by pigeon guillemots. They feed on fish and invertebrates by diving and probing the substrate with their bills. Because their diet includes benthic organisms living in the intertidal zone, they could encounter subsurface oil while foraging. However, guillemots do not use the intertidal zone exclusively and can travel several miles offshore to feed. Thus, their exposure to lingering oil is likely intermittent.

Reduction in forage fish, specifically herring and sand lance, has been implicated in declines of pigeon guillemots. The extent to which the oil spill resulted in the depletion of these species could indirectly injure guillemots and other seabirds by removing the food resources on which they depend. Other factors, such as predation and interactions with commercial fisheries, might be contributing to the negative population trend; however comprehensive studies including these variables have not been conducted.

The pigeon guillemot population continues to decline in both oiled and unoiled areas of Prince William Sound. Nest predation is a potential source of mortality that may be limiting recovery in some areas, implying that predator removals could prove an effective restoration option. To establish the recovery of this species to the recovery objective of increasing levels of abundance and productivity that would have existed without the spill, additional data on productivity needs to be gained to form a reasonable estimate. Pigeon guillemots are considered to be not recovered from the effects of the spill.

3.6.3 Rockfish: Very Likely Recovered

From 1989–1991, higher petroleum hydrocarbon concentrations were measured in rockfish from oiled areas when compared to unoiled areas. Interpretation of these data is limited, however, because oil accumulation differs by species and by age of the fish, and these variables were not fixed across sites. Other Council-funded studies have been conducted on rockfish since the spill, including 1) an examination of larval growth of fish, (including rockfish) in 1989; 2) a genetics investigation designed to identify species of rockfish larvae and young in the Gulf of Alaska and 3) a microscopic examination of fish tissues to identify lesions associated with oil exposure. These studies were inconclusive as none of them directly linked exposure of *Exxon Valdez* oil to any of the endpoints that were measured.

It is unlikely that adult rockfish are currently being exposed to lingering oil because known pockets of lingering oil rarely occur in their preferred habitat. Documented lingering bioavailable oil is in the subsurface sediments of the intertidal zone, and adult rockfish mostly occur in differing habitats of subtidal areas and in pelagic environments. From 1999–2000, no differences were measured in physiological responses to oil in rockfish from oiled and unoiled areas. Nearshore environments, however, provide important rearing habitat for young-of-the-year and

juvenile rockfish of a number of species. Since lingering oil is present in the intertidal zone, the risk of exposure is present during early life history stages for those species.

Although it is unlikely that most species and life-stages of rockfish are currently being exposed to lingering oil, the original extent of injury was not documented and the potential for continued exposure by young-of-the-year and juveniles of some species is present. Since the spill, few studies have provided information about rockfish abundance, species composition and the impacts of commercial fisheries. Therefore, the current understanding of the long-term effects of the original spill cannot be determined and the Council considers the status of rockfish to be very likely recovered. Based on the available data, understanding of ecological interactions and the expected small size of lingering impacts, it is unlikely that an effect, if any, will impair function of the ecological system and thus there are likely more effective uses of research funds than on further study of this species.

3.6.4 Sockeye Salmon: Recovered

Although sockeye freshwater growth tends to return to normal within two or three years following an overescapement event, there are indications that the populations are less stable for several years. The overescapement following the spill resulted in lower sockeye productivity, (as measured by return per spawner) in the Kenai River watershed from 1989–92. However, production of zooplankton in both Red and Akalura lakes on Kodiak Island quickly rebounded from the initial effects overgrazing. By 1997, Red Lake had responded favorably in terms of smolt and adult production and was at or near pre-spill production of adult sockeye. At Akalura Lake there were low juvenile growth rates in freshwater during the period 1989–92, and these years of low growth correspond to low adult escapements during the period 1994–97. Starting in 1993, however, the production of smolts per adult increased sharply and the smolt sizes and age composition suggested that rearing conditions had improved. It is possible that overescapement also affected lakes on Afognak Island and on the Alaska Peninsula. However, analysis of sockeye freshwater growth rates of juveniles from Chignik Lake on the Alaska Peninsula did not identify any impacts associated with a 1989 overescapement event. On the basis of catch data through 2001 and in view of recent analyses of return per spawner estimates presented to the Alaska Board of Fisheries in 2001, the return-per-spawner in the Kenai River system is within historical bounds. Therefore, it is highly unlikely that the effects that reverberated from the overescapements in 1989 continue to affect sockeye salmon. In 2002, this species was considered to be recovered from the effects of the oil spill.

3.6.5 Kittlitz's Murrelet: Unknown

Few studies have been conducted on Kittlitz's murrelets, however they are known to nest in areas of glacial outcroppings, and they are thought to reside within the Sound from May until September/October. Kittlitz's murrelets have an intrinsically low population growth rate, thus recovery from an acute loss is likely to be slow.

The Kittlitz's murrelet is a candidate species for listing as threatened or endangered under the federal Endangered Species Act. They declined 99 percent from 1972 to 2004 and 88 percent from 1989–2004. While this decline likely started prior to the spill, the rate of decline was 18 percent per year from 1972, but beginning in 1989 that rate increased to 31 percent.

Natural recovery has not restored this resource to pre-spill levels or levels that would have existed had the spill not occurred. What little evidence is available reveals possible predator limitation, within their feeding areas, and impacts due to a shifting climate. While it is likely that basic biological studies would be useful to understand what may be limiting recovery, it is unlikely, due to these confounding effects, that further study will clarify whether there are still residual effects of the spill. In addition, the rarity of this species makes it difficult and expensive to study.

The recovery status for the Kittlitz's murrelet remains unknown. Further, due to the small populations and the confounding effects discussed above, it is likely that additional studies would be both relatively expensive and unable to demonstrate an effect of the spill or to clarify this species' injury status.

3.6.6 Marbled Murrelets: Unknown

Marbled murrelets were declining in the Sound before the oil spill, and the decline has continued since the spill. It is listed as a threatened species in Washington, Oregon, California and British Columbia. Marbled murrelets have low intrinsic productivity and a slow population growth rate. Therefore, recovery from an acute loss will likely take many years.

Marbled murrelets rely on forage fish such as Pacific herring and Pacific sand lance, which may be declining in the spill area due to various reasons including a potential link to EVOS. Their dietary preferences and foraging areas make significant contact with lingering oil unlikely. Exogenous factors such as climatic factors, decreases in habitat availability, and shifts in forage fish populations are the most likely drivers of murrelet population dynamics. Marbled murrelets do not meet their original recovery objective of increasing or stable populations. Moreover, their decline could be attributable in part to a decline in a primary food source; high-lipid forage fish, particularly sand lance and Pacific herring. Based on available data and scientific understanding, the mechanistic linkage between the oil spill, reduction in high-lipid forage fishes and the decline in marbled murrelets remains uncertain. Because of the great variability in the marbled murrelet annual census in the years after the spill, it is unlikely that the loss of even as much as 7–12 percent of the PWS population (the estimated spill mortality) would have been detectable by census techniques.

The recovery status for marbled murrelets remains unknown due to conflicting information and a lack of critical data. Further, due to the confounding effects discussed above, additional studies

would likely be unable to definitively demonstrate an effect of the spill with a high degree of confidence or to clarify this species' injury status.

3.6.7 Pacific Herring: Not Recovered

The herring fishery in the Sound has been closed for 15 of the 21 years since the spill. The population began increasing again in 1997 and the fishery was opened briefly in 1997 and 1998. However, the population increase stalled in 1999, and recent research suggests that the opening of the fishery in 1997 and 1998 stressed an already weakened population and contributed to the 1999 decline. The fishery has been closed since then and no trend suggesting healthy recovery has occurred.

One of the primary factors currently limiting recovery of herring in the Sound seems to be disease. Two pathogens, a virus and a fungal infection are prevalent in herring populations among several age classes. Conditions which made herring susceptible to these two diseases (viral hemorrhagic septicemia and Icthyophonus hoferi infection) are unknown, but it appears they have been impacting herring for over a decade. These diseases do not usually distress fish populations for such a long duration, and this cycle seems to be unique to the herring of Prince William Sound.

Lingering oil exists in the Sound, however there does not appear to be much overlap between current herring spawning areas and sites known to harbor residual oil. In 2006, some herring spawn was observed in areas of the Sound that were oiled however, the spatial extent was limited, and this was the first year in decades that it has been reported. Therefore, it is not likely that lingering oil is directly affecting spawning adults, eggs or larvae.

Low genetic diversity does not appear to be a limitation within herring populations. It was suggested that historic overfishing coupled with the population crash of 1993 could have resulted in a population with low genetic diversity. Similar genetic structure could limit a population's ability to tolerate disease or recover from acute losses, but the genetic diversity of Prince William Sound herring is no different from other northwest populations.

Multigenerational toxicity and effects from original contact with oil does not seem plausible, however this hypothesis has not been directly investigated. Other factors may have contributed to the crash of 1993. Some evidence implies that zooplankton production in the 1990s was less than in the 1980s, thereby causing food to be limited at the time of a peaking population. This hypothesis is offered some support by the fact that the average size-at-age of herring had been decreasing since the mid-1980s as population numbers were rising. Poor nutrition may also increase susceptibility of herring to disease.

Predation also plays a role in herring population dynamics, as they are a primary forage fish within the Prince William Sound ecosystem. It is plausible that the small herring population is

fighting an on-going disease problem and is further being kept in check by predators such as whales, seals, sea lions and seabirds.

Despite the numerous studies directed at understanding the effects of oil on herring, the causes constraining population recovery are not well understood. A combination of factors, including disease, predation and poor recruitment appear to contribute to the continued suppression of herring populations in the Sound. In summary, Prince William Sound Pacific herring have not met their recovery objective. No strongly successful year class has been recruited into the population and health indices suggest that herring in the Sound are not fit. Therefore, the Pacific herring are considered to be not recovering from the effects of the spill.

3.7 Human Services

The Spill had significant negative impacts, both culturally and economically, on the people who live in the spill area. The lives of the people who live, work, and recreate in the areas affected by the spill were completely disrupted in the spring and summer of 1989. The Council recognized those impacts. In an effort to address those impacts, the Council has devoted a major portion of restoration funds to the restoration of the fish, birds, marine mammals, and archaeological resources that support human communities in the spill area.

3.7.1 Recreation and Tourism: Recovering

Recreation and tourism accounted for 26,000 jobs, generated $2.4 billion in gross sales and contributed $1.5 billion to Alaska's economy in 2003. The number of visitors to Alaska has increased in the years since the spill and it is expected that the recreation and tourism industry in south-central Alaska will grow approximately 28 percent per year through 2020. By 2001, more than $10 million had been spent on repair and restoration of recreational facilities in the spill area, and damage caused by the spill or clean-up efforts at the Green Island cabin and Fleming Spit campsites were repaired.

Telephone interviews conducted in 1999 and 2002 of people who used the spill area for recreation before and after the spill, indicated that, although oil remained on beaches, it did not deter them from using the area. However, they continued to report diminished wildlife sightings in Prince William Sound, particularly in heavily oiled areas such as around Knight Island. They also reported seeing fewer seabirds, killer whales, sea lions, seals, and sea otters than were generally sighted before the spill, but also reported observing increases in the number of seabirds over the last several years. Key informants with experience along the outer Kenai coast reported diminished sightings of seabirds, seals, and sea lions. However, they indicated that the possible presence of residual oil has no effect on recreational activities along the outer Kenai coast, the Kodiak Archipelago, and the Lake Clark and Katmai national park coastlines. Changes in the amount of wildlife observed could be due to a variety of factors, including the spill.

Recreation and tourism rely on both consumptive and non-consumptive uses of natural resources. Although these activities have increased since the spill, several resources have not yet recovered from the spill and beaches used for recreation contain lingering oil. Resources that are important to recreation and tourism, but are still not considered recovered from the spill or their recovery is unknown include harbor seals, Kittlitz's and marbled murrelet, pigeon guillemot, clams, mussels, harlequin ducks, sea otters and killer whales. Sportfishing resources for which the recovery status is unknown are cutthroat trout and rockfish. However, the salmon species that were injured (pink and sockeye salmon) are recovered from the effects of the spill.

Even though visitation has increased since the oil spill, Council's recovery objective requires that the injured resources important to recreation be recovered and recreational use of oiled beaches not be impaired. Lingering oil remains on beaches and in some localized areas this remains a concern for users. Moreover, several natural resources have not recovered from the effects of the spill. Therefore, Council finds recreation and tourism to be recovering from the effects of the spill, but not yet recovered.

3.7.2 Passive Use: Recovering

The Council determined that passive use injuries occurred as a result of the oil spill because natural resources including scenic shorelines, wilderness areas, and popular wildlife species, from which passive uses are derived, were injured. The key to the recovery of passive use is providing the public with current information on the status of injured resources and the progress made towards their recovery.

Passive use is the service provided by natural resources to people that will likely not visit, contact, or otherwise use the resource. Thus, injuries to passive use are tied to public perceptions of injured resources. Passive use is the appreciation of the aesthetic and intrinsic values of undisturbed areas and the value derived from simply knowing that a resource exists. The oil spill occurred in what many Americans viewed as an undisturbed area and caused visible injury to shorelines, fish and wildlife.

Two vital components of the Council's restoration effort are the research, monitoring, and general restoration program and the habitat protection and acquisition program. Extensive work has been done to restore and monitor resources and communicate these findings to the public. The research, monitoring, and general restoration program is funded each year through the annual work plan, which documents the projects that are currently funded to implement restoration activities for injured resources and services. The habitat protection program preserves habitat important to injured resources through the acquisition of land or interests in land. As of 2006, the Council has protected more than 630,000 acres of habitat, including more than 1,400 miles of coastline and over 300 streams valuable for salmon spawning and rearing.

Other public information efforts in which the Council is currently engaged include:

- The Council's website (www.evostc.state.ak.us) offers detailed information regarding past, current, and future restoration efforts
- The Council prepares a number of documents for distribution to the public including:
    - The *Invitation for Proposals*, which solicits restoration project ideas from the scientific community and the public
    - The Annual Work Plan (described above)
    - Updates to the *Restoration Plan* (1996, 1999, 2002, & 2006) which periodically provides new information on the recovery status of injured resources and services.
- Project final reports are available to the public at the Council's website, through the Alaska Resource Library and Information Services (ARLIS) in Anchorage, as well as at several other libraries in the State, the Library of Congress, and through NTIS (National Technical Information Service). In addition, the Council supports researchers in publishing their project results in peer-reviewed scientific literature, which expands their audience well beyond Alaska.
- The Council supports an annual marine science symposium, which is open to the public that provides a venue in which to report the progress of restoration in the spill area.
- Public Input: The Public Advisory Committee (PAC) is an important means of keeping stakeholders and others informed of the progress of restoration and providing the public's opinions to the Council as they make decisions. Additionally, public meetings are held periodically throughout the spill area. All meetings of the Council are widely advertised and opportunity for public comment is always provided.

Until the public no longer perceives that lingering oil is adversely affecting the aesthetics and intrinsic value of the spill area it cannot be considered recovered. Because recovery of a number of injured resources is incomplete, the Council considers services related to passive use to be recovering from the effects of the spill.

3.7.3 Subsistence: Recovering

After the spill, subsistence harvest declined between 9–77 percent in 10 villages within Prince William Sound, Cook Inlet and Kodiak. Villages in Tatitlek and Chenega reduced their harvest by 56 and 57 percent, respectively. Outside of the Sound, harvest declined in Akhiok (on the lee side of Kodiak Island) by nine percent, but by 77 percent in Ouzinkie, which is on the northern side of the island. The primary reason that harvest declined so dramatically was the fear that oil had contaminated the resources and made them unfit to eat.

Harvest levels have generally increased in many communities since the spill, but results of harvest surveys have been variable. By 2003, they were generally higher than pre-spill levels in the communities in Cook Inlet, but lower in Kodiak and Prince William Sound (except for Cordova). Even though the harvest levels in the PWS communities were not as high as pre-spill

estimates, they were within the range of other Alaska rural communities. Harvest composition was also altered by the spill. In the first few years following the spill, people harvested more fish and shellfish than marine mammals because of the reduced number of marine mammals and the perception that these resources were contaminated and unsafe to eat.

Both safety concerns and the reduced availability of shellfish contributed to a decline in harvest levels. From 1989–94, subsistence foods were tested for evidence of hydrocarbon contamination, with no or very low concentrations of petroleum hydrocarbons found in most subsistence foods. However, concerns about oil contamination remained, and there was a belief that the increase in paralytic shellfish poisoning (PSP) was linked with *Exxon Valdez* oil. By 2003, most subsistence users expressed confidence in foods such as seals, finfish and chitons. However, the safety of certain shellfish, such as clams was still met with skepticism.
Subsistence use is a central way of life for many of the communities affected by the spill, thus the value of subsistence cannot be measured by harvest levels alone. The subsistence lifestyle encompasses a cultural value of traditional and customary use of natural resources. Following the oil spill, there was concern that the spill disrupted opportunities for young people to learn cultural subsistence practices and techniques, and that this knowledge may be lost to them in the future. In a 2004 survey of the spill area communities, 83 percent of respondents stated that their "traditional way of life" had been injured by the oil spill and 74 percent stated that recovery had not occurred.

Many factors may contribute to the changes observed in subsistence harvests and the lifestyle surrounding this tradition. Demographic changes in village populations, ocean warming, increased competition for subsistence resources by other people (e.g., sport fishing charters), predators (e.g., sea otters), and increased awareness of PSP and other contaminants may play a role in resource availability, food safety, and participation in traditional practices.

Fears about food safety have diminished since the spill, but it is still a concern for some users. Additionally, harvest levels from villages in the spill area are comparable to other Alaskan communities. However, many subsistence resources injured by the spill, including clams and mussels, have still not recovered from the effects of the spill. For these reasons, subsistence is considered to be recovering from the effects of the oil spill.

3.7.4 Commercial Fishing: Recovering

In the 1994 *Restoration Plan*, the Council specifically recognized the declines in pink salmon and Pacific herring populations, and considered the reduction in these two fisheries as the biggest contributors to injury of the commercial fishing service in the spill area. Therefore, many restoration activities were focused towards these resources. The strategy for restoring commercial fishing included funding projects that accelerated fish population recovery, protected and purchased important habitat and monitored recovery progress. By 2002, the Council considered pink salmon and sockeye salmon to be recovered from the oil spill. However,

recovery was not considered complete for Pacific herring and the recovery status of this resource remains 'Not recovering' (see individual resource accounts).

Income from commercial fishing dramatically declined immediately after the spill, and for a variety of reasons, disruptions to income from commercial fishing continue today, as evidenced by changes in average earnings, ex-vessel prices and limited entry permit values. Natural variability in fish returns and a number of economic changes in the commercial fishing industry since 1989 probably mean that many of these changes in income are not directly attributable to the spill. However, these factors also make discerning spill-related impacts difficult. Economic changes confronting the industry include the increased world supply of salmon (due primarily to farmed salmonids) and corresponding reduced prices, entry restrictions in certain fisheries (such as Individual Fishing Quotas, for halibut and sablefish), allocation changes (e.g., a reduction in the allocation of Cook Inlet sockeye salmon to commercial fishermen), reduction in processing capacity, and spatial limitations of groundfish fisheries in the spill areas in conjunction with sea lion management. Finally, competition among commercial, recreational, and subsistence fishers influence management decisions of these shared resources.

Since 1989, there have been no non-herring, spill-related, district-wide fishery closures related to oil contamination and populations of pink and sockeye salmon are considered recovered from the effects of the spill. The Prince William Sound herring fishery has been closed for 15 of the 21 years since the spill and herring are not considered recovered. Commercial fishing, as a lost or reduced service, is considered to be recovering from the effects of the oil spill.

3.7.5 Archeological Resources: Recovered

Assessments of 14 sites in 1993 suggested that most of the archaeological vandalism that can be linked to the spill occurred early in 1989, before adequate constraints were put into place over the activities of oil spill clean-up personnel. Most vandalism took the form of "prospecting" for high yield sites. Once these problems were recognized, protective measures were implemented and successfully limited additional injury. Although some cases of vandalism were documented in the 1990s, there appears to be no spill-related vandalism at the present time.

From 1994–1997, two sites in Prince William Sound were partly documented, excavated, and stabilized by professional archaeologists because they had been so badly damaged by oiling and erosion. The presence of oil in sediment samples taken from four sites in 1995 did not appear to have been the result of re-oiling by *Exxon Valdez* oil. Residual oil does not appear to be contaminating any known archaeological sites.

In 1993, the Council provided part of the construction costs for the Alutiiq Archaeological Repository in Kodiak (www.alutiiqmuseum.com). This facility now houses Kodiak area artifacts that were collected during spill response. In 1999, the Council approved funding for an archaeological repository and local display facilities for artifacts from Prince William Sound and

lower Cook Inlet. Local displays are open to the public in Port Graham, Cordova, Seward, Seldovia, and Tatitlek. The facility in Seward serves as the repository for the Chugach region.

Based on the apparent absence or extremely low rate of spill-related vandalism and the preservation of artifacts and scientific data on archeological sites, archaeological resources are considered to be recovered.

3.7.6 Designated Wilderness Areas: Recovering

Six moderately to heavily oiled sites on the Kenai and Katmai coasts were surveyed in 1994, at which time some oil mousse persisted in a remarkably unweathered state on boulder-armored beaches at five sites. These sites were visited again in 1999, and oil was found along park shorelines of the Katmai coast. Surveys carried out in 2001 and 2003 to determine the surface and subsurface distribution of oil in Prince William Sound found lingering oil on shorelines within designated wilderness study areas. Finally, in 2005 the sites surveyed in 1999 were again sampled. Although surface cover of oil had declined, the subsurface oil persisted in amounts similar to those found in 1999. Moreover, the oil at those sites was compositionally similar to samples collected 11days after the spill.

However, in many areas, the amount of oil has diminished since 1990. Therefore, designated wilderness areas are considered to be recovering.

CHAPTER 4 – ENVIRONMENTAL CONSEQUENCES

This chapter contains the analysis of the environmental consequences that could result from implementing the two alternatives described. As with the September 1994 Final Environmental Impact Statement, this supplemental environmental impact statement (SEIS) differs from many EISs in that this analysis focuses on the two alternatives for creating increases in populations or services from some existing level, rather than the degree of loss or gain to natural resources from implementation of alternatives.

4.1 Alternative 1: No Action

If the Alternative 1: No Action was implemented, the current practices of the Council would continue and the scope of present Council activities or programs would not change. Similarly, agency monitoring of natural recovery would remain at present levels, and their responsibilities would remain unchanged. The remaining funds from the civil settlement would be spent on a broad range of restoration activities in an annual cycle through Council administration, as it is at present.

The analysis of Alternative 1 in the SEIS is consistent with that presented in the FEIS for Alternative 5. FEIS, Ch. 4, pg. 111–136. In addition, the efforts the Council had initially implemented to achieve environmental justice will be continued so that future work continues to be fair and equitable. FEIS, Ch. 2, pg. 2–4.

4.2 Alternative 2: The Proposed Action

In this alternative, the Council focuses on five defined areas of restoration: herring, lingering oil, long-term monitoring of oceanographic conditions and injured resources and services, harbor protection, marine restoration, and lessons learned/outreach, and habitat acquisition and protection. The analysis of Alternative 2 is consistent with that presented in the FEIS for Alternative 5, with the following analysis categorized by focus area and detailed below. FEIS, Ch. 4, pg. 111–136. Although the focus of future restoration projects will be on the restoration of injured species and services, other considerations will be made. Specifically, environmental justice issues will be considered, analyzed, and determined on a case-by-case basis as future projects are decided upon, consistent with the Council's policies. FEIS, Ch. 2, pg. 2–4. The Council strives for fairness in all impacts of these future projects, however the location of projects are largely determined by the geographic location of each species' preferred habitat.

4.2.1 Long-Term Herring Research

The September 1994 FEIS preferred Alternative (5) contemplated the natural recovery of Pacific herring through habitat protection and acquisition, found in FEIS, Ch. 4, pg. 134. Alternative 2 envisions long-term monitoring and research of herring to examine the reasons for the continued

decline of herring in Prince William Sound (PWS), to identify and evaluate potential recovery options and to recommend a course of action for restoration of PWS herring.

The activities contemplated by this proposed action are consistent with the research and monitoring activities outlined in the 1994 Plan analyzed by the FEIS. *Exxon Valdez* Oil Spill *Restoration Plan*, Ch. 3 at pg. 25 (November 1994). As noted in the FEIS, long-term monitoring and research activities could result in projects that would be only informational in nature but extremely beneficial to the restoration of injured resources or the services they provide. These benefits either depend on the results of research that is not yet completed or require an agency management action that is outside the jurisdiction of the Council. Therefore, the impact of ongoing research and management actions by other agencies will not be analyzed in this SEIS. *See also*, FEIS, Ch. 1, pg. 22.

4.2.1.1 Environmental Consequences

The environmental consequences of long-term research and monitoring of Pacific herring populations on the offshore ecosystem were evaluated for the short-term and the long-term. With respect to long-term monitoring, "short-term" pertains to a four-year period after these research and monitoring activities begin, i.e., one herring spawning cycle. "Long-term" pertains to the period over four years after these research and monitoring activities begin.

Short-term: Negligible benefits. Although some benefits, such as but not limited to a better understanding of life-cycle changes, herring population make up, and geographic distribution, may accrue quickly, it is not reasonable to expect substantial results that can then be applied within one lifecycle of herring as this time frame is too short to expect scientifically substantial results.

Long-term: Uncertain level of benefits. These actions may assist in the recovery and long-term management of herring populations, as more detail of herring life cycles, genetics, distribution, and population sizes could be determined which will inform management decisions. However, the long-term recovery of Pacific herring is unknown because, although there is evidence to suggest that the spill had an effect on Pacific herring reproduction, it is not possible to attribute their population declines solely on the spill.

4.2.1.2 Social and Economic Impacts

The impacts of long-term research and monitoring of Pacific herring populations on social and economic uses, such as subsistence, sport and commercial fishing, and wilderness, which are dependent upon the resource were evaluated for the short-term and the long-term. With respect to long-term monitoring, "short-term" pertains to a four-year period after these research and monitoring activities begin, i.e., one herring spawning cycle. "Long-term" pertains to the period over four years after these research and monitoring activities begin.

Short-term: Negligible benefits. Although some benefits may accrue quickly, it is not reasonable to expect substantial results that can then be applied within one lifecycle of herring.

Long-term: Uncertain level of benefits. These actions may assist in the recovery and long-term management of herring populations which could contribute to an increase in these uses. However, the long-term recovery of Pacific herring is unknown because, although there is evidence to suggest that the spill had an effect on Pacific herring reproduction, it is not possible to blame their population declines solely on the spill and thus a projection of benefits is speculative.

4.2.2 Long-Term Monitoring of Oceanographic Conditions and injured resources
The activities contemplated by this proposed action are consistent with the research and monitoring activities outlined in the 1994 Plan analyzed by the FEIS, but rather than focusing on a list of species, the Council proposes to focus on broader oceanographic conditions and key indicator species. *Exxon Valdez* Oil Spill *Restoration Plan*, Ch. 3 at pg. 25 (November 1994); NOI, Fed. Reg. Vol. 75, No. 14 at pg. 3708 (Jan. 22, 2010).

The Council contemplates monitoring a number of key species in the spill-affected ecosystems including forage fish, killer whales, seabirds, bivalves, and sea otters. The Council also realizes the importance of changing oceanographic conditions in the Sound as playing a vital role in the recovery of many injured resources and services. Monitoring factors such as temperature, salinity, turbidity, and zooplankton availability will play an important role in determining the overall health of the ecosystem.

As noted in the FEIS, long-term monitoring and research activities could result in projects that would be only informational in nature but extremely beneficial to the restoration of injured resources or the services they provide if the information were used or acted upon by the Council or other relevant agencies. The realization of these benefits may require an agency management action that is outside the jurisdiction of the Council. Therefore, the impacts of such potential specific management actions are not analyzed in this SEIS. *See also*, FEIS, Ch. 1, pg. 22. Rather, the impacts of implementing long-term monitoring projects are evaluated.

4.2.2.1 Environmental Consequences
The environmental consequences of long-term monitoring of oceanographic conditions and biological resources in nearshore and offshore ecosystems were evaluated for the short-term and the long-term. With respect to long-term monitoring, "short-term" pertains to a five-year period after monitoring begins. "Long-term" pertains to the period over five years after monitoring begins.

Short-term: Uncertain or Low benefits. Depending on the nature and design of the long-term monitoring, some benefits could be experienced within five years after the start of implementation, such that information learned during the study may be made available for the Council or other relevant agencies to enhance impending restoration or management activities. The benefit of this type of long-term monitoring would be low as studies that rely on a compilation of multiple years of new data have to factor in that the maximum potential benefits

will not likely be realized within five years as it takes considerable time to analyze and compile data. Unless the Council is committed to implementing activities based on the findings of the long-term monitoring, any benefits generated by long-term monitoring will rely on action being taken by the agencies which have responsibility for managing these natural resources. Since such action is beyond the control of the Council, the actual realization of restoration benefits is uncertain.

Long-term: Uncertain to Moderate benefits. It can be expected that these actions will produce information that may illuminate the larger ecosystem shifts that impact and influence a broad variety of species and resources injured by the spill. The increase in information will be a benefit to resource managers and scientists, and thus enable management strategies and long-term restoration that will support spill area marine ecosystems. Unless the Council is committed to implementing management activities based on the findings of the long-term monitoring, any benefits generated by long-term monitoring will rely on action being taken by the agencies which have responsibility for managing these natural resources. Since such action is beyond the control of the Council, the actual realization of restoration benefits is uncertain.

4.2.2.2 Social and Economic Impacts

The impacts of long-term monitoring of oceanographic conditions for nearshore and offshore ecosystems on social and economic uses, such as subsistence, wilderness, recreation and tourism, sport and commercial fishing, which depend on these marine ecosystems were evaluated for the short-term and the long-term. With respect to long-term monitoring, "short-term" pertains to a five-year period after monitoring begins. "Long-term" pertains to the period over five years after monitoring begins.

Short-term: Low benefits. Although some benefits, such as use of real-time oceanographic conditions data, may accrue quickly, it is not reasonable to expect substantial results within a five-year period.

Long-term: Moderate benefits. It can be expected that these actions will produce information that may illuminate the larger ecosystem shifts that impact and influence a broad variety of species and resources injured by the spill. This information can be used to support these uses, as well as supporting management strategies and long-term restoration that will support spill area marine ecosystems and thus further facilitate additional social and economic use of these resources.

4.2.3 Lingering Oil

The Council previously provided funding to studies that would determine the extent, distribution and biodegradability of lingering oil in the nearshore marine environment. Current research is also underway to quantify the degree of injury caused by the remaining lingering oil, evaluate the feasibility of additional remediation activities, and evaluate whether additional remedial activities would adversely affect the environment.

Lingering oil research activities may also result in projects that would be only informational in nature but potentially beneficial to the restoration of injured resources or the services through either informing the active removal of lingering oil or producing information indicating that removal of the oil would increase the injury to affected species. As discussed above, the nature of the benefits from lingering oil research depend on the results of research that is not yet completed or require an agency management action that is outside the jurisdiction of the Council. Since it is not currently known if additional remedial activities are warranted, the impact of potential remedial actions will not be analyzed in this SEIS.

4.2.3.1 Environmental Consequences

Environmental Consequences of lingering oil research With respect to lingering oil research, "short-term" pertains to a five-year period after research activities begin. "Long-term" pertains to the period over five years after research activities begin.

Short-term effects: Unknown effects. For direct restoration actions, effects are unknown because these potential actions are still being tested.

Long-term effects: Unknown effects. For direct restoration actions, effects are unknown because these potential actions are still being tested.

4.2.3.2 Social and Economic Impacts

The impacts of lingering oil research on social and economic uses, such as subsistence, sport and commercial fishing, wilderness, recreation and tourism and archeological/cultural resources, were evaluated for the short-term and the long-term. With respect to lingering oil research, "short-term" pertains to a five-year period after research activities begin. "Long-term" pertains to the period over five years after research activities begin.

Short-term effects: Unknown to Low effects. For direct restoration actions, effects are largely unknown because these potential actions are still being tested. There has been some moderate benefit as the current activities which have employed some spill-area personnel and equipment to conduct these research activities.

Long-term effects: Unknown effects. For direct restoration actions, effects are unknown because these potential actions are still being tested.

4.2.4 Harbor protection, marine restoration, and lessons learned/outreach

4.2.4.1 Waste disposal and harbor projects

The Council seeks to further reduce pollution in the marine environment to contribute to the recovery of injured natural resources or services with actions to reduce the improper disposal of waste, such as oily bilge water, used engine parts, paints, solvents and lead-acid batteries. Improper disposal of these wastes in landfills adversely affects the quality of nearby marine waters through runoff and leaching. Chronic marine pollution stresses fish and wildlife

resources, possibly delaying recovery of resources injured by the spill. In the past, the Council has approved the funding of several projects to prepare waste management plans and has contributed to their implementation. The proposed alternative envisions similar actions, such as the acquisition of waste oil management equipment and the construction of environmental operating stations for the drop-off of used oil and other hazardous waste in spill area coastal communities.

4.2.4.1.1 Environmental Consequences

The environmental consequences of waste disposal and harbor projects on nearshore and offshore marine ecosystems near coastal communities in spill area were evaluated for the short-term and the long-term. With respect to these projects, "short-term" pertains to a ten-year period after such projects begin. "Long-term" pertains to the period over ten years after these projects begin.

Short-term: High benefits. The proposed actions may substantially benefit associated marine ecosystems in areas of implementation in the short-term after implementation of the activities as waste products would no longer be introduced into the marine environment.

Long-term: Low benefits. The initial benefits of the proposed actions to areas in which they are implemented may gradually lessen with the passage of time, being that the protection measures have succeeded in reducing or eliminating waste from entering the environment. In addition, a continuation or increase in sources of pollution in these areas would overwhelm the measures and cause a lowering of benefit to the area.

4.2.4.1.2 Social and Economic Impacts

The impacts of waste disposal and harbor projects on social and economic uses, such as subsistence, wilderness, recreation and tourism, sport and commercial fishing and archeological/cultural resources were evaluated for the short-term and the long-term. With respect to these projects, "short-term" pertains to a ten-year period after research activities begin. "Long-term" pertains to the period over ten years after the project begins.

Short-term: High benefits. The proposed actions may substantially benefit human services associated with the marine ecosystems in areas of implementation in the short-term after implementation of the activities.

Long-term: Low benefits. The initial benefits of the proposed actions to social and economic uses which depend upon the areas in which they are implemented may gradually lessen with the passage of time and a continuation or increase in sources of pollution in these areas.

4.2.4.2 Marine Debris Removal

The Council proposes to fund marine debris removal that affects the spill area marine ecosystem. Marine debris is an issue in the marine and near-shore environment, where it is likely that thousands of marine debris exist within three nautical miles of the Alaska coastline. Marine

debris removal projects can result in an immediate improvement to the coastal habitat, reduces entrapment hazards for marine wildlife, and reduces marine pollution affecting natural resources injured by the spill and thus further supports restoration.

4.2.4.2.1 Environmental Consequences

The environmental consequences of marine debris removal on nearshore and offshore marine ecosystems in the spill area were evaluated for the short-term and the long-term. With respect to these projects, "short-term" pertains to a five-year period after such activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: High benefits. The proposed actions may substantially benefit associated marine ecosystems in areas of implementation in the short-term after implementation of the activities as threats from derelict fishing gear, plastics, and chemical leaching would be removed. However, some marine debris may provide habitat for marine organisms. For example, old fishing gear can provide substrate for barnacle or algae attachment and may provide shelter for crustaceans. Removing such "habitat" will have an immediate adverse effect on the microcosm of organisms using it, but the positive effect of debris removal is thought to outweigh the adverse effect.

Long-term: Low benefits. This restoration activity only removes deposited marine debris. To reduce marine debris in the long-term would require education and a change in human waste generation activities. In the absence of such behavioral shifts, new marine debris will continue to be deposited in areas that were previously cleaned. Thus, the initial benefits of the proposed actions to areas in which they are implemented may gradually lessen with the passage of time and a continuation or increase in sources of pollution in these areas.

4.2.4.2.2 Social and Economic Impacts

The impacts of marine debris removal on social and economic uses, such as subsistence, recreation and tourism, wilderness, sport and commercial fishing and possibly archeological/cultural resources, were evaluated for the short-term and the long-term. With respect to these projects, "short-term" pertains to a five-year period after activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: High benefits. The proposed actions may substantially benefit the uses associated with the marine ecosystems in areas of implementation in the short-term after implementation of the activities. Depending on how a marine debris removal program is structured, the program could offer immediate local employment opportunities.

Long-term: Low benefits. The initial benefits of the proposed actions on social and economic uses which depend upon the areas in which they are implemented may gradually lessen with the passage of time and a continuation or increase in sources of pollution in these areas. Depending on how a marine debris removal program is structured, the program could offer long-term local employment opportunities.

4.2.4.3 Lessons learned/outreach

Damage to natural resources can occur not only with the initial spill, but additional damage can also be caused by spill response efforts. The Council proposes to organize, preserve and pass information regarding skilled damage assessment and how to mitigate damage from spill response activities in future spills. Activities envisioned in this effort include outreach efforts such as a conference or series of papers sharing information to be used by future responders, including natural resource assessment, the long-term costs of high-pressure washing, use of dispersants in the near-shore, sub-arctic environment and the effects of potential burning scenarios. The level of environmental and socioeconomic benefits likely to be generated by sharing of information on response, damage assessment, and restoration will depend on the location, frequency and magnitude of future oil spills.

4.2.4.3.1 Environmental Consequences

The environmental consequences of sharing information on response, damage assessment and restoration on nearshore and offshore ecosystems were evaluated for the short-term and the long-term. With respect to these activities, "short-term" pertains to a five-year period after such activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: Moderate benefits. Depending upon the incidence of future spills and similarity of conditions, it can be expected that these actions, if a spill occurs, will assist in mitigating harm from spill response activities as the future responders could learn from lessons gained during earlier spills.

Long-term: Low benefits. It can be expected that these actions assist in mitigating harm from spill response activities in future spills. Unless funded at higher levels that could sustain future activities in this area with the passage of time and the development of additional knowledge in this area, the utility of the information organized, preserved and developed with this effort will diminish as the information, technologies, and methods become more and more out of date.

4.2.4.3.2 Social and Economic Impacts

The impacts of response, damage assessment and restoration implications on the social and economic uses, such as subsistence, sport and commercial fishing, wilderness, recreation and tourism and archeological/cultural resources, which are located near or depend upon nearshore and offshore ecosystems were evaluated for the short-term and the long-term. With respect to these activities, "short-term" pertains to a five-year period after activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: Moderate benefits. Depending upon the incidence of future spills, it can be expected that these actions, if a spill occurs, will assist in mitigating harm from spill response activities and thus support related social and economic uses.

Long-term: Low benefits. It can be expected that these actions assist in mitigating harm from spill response activities in future spills and thus support related social and economic uses.

Unless funded at higher levels that could sustain future activities in this area, with the passage of time and the development of additional knowledge in this area, the utility of the information organized, preserved and developed with this effort will diminish.

4.2.5 Habitat Acquisition and Protection

At the time of the September 1994 FEIS, the Habitat Acquisition and Protection program was a primary component that was to receive the largest portion of remaining settlement funds. In both the proposed alternative and the no action alternative, this program remains a fundamental component, allotted approximately 25% of remaining funds, see FEIS, Ch. 4, pg. 111.

As discussed in the FEIS, parcels available for protection are still being developed and cannot be individually analyzed in this SEIS.

4.2.5.1 Environmental Consequences

The environmental consequences of habitat acquisition and protection on upland, nearshore and offshore ecosystems were evaluated for the short-term and the long-term. With respect to these activities, "short-term" pertains to a five-year period after such activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: Unknown level to high level of benefits. Depending upon the expected usage of parcels if they were not protected, the short-term effects of land acquisition could be of varying benefit ranging from unknown to high. Benefits include, but are not limited to, preventing the intertidal and subtidal areas from being altered by the actions that may occur on the parcels and reducing the disturbances caused by increased human activity.

Long-term: Moderate benefits. The long-term effects of habitat protection actions for reducing disturbance or preventing additional injury to injured species and spill-affected ecosystems are moderately beneficial and with the type of benefit to various injured species and spill-affected ecosystems vary among parcels.

4.2.5.2 Social and Economic Impacts

The impacts of habitat acquisition and protection on social and economic uses, such as wilderness, subsistence, sport and commercial fishing and recreation and tourism and archeological/cultural resources, were evaluated for the short-term and the long-term With respect to these activities, "short-term" pertains to a five-year period after such activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: Unknown. Depending upon the expected usage of parcels if they were not protected, the short-term effects of land acquisition could be of varying benefit to related social and economic uses.

Long-term: Moderate benefits. The long-term effects of habitat protection actions for reducing disturbance or preventing additional injury to related social and economic uses are moderately beneficial and with the type of benefit to various injured human services vary among parcels.

4.3 Cumulative Effects

The CEQ regulations for implementing NEPA define cumulative effects as: "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). It is critical to evaluate past and present actions as well as those that will happen in the foreseeable future in the action area. For the purposes of this SEIS, past and present actions include both human controlled events and natural events. Events taking place in the foreseeable future are thought of as actions that have been proposed or that are in the process of being deliberated on and debated on and are on the way to being formally proposed. Such actions may indeed be said to be "reasonably foreseeable."

Actions that may affect EVOSTC restoration include the list of projects and environmental influences below. Many of these projects were identified and discussed at length in the 1994 FEIS (Chapter 4, pages 152-163). Where there is additional information to supplement the original discussion in the 1994 FEIS, it is included below the table.

Table 2: Projects that may impact EVOS restoration efforts

ACTIVITY	PAST	PRESENT	FUTURE	COMMENT
Whittier Road Access and Whittier Harbor Expansion	X			(see below for additional information)
Trans-Alaska Gas Pipeline Terminal	X			
Institute for Marine Science at Seward	X			(Completed as Alaska SeaLife Center)
Child's Glacier Tourism Development	X			(see below)
FY 1992-1994 EVOSTC Projects	X			
Cordova Road Access	X			
Lower Cook Inlet Oil		X		(see below)

Development				
Yakutat Oil Development		X		
Shepard Point (Nelson Bay) Dredging		X		
Coastal Development in Cook Inlet		X		(see below)
Tankering from the Trans-Alaska Pipeline Terminal at Valdez			X	
FY 2010-2012 EVOSTC Projects			X	(see below)
Cordova Center			X	(see below)
Global Climate and Ocean Regime Changes		X	X	(see below)
Mortality			X	(see below)
Government Administration			X	(see below)

4.3.1 Project Management and Government Administration

FY10 – FY12 EVOSTC Projects: Projects funded during these fiscal years are scientific in nature and will not have any significant impact on the environment of the spill area. Each funded project has received a Categorical Exclusion (Section 6.03.c.3 (a)) from the National Environmental Policy Act.

Government Administration: External factors that potentially impact Council management and administration are new legislation, annual budgets, new leadership, and litigation.

Potential Impacts of the Alternatives on Management and Administration

Alternative 1 would not change the way EVOSTC projects are selected or funded, the same methods used to select projects and research objectives in the past would be implemented again. However, Alternative 2 would allow for a focused and narrowed approach to project selection, . Neither alternative would impact administration, as government administration is beyond the Council's control.

Potential Cumulative Impacts of Management and Administration

Government administration could significantly impact the Council's ability to meet its restoration goals in that pressures of time, personnel, and workload impact the staff's ability to meet work requirements. New leadership or other administrative changes at levels higher than the Council will impact current and future work, as it may require time necessary for adjustment. Projects selected by the Council for the future fiscal years will be a positive impact on the restoration goals of the Council; they will help ensure the goals and objectives are met.

4.3.2 Area Development

Lower Cook Inlet Oil Development: MMS lease sales were discussed in 2007 and one sale was proposed for Cook Inlet (#211). However, it was canceled due to lack of industry interest. A second special interest sale was mentioned in the Federal Register (73 FR 39032), but a sale number was not identified, it is assumed to still be under consideration.

Coastal Development in Cook Inlet: Port facilities improvements and expansions in the towns of Anchorage, Kenai, and Homer are ongoing.

Whittier Road Access and Whittier Harbor Expansion: This project has largely been completed. A Notice of Intent has been issued to prepare an Environmental Impact Statement for Whittier Harbor Navigation Improvements Feasibility Study. This study would consider the feasibility of expanding the existing moorage capacity for vessels at Whittier. A final EIS for this project is scheduled no sooner than January 2011. If this project were to be finalized, potential cumulative impacts of the past, present and reasonably foreseeable future actions include impacts resulting from harbor construction and resultant increase in vessel traffic. *See Notice of Intent*, Fed. Reg. Vol. 74, No. 127 (July 6, 2009).

Child's Glacier Tourism Development: Child's Glacier recreational area improvements have been completed. In addition, the Child's Glacier Lodge may be completed in Summer 2011, with overnight capacity for twelve and recreations activities including jet boat, glacier and kayak tours.

The Cordova Center: This project, for which the Council has approved partial funding, will be required to complete an Environmental Impact Statement (EIS) prior to construction. Specific impacts will be discussed at length in that document.

Potential Impacts of the Alternatives on Area Development

With respect to Alternative 1, the potential impacts to area development would be minimal, as this option does not emphasize these activities. In development areas where marina work is proposed, harbor protection, marine restoration, and lessons learned/outreach focus of Alternative 2, would be beneficial. Funding would be available for work within certain areas and expertise and guidance could be shared with interested parties. Regional development work could be carried out with a focus on water protection, marine debris removal, and restoration implications with new support.

Potential Cumulative Impacts of Area Development

As the spill-affected area continues to become more developed there is less habitat available for species survival and less opportunity for recovery at an ecosystem level. Development not only impacts land use but also the air and water quality of the area. This multi-dimension impact can be lessened with project design and engineering, but careful thought and planning needs to take place at every level to achieve minimal impacts to sensitive species and resources.

4.3.3 Large Scale Factors

Global Climate and Ocean Regime Changes: Global climate change and ocean regime changes will likely impact restoration projects in the future. These outcomes cannot yet be determined but impacts to restoration will be considered and analyzed at the time of future project selection.

Mortality: Death due to predation, disease and animal stranding are likely to occur in the action area in the next ten years.

Potential Impacts of the Alternatives on large-scale factors

Neither of the two alternatives will have an impact on the large-scale items discussed above as these factors are larger than either alternative. The decisions the Council makes to benefit impacted resources will be in response to, not due to, the factors of ocean and climate change, fluctuations in administration, and species mortality among other considerations. The data collection and interpretation within the long-term monitoring focus of Alternative 2 would assist the Council and others in determining the scope and scale of the large-scale ecological factors in regional habitats, however the work being performed in Alternative 2 would not be significant enough to contribute to or impact these large occurrences.

Potential Cumulative Impacts of large-scale factors

The cumulative consequences of these large-scale factors could be significant in both the short and long term. The Council is already working with these factors in mind, as new projects are being designed and funded researchers are considering what the habitat will be like in changing conditions, how disease and other sources of mortality can be minimized, and how to incorporate resiliency in projects. If the timing and potentially additive nature of these large-scale factors were to combine, the work of the Council would be very difficult and improvements to injured species and resources would be slowed.

CHAPTER 5 – DOCUMENT PROCESSING

5.1 List of Preparers

The following persons were primarily responsible for preparing the environmental impact statement or significant background papers.

Catherine Boerner, Science Coordinator, EVOSTC Restoration Office, 10 years experience in natural resource management and wildlife biology, prepared Chapter 3 on the Affected Environment.

Elise Hsieh, Executive Director and Attorney, EVOSTC Restoration Office, thirteen years of experience in Environmental Law, prepared the DSEIS in conjunction with EVOSTC staff and Trustee Agency Liaisons, excluding the process and public process sections in Chapter 1 and Chapter 3, the Affected Environment.

Laurel Jennings, NEPA Coordinator, NOAA Restoration Center, NW Region, three years of experience in federal environmental compliance and habitat restoration, prepared the format for the SEIS and assisted with other sections, including the Public Participation Process sections in Chapter 1.

5.2 Distribution of the draft SEIS

Below is a list of the Agencies, Organizations, and Persons to whom a notice of the availability of the draft SEIS was sent.

5.2.1 Agencies

U.S. Department of the Interior

U.S. Department of Agriculture

Alaska Department of Law

Alaska Department of Environmental Conservation

Alaska Department of Fish and Game

Alaska Department of Natural Resources

5.2.2 Organizations

Native Village of Afognak, Nancy Nelson, President

Native Village of Chenega, Pete Komkoff, President

Native Village of Chignik Lagoon, Clemens Grunert, President

Chignik Lake Village Council, John Lind, President

Native Village of Eyak, Bruce Cain, Executive Director

Native Village of Karluk, Alicia Reft, President

Larsen Bay Tribal Council, Susan Aga, Manager

Nanwalek IRA Council, Wally Kvasnikoff, Chief

Port Lions Traditional Tribal Council, Arnold Kewan, President

Native Village of Tatitlek, Roy Totemoff, President & CEO

Old Harbor Tribal Council, Emil Peterson, President

Native Village of Ouzinkie, Daniel Ellanak, President

Seldovia Village Tribe IRA and Seldovia Native Assn., Crystal Collier, CEO and Fred Elvsaas

Chenega Corporation, Brian Fox

Chugach Alaska Corporation, John F.C. Johnson

English Bay Corporation

Grouse Creek Corporation, Esther Ronne

Knikatnu, Inc, Paul Theodore

Native Village of Port Graham, Eleanor McMullen

Ninilchik Village Traditional Council, Bruce Oskalkoff

Tatitlek Corporation, Carroll Kompkoff

YAK-TAT-KWAAN INC., Donald Bremner

Chickaloon Native Village, Alan Larson

Eyak Corporation, Dan McDaniel and Rod Wohl

Kenaitze Indian Tribe, Rose Tepp

Salmatof Native Association, Jim Segura

Tyonek Native Corporation, Ted Kroto

Eklutna, Inc.

Ninilchik Native Association, Inc.

Valdez Native Tribe, Brenna Hughey

Cook Inlet Region, Inc

5.2.3 Persons

Public Advisory Committee Members:

Patience Anderson Faulkner

Torie Baker

Amanda Bauer

Jason Brune

Kurt Eilo

Larry Evanoff

Gary Fandrei

John French

Jennifer Gibbins

Lori Polasek

John Renner

Bill Rosetti

Stacy Studebaker

David Totemoff

Leaders of Municipalities:

City of Soldotna, Peter A. Micciche, Mayor

City of Valdez, Bert Cottle, Mayor

City of Whittier, Lester Lunceford, Mayor

City of Ouzinkie, Zack Chichenoff, Mayor

City of Seldovia, Keith Gain, Mayor

City of Seward, Willard Dunham, Mayor

City of Old Harbor, Rick Berns, Mayor

City of Port Lions, Steve Andresen, Mayor

City of Akhiok, Linda Amodo, Mayor

City of Chignik, Richard Sharpe, Mayor

City of Cordova, Tim Joyce, Mayor

City of Homer, James C. Hornaday, Mayor

City of Kodiak, Carolyn Floyd, City Clerk

Kodiak Island Borough, Jerome Selby, Mayor

City of Larsen Bay, Valen Norell, Mayor

CHAPTER 6 – REFERENCES

Final Environmental Impact Statement for the *Exxon Valdez* Oil Spill Restoration Plan September 1994).

Notice of Intent, Fed. Reg. Vol. 75, No. 14 at pg. 3708 (Jan. 22, 2010).

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