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New Appendix D.

RESTORATION OBJECTIVES

INTRODUCTION

Restoration objectives provide direction and focus for planning and implementation of actions to restore the injured resources and lost or reduced services that resulted from the oil spill. Since many of the injured resources and services are linked within the affected ecosystems, restoration objectives cover both the specific injured resources and services as well as the ecosystems in which they exist.

All of the resources and services addressed in this appendix are those for which injury was documented through Natural Resources Damage Assessment studies. The objectives contained in this appendix do not include all the possible strategies for achieving recovery of a resource or service. Through consultation with managers, scientists and the public the listed objectives are those identified as most likely to be obtainable and succeed in achieving restoration. Although some objectives are clearly more important than others, no prioritization is presented in this appendix.

Definition of an Objective. Restoration objectives are parts of a restoration goal which can be achieved separately. For example, if the goal is to restore populations of a certain species to prespill numbers, one objective that would aid in achieving that goal is to protect critical habitats used by that species from further disturbance. If the Trustee Council chooses to pursue this objective, the methods for protecting specific habitats would be identified as projects.

Taken by itself, any single restoration objective may not be sufficient to achieve the goal of recovery, but it describes one important means of restoration. Ideally, achieving all objectives identified for any resource or service results in full recovery. However, in practice, pursuing the most important objectives will take precedence and may not leave enough money to fund the pursuit of others. Also, there are numerous factors, such as changes in climate or oceanic conditions, which can prevent some objectives from being achieved.

Objectives for Ecosystem Restoration. Restoration will follow an ecosystem approach, primarily through monitoring and research to understand ecological relationships and through protection of large areas supporting ecologically linked species. Ecosystem objectives reflect these areas of emphasis.

Objectives are also listed for individual resources and services. These are consistent with an ecosystem approach since restoring any single resource necessarily benefits other ecologically linked species. Also, it is a guiding policy that restoration of one injured resource must not cause harm to any other species.

Use of Objectives in the Planning Process. Restoration objectives provide a means for evaluating specific project proposals in Work Plans. Objectives describe the general strategies, consistent with restoration policies, for achieving restoration goals. It is impractical to pursue all objectives simultaneously, but the subset of objectives chosen to guide a given Work Plan will provide a framework for accepting or rejecting that year's specific project proposals.

Many, but not all objectives have a measurable endpoint, which makes it possible to know when an objective has been achieved. This will facilitate decisions about funding project proposals designed to achieve an objective that has already been met.

Modification of Objective List. The list of objectives in this appendix includes reasonable strategies for achieving recovery based on our current understanding of the injury and recovery status of the injured resources and services. As new information is gained about injured resources and services, or as recovery occurs, objectives may be fulfilled, deleted or added to this plan.

ECOSYSTEM OBJECTIVES

The ecosystem is a product of complex interactions of living organisms and their physical environment. Understanding the interactions and changes in the ecosystem is necessary to predict the progress of oil spill restoration. While objectives which address the specific injured resources or services are important, accomplishing ecosystem objectives could benefit a broader range of resources and services. Only by looking at the ecosystem can we truly understand the status of a resource and manage its recovery from the oil spill.

The Ecosystem approach described in the Restoration Plan has two components, habitat protection and monitoring and research. More detailed ecosystem objectives are presented below. The monitoring and research objectives could evolve into other forms of restoration. For instance, many of these objectives would provide information on factors that influence the recovery of injured resources. Once those factors are understood, there may be restoration actions such as protection, management changes or direct manipulation that could influence the recovery of an injured resource.

HABITAT PROTECTION OBJECTIVES

The objectives encompassing an ecosystem approach through habitat protection are divided into two sections: marine environments and upland environments. These sections are interlinked, because protection of upland habitats can also benefit nearby marine habitats.

MARINE ENVIRONMENTS

Identify important marine habitats.
Important marine habitats have not been identified for many resources. More detailed objectives that address this need are presented in the monitoring and research section as well as in the specific resources section. Identification of the important marine areas for different resources will provide the information necessary in order to protect key habitats.

Protect important marine habitats.
Providing protection to important marine habitats can be accomplished through several mechanisms such as creating special designations or changing management practices. The actual form of protection will vary with the type of protection that is needed to allow an area to maintain its function in supporting injured resources.

UPLAND ENVIRONMENTS

Identify important upland habitats.
Identify important upland habitats for the injured resources and services. Considerable progress has been made towards meeting this objective since 1992 with the identification of important habitat types for many resources and services. For those resources where further work needs to be completed to identify important habitats, more detailed objectives are described under the individual resources. This objective will be completed when all upland habitat types that are integral to the survival and recovery of injured resources or especially important to specific services are identified.

Protect important upland habitats.
Protect important upland habitats through acquisitions, protective easements or management guidelines. This objective will achieved when human-caused habitat degradation does not significantly impact the recovery of injured populations. It is difficult to quantify the effect on recovery except in terms of documenting a linkage between the resource or service, key habitats, and the absence of habitat disturbance. **[note: these still need review by HPWG]**

ECOSYSTEM MONITORING AND RESEARCH OBJECTIVES

The objectives encompassing the ecosystem research and monitoring are separated into the following categories: plankton, subtidal organisms, intertidal organisms and forage fish. These objectives will need to be modified to reflect the information gained from the November workshop on Ecosystems.

THE ECOSYSTEM IMPORTANCE OF PLANKTON

Planktonic organisms are an important component of marine and lake ecosystems. They form the bottom of the food chain and are key to the survival and recovery of many of the

organisms in the oil spill area. Although there are no data that the planktonic balance in the marine environment was injured by the oil spill, its importance to other organisms makes it an important component to ecosystem studies and restoration.

Identify the natural functions of planktonic regimes.
Assess the role in variations in the physical (oceanographic) climate through multiple seasons and years to depict the plankton production and subsequent recruitment dynamics of key fish species in the oil spill area.

Determine the effects of trophic interactions on the recruitment of key fish species.
Develop an understanding of how trophic interactions within the planktonic ecosystem effects the growth and survival of juvenile pink salmon and other key fisheries species. Accomplishing this objective will identify how the interactions of the young fish with their prey species, especially zooplankton, and with their predators, especially tom cod and walleye pollock, influence the recruitment strength of a given yearclass.

Evaluate important prey species in lakes.
Develop an understanding of how the health of the planktonic ecosystems of important rearing lakes for sockeye salmon affects the juvenile survivorship, smolt production, and run strength of sockeye salmon in damaged ecosystems. There are data which show that the plankton species in some lakes were altered as a result of salmon overescapement (too many adult fish returning to spawn). A start of this objective was achieved in 1990-92.

THE ECOSYSTEM IMPORTANCE OF SUBTIDAL ORGANISMS

Recovery from the oil spill has occurred when community composition, population abundance of component species, and ecosystem functions and services in each damaged subtidal habitat have returned to levels that would have prevailed in the absence of the oil spill. Complete recovery also implies a return to normal background levels of hydrocarbons.
Monitor hydrocarbon levels in fish and sediments.
Monitor the petroleum hydrocarbon levels in subtidal fish and sediments to determine progress towards recovery. This objective will be completed when hydrocarbon levels in subtidal fish and sediments have recovered to background levels.

Monitor algae and invertebrates.
Monitor recovery of subtidal species whose populations were affected directly by the oil spill and evaluate the indirect effects of the spill on other interconnected populations that are components of the subtidal ecosystem. A project to partially accomplish this objective was initiated in 1993.

Evaluate the indirect effect of reductions in predation on subtidal organisms.
Determine the degree to which spill-related reductions in sea otters, and other key predators, have led to increases in their prey, especially sea urchins. Determine whether sea

urchin population increases have initiated the replacement of subtidal algae beds by areas overgrazed by urchins, and subsequently reduce the algal habitat which function as the subtidal nursery.

THE ECOSYSTEM IMPORTANCE OF INTERTIDAL ORGANISMS

Recovery from the oil spill has occurred when community composition, population abundance of component species, and ecosystem functions and services in each damaged intertidal habitat have returned to levels that would have prevailed in the absence of the oil spill. Complete recovery also implies a return to background levels of hydrocarbons.

Monitor and restore mussels and clam beds.
a) Monitor petroleum hydrocarbon levels in mussels, clams, and other organisms and their associated beds to document recovery. This objective will be completed when hydrocarbon levels in mussels, clams, and other organisms have recovered to background levels.
b) Develop a reliable, non-damaging method to restore mussel and clams beds in which hydrocarbon levels are elevated above background levels and appear, through monitoring, to be relatively unchanging. This objective will be completed when hydrocarbon levels in mussels, clams, and associated beach habitat have recovered to background levels.

Evaluate the indirect ecosystem effects arising from a change in key intertidal organisms.
Evaluate the indirect effects caused by changes in intertidal organisms that resulted from cleanup. High-pressure hot water and other oil cleanup techniques decimated intertidal organisms and, in some cases, altered their habitat. Use experimental manipulations of rockweed (Fucus) and damaged species of intertidal invertebrates, such as limpets, barnacles, periwinkles, and mussels, to understand the role of cascading ecosystem effects through strong interactions within the intertidal ecosystem in both delaying and promoting natural recovery. This objective is partially completed from experimental work done between 1991-1993.

Determine how changes in intertidal organisms influence recovery of other resources.
Evaluate the contributions of altered abundances of intertidal prey invertebrates such as limpets, mussels and periwinkles, and continuing oil contamination on the recovery of higher-level predators. This objective has relevance for black oystercatchers, harlequin ducks, eider ducks, scoters, sea otters and river otters.

Monitor baseline intertidal sites.
Monitor baseline control sites that can serve as a point of reference to the hydrocarbon (oil) samples collected for the damage assessment and restoration projects. Sites already exist in some regions of the oil spill area that have been monitored since 1977; however, sites throughout the oil spill area should be established.

Restore sediments on cleanup treatment beaches.

Identify the relationship between recovery of clam populations and other intertidal organisms on oiled beaches and the loss of fine sediment habitat that resulted from pressurized water treatments of those beaches. This also requires an evaluation of the rate at which finer sediments are returning naturally to reconstitute the affected intertidal habitat that has been lost and an assessment of the feasibility of restoring sediments by mechanical processes to key beaches without damaging surviving clam and other intertidal resources. This objective will be complete when treated beach fauna and flora composition and distribution is similar to untreated control beaches.

THE ECOSYSTEM IMPORTANCE OF FORAGE FISHES

Many of the injured resources feed primarily on small fish commonly referred to as forage fish. These fishes include young salmon and pollock, as well as species such as Pacific herring, capelin and sandlance. Recovery of the injured resources, as well as some of the service, may depend on the health of these fishes. Currently, there is very little information available on the status of these important fishes.

Monitor forage fish stocks.
Determine status and importance of the forage fish stocks to ecosystem health and recovery. Establish a monitoring program to determine the abundance and distribution of key forage fish in the oil spill area. This monitoring would include determining the status of walleye pollock, sandlance, capelin and Pacific herring.

Assess the impacts of changing abundance of forage fish.
Address the impacts of changing abundance of forage fishes on population health of the pelagic ecosystem by integrating forage fish monitoring with evaluations of feeding, physiological status, reproductive success, and mortality in injured forage fish consumers. Some of the forage fish consumers include harbor seals, sea lions, salmon, marbled murrelets, pigeon guillemots, and murres, other seabirds and marine mammals. This would include the need to evaluate the indirect effects of ecosystem interactions that develop from changing abundances of competitors for forage fish resources as well as direct effects of changes in food species.

RESTORATION OBJECTIVES FOR INJURED RESOURCES

MAMMALS

HARBOR SEALS

Defining recovery from the oil spill requires an understanding of the behavior and movements of the injured population. Currently, scientists do not know how far harbor seals migrate. If large numbers of harbor seals do not migrate between oiled and nonoiled areas,

then recovery will have occurred when harbor seals within the oiled area make up a similar proportion population as they did before the spill. If significant migrations do occur, a new definition of recovery is needed.

Monitor harbor seal population.
Monitor the number of harbor seals in Prince William Sound to define recovery, and document the status of the injured population. Determine the trend in harbor seal numbers in oiled and nonoiled areas. This objective will be completed when harbor seal numbers have returned to prespill levels, or when the proportion of harbor seals within the oiled area is at least as large as it was before the spill.

Identify causes limiting recovery.
Determine the status of important harbor seal prey species. Changes in the availability and distribution of harbor seal prey is one possible explanation for the long-term population decline. This objective links harbor seal feeding habits, reproductive success, physiological status, and survival to the ecosystem objectives on forage fish and salmon populations in the marine environment.

Identify any sources of human-induced mortality.
If sources of human-caused mortality are identified and determined to be contributing significantly to declining harbor seal numbers, work with the mortality source to keep the mortality within sustainable levels.

Identify and protect harbor seal habitats.
Identify and protect important seal habitat through acquisition or other means to insure that haulouts and other important habitats are not detrimentally impacted by human activities, including disturbance.

KILLER WHALES

Recovery from the oil spill has occurred when AB pod has recovered to at least 36 whales, 1988 levels, and exhibits normal behavior for resident pods.

Monitor AB pod composition and organization.
Monitor number of members, composition and organization of AB pod to document pod recovery. This objective will be completed when AB pod is recovered to at least prespill numbers and exhibits normal social behavior.

SEA OTTERS

Recovery from the oil spill has occurred when population abundance and distribution of sea otters in Prince William Sound are comparable to prespill abundance and distribution, and when age distributions of sea otter carcasses found on beaches in western Prince William Sound are similar to prespill age distributions. [note to reviewers: the p.i's that were consulted on this do not believe that there is much need to work on the recovery of sea otters in other regions of the oil spill area. If peer reviewers/Bob Spies agree, we could make that clear in this recovery statement and leave the focus on PWS, if not then this will be expanded beyond PWS.

Monitor population recovery.
Monitor changes in population abundance and distribution to document the recovery of sea otters in Prince William Sound.

Identify causes that may be limiting recovery.
a) Determine if continuing injury is occurring to sea otters in Prince William Sound by monitoring physiological variables changed as a result of the oil spill. This objective will be completed when these variables no longer differ between oiled and nonoiled areas.
b) If continuing exposure to oil is limiting recovery, determine sources of contamination and measures to reduce hydrocarbon levels. This objective would also be completed when the physiological variables that indicate continued injury are not different between oiled and nonoiled areas.

Ecosystem relationships of sea otters and intertidal and subtidal invertebrates.
Meeting the ecosystem objective, which would determine the inter-relationships between the reduction of sea otters and the resulting changes in their prey species, will also document the condition of the foraging habitat that is available to support a recovering sea otter population.

RIVER OTTERS

Because the actual injury to river otters is not well understood, defining recovery is equally difficult. Some measures of recovery from the oil spill could be based on habitat use within oiled areas relative to nonoiled areas, or when physiological indices of river otters, such as blood parameters, have returned to prespill conditions or resemble non-oiled areas.

Monitor river otters.
Monitor river otters which, in oiled areas, have altered their habitat usage and diets, and have blood values which are significantly different than river otters living in nonoiled control areas. This objective will have been completed when river otter habitat use of oiled areas and diet are similar to nonoiled control areas, and when blood values indicative of exposure to oil have recovered to be comparable to nonoiled areas.

BIRDS

BALD EAGLES

Recovery from the oil spill has occurred when Bald Eagles in the spill area have returned to their prespill numbers.

Monitor bald eagle population.
Monitor the bald eagle population in the oil spill area. This objective will be completed when bald eagle numbers have returned to prespill levels.

Identify and protect habitat.
Identify and protect important bald eagle habitat through acquisition or other means to insure that nesting and important feeding habitats are not detrimentally impacted by human activities. This will insure that the affected bald eagle population will be able to maintain its prespill size or increase in numbers to where it would have been in the absence of the spill.

BLACK OYSTERCATCHERS

Recovery from the oil spill has occurred when populations attain prespill levels, and when reproductive and growth variables in oiled areas are comparable to nonoiled areas.

Monitor population recovery.
a) Monitor population abundance and distribution to document recovery of the population in western Prince William Sound. This objective will be complete when population abundance and distribution approximates prespill conditions.
b) Monitor various reproduction and growth indices to document recovery and link to continuing exposure to oil contamination through contaminated prey. This objective will be complete when these indices are comparable between oiled and nonoiled areas.

Ecological relationships.
Evaluate the effects of altered prey abundances, especially limpets, mussels and periwinkles and continuing oil contamination on the recovery of black oystercatchers. This is a component of the broader ecosystem objective. Work on this objective was initiated in 1992.

Reduce predation. **[this objective may be removed once the policy on exemptions to the within the spill area policy are finalized.]**
Remove introduced predators from areas where they have prevented successful breeding of black oystercatchers. Introduced predators such as foxes and rats have eliminated oystercatchers and other marine bird species from many islands in Alaska. Marine bird populations, including oystercatchers, could be greatly increased by eliminating foxes from these islands, most of which occur outside the oil spill area.

COMMON MURRES

Recovery of common murres will be achieved when all affected breeding populations have attained and maintain themselves at prespill population levels. Because the level of injury differed between breeding colonies, the progress towards recovery varies between colonies.

Monitor population recovery.
Monitor murre populations and reproduction at select colonies within the oil spill area to document recovery.

Identify causes limiting recovery.
Determine the status, abundance, and distribution of forage fishes that are important common murre prey species. Determine if a change in abundance of prey is influencing the recovery of common murres. This objective is a component of the Ecosystem objectives regarding forage fish and will be completed when year-round foods have been identified and their status linked to common murre life history characteristics.

Educate the public about the adverse effects of disturbance.
Educate the public about the deleterious effects of disturbance to cliff-nesting murres and other seabirds. There have been some observations of human-caused disturbance at one of the injured murre colonies. If this is shown to be a chronic problem that is limiting the population recovery, this objective becomes more important. This objective will be completed when education programs and materials are developed and implemented, and the human-caused disturbance is reduced.

Protect important common murre colonies.
A number of important seabird colonies are on privately-owned land. This objective will be completed with acquisition or other protective measures of privately-owned seabird colonies insures that the colonies remain as quality nesting habitat.

Reduce predation **[this objective may be removed once the policy on exemptions to the within the spill area policy are finalized.]**
Remove introduced predators from areas where they have limited the breeding success of common murres. Introduced predators such as foxes and rats have eliminated murres and other seabird species from many islands in Alaska. Seabird populations, including murres, could be greatly increased by eliminating foxes from these islands, most of which occur outside the oil spill area.

HARLEQUIN DUCKS

Recovery from the oil spill has occurred when harlequin duck abundance and productivity have returned to estimated prespill conditions, or when differences in productivity are eliminated between oiled and nonoiled areas.

Identify and Protect nesting habitat.
a) Determine characteristics of high quality nesting habitats, including breeding streams and nesting sites. Preliminary field work in Prince William Sound was completed during 1991-93. This objective will be achieved when breeding streams and nest site habitats can be reliably evaluated and monitored.
b) Protect high quality breeding/nesting habitats. Identify and protect nesting habitat through acquisition or other means to ensure that a sufficient amount of high quality nesting habitat remains to maintain the existing breeding population and allow for the natural restoration of the birds lost from the oil spill.

Monitor harlequin duck populations.
Monitor abundance, distribution and reproductive success of harlequin ducks in the oil spill region to assess the year-round status of the population. This objective is met when abundance, distribution, and productivity approximate prespill levels or levels comparable to similar nonoiled areas.

Identify causes limiting recovery.
a) Determine if continuing exposure to oil is causing reduced reproductive success. Initial steps towards this objective were begun in 1993. This objective is completed when continuing oil exposure is accepted or rejected as the cause of documented physiological impacts.
b) Restore important food resources and feeding habitats. As feasible, this objective is met when oil contamination risks to foraging harlequin ducks have been reduced natural levels. This is a component of the Ecosystem objective that seeks to restore oiled mussel and clam beds to prespill conditions.

Monitor and reduce risk of significant human-induced mortality.
Evaluate human sources of mortality in harlequin ducks within the spill region and, if significant, develop appropriate strategies to minimize impacts.

MARBLED MURRELETS

Full recovery will be achieved when population trends are stable or increasing over a several year period.

Monitor population recovery.
Monitor the murrelet population to document progress towards recovery. Initial information for this objective is available from surveys in Prince William Sound, but not for other regions within the oil spill area. This objective will be complete when the population trends are stable or increasing over a several year period.

Identify and Protect nesting habitat.
a) Determine characteristics of high quality nesting habitat. This objective is partially

completed by the work done between 1991 and 1993 in Prince William Sound, Kenai Fjords and Afognak Island. The objective has been achieved when it is possible to identify high quality nesting habitat based on vegetative characteristics and/or marbled murrelet behavior (i.e. dawn flights).
b) Protect high quality nesting habitats. Identify and protect nesting habitat through acquisition or other means to ensure that a sufficient amount of high quality nesting habitat remains to maintain the existing breeding population and allow for the natural restoration of the birds lost from the oil spill.

Identify and protect food sources and forage areas. One of the possible explanations for the long-term decline in the marbled murrelet population in the Gulf of Alaska is related to problems with their prey species (forage fish). These objectives would help to determine the significance of changes in the forage fish populations and may provide a way to help reverse the long-term decline and accelerate recovery from the oil spill.

a) Identify important food sources and foraging areas. This objective will be completed when important year-round food sources and important foraging areas for marbled murrelets can be identified for the population within the oil spill area.
b) Determine the status, abundance and distribution, of forage fishes that are important marbled murrelet prey species. And determine if a change in abundance or distribution of prey is influencing the recovery of the population. This objective is a component of the Ecosystem objectives regarding forage fish and will be complete when year-round foods have been identified and their status linked to murrelet life history characteristics.

Reduce risk of human induced mortality.
Reduce the risk of human induced mortality if it is determined to be contributing significantly to population declines.

PIGEON GUILLEMOT

Recovery of the population has occurred when population abundance is equal to or greater than population abundance prior to the spill and when population trends are stable or increasing.

Monitor population recovery.
Monitor populations and breeding colonies to document recovery. Initial information for this objective is available from surveys in Prince William Sound, but not for other regions within the oil spill area.

Identify causes limiting recovery.
Determine the status of important forage fishes and their seasonal importance to pigeon guillemots. Determine if a change in abundance or distribution is influencing the recovery of the population. This objective is a component of the Ecosystem objectives regarding

forage fish and will be complete when year-round foods have been identified and their status linked to pigeon guillemot life history characteristics.

Protect habitat.
Pigeon Guillemots are widely dispersed along the coast but concentrate in favorable areas. Protect high density nesting areas through acquisition or protection of uplands to insure that a sufficient amount of habitat remains to maintain existing breeding populations and allow for the natural restoration of birds lost to the oil spill. This objective will be complete once high density nesting habitat is identified and protected.

Reduce predation **[this objective may be removed once the policy on exemptions to the within the spill area policy are finalized.]**
Remove introduced predators from areas where they have limited the breeding success of pigeon guillemots. Introduced predators such as foxes and rats have eliminated guillemots and other seabird species from many islands in Alaska. Seabird populations, including guillemots, could be greatly increased by eliminating foxes from these islands, most of which occur outside the oil spill area.

FISH

DOLLY VARDEN and CUTTHROAT TROUT

Recovery from the oil spill has occurred when Dolly Varden and cutthroat trout growth rates are equal to populations in nonoiled areas.

Monitor Dolly Varden and cutthroat trout populations.
Monitor the Dolly Varden and cutthroat trout populations in the oil spill area. This objective will be complete when growth rates of western Prince William Sound Dolly Varden and cutthroat trout compare to that of nonoiled areas.

Protect habitat.
Protect important Dolly Varden and cutthroat trout habitat through acquisition or other means to insure that all existing key habitat remains unaltered by human activities.

HERRING

In general terms, recovery has occurred when populations are healthy, productive and exist at or beyond prespill abundances. However, there is uncertainty as to the extent and mechanism of injury to herring, making it difficult to specify components and milestones of recovery. Additional research is necessary before a more precise definition of recovery can be given.

Conduct monitoring and research to better define injury.
The injury to herring is poorly understood. Distinguish injury from natural variations in abundance, document mechanisms for oil-induced injuries, and examine energy flow between trophic levels to determine factors impacting growth and survival. The objective will be achieved when the mechanism of injury is understood and the nature of injury is understood well enough to predict impacts on commercial fishing as well as other species that feed on or are consumed by herring.

Prevent overharvest of injured herring stocks.
Human harvest of injured stocks may slow recovery. To the degree that existing agency management is unable to provide this protection, gather additional information to allow more precise targeting of uninjured stocks by commercial harvests. The objective has been achieved when commercial harvests do not significantly impact injured stocks.

Protect spawning and rearing habitat from damage caused by human activities.
This objective has been achieved when human-caused habitat degradation does not significantly impact herring rearing and spawning. It is difficult to quantify the effect on fish production except in terms of documenting a linkage between herring and key habitats, and an absence of habitat disturbance.

PINK SALMON

In general terms, recovery has occurred when populations are healthy, productive and exist at prespill abundances. However, there is uncertainty as to the extent and mechanism of injury to pink salmon, making it difficult to specify components and milestones of recovery. One element of recovery that can be identified is a reduction in egg mortality to match prespill mortality rates or rates in nonoiled areas. Additional research is necessary before a more precise definition of recovery can be given. Full recovery may be prevented by climatic, oceanographic and other factors that can't be affected by restoration actions.

Conduct monitoring and research to better define injury.
The injury to pink salmon is poorly understood. Distinguish injury from natural variations in abundance, interactions between hatchery and wild stocks, document mechanisms for oil-induced injuries, and examine energy flow between trophic levels to determine factors impacting growth and survival. The objective will be achieved when the mechanism of injury is understood and the nature of injury is understood well enough to predict impacts on commercial fishing as well as other species that feed on or are consumed by pink salmon.

Prevent overharvest of injured wild stocks.
Human harvest of injured stocks may slow recovery. To the degree that existing agency management is unable to provide this protection, gather additional information to allow more precise targeting of uninjured stocks by commercial harvests. The objective has been achieved when commercial harvests do not significantly impact injured stocks.

Protect spawning and rearing habitat from damage caused by human activities.
This objective has been achieved when human-caused habitat degradation does not significantly impact pink salmon rearing and spawning. It is difficult to quantify the effect on fish production except in terms of documenting a linkage between pink salmon and key habitats, and an absence of habitat disturbance.

ROCKFISHES

In general terms, recovery has occurred when populations are healthy, productive and exist at or beyond prespill abundances. However, there is uncertainty as to the extent and mechanism of injury to rockfish, making it difficult to specify components and milestones of recovery. Additional research is necessary before a more precise definition of recovery can be given.

Monitor rockfish population.
Monitor the rockfish populations in the oil spill area for toxicity exposure and other impacts on the populations. This objective will be completed when physiological evaluation (to document disease) indicates rockfish lesions in oiled areas are similar to control areas and when other factors influencing the population are documented and understood.

SOCKEYE SALMON

Sockeye will be recovered when populations are healthy, productive and exist at prespill abundances. Indications that recovery has occurred are when rearing lakes support sockeye fry populations comparable to prespill levels and smolt outmigration is comparable to prespill levels. Climate changes, ocean conditions and other factors may prevent full recovery.

Restore production of fry and smolt.
In order for prespill numbers of adult salmon to return to spawn, sufficient numbers of fry and smolt must be produced. The objective has been met when sockeye rearing lakes produce levels of sockeye fry and smolt comparable to prespill averages without exceeding carrying capacity.

Reduce risk of adult overescapement and underescapement.
Data strongly suggests that too many spawning fish (overescapement) caused the initial oil spill injury to Kenai River sockeye. Additional overescapement might further unbalance the ecosystem and delay recovery. Future run declines may cause too few adult spawners to return (underescapement) with subsequent reduced adult returns. Escapement is influenced by fishing seasons that are set, in part, using predictions by the Alaska Department of Fish and Game. Errors in those predictions, due to lack of sufficient data, can cause over- or

underescapements. Gathering additional fisheries data, not funded under normal agency management, could reduce such errors. This objective has been achieved when fisheries managers can accurately and consistently meet escapement goals.

Protect spawning and rearing habitat from damage caused by human activities.
This objective has been achieved when human-caused habitat degradation does not significantly impact sockeye salmon rearing and spawning. It is difficult to quantify the effect on fish production except in terms of documenting a linkage between sockeye salmon and key habitats, and an absence of habitat disturbance.

ARCHAEOLOGICAL RESOURCES

Archaeological resources (i.e., archaeological sites and artifacts) do not and cannot recover as can natural resources; therefore, permanent damage to archaeological sites and artifacts can occur if they are not restored. In general, the damage to archaeological sites and artifacts occurs through looting of sites and artifacts, erosion within and around the sites as a result of cleanup activities, and by oiling. Archaeological resources will be considered recovered when spill-related injury ends, when looting and vandalism returns to or below prespill levels, and when archaeological information is available for the public and scientific community so they can learn about their cultural heritage.

Stop archaeological site deterioration.
Archaeological resources can be lost due to erosion caused by oil spill cleanup activities or by contamination with oil. This objective will be accomplished when oil spill cleanup caused erosion has been stopped and hydrocarbon concentrations are reduced so they no longer affect the organic components of the archaeological sites.

Protect archaeological sites.
Protect archaeological sites from human caused disturbances, especially looting and vandalism. This objective has been achieved when looting and vandalism of sites is at or below prespill levels.

RESTORATION OBJECTIVES FOR SERVICES

COMMERCIAL FISHING

Commercial fishing will be recovered when the population levels and distributions of commercial species match prespill conditions or when commercial harvests match prespill levels. Full recovery may be prevented by climatic, oceanographic and other factors that can't be affected by restoration actions.

Restore injured populations of commercial fish.
Almost all restoration of commercial fisheries will occur through achieving the objectives already described for pink and sockeye salmon, herring and rockfish. This may occur through General Restoration, Habitat Protection and Acquisition, and Monitoring. Development of an ecosystem model explaining impacts of trophic dynamics on commercial species will be especially helpful in this regard.

Consider creating new or enhanced salmon runs if injured populations are not recovering.
When injured populations of salmon are recovering slowly or not at all, it may be possible to create or enhance salmon runs to substitute for reduced or absent target populations. However, when it's possible, restoring the injured populations that originally supported the commercial harvest is preferable, since this has less potential than the creation of new or enhanced runs for disrupting the ecosystem or interfering with management of existing fisheries. The objective has been achieved when prespill commercial use levels have been achieved and no new ecological or fisheries management problems have been created in the process.

SUBSISTENCE

Recovery of subsistence use of resources consists of several aspects. First, injured subsistence resources must be healthy, productive, exist at prespill abundances, and be present in the same areas as before. Second, people must be confident that the resources are safe to eat. Lastly, the cultural values provided by gathering, preparing and sharing food must be reintegrated into community life.

Restore injured populations of subsistence species.
Much of the restoration of subsistence will occur through achieving the objectives already set out for the injured species used for subsistence. This may occur through General Restoration, Habitat Protection and Acquisition, and Monitoring.

Increase confidence in the safety of traditional foods.
Many subsistence users are not confident in the safety of traditional foods. This is due to a lack of confidence in the ability to determine when subsistence resources have been contaminated or otherwise affected by the oil. The objective will have been achieved when subsistence users are aware of and confident in results of tests documenting the safety of subsistence foods.

Remove oil that continues to contaminate subsistence foods.
Restore the quality and availability of traditional subsistence foods by removing oil that still contaminates intertidal areas. This objective has also been described for clams and mussels in the concept of the ecosystem approach, the difference here is to target areas that are

important for subsistence use. This objective will have been achieved when oil from the *Exxon Valdez* oil spill is no longer contaminating subsistence food sources.

Increase the availability of alternative food sources or their equivalents while injured resources are recovering.
Until injured subsistence species have recovered and confidence in food safety has been restored, alternative food sources are needed. The objective has been achieved when sufficient amounts of traditional foods, or suitable substitutes, are readily available.

Protect habitat important to subsistence resources from damage caused by human activities.
This objective has been achieved when human-caused habitat degradation does not significantly impact subsistence resources. It is difficult to quantify the effects of protection except in terms of documenting a linkage between subsistence resources and key habitats, and an absence of habitat disturbance.

Passive Uses

Passive uses of resources include the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other nonuse values. Injuries to passive uses are tied to public perceptions of injured resources. The service can only recover when people believe that resources have recovered.

For this reason, any restoration objective which aids recovery of injured resources, or prevents further injuries, will assist recovery of passive use values. No objectives have been identified which benefit only passive uses, without also addressing injured resources. Since recovery of passive uses requires that people know when recovery has occurred, the availability to the public of the latest scientific information will continue to play an important role in the restoration of passive uses.

NOTE TO REVIEWERS: Restoration objectives for Recreation and Wilderness Areas are still being developed (1 to 1.5 additional pages). They will be available for your review early next week.