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December 29 draft

MEMORANDUM

U.S. Fish & Wildlife Service
Environmental Contaminants
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File:

January 11, 1996

To: Stan Senner

From: Catherine Berg

Subject: Comments on Injury and Recovery Objectives

These comments do not necessarily represent the opinion of the U.S. Fish and Wildlife Service and further review of the document, by Fish and Wildlife Service personnel, can be expected.

General Comments:

It is a good idea to drop the restoration strategies. The restoration process is so dynamic at this point that these strategies very quickly become obsolete.

The document is improved by providing more and better information regarding the injury and, in most cases, recovery. However, I also think that we have done so much work and learned so much, especially with the birds, that we can do better than make generalizations within the recovery objectives. I don't think it is good enough anymore to say "...will have recovered when population trends are stable or increasing" or "returns to pre-spill levels". In most cases, we can expand greatly on these statements with new and improved information gained through our studies. This should be a major focus of the discussions at the workshop next week. I think the better we can define and refine the recovery objectives with specifics pertaining to the individual species to make them achievable and recognizable, the easier it will be at certain points in time to say a species is recovered and move it off the list.

Specific Comments:

Bald Eagles: Under I&R, state the number of bald eagles recovered in the morgue. I believe it was 151 birds.

Black Oystercatchers: "An estimated 1,500-2,000 oystercatchers live..." Are these year-round residents, seasonal population i.e. wintering, breeding, migrants? Clarification of this would help me to better understand the injury. Under the RO, do we know what those population pre-spill

levels were? If so, let's state a number or a range here so that it is clear when we have reached this objective. If we don't know what those levels were, then let's delete this objective and focus on defining what we know with regard to "normal" reproduction, growth rates, and age class parameters and limit our objectives to these. It seems to me that recovery may be more easily achievable and more readily recognizable along these lines than meeting a certain population number.

Common Loons: Under I&R, "Common loons in the oil-spill area may number..." Is this pre- or post-spill, wintering, breeding, resident? Clarification of this would help. Do we have any population information from the boat surveys that would be useful in understanding recovery or status?

Common Murres: Under RO, "...productivity is sustained within normal bounds." Can we further refine this to say sustained (for example) for a period of 4 years? I know a power analysis has been done for murres to determine how many surveys are needed over a certain period of time to identify that recovery is or is not occurring. This would help to refine the objective and make recovery more recognizable when it does occur.

Cutthroat Trout: Under RO, do you want to say "geographic effects" or do you instead mean "geographic differences". I think the latter is more appropriate when you are comparing biological parameters.

Designated Wilderness: Under RO, a "designated wilderness" has a legal definition; if a designated wilderness area meets that definition i.e. no remaining oil and no other physical or biological oil impacts remain, then it should be considered recovered. If you are just referring to "wilderness characteristics" then, yes, public perception is important, and negative perceptions will have to be overcome before a "wilderness area" is recovered.

Dolly Varden: Under RO, again as with cutthroat trout, do we mean geographic effects or differences?

Harbor Seals: The Recovery Objective here is too generic and vague and, from what the studies indicate, impossible to meet. I think there has surely been enough harbor seal work done to this point that we can greatly expand this objective to define something that is achievable and recognizable. As with some of the other species, it should include biological parameters such as reproduction, growth rates, weight, age class structure and possibly distribution.

Harlequin Ducks: Under the RO, do we know what those population pre-spill levels were? If so, let's state a number or a range here so that it is clear when we have reached this objective. If we don't know what those levels were, then let's delete this objective and focus on the second objective and defining what we know with regard to "normal" reproduction, growth rates, and age class and sex-structure parameters and limit our objectives to these. It seems to me that recovery may be more easily achievable and more readily recognizable along these lines than meeting a certain population level.

Intertidal Organisms: Under RO, "...would have prevailed in the absence of the spill." Since in most cases we really do not have the baseline information needed to make this determination, this will probably have to be done by comparing these oiled shorelines to similar un-oiled habitats.

Making a statement along those lines will probably make this objective more achievable and recognizable. Also, suggest changing "...return of keystone species..." to "...re-establishment of keystone species...".

Killer Whales: After reading the I&R, it seems to me that the dynamics of the killer whale social structure may never clearly reflect a recognizable recovery. They may have recovered, but the composition of the pods will never be the same. Is this a particularly bad thing? If we truly cannot define an achievable and recognizable recovery objective for this species, then based on the information gathered from the studies I would say it's recovered.

Murrelets: Under RO, I think enough studies have been done on Marbled Murrelets that we can greatly expand on this recovery objective. I don't think it's any longer appropriate to just say when population trends are stable. There are other biological parameters that we can use to determine if a species is recovering. How about the productivity index work; can this be applied to a recovery objective?

Mussels: Under I&R, "...are known to still have oil residue;" Mussel beds may still have residue but it is inert for the most part and more of a visual impact than a physiological impact. A brief discussion of the residual oils toxicity may be appropriate here because it is a key to the recovery determination. Under RO, I think we really need to expand on this objective. Exactly what do we mean by "...do not contaminate their predators." Are we not at that point now? Again, for the most part, any oil remaining in the environment is inert or has very low toxicity.

Pacific Herring: Under the RO, my concern with herring, as with the other fish species, is that the public will not perceive a recovery from spill effects until there are once again massive commercial harvests occurring. How will we make the determination or identify the "recovery", based on what the recovery objective states. Will it be when we have several years of successful commercial harvests or before that occurs? I think we need to be more specific as to how we will recognize that herring have recovered.

Pigeon Guillemot: Under I&R, here again we state that it is difficult to identify recovery based on the use of population numbers. So, under the RO, let's get rid of the objective that says recovery will be achieved when populations are stable. We have done so much work and know so much more now about the pigeon guillemot that we ought to be able to improve the recovery objectives to provide a goal that is recognizable using other biological parameters besides population.

Pink Salmon: Under the I&R, statements include "...difficult to attribute poor returns in a given year to injuries caused by oil." and "The 1994 and 1995 seasons were the first since 1989 which there were no statistically significant differences...". I like the recovery objective because it is not based on fish numbers. But looking at the injury and recovery, how many concurrent seasons will it take to achieve the objective. If we see no differences in '94-'95 and see none in '95-'96 have we reached our goal? Or do we need to continue to look at '96-'97 and '97-'98? Can we specify how many consecutive runs are required to achieve and recognize recovery based on the objective?

River Otter: Under RO, again I would suggest changing "geographic effects" to "geographic differences".

Sea Otters: Under RO, "An increasing population trend and normal reproduction and age structure in oiled parts on the Sound will indicate recovery." Period. Studies have shown that if a sea otter population is healthy, localized distribution and densities can vary greatly depending on sufficient food sources. So, do we have to wait until a certain number is achieved? It should be sufficient to achieve and recognize recovery based on the parameters stated--normal reproduction, normal age structure, normal distribution, and increasing trends. Also, since so much work has been done using histopathology to determine the oil spill effects on the health of the sea otter, that should also be applied to an objective as it could be useful in recognizing the recovery.

Sediments: Under RO, exactly what is meant by biologically harmless. Who will make this determination and what kind of technique is used to determine biologically harmless. The number of areas that were heavily oiled and the amount of oil in these areas are definitely on the decline and probably are right now biologically harmless in which case, based on the objective, sediments are recovered and we can just tick this one off the list right now. I think some specifics here would help us recognize when recovery is achieved. Do we have a time frame in mind or specific locations?

Sockeye Salmon: Under RO, again I have a concern that we will base recovery on fish numbers and meeting commercial harvest quotas. Under I&R, we state "Production of zooplankton...has returned to normal", "...problem...may not be linked to the over escapement at the time of the oil spill", "low adult escapements...are more likely the result of a mixed stock fishery harvest..." Maybe recovery of sockeye should not be based on "numbers" but should be linked to ecological parameters in the different geographic systems. Under RO, if we are going to use "adult returns-per-spawner within normal bounds" we need to more clearly define "normal bounds" i.e. "returns of # over # of consecutive years". A more specific objective will help us to recognize recovery when it is achieved.

Subtidal Organisms: Under RO, suggest changing "return of keystone species" to "re-establishment of keystone species". Would it be appropriate here to identify these locations? It may help to focus the program and quickly achieve the goal.

Overall, I think that making the recovery objectives more specific and goal oriented will help us to achieve recovery in an expedient manner and to recognize it when it happens. Thank you for the opportunity to comment. If you have any questions regarding these comments, please call me at 786-3598.

Catherine Berg

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Table 1. Resources and Services Injured by the Spill

INJURED RESOURCES

Recovered

~~Bald eagle~~

Recovering

~~Bald eagle~~
~~Black oystercatcher~~
~~Common murre~~
Intertidal organisms
~~(some)~~ ~~(everything)~~
~~Killer whale~~
Mussels
~~Pink salmon~~
Sockeye salmon
~~(Red Lake)~~ ~~(all systems)~~
Subtidal organisms
~~(some)~~ ~~(everything)~~

Not Recovering

~~Common murre~~
Harbor seal
Harlequin duck
~~Intertidal organisms~~
~~(some)~~
~~Killer whale~~
~~(AB pod)~~
Marbled murrelet
Pacific herring
Pigeon guillemot
~~Pink salmon~~
Sea otter
~~Sockeye salmon~~
~~(Kenai & Akalura systems)~~
~~Subtidal organisms~~
~~(some)~~
~~Archaeological resources~~
~~Sediment~~

Recovery Unknown

Clams - ?
Common loon
Cutthroat trout
Black oystercatcher
Dolly Varden
Kittlitz's murrelet
River otter
Rockfish

Other

Archaeological resources
Designated wilderness areas
Sediments

Services

Commercial fishing
Passive uses
Recreation and Tourism
Subsistence

29 Dec 1995
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Chapter 5
~~Goals, Objectives, and Strategies~~
Injury Status and Recovery Objectives

~~This chapter presents goals, objectives, and strategies for restoration.~~ The first part of this chapter discusses ~~goals,~~ recovery objectives~~, and strategies~~ in general. The second part describes the nature and extent of injury and recovery and ~~the~~ recovery objective~~, and the restoration strategy~~ for each injured resource and service discussed in Table 2 in Chapter 4. Detailed information on injury and recovery objectives~~, and strategies~~ can be found on the following pages:

Overview

The first part of this chapter discusses goals, objectives, and strategies in general. A goal is the end toward which an endeavor is directed; objectives are descriptions of measurable outcomes; and strategies are plans of action. Taken together, goals, objectives, and strategies produce a blueprint for restoring the spill area. To be funded, a project must be consistent with the goals and policies of the Restoration Plan and with restoration objectives and strategies as they change over time.

GOAL: *The end toward which restoration is directed*

The goal of restoration is recovery of all injured resources and services. Recovery is to be sustained by healthy, productive ecosystems that maintain naturally occurring biodiversity. All restoration actions must be directed toward this goal.

OBJECTIVES: *Measurable outcomes of restoration*

Objectives

The recovery objectives described in the following section of the restoration program are the measurable conditions that signal the recovery of individual resources or services. They are the yardsticks against which the success of the program is measured. In general, resources and services will have recovered when they return to conditions that would have existed had the spill not occurred. In nature, however, populations often undergo large natural changes, and Because it is difficult to predict conditions that would have existed in the absence of the spill. recovery is often Recovery, therefore, is most realistically defined as a return to prespill conditions or to levels that fall within the bounds of natural variation. For resources that were in decline before the spill, like harbor seals marbled murrelets, recovery may be achieved consist of stabilizing the when a population is stabilized, even if at a lower level than before the spill. For some resources, little is known about their injury and recovery status, so it is difficult to define recovery.

Where few little prespill data exist, injury is inferred from comparisons of oiled and unoiled areas, and recovery is usually defined as a return to conditions comparable to those of unoiled areas. Because the differences between oiled and unoiled areas may have existed before the spill, statements of injury and objectives based on these differences are often less certain than in those cases where prespill data exist. Alternatively, injury may be evaluated based on the number of oiled carcasses picked up following the spill relative to the estimated size of the spill-area population. Even in cases where some prespill data are available, However, there also is can be some uncertainty associated with interpreting the significance of prespill population data since populations undergo natural fluctuations. In all cases, indicators of recovery can include increased numbers of individuals, reproductive success, improved growth and survival rates, and normal age and sex composition of the injured population.

Full ecological recovery will have been achieved when the population of flora and fauna are

again present at former or prespill abundances, are 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.

[NOTE: WE PROPOSE TO ELIMINATE THE FOLLOWING GENERIC DISCUSSION OF STRATEGIES, AS WELL THE DISCUSSION OF SPECIFIC STRATEGIES FOR EACH INJURED RESOURCE (BUT NOT FOR SERVICES). THIS STUFF IS PROBABLY BEST COVERED THROUGH THE INVITATIONS, WHERE IT IS UPDATED ANNUALLY. IN ADDITION, SOME OF THE MORE GENERIC DISCUSSION IS ALREADY COVERED IN CHAPTER 3 OF THE RESTORATION PLAN. IF WE WERE TO RETAIN THIS MATERIAL, IT WOULD REQUIRE SUBSTANTIAL REVISION.]]

~~STRATEGIES: *Plans of action*~~

~~A restoration strategy is a plan of action for achieving objectives. Each year, through its annual or multiyear work plan, the Trustee Council decides which strategies to implement. Restoration strategies reflect consideration of ecosystem relationships. For example, the strategy for some injured resources includes research into why they are not recovering, such as declining or contaminated food sources or disruption of ecosystem relationships.~~

~~In this section, restoration strategies are presented under three headings: Biological Resources, Other Resources, and Services.~~

~~**Biological Resources**~~

~~Because restoration strategies for biological resources depend on whether the resource is recovering, strategies are subdivided into those for recovering resources, resources that are not recovering, and resources whose recovery is unknown.~~

~~***Recovering Resources.*** The fact that a resource is recovering suggests that nature will restore it without intervention. Consequently, restoration of recovering resources will rely primarily on natural recovery.~~

~~Because these resources are recovering, research into factors limiting recovery and general restoration projects to accelerate recovery may not be warranted. However, if a resource is not expected to recover fully on its own or if waiting for natural recovery will cause long-term harm to a community or service, appropriate alternative means of restoration would be undertaken. Habitat protection and monitoring are encouraged, as are general restoration projects that protect the resource from other sources of potential injury. (Restoration strategies under "Services" also apply to these resources.)~~

~~The restoration strategy for recovering resources has three parts:~~

- ~~Rely on natural recovery~~
- ~~Monitor recovery~~

- Protect injured resources and their habitats

Resources Not Recovering. Except for certain protective measures, attempts to restore these resources without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for these resources emphasizes determining why they are not recovering, and eliminating threats to the remaining populations.

Where sufficient knowledge about the nature of injury exists, the restoration strategy also encourages actions to promote recovery. The populations of some of these resources are in a steep decline and may not recover without help. Furthermore, some of these resources have subsistence or economic importance and their recovery is linked to the recovery of these services. (Restoration strategies under "Services" also apply to these resources.)

Research is encouraged, provided it helps explain why a resource is not recovering. Habitat protection and monitoring are also encouraged. General restoration projects are allowed if they address factors limiting recovery or if they protect the resource from other sources of potential injury.

The restoration strategy for resources that are not recovering has four parts:

- Conduct research to find out why these resources are not recovering
- Initiate, sustain, or accelerate recovery
- Monitor recovery
- Protect injured resources and their habitats

Recovery Unknown. If specialists do not know whether a resource is recovering, it will be treated in much the same way as a recovering resource. Until more is known about the nature and extent of injuries and the degree of recovery of these resources, restoration will rely primarily on natural recovery, aided by monitoring and protective measures.

Because the recovery of these resources is unknown, and, in some cases, the injury poorly understood, research into factors limiting recovery and general restoration projects to accelerate recovery may not be warranted. Habitat protection and monitoring are encouraged, as are general restoration projects that protect these resources from other sources of potential injury.

The restoration strategy for resources whose recovery is unknown has three parts:

- Rely on natural recovery
- Monitor recovery
- Protect injured resources and their habitats

Other Resources

Other injured resources include archaeological resources, designated wilderness areas and oiled sediment. The strategy for restoring archaeological resources seeks to repair and protect injured

~~sites and artifacts. The strategy for sediment includes removal or reduction of residual oil and monitoring. Any restoration strategy that aids recovery of injured resources, or prevents further injuries, will assist recovery of designated wilderness areas or wilderness study areas.~~

~~Services~~

~~Commercial fishing, passive use, recreation (including sport fishing) and tourism and subsistence are services that were reduced or lost because of the spill. Injured resources that support these services include clams, harbor seals, Pacific herring, pink salmon, sea otters, and sockeye salmon. The primary way to restore services is to restore the resources on which they depend.~~

~~Additional restoration strategies for commercial fishing, recreation and tourism, and subsistence include promoting recovery of the service as soon as possible through such means as increasing the availability, reliability, or quality of the resource on which the service depends. For some resources, this may take the form of increasing availability in the long run through improved resource management or providing replacement resources. Strategies for recreation and tourism and subsistence also include removing or reducing residual oil if treatment is cost-effective and less harmful than leaving the oil in place.~~

~~Objectives and Strategies by Resource and Service~~
Injury Status and Recovery Objective

This section describes the nature and extent of injury and recovery and the recovery objective~~, and the restoration strategy~~ for each injured resource and service. Specific strategies to achieve recovery objectives are described in annual work plans and restoration project invitations (e.g., *Invitation to Submit Restoration Projects for Federal Fiscal 1997 and Draft Restoration Program: FY 97 and Beyond*). The information in this section is expected to change ~~over time~~ as the restoration program adapts to new information. For example, population declines or sublethal effects may be documented for new resources, some resources may begin to recover or never recover, and recovery objectives ~~and strategies may~~ will change in response to new information and conditions. Hypotheses for why resources are not recovering are particularly susceptible to change as prevailing hypotheses are tested and new ones are formed.

New scientific data will be incorporated into restoration decisions without the need to change the plan. However, changes will be reported in the Trustee Council's annual status report.

Resources

Archaeological Resources

Injury and Recovery

Twenty-four archaeological sites on public lands are known to have been adversely affected by cleanup activities, or looting and vandalism linked to the oil spill. Additional sites on private land

may have been injured, but damage assessment studies were limited to public land.

Documented injuries include theft of surface artifacts, masking of subtle clues used to identify and classify sites, violation of ancient burial sites, and destruction of evidence in layered sediments. In addition, vegetation has been disturbed, which has exposed sites to accelerated erosion. The effect of oil on soil chemistry and organic remains may reduce or eliminate the utility of radiocarbon dating in some sites.

Assessments of 14 sites in 1993 suggest that most of the archaeological vandalism that can be linked to the ~~*Exxon Valdez* oil~~ spill occurred 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. In 1993, only two of the 14 sites visited showed signs of continued vandalism, ~~and the link between~~ but it is difficult to prove that this recent vandalism was related to the spill. ~~and the *Exxon Valdez* oil spill remains highly problematical~~. Oil ~~samples have not yet been analyzed, but oil~~ was visible in the intertidal zones of two of the 14 sites monitored in 1993, but because oil samples have not yet been analyzed, the *Exxon Valdez* oil spill cannot be confirmed as the source of the oil in these sites.

Monitoring of archaeological sites in 1994 and 1995 found no evidence of new damage from vandalism. The presence of oil is being determined in sediment samples taken from four sites in 1995.

None of the archaeological artifacts collected during the spill response, damage assessment, or restoration programs is stored within the spill area. These artifacts are stored in the University of Alaska Museum in Fairbanks and in the Federal Building in Juneau. Native communities in the spill area have expressed a strong interest in having them returned to the spill area for storage and display.

The Alutiiq Archaeological Repository in Kodiak, whose construction costs were partly funded by the Trustee Council, is the only physically appropriate artifact storage facility in the spill area. In 1995 the Trustee Council approved funds for development of a comprehensive community plan for restoring archaeological resources in Prince William Sound and lower Cook Inlet, including strategies for storing and displaying artifacts at appropriate facilities within the spill area.

Recovery Objective

Archaeological resources are nonrenewable: they cannot recover in the same sense as biological resources. Archaeological resources will be considered to have recovered when spill-related injury ends, looting and vandalism are at or below prespill levels, and the artifacts and scientific data which remain in vandalized sites are preserved (e.g., through excavation, site stabilization, or other forms of documentation). ~~Artifacts and data are typically preserved through excavation or other forms of documentation, or through site stabilization, depending on the nature of the injury and the characteristics of the site.~~

Bald Eagles

Injury and Recovery

Prince William Sound provided year-round and seasonal habitat for about 5,000 bald eagles. ~~Two hundred to 300~~ About 250 bald eagles ~~are estimated to have died as a result of may have been killed in~~ the spill, and productivity was reduced in oiled areas of Prince William Sound in 1989. Productivity was back to normal in 1990 and 1991, and an aerial survey of adults in 1995 indicated that the population has returned to or exceeded its prespill level in Prince William Sound. ~~However, population estimates made in 1989, 1990, and 1991 indicate that there may have been an increase in the Prince William Sound bald eagle population since the previous survey conducted in 1984. Productivity decreased in 1989, but appeared to have recovered by 1990. Because population and productivity appear to have returned to prespill levels, bald eagles may have already recovered from the effects of the spill.~~

Recovery Objective

Because the Prince William Sound population and productivity are at or above prespill levels, the bald eagle has recovered from the effects of the Exxon Valdez oil spill. ~~Bald eagles will have recovered when their population and productivity return to prespill levels.~~

Black Oystercatchers

Injury and Recovery

Black oystercatchers spend their entire lives in or near intertidal habitats and are highly vulnerable to oil pollution. An estimated 1,500-2,000 oystercatchers live in south-central Alaska. Only nine carcasses of adult oystercatchers were recovered following the spill, but estimated mortality may have been as high as, but probably did not exceed, 20 percent in the spill area. In addition, breeding activities were disrupted by the oil and clean-up activities. In comparison with oystercatchers on the largely unoiled Montague Island, oystercatchers at heavily oiled Green Island had reduced hatching success in 1989 and their chicks gained weight more slowly during 1991-93. Interpretation of these data on reproductive performance, however, are confounded by lack of pre-spill data. Productivity and survival of black oystercatchers in Prince William Sound have not been monitored since 1993, and the recovery status of this species is not currently known. ~~Within Prince William Sound, an estimated 120 to 150 black oystercatchers, representing 12-15 percent of the total estimated population, died as a result of the spill. Mortality outside of Prince William Sound is unknown. Black oystercatchers are recovering, although they may still be exposed to hydrocarbons when feeding in intertidal areas.~~

Recovery Objective

Black oystercatchers will have recovered when the Prince William Sound population returns to ~~attain~~ prespill levels and reproduction is normal. An increasing population trend and comparable

hatching success and growth rates of chicks in oiled and unoiled areas will indicate that recovery is underway. ~~reproductive success of nests and growth rates of chicks raised in oiled areas are comparable to those in unoiled areas.~~

CLAMS

Injury and Recovery

The magnitude of impacts on clam populations varies with the species of clam, degree of oiling, and location. However, data from the lower intertidal zone on sheltered beaches suggest that little-neck clams and, to a lesser extent, butter clams ~~on sheltered beaches~~ were killed or suffered slower growth rates as a result of the oil spill ~~by oiling~~ and clean-up activities. ~~In addition, growth appeared to be reduced by oil, but determination of sublethal or chronic effects is awaiting final analyses.~~ In communities on the Kenai Peninsula, Kodiak, and Alaska Peninsula, concern about the effects of the oil spill on clams and subsistence uses of clams remains high.

Recovery Objective

Based on prespill data or comparisons of oiled and unoiled sites, clams will have recovered when populations and productivity have returned to levels that would have prevailed in the absence of the oil spill ~~(prespill data or unoiled control sites)~~.

COMMON LOONS

Injury and Recovery

Carcasses of 395 loons of four species were recovered following the spill, including at least 216 common loons. The population sizes are not known for any of these species, but, in general, loons are long-lived, slow-reproducing, and have small populations. Common loons in the oil-spill area may number only a few thousand, including only hundreds in Prince William Sound. Common loons injured by the spill probably included a mixture of resident and migrant birds, and their recovery status is not known.

Recovery Objective

Without more information on injury to common loons and their recovery status, no recovery objective can be identified.

COMMON MURRES

Injury and Recovery

About 30,000 carcasses of oiled birds were picked up following the oil spill, and 74 percent of them were common and thick-billed murres (mostly common murres). Many more murres died than were actually recovered, and it is estimated that the spill-area population declined by about 40 percent, including at colonies at Resurrection Bay, the Chiswell, Barren, and Triplet Islands,

and Puale Bay. In addition to direct losses of murres, there was evidence that the timing of reproduction was disrupted and productivity reduced. Interpretation of the effects of the spill, however, is complicated by incomplete prespill data and by indications that populations at some colonies were in decline before the oil spill.

Postspill monitoring of productivity at index colonies indicates that reproductive timing and success were again within normal bounds by 1993. Numbers of adult murres were last surveyed in 1994 [check] and, at that time, had not returned to prespill levels.

~~Productivity of common murres shows signs of recovery at some injured colonies (Barren Islands, Puale Bay) but postspill population counts are still lower than prespill estimates and show no sign of recovery.~~

Recovery Objective

Common murres will have recovered when populations ~~trends are increasing significantly~~ at index colonies have returned to prespill levels and when productivity is sustained within normal bounds. ~~in the spill area and when reproductive timing and success are (Normal bounds will be determined by comparing productivity data with information from other murre colonies in the Gulf of Alaska and elsewhere.)~~

Cutthroat Trout

Injury and Recovery

Prince William Sound is at the northwestern limit of the range of cutthroat trout, and few stocks are known to exist within the sound. Local cutthroat populations rarely number more than 1,000 each, and the fish have small home ranges and are geographically isolated. Cutthroat trout, therefore, are highly vulnerable to exploitation, habitat alteration, or pollution. Following the oil spill, cutthroat trout in a small number of oiled index streams grew more slowly than in unoiled streams, possibly as a result of reduced food supplies or exposure to oil, and there is concern that reduced growth rates may reflect reduced survival. The difference in growth rates persisted through 1991. No studies have been conducted since then, and the recovery status of this species is not known. ~~Cutthroat trout have grown more slowly in oiled areas than in unoiled areas. Insufficient data are available to determine whether they are recovering.~~

Recovery Objective

Cutthroat trout will have recovered when growth rates within oiled areas are comparable to those for unoiled areas, after taking into account geographic effects.

Designated Wilderness Areas

Injury and Recovery

The oil spill delivered oil in varying quantities to the waters adjoining the seven areas within the spill area designated by Congress as wilderness areas and wilderness study areas. Oil also was deposited above the mean high-tide line in these areas. During the intense clean-up seasons of 1989 and 1990, thousands of workers and hundreds of pieces of equipment were at work in the spill area. This activity was an unprecedented imposition of people, noise, and activity on the area's undeveloped and normally sparsely occupied landscape. Although activity levels on these wilderness shores have probably returned to normal, but at some locations there is still residual oil.

Recovery Objective

Designated wilderness areas will have recovered when oil is no longer encountered in these areas and the public perceives them to be recovered from the spill.

DOLLY VARDEN

Injury and Recovery

Like the cutthroat trout, there was evidence that Dolly Varden ~~have grown~~ grew more slowly in oiled streams ~~areas~~ than in unoiled streams ~~areas~~, and there is concern that reduced growth rates reflect reduced survival. However, no data have been gathered since 1991, and the recovery status of this species is not known. ~~Insufficient data are available to determine whether they are recovering.~~

Recovery Objective

Dolly Varden will have recovered when growth rates within oiled streams ~~areas~~ are comparable to those ~~for~~ in unoiled streams ~~areas~~, after taking into account geographic effects.

Harbor Seals

Injury and Recovery

Harbor seal numbers were declining in the Gulf of Alaska, including in Prince William Sound, before the spill. An estimated 300 seals died in the sound as a direct result of the spill, and this was 6-15 percent of the prespill population. Postspill surveys in 19__ showed that seals in ~~the~~ oiled areas had declined by 43 percent, compared to 11 percent in ~~the~~ unoiled areas. Unfortunately, seals in both oiled and unoiled parts of Prince William Sound have continued to decline since the spill at an annual rate of about 6 percent. Possible factors for this long-term decline include disease and the amount or quality of food. ~~Counts made during the molt at trend count sites in Prince William Sound from 1990 to 1993 indicate that numbers may have stabilized. However, counts during pupping have continued to decline. It is not known which counts are the best indicator of population status. If the conditions that were causing the population to decline before the spill have improved, normal growth may replace the animals that were lost. However, if conditions continue to be unfavorable, the affected population may~~

~~continue to decline.~~ Harbor seals are a key subsistence resource in the oil-spill area ~~Prince William Sound~~. Subsistence hunting is ~~both~~ affected by the declining seal population and, in turn, may be affecting the recovery of harbor seals ~~status~~.

Recovery Objective

Recovery will have occurred when harbor seal population trends are stable or increasing.

HARLEQUIN DUCKS

Injury and Recovery

Harlequin ducks feed in intertidal and shallow subtidal habitats where most of the spilled oil was initially stranded. More than 200 harlequin ducks were found dead in 1989, mostly in Prince William Sound, and many more than that actually died throughout the spill area. Bile samples from harlequin ducks collected in eastern and western Prince William Sound in 1989-90 had higher concentrations of hydrocarbon metabolites than samples from harlequins collected at Juneau. Prespill data on harlequin populations and productivity are poor and complicated by possible geographic differences in habitat quality. However, the summer population in Prince William Sound is small, only a few thousand birds, and there continues to be concern about poor reproduction and a possible decline in numbers of molting birds in western versus eastern parts of the Sound. ~~There are indications of reduced densities of harlequin ducks in the breeding season; a declining trend in the summer, postbreeding population; and very poor production of young in western Prince William Sound.~~

Recovery Objective

Harlequin ducks will have recovered when breeding and postbreeding season densities and production of young return to ~~estimated~~ prespill levels. ~~or when there are no differences in these parameters between oiled and unoiled areas.~~ A normal population age- and sex-structure and reproductive success appropriate to the habitat in western Prince William Sound will indicate that recovery is underway.

Intertidal Organisms

Injury and Recovery

Portions of 1,500 miles of coastline were oiled by the spill, and both the oil and intensive clean-up activities had significant impacts on the flora and fauna of the intertidal zone, the area of beach between low and high tides. With tidal action, oil penetrated deeply into cobble and boulder beaches, and, even with intensive clean up activities, persists in some beaches today. The most significant impacts occurred in middle and upper intertidal zones on sheltered rocky shores, which is where the greatest amounts of oil were stranded.

Small invertebrates like limpets, barnacles, and marine worms were less abundant at oiled versus unoiled index sites in Prince William Sound, Kodiak Island, and on the Kenai and Alaska peninsula coasts. The size, coverage, and reproductive potential of seaweed *Fucus gardneri* (known as rockweed or popweed) also was reduced following the spill. Although numbers of many species of invertebrate fauna have increased following the spill, recovery of *Fucus* in the upper intertidal zone is lagging. Full recovery of *Fucus* is crucial for recovery of the intertidal ecosystem, since many invertebrates depend on the cover provided by this seaweed. Many intertidal resources are important to subsistence users, as well as to sea and river otters, black oystercatchers, harlequin ducks, and pigeon guillemots.

~~The lower intertidal zone and, to some extent, the middle intertidal zone are recovering. However, injuries persist in the upper intertidal zone, especially on rocky sheltered shores. Recovery of this zone appears to depend, in part, on the return of adult *Fucus* in large numbers.~~

Recovery Objective

~~Each intertidal elevation (lower, middle, or upper) will have recovered when community composition, population abundance of component species, age-class distribution, and ecosystem functions and services in each injured intertidal habitat have returned to levels that would have prevailed in the absence of the oil spill.~~ Intertidal communities will have recovered when community composition on oiled shorelines is similar to that which would have prevailed in the absence of the spill. Indications of recovery are the return of keystone species, such as *Fucus*, and provision of adequate, uncontaminated food supplies for top predators in intertidal and nearshore habitats.

Killer Whales

Injury and Recovery

About ___ killer whales in _"resident" pods regularly use Prince William Sound within their ranges. Other whales in "transient" pods enter the Sound less frequently. There has been particular concern in Prince William Sound about the resident AB pod, which numbered 36 animals prior to the spill. Fourteen whales disappeared from this pod in 1989 and 1990, during which time no young were recruited into the population. Although four calves were added to the AB pod during 1992-94, surveys in 1994 and 1995 indicate the loss of five more whales.

The link between these losses and the oil spill is only circumstantial, but the apparent mortality of killer whales in Prince William Sound following the spill far exceeds rates documented for pods in British Columbia and Puget Sound over the last 20 years. The AB pod may never regain its former size, but overall numbers of resident killer whales in Prince William Sound are at or exceed prespill levels. ~~Thirteen whales disappeared from one killer whale pod in Prince William Sound between 1988 and 1990. The injured pod is growing again.~~

Recovery Objective

Pending further evaluation of the status of the AB pod, no realistic recovery objective can be identified at this time. ~~Killer whales will have recovered when the injured pod grows to at least 36 individuals (1988 level).~~

~~Marbled~~ Murrelets, Marbled and Kittlitz's

Injury and Recovery

Prince William Sound and the northern Gulf of Alaska are key areas in the distributions of two poorly studied species of seabirds, marbled and Kittlitz's murrelets. The world population of Kittlitz's murrelet is believed to number only a few tens of thousands of birds, many of which are in the oil-spill area. The marbled murrelet is federally listed as a Threatened species in Washington, Oregon, and California; it is also listed as Threatened in British Columbia.

The marbled murrelet populations ~~were~~ was in decline before the spill. The causes of the prespill decline are unknown, but may be related to changing food supplies. The oil spill probably increased the prespill rate of decline for this species in the spill area, although the incremental injury is difficult to estimate. ~~The population of marbled murrelets may be stabilizing or even increasing since the spill.~~ Carcasses of nearly 1,100 murrelets were found after the spill, and it is estimated that as much as __ percent of the Prince William Sound marbled murrelet population was killed by the spill. Population estimates for murrelets are highly variable, and postspill boat surveys do not yet indicate any statistically significant increase in numbers of marbled murrelets in Prince William Sound. The recovery status of Kittlitz's murrelet is not known.

Recovery Objective

Marbled murrelets will have recovered when population trends are stable or increasing. No recovery objective can be identified for Kittlitz's murrelet at this time.

Mussels

Injury and Recovery

Mussels are an important prey species in the nearshore ecosystem throughout the oil-spill area, and beds of mussels provide physical stability in the intertidal zone. For these reasons, mussel beds were purposely left alone during *Exxon Valdez* clean-up operations. In 1991, high concentrations of relatively unweathered oil were found in the mussels and underlying byssal mats in certain dense mussel beds. ~~In 1991, relatively high concentrations of oil were found in mussels and in the dense underlying mat (byssal substrate) of certain oiled mussel beds. The beds were not cleaned nor was oil removed after the spill. The~~ The biological significance of oiled mussel beds is not known, but they ~~Oiled mussel beds~~ are potential pathways of ~~sources of fresh (unweathered)~~ oil contamination for local populations of harlequin ducks, black oystercatchers, river otters, and juvenile sea otters, all of which feed to some extent on mussels and show some signs of continuing injury. ~~The extent and magnitude of oiled mussel beds are unknown.~~ At least __ [70-?] mussel beds in Prince William Sound are known to still have oil residue; 12 beds were cleaned on an experimental basis in 1994. Subsistence users also continue to be concerned about contamination from oil mussel beds.

Recovery Objective

Mussels will have recovered when they do not contaminate their predators. ~~their populations and productivity are at prespill levels and they do not contain oil that contaminates higher trophic levels.~~

~~Pacific~~ Herring

42%

Injury and Recovery

Pacific herring spawned in intertidal and subtidal habitats in Prince William Sound shortly after the oil spill. As much as ~~10~~ percent of the intertidal spawning habitat and ~~40 percent of the~~ herring staging areas in the sound may have been contaminated by oil. Field studies conducted in 1989 and 1990 showed increased rates of egg mortality and larval deformities in oiled versus unoiled areas. Laboratory studies confirm that these effects can be caused by exposure to *Exxon Valdez* oil, but the significance of these injuries in the field at a population level is not known.

Wilcock

wrong word

In 1992, herring biomass in Prince William Sound was at a record level. In 1993, however, there was an unprecedented crash of adult herring. A viral disease and fungus were the probable agents of mortality, and the connection between the oil spill and the disease outbreak is under investigation. Numbers of spawning herring in Prince William Sound have remained depressed through the 1995 season. Pacific herring are extremely important ecologically as well as commercially, and the closure of the herring fishery from 1993 through 1995 has had serious economic impact on people and communities in Prince William Sound.

~~Pacific herring studies have demonstrated egg mortality and larval deformities. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, the stocks and dependent fisheries in Prince William Sound are not healthy, as indicated by the~~

Competition 1988 + pollock + herring strong year class

1989 year class herring if smothered down would not be able to get on top until pollock failed

~~low spawning biomass in 1993 and 1994 and the resultant elimination of the fisheries in those years.~~

Recovery Objective

Pacific herring will have recovered when indicators of population health, such as reproduction, growth, and recruitment, are within normal bounds and free of oil-related effects within Prince William Sound. ~~populations are healthy and productive and exist at prespill abundances.~~

recognition of how to define recovery in an ecological context

Response to alteration of the ecosystem.

PIGEON GUILLEMOT

Injury and Recovery

Although the pigeon guillemot is widely distributed, nowhere does it occur in large numbers or concentrations. Because guillemots feed in shallow, nearshore waters, both they and the fish they prey on are vulnerable to oil pollution. Like the marbled murrelet, the pigeon guillemot population in Prince William Sound was in decline before the spill. The causes of the prespill decline are unknown. It is estimated that 10-15 percent of the Gulf of Alaska population may have died in the spill, and declines along oiled shorelines in Prince William Sound were greater than along unoiled shorelines. Numbers of guillemots recorded on boat surveys are highly variable, and there is not yet any statistically significant evidence of a postspill population increase. The factors responsible for the guillemot's prespill decline may negate or mask recovery from the effects of the oil spill.

Recovery Objective

Pigeon guillemots will have recovered when the populations in Prince William Sound is ~~are~~ stable or increasing.

PINK SALMON

Injury and Recovery

About 75 percent of wild pink salmon in Prince William Sound spawn in the intertidal portions of streams and were highly vulnerable to the effects of the oil spill. Hatchery salmon and wild salmon from both intertidal and upstream spawning habitats swam through oiled waters and ingested oil particles and oiled prey as they foraged in the sound and emigrated to sea. As a result, three types of early life-stage injuries were identified: First, growth rates in juvenile salmon from oiled parts of Prince William Sound were reduced. Second, there was increased egg mortality in oiled versus unoiled streams. A possible third effect, genetic damage, is under investigation.

In the years preceding the spill, returns of wild pink salmon in Prince William Sound varied from a maximum of 21.0 million fish in 1984 to a minimum of 1.8 million in 1988. Since the spill, returns of wild pinks have varied from a high of about 14.4 million fish in 1990 to a low of about 2.2 million in 1992. There is particular concern about the Sound's southwest district,

where returns of both hatchery and wild stocks have been generally weak since the oil spill. Because of the tremendous natural variation in adult returns, however, it is difficult to attribute poor returns in a given year to injuries caused by oil. Injuries to salmon eggs and juveniles remain the best indicators of injury and recovery.

Evidence of reduced juvenile growth rates was limited to the 1989 season, but increased egg mortality persisted in oiled compared to unoiled streams through 1993. The 1994 and 1995 seasons were the first since 1989 in which there were no statistically significant differences in egg mortalities in oiled and unoiled streams. These data indicate that recovery from oil-spill effects is underway.

The Sound Ecosystem Assessment (SEA) Project is exploring physical and biological oceanographic factors that influence production of salmon and herring. These natural factors are likely to have the greatest influence over year-to-year returns in both wild and hatchery stocks of pink salmon.

~~Pink salmon studies have demonstrated egg mortality, fry deformities, and reduced growth in juveniles. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, there is evidence of continued damage in some stocks from exposure to oil, and there were unexpectedly poor runs of both wild and hatchery stocks of pink salmon in Prince William Sound in 1992 and 1993. In 1994, runs were still depressed but exceeded forecasts.~~

Recovery Objective

Pink salmon will have recovered when population indicators, such as growth and survival, are within normal bounds and there are no statistically significant differences in egg mortalities in oiled and unoiled streams for two years each of odd- and even-year runs in Prince William Sound. ~~populations are healthy and productive and exist at prespill abundance. An indication of recovery is when egg mortalities in oiled areas match prespill levels or levels in unoiled areas.~~

Ecological processes

River Otters

Injury and Recovery

River otters have a low density and an unknown population size in Prince William Sound, and, therefore, it is hard to assess oil-spill effects. Twelve otter carcasses were found following the spill. Studies conducted during 1989-1991 identified several differences between otters in oiled and unoiled areas in Prince William Sound, including biochemical evidence of exposure to hydrocarbons or other sources of stress, reduced diversity in prey species, reduced body size (length-weight), and increased territory size. However, sample sizes were small, and it is not clear that these differences are the result of the oil spill. The Nearshore Vertebrate Predator project, now underway, will shed new light on the status of the river otters. In 1995 the Alaska Board of Game used its emergency authority to restrict trapping of river otters in western Prince William Sound to ensure that the results of this study are not compromised by the removal of

animals from study areas on Montague and Knight islands. ~~River otters in Prince William Sound have suffered sublethal effects from the spill and may continue to be exposed to hydrocarbons.~~

Recovery Objective

The river otter will have recovered when biochemical indices of hydrocarbon exposure or other stresses and indices of habitat use are similar between oiled and unoiled areas of Prince William Sound, after taking into account any geographic effects. ~~Indications of recovery are when habitat use, food habitats and physiological indices have returned to prespill conditions.~~

ROCKFISH

Injury and Recovery

Very little is known about rockfish populations in the northern Gulf of Alaska. Dead adult rockfish were recovered following the oil spill, and chemical analysis of five specimens indicated that oil ingestion was the cause of death. Analysis of other rockfish showed exposure ~~were exposed~~ to hydrocarbons and ~~showed~~ sublethal effects. ~~Furthermore~~ In addition, closures to salmon fisheries apparently increased fishing pressures on rockfish, which may have affected ~~be affecting their~~ the rockfish population. However, the original extent ~~and mechanism~~ of injury and the current status of ~~to~~ this species are unknown.

Recovery Objective

Without further study, a recovery objective cannot be defined.

SEA OTTERS

Injury and Recovery

Surveys of sea otters in the 1970s and 1980s indicate that the population was expanding and about 10,000 animals lived in Prince William Sound prior to the spill. Based on the number of carcasses and other data, population models suggest that 3,500-5,500 otters died in the first few months following the spill. In 1990 and 1991, unusual numbers of prime-age adult otters were found dead and there was evidence of an increased death rate in recently weaned juveniles. By 1992-93, mortality rates for juveniles had decreased, but were still higher in oiled than in unoiled parts of Prince William Sound. Boat surveys conducted in March and July in 1993 and again in 1994 indicated a population of about 7,700 otters in the Sound, but there was no statistically significant evidence of a population increase following the spill (1990-1994). The Nearshore Vertebrate Predator project, which was started in 1995, should help clarify the recovery status of the sea otter in Prince William Sound. ~~Sea otters do not appear to be recovering, but are expected to eventually recover to their prespill population. Exactly what population increases would constitute recovery is very uncertain, as there are no population data from 1986 to 1989, and the population may have been increasing in Eastern Prince William Sound during that time. In addition, only large changes in the population can be reliably detected with current measuring techniques. However, there are recent indications that the patterns of~~

~~juvenile and mid-aged mortalities are returning to prespill conditions.~~

Recovery Objective

Sea otters will have recovered when the Prince William Sound population returns to its prespill abundance and distribution. An increasing population trend and normal reproduction and age structure in oiled parts of the sound will indicate that recovery is underway. ~~Sea otters will be considered recovered when population abundance and distribution are comparable to prespill abundance and distribution, and when all ages appear healthy.~~

SEDIMENTS

Injury and Recovery

With tidal action, oil penetrated deeply into cobble and boulder beaches that are ~~relatively~~ common on ~~the rocky islands of~~ shorelines throughout the spill area, especially in sheltered habitats. Cleaning removed much of the oil from the intertidal zone but subsurface oil persisted in many heavily oiled beaches and associated subtidal sediments. ~~in mussel beds, which were avoided during the cleanup.~~ Subsurface oil persists at least at ___ locations in Prince William Sound and as far away as the Alaska Peninsula. While much of this oil is probably not biologically active, it is of great concern to residents in oil-spill communities, and there are sites where sheening still occurs.

Following the oil spill, chemical analyses of oil in sediments were conducted at a small number of index sites in Prince William Sound. At these sites, oil in sediments reached its greatest concentrations at water depths of 20 meters, although elevated levels of hydrocarbon-degrading bacteria (associated with elevated hydrocarbons) were detected at depths of 40 and 100 meters in 1990 in Prince William Sound. ~~Chemical analyses show that *Exxon Valdez* oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases.~~ By 1993, however, there was little evidence of *Exxon Valdez* oil and related microbial activity at most index sites in Prince William Sound, except at those associated with sheltered beaches that were heavily oiled in 1989. These index sites--at Herring, Northwest, and Sleepy bays--were among the ___ at which subsurface oiling is still known to occur (see above).

Recovery Objective

Sediments will have recovered when ~~contamination causes no negative effects to the spill ecosystem~~ residues of subsurface oil at sheltered sites that were previously heavily oiled are declining or are biologically harmless.

SOCKEYE SALMON

adversely altering

Injury and Recovery

Commericial fishing was closed in portions of Cook Inlet and near Kodiak in 1989 to avoid any possibility of contaminated salmon being sent to market. As a result, there were higher-than-usual numbers (i.e., overescapement) of spawning fish entering the Kenai River, Red and Akalura lakes on Kodiak Island, and other lakes on Afognak Island and the Alaska Peninsula. Initially these high escapements may have produced an overabundance of juvenile sockeye that consumed huge quantities of zooplankton, thus destroying planktonic food webs in the nursery lakes. Although the exact mechanism is unclear, the result was lost sockeye production as shown by declines in the returns of adults per spawning sockeye.

The effects of the 1989 overescapement have persisted in the Kenai River system through 1995. Although the overall escapement goal for that system was met in 1995, there is concern that the initial overescapement will continue to affect post-spill year-classes and that sockeye returns are yet not sufficient to fulfill the commericial, recreational, and subsistence demands on sockeye salmon in the Kenai River system.

rebounded from the effects of O.E.

Production of zooplankton in both Red and Akalura lakes on Kodiak Island has returned to normal. There continues to be some problem in the rate of production of sockeye fry in Red Lake, which may or may not be linked to the overescapement at the time of the oil spill. Continuing low adult escapements at Akalura Lake are more likely the result of a mixed stock fishery harvest in the Kodiak vicinity than a result of the earlier overescapement.

~~Sockeye salmon in Red Lake, Akalura Lake, and lakes in the Kenai River system declined in population because of adult overescapement in 1989. The Red Lake system may be recovering because the plankton has recovered and fry survival improved in 1993. However, Akalura Lake and the Kenai River lakes have not recovered: smolt production has continued to decline from these lakes. In the Kenai River lakes, for example, smolt production has declined from 30 million in 1989 to 6 million in 1990 and to less than 1 million in 1992 and 1993.~~

Recovery Objective

overwintering survival or juvenile abundance

Sockeye salmon in the Kenai River system and Red and Akalura lakes will have recovered when adult returns-per-spawner are within normal bounds. ~~affected lakes will have recovered when populations are able to support overwinter survival rates and smolt outmigrations comparable to prespill levels.~~

- low egg-to-fry survival
- in the freshwater ~~stock~~ back
- competition
- interception of adults in mixed stock fishery

Subtidal Organisms

Injury and Recovery

Oil that was transported down to subtidal habitats apparently caused changes in the size and species composition of plant and animal populations below lower tides. Different habitats, including eelgrass beds, kelp beds, and deep water, were compared at oiled and unoiled sites. The greatest effects were detected at oiled sites with sandy sea bottoms under eelgrass beds, at which there were reduced numbers and diversity of helmet crabs, amphipods, and other

low production adults due to small size smolts which may be due to factors in addition to the effects of O.E.

crustaceans and mollusks. There also were sublethal effects on the eelgrass itself. Organisms living in sediment at depths of 3-20 meters were especially affected. Some opportunistic, such as *Musculus* mussels, a variety of polychaetes, and juvenile cod, apparently increased in numbers at oiled sites. Differences in oiled and uncoiled sites were less evident by 1993.

~~Certain subtidal organisms, like eelgrass and some species of algae, appear to be recovering. Other subtidal organisms, like leather stars and helmet crabs, showed little signs of recovery through 1991.~~

Recovery Objective

Subtidal communities will have recovered when community composition in oiled areas, especially in association with eelgrass beds, is similar to that which would have prevailed in the absence of the spill. Indications of recovery are the return of keystone species, such as certain amphipods and other oil-sensitive crustaceans. ~~Subtidal communities will have recovered when the community composition, age-class distribution, population abundance of component species, and ecosystem functions and services in each injured subtidal habitat have returned to levels that would have prevailed in the absence of the oil spill.~~

Services

and poor fishery recruitment since 1989

Commercial Fishing

Injury and Recovery

Commercial fishing is a service that was injured through injury to commercial fish species (see individual resources) and also through fishing closures. In 1989, closures affected fisheries in Prince William Sound, lower Cook Inlet, upper Cook Inlet, Kodiak, and Chignik. These fisheries opened again in 1990. Since then, there have been no spill-related district-wide closures, except for the Prince William Sound herring fishery, which was closed in 1993 and has remained closed since then due to the collapse of the herring population. These closures, including the on-going closure of the herring fishery in Prince William Sound, harmed the livelihoods of persons who fish for a living and the communities in which they live. To the extent that the oil spill continues to be a factor that reduces opportunities to catch fish, there is on-going injury to commercial fishing as a service.

On this basis, the Trustee Council continues to make major investments in projects to understand and restore commercially important fish species that were injured by the oil spill. These projects include: supplementation work, such as fertilizing Coghill Lake to enhance its sockeye salmon run and construction of a barrier bypass at Little Waterfall Creek; development of tools that have almost immediate benefit for fisheries management, such as otolith mass marking of pink salmon in Prince William Sound and in-season genetic stock identification for sockeye salmon in Cook Inlet; and research such as the SEA Project and genetic mapping which will enhance the ability to predict and manage fisheries over the long-term.

~~Continuing injuries to commercial fishing may cause hardships for fishermen and related businesses. Each year that commercial fishing remains below prespill levels compounds the injury to the fishermen and, in many instances, the communities in which they live or work.~~

~~The Trustee Council recognizes the impact to communities and people of the Prince William Sound region resulting from the sharp decline in pink salmon and herring fisheries in past years. In 1994, the Trustee Council committed over six million dollars to help address these issues through the development of an ecosystem-based study for Prince William Sound. Some of the pink salmon and herring problems may be unrelated to the spill. However, the Council will continue to address these important problems.~~

Recovery Objective

Commercial fishing will have recovered when the commercially important fish species have recovered and opportunities to catch these species are not lost or reduced due to effects of the oil spill. population levels and distribution of injured or replacement fish used by the commercial fishing industry match conditions that would have existed had the spill not occurred. Because of the difficulty of separating spill-related effects from other changes in fish runs, the Trustee Council may use prespill conditions as a substitute measure for conditions that would have existed had the spill not occurred.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

The primary method for restoring commercial fishing is to restore the species that are fished commercially, such as pink salmon, Pacific herring, and sockeye salmon. These species are discussed elsewhere in this chapter. Three additional parts of the strategy for restoring commercial fishing are the following:

Promote recovery of commercial fishing as soon as possible. Many communities that rely on commercial fishing will be significantly harmed while waiting for commercial fish resources to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of commercial fishing. This objective may be accomplished through increasing availability, reliability, or quality of commercial fish resources, depending on the nature of the injury. For resources that have sharply declined since the spill, such as pink salmon, and Pacific herring in Prince William Sound, this objective may take the form of increasing availability in the long run through improved fisheries management. Another example is providing replacement fish for harvest.

Protect commercial fish resources from further degradation. Further stress on commercial fish resources could impede recovery. Appropriate protection can take the form of habitat protection and acquisition if a resource faces loss of habitat. The Trustee Council can also contribute to the protection of commercial fish species by providing information needed to improve their management.

Monitor recovery. Monitoring the recovery of commercial fishing will track the progress of

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

Passive Use

Injury and Recovery

Passive use of resources includes the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other nonuse values. Injuries to passive uses are tied to public perceptions of injured resources. [NOTE: THIS SAYS ALMOST NOTHING ABOUT INJURY. IS THERE ANYTHING TO SAY? PERHAPS A REFERENCE TO THE VALUATION SURVEYS DONE FOLLOWING THE SPILL?]

Recovery Objective

Passive uses will have recovered when people perceive that aesthetic and intrinsic values associated with the spill area are no longer diminished by the oil spill.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

Any restoration strategy that aids recovery of injured resources, or prevents further injuries, will assist recovery of passive use values. No strategies have been identified that 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.

Recreation and Tourism

Injury and Recovery

The spill disrupted use of the spill area for recreation and tourism. Resources important for wildlife viewing and which are still injured by the spill include killer whale, sea otter, harbor seal, ~~bald eagle,~~ and various seabirds. Residual oil exists on some beaches with high value for recreation, and its presence may decrease the quality of recreational experiences and discourage recreational use of these beaches.

Closures of sport hunting and fishing also affected use of the spill area for recreation and tourism. Sport fishing resources include salmon, rockfish, Dolly Varden, and cutthroat trout. The Alaska Board of Fisheries restricted sport harvest of cutthroat trout in Prince William Sound in 1991 [?], and those restrictions remain in place. Harlequin ducks are hunted in the spill area. The Alaska Board of Game restricted sport harvest of harlequin ducks in Prince William Sound in 1991, and those restrictions remain in place.

Recreation was also affected by changes in human use in response to the spill. For example, displacement of use from oiled areas to unoiled areas increased management problems and facility use in unoiled areas. Some facilities, such as the Green Island cabin and the Fleming Spit camp area, were injured by clean-up workers.

In the years since the oil spill, there has been a general, marked increase in visitation to the spill area. There are still locations within the oil-spill area, however, avoided by recreational users because of the presence of residual oil.

Recovery Objective

Recreation and tourism will have recovered, in large part, when the fish and wildlife resources on which they depend have recovered, recreation use of oiled beaches is no longer impaired, and facilities and management capabilities can accommodate changes in human use.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

Preserve or improve the recreational and tourism values of the spill area. Habitat protection and acquisition are important means of preserving and enhancing the opportunities offered by the spill area. Facilities damaged during cleanup may be repaired if they are still needed. New facilities may restore or enhance opportunities for recreational use of natural resources. Improved or intensified public recreation management may be warranted in some circumstances. Projects that restore or enhance recreation and tourism would be considered only if they are consistent with the character and public uses of the area. However, all projects to preserve and improve recreation and tourism values must be related to an injured natural resource. See Policy 9 in Chapter 2.

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

Monitor recovery. Monitor the recovery of resources used for recreation and tourism. Also monitor changes in recreation and tourism in the spill area.

SUBSISTENCE

Injury and Recovery

Before the oil spill, the Alaska Department of Fish and Game had documented 15 Native Alaskan communities (with about 2,200 people) in Prince William Sound, lower Cook Inlet, Kodiak, and the Alaska Peninsula that relied heavily on subsistence resources, such as fish, shellfish, seals, deer, and waterfowl. Per capita subsistence harvest ranged from nearly 200 pounds to more than 600 pounds per year. Subsistence harvests of fish and wildlife in most of these villages declined substantially following the oil spill. The reasons for these declines included reduced

availability of fish and wildlife to harvest, concern about possible health effects of eating contaminated or injured fish and wildlife, and disruption of lifestyles due to clean-up and other activities.

Subsistence foods were tested for evidence of hydrocarbon contamination during 1989-1994, and the results indicated that most resources contained no or very low concentrations of petroleum hydrocarbons. Eating foods with low levels of hydrocarbons posed no risk to human health, although subsistence users were advised not to eat shellfish from obviously contaminated areas. Samples of ducks from the Chenega Bay area in 1994 showed that exposure to crude oil had decreased significantly compared to the exposure levels documented since 1990.

Residual oil exists on some beaches near subsistence communities, and, in general, there continues to be concern or at least uncertainty about the safety of fish and wildlife resources. Uncertainty about the safety of resources reduces their use and value for subsistence.

Surveys by the Alaska Department of Fish and Game indicate that in some communities subsistence resources appear to be harvested at prespill levels based on total pounds-per-person. It is important to note, however, that the composition of many diets has shifted to include more fish and fewer seals. Diet composition continues to be a serious concern to subsistence users.

Subsistence users say that maintaining their subsistence culture depends on uninterrupted use of fish and wildlife resources. The more time users spend away from subsistence activities, the less likely that they will return to these practices. Continuing injury to natural resources used for subsistence may affect the way of life of entire communities. There is particular concern that the oil spill disrupted opportunities for young people to learn subsistence culture, and that this knowledge may be lost to them in the future.

Recovery Objective

Subsistence will have recovered when injured resources used for subsistence are healthy and productive and exist at prespill levels. In addition, there is recognition that people must be ~~and when people are~~ confident that the resources are safe to eat~~. One indication that recovery has occurred is when~~ and that the cultural values provided by gathering, preparing, and sharing food need to be ~~are~~ reintegrated into community life.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

The primary way of restoring subsistence is to restore injured resources used for subsistence, such as clams, harbor seals, Pacific herring, pink salmon, sea otters, and sockeye salmon. These are discussed elsewhere in this chapter. Four additional parts of the strategy to restore subsistence are the following:

Promote recovery of subsistence as soon as possible. Many subsistence communities will be significantly harmed while waiting for resources used for subsistence to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of subsistence use. This objective may be accomplished through increasing availability, reliability, or quality of resources used for subsistence, or increasing the confidence of subsistence users. Specifically, if subsistence harvest has not returned to prespill levels because users doubt the safety of particular resources, this objective may take the form of increasing the reliability of the resource through food safety testing. Other examples are the acquisition of alternative food sources and improved use of existing resources. However, all projects to promote subsistence must be related to an injured natural resource. See Policy 9 in Chapter 2.

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

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

Monitor recovery. Monitor the recovery of resources used for subsistence. Also monitor subsistence harvest.

TELECOPY COVER PAGE

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TO: X Molly McCammon
Stan Senner

UNIT: _____

FAX: _____

FROM: Maria Lisowski

NUMBER OF PAGES (not including the cover sheet) 1

DATE: 1/8/96 TIME: 445

COMMENTS:

Please make sure each receives a copy. Thanks.

United States Department of Agriculture
Office of General Counsel

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January 8, 1996

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGED COMMUNICATION
ATTORNEY WORK PRODUCT/DO NOT RELEASE UNDER FOIA

TO: Molly McCammon
Executive Director
Exxon Valdez Oil Spill Trustee Council

FROM: Maria Lisowski
Attorney

SUBJECT: NEPA Compliance--Revised Restoration Plan

You have asked for comments regarding the Preliminary Revised Draft of Chapter 5 (Recovery Objectives) of the Restoration Plan (hereafter "Revised Draft"). While I have been unable to review the substance of this document in its entirety due to other workload, I am concerned with pursuing this revision of the Restoration Plan without also considering compliance with the National Environmental Policy Act (NEPA).

As you know, an environmental impact statement (EIS) was prepared for the Restoration Plan. The Council on Environmental Quality regulations provide that agencies shall prepare a supplement to a final EIS if, among other things, there are significant new circumstances or information relevant to environmental concerns that bear upon the proposed action or its impacts. 40 C.F.R. § 1502.9(c). It appears that the information contained in the Revised Draft may constitute significant new circumstances or information relevant to environmental concerns regarding restoration actions or their impacts.

Until appropriate agency NEPA analysis is undertaken to determine whether the Restoration Plan EIS must be supplemented and in what manner that supplementation is to occur, the proposed public release of the Revised Draft should not occur. The document may eventually be released as part of a public comment period pursuant to the NEPA process. However, until a determination is made regarding how NEPA will be complied with, no public release of the Revised Draft should occur.

cc: P.Janik, RF
J.Wolfe, EAM
D.Gibbons, EAM
S.Senner

21.1.2 K

Hamer

Exxon Valdez Oil Spill Trustee Council
Restoration Office
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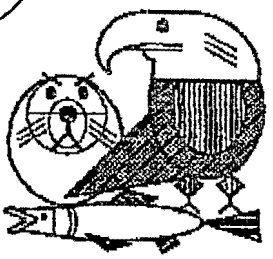

FAX COVER SHEET

To: Restoration Work Force

From: Molly McCammon Date: 1/2/96

Comments: Total Pages: 1

Happy New Year! A revised chapter 5 of the Restoration Plan was mailed to you on Friday. It's about 28 pages long. Comments are due Jan. 9. If you would like to pick up a copy at the office - give us a call here.

RESTORATION WORK FORCE MEMBERS INCLUDE:

Belt, Gina
Berg, Catherine
Fries, Carol
Gibbons, Dave
Joe Sullivan/Bill Hauser
Bartels, Leslie/Lisa Thomas
Miraglia, Rita
Morris, Byron
Piper, Ernie
Rice, Bud
Spies, Bob
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Wright, Bruce

Alex Swiderski
Maria Lisowski
Barry Roth

Document Sent By:

8/17/95

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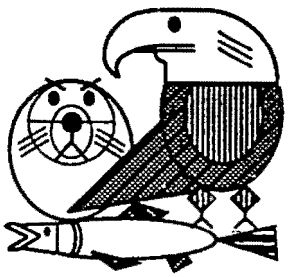

MEMORANDUM

To: **Restoration Work Force**
Agency Liaisons
Legal Counsel

From: **Molly McCammon**
Executive Director

Re: **Preliminary Revised Draft of Chapter 5 (Recovery Objectives)**

Date: **December 29, 1995**

Pages 5 and 32 of the Restoration Plan note that the plan is a dynamic document, subject to updating based on new information. On that basis, I have attached for your review a preliminary revised draft of Chapter 5 of the Restoration Plan. The next step in this process is for agency staff to review this at a macro level in order to identify areas where you believe there may be significant errors in fact or concept. It would be helpful if you could return your comments to Stan Senner by January 9, the date of the next meeting of the Restoration Work Force.

Based on your comments and concerns, we will produce another, revised draft, which will be distributed to participants in the 1996 Restoration Workshop. This draft will be among the materials handed out at the workshop registration table on January 16th.

These revised recovery objectives will be discussed at the workshop in breakout sessions on Thursday, January 18th, and with the core peer reviewers before they leave Anchorage. Based on this feedback, the Restoration Office staff will then make additional revisions and copies will be circulated to you and the Trustees. I will looking for the Trustees' "informed consent" so that this can be sent out for public comment in February, along with the FY 1997 Invitation. Following public comment, a final version will be prepared for Trustee Council action, probably at the same time as they consider the FY 1997 Work Plan.

The primary focus of this revised Chapter 5 is on Injury Status and Recovery Objectives. We propose to delete the generic discussion of strategies, which is badly out of date, as well as the resource-specific strategies, which are better covered (and updated) through the annual Invitations. We propose to retain the strategies for the

services, although they may still need to be revised. With respect to the status of Injury and Recovery, the discussion for each resource is opened with a statement or two of context and a description of why the resource or service originally was considered to be injured. Each discussion is closed with a few sentences regarding current status. In regard to the Recovery Objectives, the goal was to identify a goal that is realistic and measurable, given what we know about a resource or service's current status.

An earlier draft of this document was reviewed by Dr. Spies and the core peer reviewers, but please identify where more work may be needed. Do not worry now about editorial details, although such comments are always welcome. Thank you for your help with this. Give Stan or me a call if you have any questions.

enclosure (1)

cc: Robert Spies
Core peer reviewers

Table 1. Resources and Services Injured by the Spill

29 Dec 95
DRAFT

INJURED RESOURCES

Recovered

~~Bald eagle~~

Recovering

~~Bald eagle~~
~~Black oystercatcher~~
Common murre
Intertidal organisms
~~(some)~~ (everything) all
~~Killer whale~~
Mussels
Pink salmon
Sockeye salmon
~~(Red Lake)~~ (all systems)
Subtidal organisms
~~(some)~~ (everything) all

Not Recovering

~~Common murre~~
Harbor seal
Harlequin duck
~~Intertidal organisms~~
~~(some)~~
Killer whale
(AB pod)
Marbled murrelet
Pacific herring
Pigeon guillemot
~~Pink salmon~~
Sea otter
~~Sockeye salmon~~
~~(Kenai & Akalura systems)~~
~~Subtidal organisms~~
~~(some)~~
~~Archaeological resources~~
~~Sediment~~

Recovery Unknown

Clams - ?
Common loon
Cutthroat trout
Black oystercatcher
Dolly Varden
Kittlitz's murrelet
River otter
Rockfish

Other

Archaeological resources
Designated wilderness areas
Sediments

Services

Commercial fishing
Passive uses
Recreation and Tourism
Subsistence

29 Dec 1995
DRAFT

Chapter 5
~~Goals, Objectives, and Strategies~~
Injury Status and Recovery Objectives

~~This chapter presents goals, objectives, and strategies for restoration.~~ The first part of this chapter discusses ~~goals,~~ recovery objectives~~, and strategies~~ in general. The second part describes the nature and extent of injury status and ~~recovery~~ and ~~the~~ recovery objective~~, and the restoration strategy~~ for each injured resource and service discussed in Table 2 in Chapter 4. Detailed information on injury status and recovery objectives~~, and strategies~~ can be found on the following pages:

Overview

The first part of this chapter discusses goals, objectives, and strategies in general. A goal is the end toward which an endeavor is directed; objectives are descriptions of measurable outcomes; and strategies are plans of action. Taken together, goals, objectives, and strategies produce a blueprint for restoring the spill area. To be funded, a project must be consistent with the goals and policies of the Restoration Plan and with restoration objectives and strategies as they change over time.

GOAL: *The end toward which restoration is directed*

The goal of restoration is recovery of all injured resources and services. Recovery is to be sustained by healthy, productive ecosystems that maintain naturally occurring biodiversity. All restoration actions must be directed toward this goal.

OBJECTIVES: *Measurable outcomes of restoration*

Objectives

The recovery objectives described in the following section of the restoration program are the measurable conditions that signal the recovery of individual resources or services. They are the yardsticks against which the success of the program is measured. In general, resources and services will have recovered when they return to conditions that would have existed had the spill not occurred. In nature, however, populations often undergo large natural changes, and Because it is difficult to predict conditions that would have existed in the absence of the spill. recovery is often Recovery, therefore, is most realistically defined as a return to prespill conditions or to levels that fall within the bounds of natural variation. For resources that were in decline before the spill, like harbor seals marbled murrelets, recovery may be achieved consist of stabilizing the when a population is stabilized, even if at a lower level than before the spill. For some resources, little is known about their injury and recovery status, so it is difficult to define recovery.

Where few little prespill data exist, injury is inferred from comparisons of oiled and unoiled areas, and recovery is usually defined as a return to conditions comparable to those of unoiled areas. Because the differences between oiled and unoiled areas may have existed before the spill, statements of injury and objectives based on these differences are often less certain than in those cases where prespill data exist. Alternatively, injury may be evaluated based on the number of oiled carcasses picked up following the spill relative to the estimated size of the spill-area population. Even in cases where some prespill data are available, However, there also is can be some uncertainty associated with interpreting the significance of prespill population data since populations undergo natural fluctuations. In all cases, indicators of recovery can include increased numbers of individuals, reproductive success, improved growth and survival rates, and normal age and sex composition of the injured population.

Full ecological recovery will have been achieved when the population of flora and fauna are

again present at former or prespill abundances, are 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.

[NOTE: WE PROPOSE TO ELIMINATE THE FOLLOWING GENERIC DISCUSSION OF STRATEGIES, AS WELL THE DISCUSSION OF SPECIFIC STRATEGIES FOR EACH INJURED RESOURCE (BUT NOT FOR SERVICES). THIS STUFF IS PROBABLY BEST COVERED THROUGH THE INVITATIONS, WHERE IT IS UPDATED ANNUALLY. IN ADDITION, SOME OF THE MORE GENERIC DISCUSSION IS ALREADY COVERED IN CHAPTER 3 OF THE RESTORATION PLAN. IF WE WERE TO RETAIN THIS MATERIAL, IT WOULD REQUIRE SUBSTANTIAL REVISION.]]

~~STRATEGIES: *Plans of action*~~

~~A restoration strategy is a plan of action for achieving objectives. Each year, through its annual or multiyear work plan, the Trustee Council decides which strategies to implement. Restoration strategies reflect consideration of ecosystem relationships. For example, the strategy for some injured resources includes research into why they are not recovering, such as declining or contaminated food sources or disruption of ecosystem relationships.~~

~~In this section, restoration strategies are presented under three headings: Biological Resources, Other Resources, and Services.~~

~~**Biological Resources**~~
~~Because restoration strategies for biological resources depend on whether the resource is recovering, strategies are subdivided into those for recovering resources, resources that are not recovering, and resources whose recovery is unknown.~~

~~***Recovering Resources.*** The fact that a resource is recovering suggests that nature will restore it without intervention. Consequently, restoration of recovering resources will rely primarily on natural recovery.~~

~~Because these resources are recovering, research into factors limiting recovery and general restoration projects to accelerate recovery may not be warranted. However, if a resource is not expected to recover fully on its own or if waiting for natural recovery will cause long-term harm to a community or service, appropriate alternative means of restoration would be undertaken. Habitat protection and monitoring are encouraged, as are general restoration projects that protect the resource from other sources of potential injury. (Restoration strategies under "Services" also apply to these resources.)~~

~~The restoration strategy for recovering resources has three parts:~~

- ~~Rely on natural recovery~~
- ~~Monitor recovery~~

- Protect injured resources and their habitats

Resources Not Recovering. Except for certain protective measures, attempts to restore these resources without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for these resources emphasizes determining why they are not recovering, and eliminating threats to the remaining populations.

Where sufficient knowledge about the nature of injury exists, the restoration strategy also encourages actions to promote recovery. The populations of some of these resources are in a steep decline and may not recover without help. Furthermore, some of these resources have subsistence or economic importance and their recovery is linked to the recovery of these services. (Restoration strategies under "Services" also apply to these resources.)

Research is encouraged, provided it helps explain why a resource is not recovering. Habitat protection and monitoring are also encouraged. General restoration projects are allowed if they address factors limiting recovery or if they protect the resource from other sources of potential injury.

The restoration strategy for resources that are not recovering has four parts:

- Conduct research to find out why these resources are not recovering
- Initiate, sustain, or accelerate recovery
- Monitor recovery
- Protect injured resources and their habitats

Recovery Unknown. If specialists do not know whether a resource is recovering, it will be treated in much the same way as a recovering resource. Until more is known about the nature and extent of injuries and the degree of recovery of these resources, restoration will rely primarily on natural recovery, aided by monitoring and protective measures.

Because the recovery of these resources is unknown, and, in some cases, the injury poorly understood, research into factors limiting recovery and general restoration projects to accelerate recovery may not be warranted. Habitat protection and monitoring are encouraged, as are general restoration projects that protect these resources from other sources of potential injury.

The restoration strategy for resources whose recovery is unknown has three parts:

- Rely on natural recovery
- Monitor recovery
- Protect injured resources and their habitats

Other Resources

Other injured resources include archaeological resources, designated wilderness areas and oiled sediment. The strategy for restoring archaeological resources seeks to repair and protect injured

~~sites and artifacts. The strategy for sediment includes removal or reduction of residual oil and monitoring. Any restoration strategy that aids recovery of injured resources, or prevents further injuries, will assist recovery of designated wilderness areas or wilderness study areas.~~

~~**Services**~~

~~Commercial fishing, passive use, recreation (including sport fishing) and tourism and subsistence are services that were reduced or lost because of the spill. Injured resources that support these services include clams, harbor seals, Pacific herring, pink salmon, sea otters, and sockeye salmon. The primary way to restore services is to restore the resources on which they depend.~~

~~Additional restoration strategies for commercial fishing, recreation and tourism, and subsistence include promoting recovery of the service as soon as possible through such means as increasing the availability, reliability, or quality of the resource on which the service depends. For some resources, this may take the form of increasing availability in the long run through improved resource management or providing replacement resources. Strategies for recreation and tourism and subsistence also include removing or reducing residual oil if treatment is cost effective and less harmful than leaving the oil in place.~~

~~Objectives and Strategies by Resource and Service~~ Injury Status and Recovery Objective

This section describes the nature and extent of injury and recovery and the recovery objective~~, and the restoration strategy~~ for each injured resource and service. Specific strategies to achieve recovery objectives are described in annual work plans and restoration project invitations (e.g., *Invitation to Submit Restoration Projects for Federal Fiscal 1997 and Draft Restoration Program: FY 97 and Beyond).* The information in this section is expected to change ~~over time~~ as the restoration program adapts to new information. For example, population declines or sublethal effects may be documented for new resources, some resources may begin to recover or never recover, and recovery objectives ~~and strategies may~~ will change in response to new information and conditions. Hypotheses for why resources are not recovering are particularly susceptible to change as prevailing hypotheses are tested and new ones are formed.

New scientific data will be incorporated into restoration decisions without the need to change the plan. However, changes will be reported in the Trustee Council's annual status report.

Resources

Archaeological Resources

Injury and Recovery

Twenty-four archaeological sites on public lands are known to have been adversely affected by cleanup activities, or looting and vandalism linked to the oil spill. Additional sites on private land

may have been injured, but damage assessment studies were limited to public land.

Documented injuries include theft of surface artifacts, masking of subtle clues used to identify and classify sites, violation of ancient burial sites, and destruction of evidence in layered sediments. In addition, vegetation has been disturbed, which has exposed sites to accelerated erosion. The effect of oil on soil chemistry and organic remains may reduce or eliminate the utility of radiocarbon dating in some sites.

Assessments of 14 sites in 1993 suggest that most of the archaeological vandalism that can be linked to the ~~*Exxon Valdez* oil~~ spill occurred 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. In 1993, only two of the 14 sites visited showed signs of continued vandalism, ~~and the link between~~ but it is difficult to prove that this recent vandalism was related to the spill. ~~and the *Exxon Valdez* oil spill remains highly problematical~~. Oil ~~samples have not yet been analyzed, but oil~~ was visible in the intertidal zones of two of the 14 sites monitored in 1993, but because oil samples have not yet been analyzed, the *Exxon Valdez* oil spill cannot be confirmed as the source of the oil in these sites.

Monitoring of archaeological sites in 1994 and 1995 found no evidence of new damage from vandalism. The presence of oil is being determined in sediment samples taken from four sites in 1995.

None of the archaeological artifacts collected during the spill response, damage assessment, or restoration programs is stored within the spill area. These artifacts are stored in the University of Alaska Museum in Fairbanks and in the Federal Building in Juneau. Native communities in the spill area have expressed a strong interest in having them returned to the spill area for storage and display.

The Alutiiq Archaeological Repository in Kodiak, whose construction costs were partly funded by the Trustee Council, is the only physically appropriate artifact storage facility in the spill area. In 1995 the Trustee Council approved funds for development of a comprehensive community plan for restoring archaeological resources in Prince William Sound and lower Cook Inlet, including strategies for storing and displaying artifacts at appropriate facilities within the spill area.

Recovery Objective

Archaeological resources are nonrenewable: they cannot recover in the same sense as biological resources. Archaeological resources will be considered to have recovered when spill-related injury ends, looting and vandalism are at or below prespill levels, and the artifacts and scientific data which remain in vandalized sites are preserved (e.g., through excavation, site stabilization, or other forms of documentation). ~~Artifacts and data are typically preserved through excavation or other forms of documentation, or through site stabilization, depending on the nature of the injury and the characteristics of the site.~~

BALD EAGLES

Injury and Recovery

Prince William Sound provided year-round and seasonal habitat for about 5,000 bald eagles. ~~Two hundred to 300~~ About 250 bald eagles are estimated to have died as a result of ~~may have been killed in~~ the spill, and productivity was reduced in oiled areas of Prince William Sound in 1989. Productivity was back to normal in 1990 and 1991, and an aerial survey of adults in 1995 indicated that the population has returned to or exceeded its prespill level in Prince William Sound. ~~However, population estimates made in 1989, 1990, and 1991 indicate that there may have been an increase in the Prince William Sound bald eagle population since the previous survey conducted in 1984. Productivity decreased in 1989, but appeared to have recovered by 1990. Because population and productivity appear to have returned to prespill levels, bald eagles may have already recovered from the effects of the spill.~~

Recovery Objective

Because the Prince William Sound population and productivity are at or above prespill levels, the bald eagle has recovered from the effects of the Exxon Valdez oil spill. ~~Bald eagles will have recovered when their population and productivity return to prespill levels.~~

BLACK OYSTERCATCHERS

Injury and Recovery

Black oystercatchers spend their entire lives in or near intertidal habitats and are highly vulnerable to oil pollution. An estimated 1,500-2,000 oystercatchers live in south-central Alaska. Only nine carcasses of adult oystercatchers were recovered following the spill, but estimated mortality may have been as high as ~~, but probably did not exceed,~~ 20 percent in the spill area. In addition, breeding activities were disrupted by the oil and clean-up activities. In comparison with oystercatchers on the largely unoiled Montague Island, oystercatchers at heavily oiled Green Island had reduced hatching success in 1989 and their chicks gained weight more slowly during 1991-93. Interpretation of these data on reproductive performance, however, are confounded by lack of pre-spill data. Productivity and survival of black oystercatchers in Prince William Sound have not been monitored since 1993, and the recovery status of this species is not ~~currently~~ known. ~~Within Prince William Sound, an estimated 120 to 150 black oystercatchers, representing 12-15 percent of the total estimated population, died as a result of the spill. Mortality outside of Prince William Sound is unknown. Black oystercatchers are recovering, although they may still be exposed to hydrocarbons when feeding in intertidal areas.~~

Recovery Objective

Black oystercatchers will have recovered when the Prince William Sound population returns to ~~attain~~ prespill levels and reproduction is normal. An increasing population trend and comparable

hatching success and growth rates of chicks in oiled and unoiled areas will indicate that recovery is underway. ~~reproductive success of nests and growth rates of chicks raised in oiled areas are comparable to those in unoiled areas.~~

CLAMS

Injury and Recovery

The magnitude of impacts on clam populations varies with the species of clam, degree of oiling, and location. However, data from the lower intertidal zone on sheltered beaches suggest that little-neck clams and, to a lesser extent, butter clams ~~on sheltered beaches~~ were killed or suffered slower growth rates as a result of the oil spill ~~by oiling~~ and clean-up activities. ~~In addition, growth appeared to be reduced by oil, but determination of sublethal or chronic effects is awaiting final analyses.~~ In communities on the Kenai Peninsula, Kodiak, and Alaska Peninsula, concern about the effects of the oil spill on clams and subsistence uses of clams remains high.

Recovery Objective

Based on prespill data or comparisons of oiled and unoiled sites, clams will have recovered when populations and productivity have returned to levels that would have prevailed in the absence of the oil spill ~~(prespill data or unoiled control sites)~~.

COMMON LOONS

Injury and Recovery

Carcasses of 395 loons of four species were recovered following the spill, including at least 216 common loons. The population sizes are not known for any of these species, but, in general, loons are long-lived, slow-reproducing, and have small populations. Common loons in the oil-spill area may number only a few thousand, including only hundreds in Prince William Sound. Common loons injured by the spill probably included a mixture of resident and migrant birds, and their recovery status is not known.

Chapter title refers to "Injury Status"

Recovery Objective

Without more information on injury to common loons and their recovery status, no recovery objective can be identified.

COMMON MURRES

Injury and Recovery

About 30,000 carcasses of oiled birds were picked up following the oil spill, and 74 percent of them were common and thick-billed murres (mostly common murres). Many more murres died than were actually recovered, and it is estimated that the spill-area population declined by about 40 percent, including at colonies at Resurrection Bay, the Chiswell, Barren, and Triplet islands,

and Puale Bay. In addition to direct losses of murres, there was evidence that the timing of reproduction was disrupted and productivity reduced. Interpretation of the effects of the spill, however, is complicated by incomplete prespill data and by indications that populations at some colonies were in decline before the oil spill.

Postspill monitoring of productivity at index colonies indicates that reproductive timing and success were again within normal bounds by 1993. Numbers of adult murres were last surveyed in 1994 [check] and, at that time, had not returned to prespill levels.

~~Productivity of common murres shows signs of recovery at some injured colonies (Barren Islands, Puale Bay) but postspill population counts are still lower than prespill estimates and show no sign of recovery.~~

Recovery Objective

Common murres will have recovered when populations ~~trends are increasing significantly~~ at index colonies have returned to prespill levels and when productivity is sustained within normal bounds. ~~in the spill area and when reproductive timing and success are (Normal bounds will be determined by comparing productivity data with information from other murre colonies in the Gulf of Alaska and elsewhere.)~~

Cutthroat Trout

Injury and Recovery

Prince William Sound is at the northwestern limit of the range of cutthroat trout, and few stocks are known to exist within the sound. Local cutthroat populations rarely number more than 1,000 each, and the fish have small home ranges and are geographically isolated. Cutthroat trout, therefore, are highly vulnerable to exploitation, habitat alteration, or pollution. Following the oil spill, cutthroat trout in a small number of oiled index streams grew more slowly than in unoiled streams, possibly as a result of reduced food supplies or exposure to oil, and there is concern that reduced growth rates may reflect reduced survival. The difference in growth rates persisted through 1991. No studies have been conducted since then, and the ~~recovery~~ status of this species is not known. ~~Cutthroat trout have grown more slowly in oiled areas than in unoiled areas. Insufficient data are available to determine whether they are recovering.~~

Recovery Objective

Cutthroat trout will have recovered when growth rates within oiled areas are comparable to those for unoiled areas, after taking into account geographic effects.

Designated Wilderness Areas

Injury and Recovery

The oil spill delivered oil in varying quantities to the waters adjoining the seven areas within the spill area designated by Congress as wilderness areas and wilderness study areas. Oil also was deposited above the mean high-tide line in these areas. During the intense clean-up seasons of 1989 and 1990, thousands of workers and hundreds of pieces of equipment were at work in the spill area. This activity was an unprecedented imposition of people, noise, and activity on the area's undeveloped and normally sparsely occupied landscape. Although activity levels on these wilderness shores have probably returned to normal, ~~but~~ at some locations, there is still residual oil.

Recovery Objective

Designated wilderness areas will have recovered when oil is no longer encountered in these areas and the public perceives them to be recovered from the spill.

DOLLY VARDEN

Injury and Recovery

Like the cutthroat trout, there was evidence that Dolly Varden ~~have grown~~ grew more slowly in oiled streams ~~areas~~ than in unoiled streams ~~areas~~, and there is concern that reduced growth rates reflect reduced survival. However, no data have been gathered since 1991, and the recovery status of this species is not known. ~~Insufficient data are available to determine whether they are recovering.~~

Recovery Objective

Dolly Varden will have recovered when growth rates within oiled streams ~~areas~~ are comparable to those ~~for~~ in unoiled streams ~~areas~~, after taking into account geographic effects.

Harbor Seals

Injury and Recovery

Harbor seal numbers were declining in the Gulf of Alaska, including in Prince William Sound, before the spill. An estimated 300 seals died in the sound as a direct result of the spill, and this was 6-15 percent of the prespill population. Postspill surveys in 19__ showed that seals in ~~the~~ oiled areas had declined by 43 percent, compared to 11 percent in ~~the~~ unoiled areas. Unfortunately, seals in both oiled and unoiled parts of Prince William Sound have continued to decline since the spill at an annual rate of about 6 percent. Possible factors for this long-term decline include disease and the amount or quality of food. ~~Counts made during the molt at trend count sites in Prince William Sound from 1990 to 1993 indicate that numbers may have stabilized. However, counts during pupping have continued to decline. It is not known which counts are the best indicator of population status. If the conditions that were causing the population to decline before the spill have improved, normal growth may replace the animals that were lost. However, if conditions continue to be unfavorable, the affected population may~~

~~continue to decline.~~ Harbor seals are a key subsistence resource in the oil spill area ~~Prince William Sound~~. Subsistence hunting is ~~both~~ affected by the declining seal population and, in turn, may be affecting the recovery of harbor seals ~~status~~.

Recovery Objective

Recovery will have occurred when harbor seal population trends are stable or increasing.

HARLEQUIN DUCKS

Injury and Recovery

Harlequin ducks feed in intertidal and shallow subtidal habitats where most of the spilled oil was initially stranded. More than 200 harlequin ducks were found dead in 1989, mostly in Prince William Sound, and many more than that actually died throughout the spill area. Bile samples from harlequin ducks collected in eastern and western Prince William Sound in 1989-90 had higher concentrations of hydrocarbon metabolites than samples from harlequins collected at Juneau. Prespill data on harlequin populations and productivity are poor and complicated by possible geographic differences in habitat quality. However, the summer population in Prince William Sound is small, only a few thousand birds, and there continues to be concern about poor reproduction and a possible decline in numbers of molting birds in western versus eastern parts of the Sound. ~~There are indications of reduced densities of harlequin ducks in the breeding season; a declining trend in the summer, postbreeding population; and very poor production of young in western Prince William Sound.~~

Recovery Objective

Harlequin ducks will have recovered when breeding and postbreeding season densities and production of young return to ~~estimated~~ prespill levels. ~~or when there are no differences in these parameters between oiled and unoiled areas.~~ A normal population age- and sex-structure and reproductive success appropriate to the habitat in western Prince William Sound will indicate that recovery is underway.

Intertidal Organisms

Injury and Recovery

Portions of 1,500 miles of coastline were oiled by the spill, and both the oil and intensive clean-up activities had significant impacts on the flora and fauna of the intertidal zone, the area of beach between low and high tides. With tidal action, oil penetrated deeply into cobble and boulder beaches, and, even with intensive clean up activities, persists in some beaches today. The most significant impacts occurred in middle and upper intertidal zones on sheltered rocky shores, which is where the greatest amounts of oil were stranded.

Small invertebrates like limpets, barnacles, and marine worms were less abundant at oiled versus unoiled index sites in Prince William Sound, Kodiak Island, and on the Kenai and Alaska peninsula coasts. The size, coverage, and reproductive potential of seaweed *Fucus gardneri* (known as rockweed or popweed) also was reduced following the spill. Although numbers of many species of invertebrate fauna have increased following the spill, recovery of *Fucus* in the upper intertidal zone is lagging. Full recovery of *Fucus* is crucial for recovery of the intertidal ecosystem, since many invertebrates depend on the cover provided by this seaweed. Many intertidal resources are important to subsistence users, as well as to sea and river otters, black oystercatchers, harlequin ducks, and pigeon guillemots.

~~The lower intertidal zone and, to some extent, the middle intertidal zone are recovering. However, injuries persist in the upper intertidal zone, especially on rocky sheltered shores. Recovery of this zone appears to depend, in part, on the return of adult *Fucus* in large numbers.~~

Recovery Objective

~~Each intertidal elevation (lower, middle, or upper) will have recovered when community composition, population abundance of component species, age-class distribution, and ecosystem functions and services in each injured intertidal habitat have returned to levels that would have prevailed in the absence of the oil spill.~~ Intertidal communities will have recovered when community composition on oiled shorelines is similar to that which would have prevailed in the absence of the spill. Indications of recovery are the return of keystone species, such as *Fucus*, and provision of adequate, uncontaminated food supplies for top predators in intertidal and nearshore habitats.

Killer Whales

Injury and Recovery

About ___ killer whales in _ "resident" pods regularly use Prince William Sound within their ranges. Other whales in "transient" pods enter the Sound less frequently. There has been particular concern in Prince William Sound about the resident AB pod, which numbered 36 animals prior to the spill. Fourteen whales disappeared from this pod in 1989 and 1990, during which time no young were recruited into the population. Although four calves were added to the AB pod during 1992-94, surveys in 1994 and 1995 indicate the loss of five more whales.

The link between these losses and the oil spill is only circumstantial, but the apparent mortality of killer whales in Prince William Sound following the spill far exceeds rates documented for pods in British Columbia and Puget Sound over the last 20 years. The AB pod may never regain its former size, but overall numbers of resident killer whales in Prince William Sound are at or exceed prespill levels. ~~Thirteen whales disappeared from one killer whale pod in Prince William Sound between 1988 and 1990. The injured pod is growing again.~~

Recovery Objective

Pending further evaluation of the status of the AB pod, no realistic recovery objective can be identified at this time. ~~Killer whales will have recovered when the injured pod grows to at least 36 individuals (1988 level).~~

~~Marbled~~ Murrelets, Marbled and Kittlitz's

Injury and Recovery

Prince William Sound and the northern Gulf of Alaska are key areas in the distributions of two poorly studied species of seabirds, marbled and Kittlitz's murrelets. The world population of Kittlitz's murrelet is believed to number only a few tens of thousands of birds, many of which are in the oil-spill area. The marbled murrelet is federally listed as a Threatened species in Washington, Oregon, and California; it is also listed as Threatened in British Columbia.

The marbled murrelet populations in Prince William Sound was ~~were~~ in decline before the spill. The causes of the prespill decline are unknown, but may be related to changing food supplies. The oil spill probably increased the prespill rate of decline for this species in the spill area, although the incremental injury is difficult to estimate. ~~The population of marbled murrelets may be stabilizing or even increasing since the spill.~~ Carcasses of nearly 1,100 murrelets were found after the spill, and it is estimated that as much as __ percent of the Prince William Sound marbled murrelet population was killed by the spill. Population estimates for murrelets are highly variable, and postspill boat surveys do not yet indicate any statistically significant increase in numbers of marbled murrelets in Prince William Sound. The recovery status of Kittlitz's murrelet is not known.

Recovery Objective

Marbled murrelets will have recovered when population trends are stable or increasing. No recovery objective can be identified for Kittlitz's murrelet at this time.

Mussels

Injury and Recovery

Mussels are an important prey species in the nearshore ecosystem throughout the oil-spill area, and beds of mussels provide physical stability in the intertidal zone. For these reasons, mussel beds were purposely left alone during *Exxon Valdez* clean-up operations. In 1991, high concentrations of relatively unweathered oil were found in the mussels and underlying byssal mats in certain dense mussel beds. ~~In 1991, relatively high concentrations of oil were found in mussels and in the dense underlying mat (byssal substrate) of certain oiled mussel beds. The beds were not cleaned nor was oil removed after the spill. The~~ The biological significance of oiled mussel beds is not known, but they ~~Oiled mussel beds~~ are potential pathways of ~~sources of fresh (unweathered)~~ oil contamination for local populations of harlequin ducks, black oystercatchers, river otters, and juvenile sea otters, all of which feed to some extent on mussels and show some signs of continuing injury. ~~The extent and magnitude of oiled mussel beds are unknown.~~ At least __ [70-?] mussel beds in Prince William Sound are known to still have oil residue; 12 beds were cleaned on an experimental basis in 1994. Subsistence users also continue to be concerned about contamination from oil mussel beds.

Recovery Objective

Mussels will have recovered when they do not contaminate their predators. ~~their populations and productivity are at prespill levels and they do not contain oil that contaminates higher trophic levels.~~

PACIFIC HERRING

Injury and Recovery

Pacific herring spawned in intertidal and subtidal habitats in Prince William Sound shortly after the oil spill. As much as 10 percent of the intertidal spawning habitat and 40 percent of the herring staging areas in the Sound may have been contaminated by oil. Field studies conducted in 1989 and 1990 showed increased rates of egg mortality and larval deformities in oiled versus unoiled areas. Laboratory studies confirm that these effects can be caused by exposure to *Exxon Valdez* oil, but the significance of these injuries ~~in the field~~ at a population level is not known.

In 1992, herring biomass in Prince William Sound was at a record level. In 1993, however, there was an unprecedented crash of adult herring. A viral disease and fungus were the probable agents of mortality, and the connection between the oil spill and the disease outbreak is under investigation. Numbers of spawning herring in Prince William Sound have remained depressed through the 1995 season. Pacific herring are extremely important ecologically as well as commercially, and the closure of the herring fishery from 1993 through 1995 has had serious economic impact on people and communities in Prince William Sound.

~~Pacific herring studies have demonstrated egg mortality and larval deformities. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, the stocks and dependent fisheries in Prince William Sound are not healthy, as indicated by the~~

~~low spawning biomass in 1993 and 1994 and the resultant elimination of the fisheries in those years.~~

Recovery Objective

Pacific herring will have recovered when indicators of population health, such as reproduction, growth, and recruitment, are within normal bounds and free of oil-related effects within Prince William Sound. ~~populations are healthy and productive and exist at prespill abundances.~~

PIGEON GUILLEMOT

Injury and Recovery

Although the pigeon guillemot is widely distributed, nowhere does it occur in large numbers or concentrations. Because guillemots feed in shallow, nearshore waters, both they and the fish they prey on are vulnerable to oil pollution. Like the marbled murrelet, the pigeon guillemot population in Prince William Sound was in decline before the spill. The causes of the prespill decline are unknown. It is estimated that 10-15 percent of the Gulf of Alaska population may have died in the spill, and declines along oiled shorelines in Prince William Sound were greater than along unoiled shorelines. Numbers of guillemots recorded on boat surveys are highly variable, and there is not yet any statistically significant evidence of a postspill population increase. The factors responsible for the guillemot's prespill decline may negate or mask recovery from the effects of the oil spill.

Recovery Objective

Pigeon guillemots will have recovered when the populations in Prince William Sound is ~~are~~ stable or increasing.

PINK SALMON

Injury and Recovery

About 75 percent of wild pink salmon in Prince William Sound spawn in the intertidal portions of streams and were highly vulnerable to the effects of the oil spill. Hatchery salmon and wild salmon from both intertidal and upstream spawning habitats swam through oiled waters and ingested oil particles and oiled prey as they foraged in the sound and emigrated to sea. As a result, three types of early life-stage injuries were identified: First, growth rates in juvenile salmon from oiled parts of Prince William Sound were reduced. Second, there was increased egg mortality in oiled versus unoiled streams. A possible third effect, genetic damage, is under investigation.

In the years preceding the spill, returns of wild pink salmon in Prince William Sound varied from a maximum of 21.0 million fish in 1984 to a minimum of 1.8 million in 1988. Since the spill, returns of wild pinks have varied from a high of about 14.4 million fish in 1990 to a low of about 2.2 million in 1992. There is particular concern about the Sound's southwest district,

where returns of both hatchery and wild stocks have been generally weak since the oil spill. Because of the tremendous natural variation in adult returns, however, it is difficult to attribute poor returns in a given year to injuries caused by oil. Injuries to salmon eggs and juveniles remain the best indicators of injury and recovery.

Evidence of reduced juvenile growth rates was limited to the 1989 season, but increased egg mortality persisted in oiled compared to unoiled streams through 1993. The 1994 and 1995 seasons were the first since 1989 in which there were no statistically significant differences in egg mortalities in oiled and unoiled streams. These data indicate that recovery from oil-spill effects is underway.

The Sound Ecosystem Assessment (SEA) Project is exploring physical and biological oceanographic factors that influence production of salmon and herring. These natural factors are likely to have the greatest influence over year-to-year returns in both wild and hatchery stocks of pink salmon.

~~Pink salmon studies have demonstrated egg mortality, fry deformities, and reduced growth in juveniles. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, there is evidence of continued damage in some stocks from exposure to oil, and there were unexpectedly poor runs of both wild and hatchery stocks of pink salmon in Prince William Sound in 1992 and 1993. In 1994, runs were still depressed but exceeded forecasts.~~

Recovery Objective

Pink salmon will have recovered when population indicators, such as growth and survival, are within normal bounds and there are no statistically significant differences in egg mortalities in oiled and unoiled streams for two years each of odd- and even-year runs in Prince William Sound. ~~populations are healthy and productive and exist at prespill abundance. An indication of recovery is when egg mortalities in oiled areas match prespill levels or levels in unoiled areas.~~

River Otters

Injury and Recovery

River otters have a low density and an unknown population size in Prince William Sound, and, therefore, it is hard to assess oil-spill effects. Twelve otter carcasses were found following the spill. Studies conducted during 1989-1991 identified several differences between otters in oiled and unoiled areas in Prince William Sound, including biochemical evidence of exposure to hydrocarbons or other sources of stress, reduced diversity in prey species, reduced body size (length-weight), and increased territory size. However, sample sizes were small, and it is not clear that these differences are the result of the oil spill. The Nearshore Vertebrate Predator project, now underway, will shed new light on the status of the river otters. In 1995 the Alaska Board of Game used its emergency authority to restrict trapping of river otters in western Prince William Sound to ensure that the results of this study are not compromised by the removal of

animals from study areas on Montague and Knight islands. ~~River otters in Prince William Sound have suffered sublethal effects from the spill and may continue to be exposed to hydrocarbons.~~

Recovery Objective

The river otter will have recovered when biochemical indices of hydrocarbon exposure or other stresses and indices of habitat use are similar between oiled and unoiled areas of Prince William Sound, after taking into account any geographic effects. ~~Indications of recovery are when habitat use, food habitats and physiological indices have returned to prespill conditions.~~

ROCKFISH

Injury and Recovery

Very little is known about rockfish populations in the northern Gulf of Alaska. Dead adult rockfish were recovered following the oil spill, and chemical analysis of five specimens indicated that oil ingestion was the cause of death. Analysis of other rockfish showed exposure ~~were exposed~~ to hydrocarbons and ~~showed~~ sublethal effects. ~~Furthermore~~ In addition, closures to salmon fisheries apparently increased fishing pressures on rockfish, which may have affected ~~be affecting their~~ the rockfish population. However, the original extent ~~and mechanism~~ of injury and the current status of ~~to~~ this species are unknown.

Recovery Objective

Without further study, a recovery objective cannot be defined.

SEA OTTERS

Injury and Recovery

Surveys of sea otters in the 1970s and 1980s indicate that the population was expanding and about 10,000 animals lived in Prince William Sound prior to the spill. Based on the number of carcasses and other data, population models suggest that 3,500-5,500 otters died in the first few months following the spill. In 1990 and 1991, unusual numbers of prime-age adult otters were found dead and there was evidence of an increased death rate in recently weaned juveniles. By 1992-93, mortality rates for juveniles had decreased, but were still higher in oiled than in unoiled parts of Prince William Sound. Boat surveys conducted in March and July in 1993 and again in 1994 indicated a population of about 7,700 otters in the Sound, but there was no statistically significant evidence of a population increase following the spill (1990-1994). The Nearshore Vertebrate Predator project, which was started in 1995, should help clarify the recovery status of the sea otter in Prince William Sound. ~~Sea otters do not appear to be recovering, but are expected to eventually recover to their prespill population. Exactly what population increases would constitute recovery is very uncertain, as there are no population data from 1986 to 1989, and the population may have been increasing in Eastern Prince William Sound during that time. In addition, only large changes in the population can be reliably detected with current measuring techniques. However, there are recent indications that the patterns of~~

~~juvenile and mid-aged mortalities are returning to prespill conditions.~~

Recovery Objective

Sea otters will have recovered when the Prince William Sound population returns to its prespill abundance and distribution. An increasing population trend and normal reproduction and age structure in oiled parts of the sound will indicate that recovery is underway. ~~Sea otters will be considered recovered when population abundance and distribution are comparable to prespill abundance and distribution, and when all ages appear healthy.~~

SEDIMENTS

Injury and Recovery

With tidal action, oil penetrated deeply into cobble and boulder beaches that are ~~relatively~~ common on ~~the rocky islands of~~ shorelines throughout the spill area, especially in sheltered habitats. Cleaning removed much of the oil from the intertidal zone but subsurface oil persisted in many heavily oiled beaches and associated subtidal sediments. ~~in mussel beds, which were avoided during the cleanup.~~ Subsurface oil persists at least at ___ locations in Prince William Sound and as far away as the Alaska Peninsula. While much of this oil is probably not biologically active, it is of great concern to residents in oil-spill communities, and there are sites where sheening still occurs.

Following the oil spill, chemical analyses of oil in sediments were conducted at a small number of index sites in Prince William Sound. At these sites, oil in sediments reached its greatest concentrations at water depths of 20 meters, although elevated levels of hydrocarbon-degrading bacteria (associated with elevated hydrocarbons) were detected at depths of 40 and 100 meters in 1990 in Prince William Sound. ~~Chemical analyses show that *Exxon Valdez* oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases.~~ By 1993, however, there was little evidence of *Exxon Valdez* oil and related microbial activity at most index sites in Prince William Sound, except at those associated with sheltered beaches that were heavily oiled in 1989. These index sites--at Herring, Northwest, and Sleepy bays--were among the ___ at which subsurface oiling is still known to occur (see above).

Recovery Objective

Sediments will have recovered when ~~contamination causes no negative effects to the spill ecosystem~~ residues of subsurface oil at sheltered sites that were previously heavily oiled are declining or are biologically harmless.

SOCKEYE SALMON

Injury and Recovery

Commericial fishing was closed in portions of Cook Inlet and near Kodiak in 1989 to avoid any possibility of contaminated salmon being sent to market. As a result, there were higher-than-usual numbers (i.e., overescapement) of spawning fish entering the Kenai River, Red and Akalura lakes on Kodiak Island, and other lakes on Afognak Island and the Alaska Peninsula. Initially these high escapements may have produced an overabundance of juvenile sockeye that consumed huge quantities of zooplankton, thus destroying planktonic food webs in the nursery lakes. Although the exact mechanism is unclear, the result was lost sockeye production as shown by declines in the returns of adults per spawning sockeye.

The effects of the 1989 overescapement have persisted in the Kenai River system through 1995. Although the overall escapement goal for that system was met in 1995, there is concern that the initial overescapement will continue to affect post-spill year-classes and that sockeye returns are yet not sufficient to fulfill the commericial, recreational, and subsistence demands on sockeye salmon in the Kenai River system.

Production of zoolplankton in both Red and Akalura lakes on Kodiak Island has returned to normal. There continues to be some problem in the rate of production of sockeye fry in Red Lake, which may ~~or may not~~ be linked to the overescapement at the time of the oil spill. Continuing low adult escapements at Akalura Lake are more likely the result of a mixed stock fishery harvest in the Kodiak vicinity than a result of the earlier overescapement.

~~Sockeye salmon in Red Lake, Akalura Lake, and lakes in the Kenai River system declined in population because of adult overescapement in 1989. The Red Lake system may be recovering because the plankton has recovered and fry survival improved in 1993. However, Akalura Lake and the Kenai River lakes have not recovered: smolt production has continued to decline from these lakes. In the Kenai River lakes, for example, smolt production has declined from 30 million in 1989 to 6 million in 1990 and to less than 1 million in 1992 and 1993.~~

Recovery Objective

Sockeye salmon in the Kenai River system and Red and Akalura lakes will have recovered when adult returns-per-spawner are within normal bounds. ~~affected lakes will have recovered when populations are able to support overwinter survival rates and smolt outmigrations comparable to prespill levels.~~

Subtidal Organisms

Injury and Recovery

Oil that was transported down to subtidal habitats apparently caused changes in the size and species composition of plant and animal populations below lower tides. Different habitats, including eelgrass beds, kelp beds, and deep water, were compared at oiled and unoiled sites. The greatest effects were detected at oiled sites with sandy sea bottoms under eelgrass beds, at which there were reduced numbers and diversity of helmet crabs, amphipods, and other

crustaceans and mollusks. There also were sublethal effects on the eelgrass itself. Organisms living in sediment at depths of 3-20 meters were especially affected. Some opportunistic, such as *Musculus* mussels, a variety of polychaetes, and juvenile cod, apparently increased in numbers at oiled sites. Differences in oiled and unoiled sites were less evident by 1993.

~~Certain subtidal organisms, like eelgrass and some species of algae, appear to be recovering. Other subtidal organisms, like leather stars and helmet crabs, showed little signs of recovery through 1991.~~

Recovery Objective

Subtidal communities will have recovered when community composition in oiled areas, especially in association with eelgrass beds, is similar to that which would have prevailed in the absence of the spill. Indications of recovery are the return of keystone species, such as certain amphipods and other oil-sensitive crustaceans. ~~Subtidal communities will have recovered when the community composition, age-class distribution, population abundance of component species, and ecosystem functions and services in each injured subtidal habitat have returned to levels that would have prevailed in the absence of the oil spill.~~

Services

Commercial Fishing

Injury and Recovery

Commercial fishing is a service that was injured through injury to commercial fish species (see individual resources) and also through fishing closures. In 1989, closures affected fisheries in Prince William Sound, lower Cook Inlet, upper Cook Inlet, Kodiak, and Chignik. These fisheries opened again in 1990. Since then, there have been no spill-related district-wide closures, except for the Prince William Sound herring fishery, which was closed in 1993 and has remained closed since then due to the collapse of the herring population. These closures, including the on-going closure of the herring fishery in Prince William Sound, harmed the livelihoods of persons who fish for a living and the communities in which they live. To the extent that the oil spill continues to be a factor that reduces opportunities to catch fish, there is on-going injury to commercial fishing as a service.

On this basis, the Trustee Council continues to make major investments in projects to understand and restore commercially important fish species that were injured by the oil spill. These projects include: supplementation work, such as fertilizing Coghill Lake to enhance its sockeye salmon run and construction of a barrier bypass at Little Waterfall Creek; development of tools that have almost immediate benefit for fisheries management, such as otolith mass marking of pink salmon in Prince William Sound and in-season genetic stock identification for sockeye salmon in Cook Inlet; and research such as the SEA Project and genetic mapping which will enhance the ability to predict and manage fisheries over the long-term.

~~Continuing injuries to commercial fishing may cause hardships for fishermen and related businesses. Each year that commercial fishing remains below prespill levels compounds the injury to the fishermen and, in many instances, the communities in which they live or work.~~

~~The Trustee Council recognizes the impact to communities and people of the Prince William Sound region resulting from the sharp decline in pink salmon and herring fisheries in past years. In 1994, the Trustee Council committed over six million dollars to help address these issues through the development of an ecosystem-based study for Prince William Sound. Some of the pink salmon and herring problems may be unrelated to the spill. However, the Council will continue to address these important problems.~~

Recovery Objective

Commercial fishing will have recovered when the commercially important fish species have recovered and opportunities to catch these species are not lost or reduced ~~due~~ because of to effects of the oil spill. population levels and distribution of injured or replacement fish used by the commercial fishing industry match conditions that would have existed had the spill not occurred. Because of the difficulty of separating spill-related effects from other changes in fish runs, the Trustee Council may use prespill conditions as a substitute measure for conditions that would have existed had the spill not occurred.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

The primary method for restoring commercial fishing is to restore the species that are fished commercially, such as pink salmon, Pacific herring, and sockeye salmon. These species are discussed elsewhere in this chapter. Three additional parts of the strategy for restoring commercial fishing are the following:

Promote recovery of commercial fishing as soon as possible. Many communities that rely on commercial fishing will be significantly harmed while waiting for commercial fish resources to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of commercial fishing. This objective may be accomplished through increasing availability, reliability, or quality of commercial fish resources, depending on the nature of the injury. For resources that have sharply declined since the spill, such as pink salmon, and Pacific herring in Prince William Sound, this objective may take the form of increasing availability in the long run through improved fisheries management. Another example is providing replacement fish for harvest.

Protect commercial fish resources from further degradation. Further stress on commercial fish resources could impede recovery. Appropriate protection can take the form of habitat protection and acquisition if a resource faces loss of habitat. The Trustee Council can also contribute to the protection of commercial fish species by providing information needed to improve their management.

Monitor recovery. Monitoring the recovery of commercial fishing will track the progress of

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

Passive Use

Injury and Recovery

Passive use of resources includes the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other nonuse values. Injuries to passive uses are tied to public perceptions of injured resources. [NOTE: THIS SAYS ALMOST NOTHING ABOUT INJURY. IS THERE ANYTHING TO SAY? PERHAPS A REFERENCE TO THE VALUATION SURVEYS DONE FOLLOWING THE SPILL?]

Recovery Objective

Passive uses will have recovered when people perceive that aesthetic and intrinsic values associated with the spill area are no longer diminished by the oil spill.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

Any restoration strategy that aids recovery of injured resources, or prevents further injuries, will assist recovery of passive use values. No strategies have been identified that 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.

Recreation and Tourism

Injury and Recovery

The spill disrupted use of the spill area for recreation and tourism. Resources important for wildlife viewing and which are still injured by the spill include killer whale, sea otter, harbor seal, ~~bald eagle,~~ and various seabirds. Residual oil exists on some beaches with high value for recreation, and its presence may decrease the quality of recreational experiences and discourage recreational use of these beaches.

Closures of sport hunting and fishing also affected use of the spill area for recreation and tourism. Sport fishing resources include salmon, rockfish, Dolly Varden, and cutthroat trout. The Alaska Board of Fisheries restricted sport harvest of cutthroat trout in Prince William Sound in 1991 [?], and those restrictions remain in place. Harlequin ducks are hunted in the spill area. The Alaska Board of Game restricted sport harvest of harlequin ducks in Prince William Sound in 1991, and those restrictions remain in place.

Recreation was also affected by changes in human use in response to the spill. For example, displacement of use from oiled areas to unoiled areas increased management problems and facility use in unoiled areas. Some facilities, such as the Green Island cabin and the Fleming Spit camp area, were injured by clean-up workers.

In the years since the oil spill, there has been a general, marked increase in visitation to the spill area. There are still locations within the oil-spill area, however, avoided by recreational users because of the presence of residual oil.

Recovery Objective

Recreation and tourism will have recovered, in large part, when the fish and wildlife resources on which they depend have recovered, recreation use of oiled beaches is no longer impaired, and facilities and management capabilities can accommodate changes in human use.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

Preserve or improve the recreational and tourism values of the spill area. Habitat protection and acquisition are important means of preserving and enhancing the opportunities offered by the spill area. Facilities damaged during cleanup may be repaired if they are still needed. New facilities may restore or enhance opportunities for recreational use of natural resources. Improved or intensified public recreation management may be warranted in some circumstances. Projects that restore or enhance recreation and tourism would be considered only if they are consistent with the character and public uses of the area. However, all projects to preserve and improve recreation and tourism values must be related to an injured natural resource. See Policy 9 in Chapter 2.

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

Monitor recovery. Monitor the recovery of resources used for recreation and tourism. Also monitor changes in recreation and tourism in the spill area.

SUBSISTENCE

Injury and Recovery

Before the oil spill, the Alaska Department of Fish and Game had documented 15 Native Alaskan communities (with about 2,200 people) in Prince William Sound, lower Cook Inlet, Kodiak, and the Alaska Peninsula that relied heavily on subsistence resources, such as fish, shellfish, seals, deer, and waterfowl. Per capita subsistence harvest ranged from nearly 200 pounds to more than 600 pounds per year. Subsistence harvests of fish and wildlife in most of these villages declined substantially following the oil spill. The reasons for these declines included reduced

availability of fish and wildlife to harvest, concern about possible health effects of eating contaminated or injured fish and wildlife, and disruption of lifestyles due to clean-up and other activities.

Subsistence foods were tested for evidence of hydrocarbon contamination during 1989-1994, and the results indicated that most resources contained no or very low concentrations of petroleum hydrocarbons. Eating foods with low levels of hydrocarbons posed no risk to human health, although subsistence users were advised not to eat shellfish from obviously contaminated areas. Samples of ducks from the Chenega Bay area in 1994 showed that exposure to crude oil had decreased significantly compared to the exposure levels documented since 1990.

Residual oil exists on some beaches near subsistence communities, and, in general, there continues to be concern or at least uncertainty about the safety of fish and wildlife resources. Uncertainty about the safety of resources reduces their use and value for subsistence.

Surveys by the Alaska Department of Fish and Game indicate that in some communities subsistence resources appear to be harvested at prespill levels based on total pounds-per-person. It is important to note, however, that the composition of many diets has shifted to include more fish and fewer seals. Diet composition continues to be a serious concern to subsistence users.

Subsistence users say that maintaining their subsistence culture depends on uninterrupted use of fish and wildlife resources. The more time users spend away from subsistence activities, the less likely that they will return to these practices. Continuing injury to natural resources used for subsistence may affect the way of life of entire communities. There is particular concern that the oil spill disrupted opportunities for young people to learn subsistence culture, and that this knowledge may be lost to them in the future.

Recovery Objective

Subsistence will have recovered when injured resources used for subsistence are healthy and productive and exist at prespill levels. In addition, there is recognition that people must be ~~and when people are~~ confident that the resources are safe to eat~~. One indication that recovery has occurred is when~~ and that the cultural values provided by gathering, preparing, and sharing food need to be ~~are~~ reintegrated into community life.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

The primary way of restoring subsistence is to restore injured resources used for subsistence, such as clams, harbor seals, Pacific herring, pink salmon, sea otters, and sockeye salmon. These are discussed elsewhere in this chapter. Four additional parts of the strategy to restore subsistence are the following:

Promote recovery of subsistence as soon as possible. Many subsistence communities will be significantly harmed while waiting for resources used for subsistence to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of subsistence use. This objective may be accomplished through increasing availability, reliability, or quality of resources used for subsistence, or increasing the confidence of subsistence users. Specifically, if subsistence harvest has not returned to prespill levels because users doubt the safety of particular resources, this objective may take the form of increasing the reliability of the resource through food safety testing. Other examples are the acquisition of alternative food sources and improved use of existing resources. However, all projects to promote subsistence must be related to an injured natural resource. See Policy 9 in Chapter 2.

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

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

Monitor recovery. Monitor the recovery of resources used for subsistence. Also monitor subsistence harvest.

21.1.2g

Exxon Valdez Oil Spill Trustee Council

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FAX COVER SHEET

FAX COMPLETE

Leslie Holland-Bartels

To: Jim Bodkin Number: NBS 786-3636

From: Stan Senner Date: 12 Jan '96

Comments: Total Pages: 2

Would you help me with the accuracy of this update? It needs to stay short, but we can add or change as needed. Can we say that numbers are now generally back to pre-spill levels, except for local areas? (This is the perception of some folks, including local residents.)

786-3550

Document Sent By:

2/15/95

21.1.2I

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January 2, 1996

Stan Senner, Science Coordinator
EVOS Trustee Council Office
645 "G" Street, 4th floor
Anchorage, AK 99501

Dear Stan:

I have several comments on the "24 Dec 95" Draft of revisions to Chapter 5 of the Restoration Plan. I will begin with my comments on the **Subsistence** section.

Under the heading "Injury and Recovery" (pg. 23): There is a reference to "15 Native Alaskan" communities. Generally, we use "Native Alaskan" to refer to someone born and raised in Alaska. The term "Alaskan Native" is used to refer to the indigenous population. We also generally refer to these communities as "predominantly Alaskan Native", as the population is not exclusively Native.

In reading the text, (specifically on pg. 24) I found it was often unclear who made particular determinations and statements regarding subsistence food safety. I think it is important to make such distinctions, for example:

The U.S. Food and Drug Administration determined that eating foods with low levels of hydrocarbons posed no significant additional risk to human health (the words significant additional should be added to the text here, as the current statement is inaccurate).

The Oil Spill Health Task Force advised subsistence users not to eat shellfish from beaches where oil can be seen or smelled on the surface or subsurface (this phrasing is less ambiguous than "obviously contaminated areas".)

Subsistence users remain concerned and uncertain about the safety of fish and other wild. resources (As currently phrased, this statement creates the impression that everyone, including the people giving health advice (FDA, OSHTF) remain concerned and uncertain).

I think it would strengthen the section on subsistence food safety (pg. 24) to add a statement to the effect that, at the time of the spill there were no existing guidelines for safe levels of human consumption of hydrocarbons in food. This whole program was unprecedented.

I also have comments on two other sections of the revision:

Sea Otters: (pgs. 17& 18) Residents of the communities in the oil spill impact area have repeatedly reported that they think the population levels of sea otters have returned to what they were before the spill, and some say there are more sea otters than before the spill. Local people have expressed disbelief that sea otters remain in the "not recovering" category, as this does not correspond with what their observations. This discrepancy leads them to question the accuracy of

the rest of the list. Perhaps it would help to include in the text some indication that these local reports have been heard and considered, even if the position of sea otters on the list does not change.

Archaeology: The recovery objective (pg. 6) should be revised to include: Archaeological resources will have recovered when the artifacts removed as a result of the oil spill beach treatment activities are returned to the region. This revision was discussed and agreed to by the participants in the Archaeology session at the 1995 Restoration Science Workshop. The peer reviewer agreed this was a reasonable addition to the objectives. I mention this because I participated in the session, along with representatives from Chenega Bay, Tatitlek, Port Graham, the Chugach Heritage Foundation, Chugachmuit, and the Chugach Alaska Corporation.

Thank you for the opportunity to review the revisions. Please feel free to call me if you have any question about these comments.

Sincerely,

Rita A. Miraglia
Oil Spill Coordinator
Division of Subsistence

cc: Jim Fall
Bill Simeone
Joe Sullivan

21.1.2 H

Exxon Valdez Oil Spill Trustee Council

Restoration Office
645 G Street, Suite 401, Anchorage, Alaska 99501-3451
Phone: (907) 278-8012 Fax: (907) 276-7178

MEMORANDUM

To: **Restoration Work Force**
Agency Liaisons
Legal Counsel

From: **Molly McCammon**
Executive Director

Re: **Preliminary Revised Draft of Chapter 5 (Recovery Objectives)**

Date: **December 29, 1995**

Pages 5 and 32 of the Restoration Plan note that the plan is a dynamic document, subject to updating based on new information. On that basis, I have attached for your review a preliminary revised draft of Chapter 5 of the Restoration Plan. The next step in this process is for agency staff to review this at a macro level in order to identify areas where you believe there may be significant errors in fact or concept. It would be helpful if you could return your comments to Stan Senner by January 9, the date of the next meeting of the Restoration Work Force.

Based on your comments and concerns, we will produce another, revised draft, which will be distributed to participants in the 1996 Restoration Workshop. This draft will be among the materials handed out at the workshop registration table on January 16th.

These revised recovery objectives will be discussed at the workshop in breakout sessions on Thursday, January 18th, and with the core peer reviewers before they leave Anchorage. Based on this feedback, the Restoration Office staff will then make additional revisions and copies will be circulated to you and the Trustees. I will looking for the Trustees' "informed consent" so that this can be sent out for public comment in February, along with the FY 1997 Invitation. Following public comment, a final version will be prepared for Trustee Council action, probably at the same time as they consider the FY 1997 Work Plan.

The primary focus of this revised Chapter 5 is on Injury Status and Recovery Objectives. We propose to delete the generic discussion of strategies, which is badly out of date, as well as the resource-specific strategies, which are better covered (and updated) through the annual Invitations. We propose to retain the strategies for the

services, although they may still need to be revised. With respect to the status of Injury and Recovery, the discussion for each resource is opened with a statement or two of context and a description of why the resource or service originally was considered to be injured. Each discussion is closed with a few sentences regarding current status. In regard to the Recovery Objectives, the goal was to identify a goal that is realistic and measurable, given what we know about a resource or service's current status.

An earlier draft of this document was reviewed by Dr. Spies and the core peer reviewers, but please identify where more work may be needed. Do not worry now about editorial details, although such comments are always welcome. Thank you for your help with this. Give Stan or me a call if you have any questions.

enclosure (1)

cc: Robert Spies
Core peer reviewers

21.1.26

~~juvenile and mid-aged mortalities are returning to prespill conditions.~~

Recovery Objective

Sea otters will have recovered when the Prince William Sound population returns to its prespill abundance and distribution. An increasing population trend and normal reproduction and age structure in oiled parts of the sound will indicate that recovery is underway. ~~Sea otters will be considered recovered when population abundance and distribution are comparable to prespill abundance and distribution, and when all ages appear healthy.~~

SEDIMENTS

Injury and Recovery

With tidal action, oil penetrated deeply into cobble and boulder beaches that are ~~relatively~~ common on ~~the rocky islands of~~ shorelines throughout the spill area, especially in sheltered habitats. Cleaning removed much of the oil from the intertidal zone but subsurface oil persisted in many heavily oiled beaches and associated subtidal sediments. ~~in mussel beds, which were avoided during the cleanup.~~ Subsurface oil persists at least at ___ locations in Prince William Sound and as far away as the Alaska Peninsula. While much of this oil is probably not biologically active, it is of great concern to residents in oil-spill communities, and there are sites where sheening still occurs.

Following the oil spill, chemical analyses of oil in sediments were conducted at a small number of index sites in Prince William Sound. At these sites, oil in sediments reached its greatest concentrations at water depths of 20 meters, although elevated levels of hydrocarbon-degrading bacteria (associated with elevated hydrocarbons) were detected at depths of 40 and 100 meters in 1990 in Prince William Sound. ~~Chemical analyses show that *Exxon Valdez* oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases.~~ By 1993, however, there was little evidence of *Exxon Valdez* oil and related microbial activity at most index sites in Prince William Sound, except at those associated with sheltered beaches that were heavily oiled in 1989. These index sites--at Herring, Northwest, and Sleepy bays--were among the ___ at which subsurface oiling is still known to occur (see above).

Re~~covery Objective~~

Se~~diments will be recovered~~ when ~~contamination causes no negative effects to the spill ec~~ace oil at sheltered sites that were previously heavily oiled are de~~termined to be harmless.~~

Recovery obj

Kodiak shoreline survey

oiled in PWS 5.4 km of shoreline

SOCKEYE SALMON

21.1.26

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Recovery Objective

Sediments will have recovered when ~~contamination causes no negative effects to the spill ecosystem~~ residues of subsurface oil at sheltered sites that were previously heavily oiled are declining or are biologically harmless.

SOCKEYE SALMON

animals from study areas on Montague and Knight islands. ~~River otters in Prince William Sound have suffered sublethal effects from the spill and may continue to be exposed to hydrocarbons.~~

Recovery Objective

The river otter will have recovered when biochemical indices of hydrocarbon exposure or other stresses and indices of habitat use are similar between oiled and unoiled areas of Prince William Sound, after taking into account any geographic effects. ~~Indications of recovery are when habitat use, food habitats and physiological indices have returned to prespill conditions.~~

ROCKFISH

Injury and Recovery

Very little is known about rockfish populations in the northern Gulf of Alaska. Dead adult rockfish were recovered following the oil spill, and chemical analysis of five specimens indicated that oil ingestion was the cause of death. Analysis of other rockfish showed exposure ~~were exposed~~ to hydrocarbons and ~~showed~~ sublethal effects. ~~Furthermore~~ In addition, closures to salmon fisheries apparently increased fishing pressures on rockfish, which may have affected ~~be affecting their~~ the rockfish population. However, the original extent ~~and mechanism~~ of injury and the current status of ~~to~~ this species are unknown.

Recovery Objective

Without further study, a recovery objective cannot be defined.

SEA OTTERS

Injury and Recovery

Surveys of sea otters in the 1970s and 1980s indicate that the population was expanding and about 10,000 animals lived in Prince William Sound prior to the spill. Based on the number of carcasses and other data, population models suggest that 3,500-5,500 otters died in the first few months following the spill. In 1990 and 1991, unusual numbers of prime-age adult otters were found dead and there was evidence of an increased death rate in recently weaned juveniles. By 1992-93, mortality rates for juveniles had decreased, but were still higher in oiled than in unoiled parts of Prince William Sound. Boat surveys conducted in March and July in 1993 and again in 1994 indicated a population of about 7,700 otters in the Sound, but there was no statistically significant evidence of a population increase following the spill (1990-1994). The Nearshore Vertebrate Predator project, which was started in 1995, should help clarify the recovery status of the sea otter in Prince William Sound. ~~Sea otters do not appear to be recovering, but are expected to eventually recover to their prespill population. Exactly what population increases would constitute recovery is very uncertain, as there are no population data from 1986 to 1989, and the population may have been increasing in Eastern Prince William Sound during that time. In addition, only large changes in the population can be reliably detected with current measuring techniques. However, there are recent indications that the patterns of~~

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Exxon Valdez Oil Spill Trustee Council

Restoration Office
645 G Street, Suite 401, Anchorage, Alaska 99501-3451
Phone: (907) 278-8012 Fax: (907) 276-7178

Peterson comments

MEMORANDUM

To: Restoration Work Force
Agency Liaisons
Legal Counsel

From: Molly McCammon
Executive Director

Re: Preliminary Revised Draft of Chapter 5 (Recovery Objectives)

Date: December 29, 1995

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An earlier draft of this document was reviewed by Dr. Spies and the core peer reviewers, but please identify where more work may be needed. Do not worry now about editorial details, although such comments are always welcome. Thank you for your help with this. Give Stan or me a call if you have any questions.

enclosure (1)

cc: Robert Spies
Core peer reviewers

29 Dec 95
DRAFT

Table 1. Resources and Services Injured by the Spill

INJURED RESOURCES

Recovered

~~Bald eagle~~

Recovering

~~Bald eagle~~
~~Black oystercatcher~~
~~Common murre~~
Intertidal organisms
~~(some)~~ ~~(everything)~~
~~Killer whale~~
Mussels
~~Pink salmon~~
Sockeye salmon
~~(Red Lake)~~ ~~(all systems)~~
Subtidal organisms
~~(some)~~ ~~(everything)~~

Not Recovering

~~Common murre~~
Harbor seal
Harlequin duck
~~Intertidal organisms~~
~~(some)~~
~~Killer whale~~
~~(AB pod)~~
Marbled murrelet
Pacific herring
Pigeon guillemot
~~Pink salmon~~
Sea otter
~~Sockeye salmon~~
~~(Kenai & Akalura systems)~~
~~Subtidal organisms~~
~~(some)~~
~~Archaeological resources~~
~~Sediment~~

Recovery Unknown

Clams - ?
Common loon
Cutthroat trout
Black oystercatcher
Dolly Varden
Kittlitz's murrelet
River otter
Rockfish

Other

Archaeological resources
Designated wilderness areas
Sediments

Services

Commercial fishing
Passive uses
Recreation and Tourism
Subsistence

29 Dec 1995
DRAFT

Chapter 5
~~Goals, Objectives, and Strategies~~
Injury Status and Recovery Objectives

~~This chapter presents goals, objectives, and strategies for restoration.~~ The first part of this chapter discusses ~~goals,~~ recovery objectives~~, and strategies~~ in general. The second part describes the nature and extent of injury and recovery and ~~the~~ recovery objective~~, and the restoration strategy~~ for each injured resource and service discussed in Table 2 in Chapter 4. Detailed information on injury and recovery objectives~~, and strategies~~ can be found on the following pages:

and Thick-billed ?

No mention of "BACI" design – i.e., you best assess recovery by having Before and After data in both spill and control areas. Then you have a control for both spatial and temporal variability unrelated to the oil

~~Overview~~

~~The first part of this chapter discusses goals, objectives, and strategies in general. A goal is the end toward which an endeavor is directed; objectives are descriptions of measurable outcomes; and strategies are plans of action. Taken together, goals, objectives, and strategies produce a blueprint for restoring the spill area. To be funded, a project must be consistent with the goals and policies of the Restoration Plan and with restoration objectives and strategies as they change over time.~~

and can estimate oil effects as the degree to which pre-spill differences between oiled and control areas fail to be achieved after the spill.

~~GOAL: *The end toward which restoration is directed*~~

~~The goal of restoration is recovery of all injured resources and services. Recovery is to be sustained by healthy, productive ecosystems that maintain naturally occurring biodiversity. All restoration actions must be directed toward this goal.~~

~~OBJECTIVES: *Measurable outcomes of restoration*~~

Objectives

The recovery objectives described in the following section ~~of the restoration program~~ are the measurable conditions that signal the recovery of individual resources or services. ~~They are the yardsticks against which the success of the program is measured.~~ In general, resources and services will have recovered when they return to conditions that would have existed had the spill not occurred. In nature, however, populations often undergo large natural changes, and ~~Because~~ it is difficult to predict conditions that would have existed in the absence of the spill. ~~recovery is often~~ Recovery, therefore, is most realistically defined as a return to prespill conditions or to levels that fall within the bounds of natural variation. For resources that were in decline before the spill, like harbor seals ~~marbled murrelets~~, recovery may be achieved ~~consist of stabilizing the~~ when a population is stabilized, even if at a lower level than before the spill. For some resources, little is known about their injury and recovery status, so it is difficult to define recovery.

indicated by

defined as

similar

I am not convinced that this method is worse

Where few ~~little~~ prespill data exist, injury is inferred from comparisons of oiled and unoiled areas, and recovery is usually defined as a return to conditions ~~comparable~~ to those of unoiled areas. Because the differences between oiled and unoiled areas may have existed before the spill, statements of injury and objectives based on these differences are often less certain than in those cases where prespill data exist. Alternatively, injury may be evaluated based on the number of oiled carcasses picked up following the spill relative to the estimated size of the spill-area population. Even in cases where some prespill data are available, ~~However,~~ there also is ~~can be some~~ uncertainty associated with interpreting the significance of prespill population data since populations undergo natural fluctuations. In all cases, indicators of recovery can include increased numbers of individuals, reproductive success, improved growth and survival rates, and normal age and sex composition of the injured population.

Full ecological recovery will have been achieved when the population of flora and fauna are

not necessarily — this could be an indicator, necessary for use in the absence of BACI design

again present at former or prespill abundances, are 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.

[NOTE: WE PROPOSE TO ELIMINATE THE FOLLOWING GENERIC DISCUSSION OF STRATEGIES, AS WELL THE DISCUSSION OF SPECIFIC STRATEGIES FOR EACH INJURED RESOURCE (BUT NOT FOR SERVICES). THIS STUFF IS PROBABLY BEST COVERED THROUGH THE INVITATIONS, WHERE IT IS UPDATED ANNUALLY. IN ADDITION, SOME OF THE MORE GENERIC DISCUSSION IS ALREADY COVERED IN CHAPTER 3 OF THE RESTORATION PLAN. IF WE WERE TO RETAIN THIS MATERIAL, IT WOULD REQUIRE SUBSTANTIAL REVISION.]]

~~STRATEGIES: *Plans of action*~~

~~A restoration strategy is a plan of action for achieving objectives. Each year, through its annual or multiyear work plan, the Trustee Council decides which strategies to implement. Restoration strategies reflect consideration of ecosystem relationships. For example, the strategy for some injured resources includes research into why they are not recovering, such as declining or contaminated food sources or disruption of ecosystem relationships.~~

~~In this section, restoration strategies are presented under three headings: Biological Resources, Other Resources, and Services.~~

~~**Biological Resources**~~

~~Because restoration strategies for biological resources depend on whether the resource is recovering, strategies are subdivided into those for recovering resources, resources that are not recovering, and resources whose recovery is unknown.~~

~~***Recovering Resources.*** The fact that a resource is recovering suggests that nature will restore it without intervention. Consequently, restoration of recovering resources will rely primarily on natural recovery.~~

~~Because these resources are recovering, research into factors limiting recovery and general restoration projects to accelerate recovery may not be warranted. However, if a resource is not expected to recover fully on its own or if waiting for natural recovery will cause long-term harm to a community or service, appropriate alternative means of restoration would be undertaken. Habitat protection and monitoring are encouraged, as are general restoration projects that protect the resource from other sources of potential injury. (Restoration strategies under "Services" also apply to these resources.)~~

~~The restoration strategy for recovering resources has three parts:~~

- ~~Rely on natural recovery~~
- ~~Monitor recovery~~

- Protect injured resources and their habitats

Resources Not Recovering. Except for certain protective measures, attempts to restore these resources without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for these resources emphasizes determining why they are not recovering, and eliminating threats to the remaining populations.

Where sufficient knowledge about the nature of injury exists, the restoration strategy also encourages actions to promote recovery. The populations of some of these resources are in a steep decline and may not recover without help. Furthermore, some of these resources have subsistence or economic importance and their recovery is linked to the recovery of these services. (Restoration strategies under "Services" also apply to these resources.)

Research is encouraged, provided it helps explain why a resource is not recovering. Habitat protection and monitoring are also encouraged. General restoration projects are allowed if they address factors limiting recovery or if they protect the resource from other sources of potential injury.

The restoration strategy for resources that are not recovering has four parts:

- Conduct research to find out why these resources are not recovering
- Initiate, sustain, or accelerate recovery
- Monitor recovery
- Protect injured resources and their habitats

Recovery Unknown. If specialists do not know whether a resource is recovering, it will be treated in much the same way as a recovering resource. Until more is known about the nature and extent of injuries and the degree of recovery of these resources, restoration will rely primarily on natural recovery, aided by monitoring and protective measures.

Because the recovery of these resources is unknown, and, in some cases, the injury poorly understood, research into factors limiting recovery and general restoration projects to accelerate recovery may not be warranted. Habitat protection and monitoring are encouraged, as are general restoration projects that protect these resources from other sources of potential injury.

The restoration strategy for resources whose recovery is unknown has three parts:

- Rely on natural recovery
- Monitor recovery
- Protect injured resources and their habitats

Other Resources

Other injured resources include archaeological resources, designated wilderness areas and oiled sediment. The strategy for restoring archaeological resources seeks to repair and protect injured

~~sites and artifacts. The strategy for sediment includes removal or reduction of residual oil and monitoring. Any restoration strategy that aids recovery of injured resources, or prevents further injuries, will assist recovery of designated wilderness areas or wilderness study areas.~~

~~Services~~

~~Commercial fishing, passive use, recreation (including sport fishing) and tourism and subsistence are services that were reduced or lost because of the spill. Injured resources that support these services include clams, harbor seals, Pacific herring, pink salmon, sea otters, and sockeye salmon. The primary way to restore services is to restore the resources on which they depend.~~

~~Additional restoration strategies for commercial fishing, recreation and tourism, and subsistence include promoting recovery of the service as soon as possible through such means as increasing the availability, reliability, or quality of the resource on which the service depends. For some resources, this may take the form of increasing availability in the long run through improved resource management or providing replacement resources. Strategies for recreation and tourism and subsistence also include removing or reducing residual oil if treatment is cost effective and less harmful than leaving the oil in place.~~

~~Objectives and Strategies by Resource and Service~~
Injury Status and Recovery Objective

This section describes the nature and extent of injury and recovery and the recovery objective~~, and the restoration strategy~~ for each injured resource and service. Specific strategies to achieve recovery objectives are described in annual work plans and restoration project invitations (e.g., *Invitation to Submit Restoration Projects for Federal Fiscal 1997 and Draft Restoration Program: FY 97 and Beyond).* The information in this section is expected to change ~~over time~~ as the restoration program adapts to new information. For example, population declines or sublethal effects may be documented for new resources, some resources may begin to recover or never recover, and recovery objectives ~~and strategies may~~ will change in response to new information and conditions. Hypotheses for why resources are not recovering are particularly susceptible to change as prevailing hypotheses are tested and new ones are formed.

New scientific data will be incorporated into restoration decisions without the need to change the plan. However, changes will be reported in the Trustee Council's annual status report.

Resources

Archaeological Resources

Injury and Recovery

Twenty-four archaeological sites on public lands are known to have been adversely affected by cleanup activities, or looting and vandalism linked to the oil spill. Additional sites on private land

may have been injured, but damage assessment studies were limited to public land.

Documented injuries include theft of surface artifacts, masking of subtle clues used to identify and classify sites, violation of ancient burial sites, and destruction of evidence in layered sediments. In addition, vegetation has been disturbed, which has exposed sites to accelerated erosion. The effect of oil on soil chemistry and organic remains may reduce or eliminate the utility of radiocarbon dating in some sites.

Assessments of 14 sites in 1993 suggest that most of the archaeological vandalism that can be linked to the ~~*Exxon Valdez* oil~~ spill occurred 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. In 1993, only two of the 14 sites visited showed signs of continued vandalism, ~~and the link between~~ but it is difficult to prove that this recent vandalism was related to the spill. ~~and the *Exxon Valdez* oil spill remains highly problematical~~. Oil ~~samples have not yet been analyzed, but oil~~ was visible in the intertidal zones of two of the 14 sites monitored in 1993, but because oil samples have not yet been analyzed, the *Exxon Valdez* oil spill cannot be confirmed as the source of the oil in these sites.

Monitoring of archaeological sites in 1994 and 1995 found no evidence of new damage from vandalism. The presence of oil is being determined in sediment samples taken from four sites in 1995.

None of the archaeological artifacts collected during the spill response, damage assessment, or restoration programs is stored within the spill area. These artifacts are stored in the University of Alaska Museum in Fairbanks and in the Federal Building in Juneau. Native communities in the spill area have expressed a strong interest in having them returned to the spill area for storage and display.

The Alutiiq Archaeological Repository in Kodiak, whose construction costs were partly funded by the Trustee Council, is the only physically appropriate artifact storage facility in the spill area. In 1995 the Trustee Council approved funds for development of a comprehensive community plan for restoring archaeological resources in Prince William Sound and lower Cook Inlet, including strategies for storing and displaying artifacts at appropriate facilities within the spill area.

Recovery Objective

Archaeological resources are nonrenewable: they cannot recover in the same sense as biological resources. Archaeological resources will be considered to have recovered when spill-related injury ends, looting and vandalism are at or below prespill levels, and the artifacts and scientific data which remain in vandalized sites are preserved (e.g., through excavation, site stabilization, or other forms of documentation). ~~Artifacts and data are typically preserved through excavation or other forms of documentation, or through site stabilization, depending on the nature of the injury and the characteristics of the site.~~

BALD EAGLES

Injury and Recovery

Prince William Sound provided year-round and seasonal habitat for about 5,000 bald eagles. ~~Two hundred to 300~~ About 250 bald eagles are estimated to have died as a result of ~~may have been killed in~~ the spill, and productivity was reduced in oiled areas of Prince William Sound in 1989. Productivity was back to normal in 1990 and 1991, and an aerial survey of adults in 1995 indicated that the population has returned to or exceeded its prespill level in Prince William Sound. ~~However, population estimates made in 1989, 1990, and 1991 indicate that there may have been an increase in the Prince William Sound bald eagle population since the previous survey conducted in 1984. Productivity decreased in 1989, but appeared to have recovered by 1990. Because population and productivity appear to have returned to prespill levels, bald eagles may have already recovered from the effects of the spill.~~

Recovery Objective

Because the Prince William Sound population and productivity are at or above prespill levels, the bald eagle has recovered from the effects of the Exxon Valdez oil spill. ~~Bald eagles will have recovered when their population and productivity return to prespill levels.~~

BLACK OYSTERCATCHERS

Injury and Recovery

Black oystercatchers spend their entire lives in or near intertidal habitats and are highly vulnerable to oil pollution. An estimated 1,500-2,000 oystercatchers live in south-central Alaska. Only nine carcasses of adult oystercatchers were recovered following the spill, but estimated mortality may have been as high as, but probably did not exceed, 20 percent in the spill area. In addition, breeding activities were disrupted by the oil and clean-up activities. In comparison with oystercatchers on the largely unoiled Montague Island, oystercatchers at heavily oiled Green Island had reduced hatching success in 1989 and their chicks gained weight more slowly during 1991-93. Interpretation of these data on reproductive performance, however, are confounded by lack of pre-spill data. Productivity and survival of black oystercatchers in Prince William Sound have not been monitored since 1993, and the recovery status of this species is not currently known. ~~Within Prince William Sound, an estimated 120 to 150 black oystercatchers, representing 12-15 percent of the total estimated population, died as a result of the spill. Mortality outside of Prince William Sound is unknown. Black oystercatchers are recovering, although they may still be exposed to hydrocarbons when feeding in intertidal areas.~~

Recovery Objective

Black oystercatchers will have recovered when the Prince William Sound population returns to ~~attain~~ prespill levels and reproduction is normal. An increasing population trend and comparable

hatching success and growth rates of chicks in oiled and unoiled areas will indicate that recovery is underway. ~~reproductive success of nests and growth rates of chicks raised in oiled areas are comparable to those in unoiled areas.~~

CLAMS

Injury and Recovery

The magnitude of impacts on clam populations varies with the species of clam, degree of oiling, and location. However, data from the lower intertidal zone on sheltered beaches suggest that little neck clams and, to a lesser extent, butter clams ~~on sheltered beaches~~ were killed or suffered slower growth rates as a result of the oil spill ~~by oiling~~ and clean-up activities. ~~In addition, growth appeared to be reduced by oil, but determination of sublethal or chronic effects is awaiting final analyses.~~ In communities on the Kenai Peninsula, Kodiak, and Alaska Peninsula, concern about the effects of the oil spill on clams and subsistence uses of clams remains high.

Recovery Objective

Based on prespill data or comparisons of oiled and unoiled sites, clams will have recovered when populations and productivity have returned to levels that would have prevailed in the absence of the oil spill ~~(prespill data or unoiled control sites)~~.

COMMON LOONS

Injury and Recovery

Carcasses of 395 loons of four species were recovered following the spill, including at least 216 common loons. The population sizes are not known for any of these species, but, in general, loons are long-lived, slow-reproducing, and have small populations. Common loons in the oil-spill area may number only a few thousand, including only hundreds in Prince William Sound. Common loons injured by the spill probably included a mixture of resident and migrant birds, and their recovery status is not known.

Recovery Objective

Without more information on injury to common loons and their recovery status, no recovery objective can be identified.

COMMON MURRES

Injury and Recovery

About 30,000 carcasses of oiled birds were picked up following the oil spill, and 74 percent of them were common and thick-billed murres (mostly common murres). Many more murres died than were actually recovered, and it is estimated that the spill-area population declined by about 40 percent, including at colonies at Resurrection Bay, the Chiswell, Barren, and Triplet islands,

and Puale Bay. In addition to direct losses of murres, there was evidence that the timing of reproduction was disrupted and productivity reduced. Interpretation of the effects of the spill, however, is complicated by incomplete prespill data and by indications that populations at some colonies were in decline before the oil spill.

Postspill monitoring of productivity at index colonies indicates that reproductive timing and success were again within normal bounds by 1993. Numbers of adult murres were last surveyed in 1994 [check] and, at that time, had not returned to prespill levels.

~~Productivity of common murres shows signs of recovery at some injured colonies (Barren Islands, Puale Bay) but postspill population counts are still lower than prespill estimates and show no sign of recovery.~~

Recovery Objective

Common murres will have recovered when populations ~~trends are increasing significantly~~ at index colonies have returned to prespill levels and when productivity is sustained within normal bounds. ~~in the spill area and when reproductive timing and success are (Normal bounds will be determined by comparing productivity data with information from other murre colonies in the Gulf of Alaska and elsewhere.)~~

Cutthroat Trout

imply (lead to)

Injury and Recovery

Prince William Sound is at the northwestern limit of the range of cutthroat trout, and few stocks are known to exist within the sound. Local cutthroat populations rarely number more than 1,000 each, and the fish have small home ranges and are geographically isolated. Cutthroat trout, therefore, are highly vulnerable to exploitation, habitat alteration, or pollution. Following the oil spill, cutthroat trout in a small number of oiled index streams grew more slowly than in unoiled streams, possibly as a result of reduced food supplies or exposure to oil, and there is concern that reduced growth rates may reflect reduced survival. The difference in growth rates persisted through 1991. No studies have been conducted since then, and the recovery status of this species is not known. ~~Cutthroat trout have grown more slowly in oiled areas than in unoiled areas. Insufficient data are available to determine whether they are recovering.~~

Recovery Objective

similar

Cutthroat trout will have recovered when growth rates within oiled areas are ~~comparable~~ to those for unoiled areas, after taking into account geographic effects.

Designated Wilderness Areas

Injury and Recovery

The oil spill delivered oil in varying quantities to the waters adjoining the seven areas within the spill area designated by Congress as wilderness areas and wilderness study areas. Oil also was deposited above the mean high-tide line in these areas. During the intense clean-up seasons of 1989 and 1990, thousands of workers and hundreds of pieces of equipment were at work in the spill area. This activity was an unprecedented imposition of people, noise, and activity on the area's undeveloped and normally sparsely occupied landscape. Although activity levels on these wilderness shores have probably returned to normal, but at some locations there is still residual oil.

Recovery Objective

Designated wilderness areas will have recovered when oil is no longer encountered in these areas and the public perceives them to be recovered from the spill.

imply (or lead to)

DOLLY VARDEN

Injury and Recovery

Like the cutthroat trout, there was evidence that Dolly Varden ~~have grown~~ grew more slowly in oiled streams ~~areas~~ than in unoiled streams ~~areas~~, and there is concern that reduced growth rates reflect reduced survival. However, no data have been gathered since 1991, and the recovery status of this species is not known. ~~Insufficient data are available to determine whether they are recovering.~~

Recovery Objective

Dolly Varden will have recovered when growth rates within oiled streams ~~areas~~ are comparable to those ~~for~~ in unoiled streams ~~areas~~, after taking into account geographic effects.

Harbor Seals

Injury and Recovery

Harbor seal numbers were declining in the Gulf of Alaska, including in Prince William Sound, before the spill. An estimated 300 seals died in the sound as a direct result of the spill, and this was 6-15 percent of the prespill population. Postspill surveys in 19__ showed that seals in ~~the~~ oiled areas had declined by 43 percent, compared to 11 percent in ~~the~~ unoiled areas. Unfortunately, seals in both oiled and unoiled parts of Prince William Sound have continued to decline since the spill at an annual rate of about 6 percent. Possible factors for this long-term decline include disease and the amount or quality of food. ~~Counts made during the molt at trend count sites in Prince William Sound from 1990 to 1993 indicate that numbers may have stabilized. However, counts during pupping have continued to decline. It is not known which counts are the best indicator of population status. If the conditions that were causing the population to decline before the spill have improved, normal growth may replace the animals that were lost. However, if conditions continue to be unfavorable, the affected population may~~

~~continue to decline.~~ Harbor seals are a key subsistence resource in the oil-spill area ~~Prince William Sound~~. Subsistence hunting is ~~both~~ affected by the declining seal population and, in turn, may be affecting the recovery of harbor seals ~~status~~.

Recovery Objective

Recovery will have occurred when harbor seal population trends are stable or increasing.

HARLEQUIN DUCKS

Injury and Recovery

Harlequin ducks feed in intertidal and shallow subtidal habitats where most of the spilled oil was initially stranded. More than 200 harlequin ducks were found dead in 1989, mostly in Prince William Sound, and many more than that actually died throughout the spill area. Bile samples from harlequin ducks collected in eastern and western Prince William Sound in 1989-90 had higher concentrations of hydrocarbon metabolites than samples from harlequins collected at Juneau. Prespill data on harlequin populations and productivity are poor and complicated by possible geographic differences in habitat quality. However, the summer population in Prince William Sound is small, only a few thousand birds, and there continues to be concern about poor reproduction and a possible decline in numbers of molting birds in western versus eastern parts of the Sound. ~~There are indications of reduced densities of harlequin ducks in the breeding season; a declining trend in the summer, postbreeding population; and very poor production of young in western Prince William Sound.~~

Recovery Objective

Harlequin ducks will have recovered when breeding and postbreeding season densities and production of young return to ~~estimated~~ prespill levels. ~~or when there are no differences in these parameters between oiled and unoiled areas.~~ A normal population age- and sex-structure and reproductive success appropriate to the habitat in western Prince William Sound will indicate that recovery is underway.

Other opportunistic species such as a small Ehthamalus barnacle and oligochaete worms became more abundant at oiled shores in years after the spill.

INTERTIDAL ORGANISMS

Injury and Recovery

Portions of 1,500 miles of coastline were oiled by the spill, and both the oil and intensive clean-up activities had significant impacts on the flora and fauna of the intertidal zone, the area of beach between low and high tides. With tidal action, oil penetrated deeply into cobble and boulder beaches, and, even with intensive clean up activities, persists in some beaches today. The most significant impacts occurred in middle and upper intertidal zones on sheltered rocky shores, which is where the greatest amounts of oil were stranded.

Small invertebrates like limpets, ~~barnacles, and marine worms~~ periwinkles and balanoid barnacles were less abundant at oiled versus unoiled index sites in Prince William Sound, Kodiak Island, and on the Kenai and Alaska peninsula coasts. The size, coverage, and reproductive potential of seaweed *Fucus gardneri* (known as rockweed or popweed) also was reduced following the spill. Although numbers of many species ~~of invertebrate fauna~~ have increased following the spill, recovery of *Fucus* in the upper intertidal zone is lagging. Full recovery of *Fucus* is crucial for recovery of the intertidal ecosystem, since many invertebrates depend on the cover provided by this seaweed. Many intertidal resources are important to subsistence users, as well as to sea and river otters, black oystercatchers, harlequin ducks, and pigeon guillemots.

~~The lower intertidal zone and, to some extent, the middle intertidal zone are recovering. However, injuries persist in the upper intertidal zone, especially on rocky sheltered shores. Recovery of this zone appears to depend, in part, on the return of adult *Fucus* in large numbers.~~

Recovery Objective

~~Each intertidal elevation (lower, middle, or upper) will have recovered when community composition, population abundance of component species, age-class distribution, and ecosystem functions and services in each injured intertidal habitat have returned to levels that would have prevailed in the absence of the oil spill.~~ Intertidal communities will have recovered when community composition on oiled shorelines is similar to that which would have prevailed in the absence of the spill. Indications of recovery are the return of keystone species, such as *Fucus*, and provision of adequate, uncontaminated food supplies for top predators in intertidal and nearshore habitats.

KILLER WHALES

Injury and Recovery

About ___ killer whales in _ "resident" pods regularly use Prince William Sound within their ranges. Other whales in "transient" pods enter the Sound less frequently. There has been particular concern in Prince William Sound about the resident AB pod, which numbered 36 animals prior to the spill. Fourteen whales disappeared from this pod in 1989 and 1990, during which time no young were recruited into the population. Although four calves were added to the AB pod during 1992-94, surveys in 1994 and 1995 indicate the loss of five more whales.

any wish to address AT Transient pod ?

The link between these losses and the oil spill is only circumstantial, but the apparent mortality of killer whales in Prince William Sound following the spill far exceeds rates documented for pods in British Columbia and Puget Sound over the last 20 years. The AB pod may never regain its former size, but overall numbers of resident killer whales in Prince William Sound are at or exceed prespill levels. ~~Thirteen whales disappeared from one killer whale pod in Prince William Sound between 1988 and 1990. The injured pod is growing again.~~

Recovery Objective

Pending further evaluation of the status of the AB pod, no realistic recovery objective can be identified at this time. ~~Killer whales will have recovered when the injured pod grows to at least 36 individuals (1988 level).~~

~~Marbled~~ Murrelets, Marbled and Kittlitz's

Injury and Recovery

Prince William Sound and the northern Gulf of Alaska are key areas in the distributions of two poorly studied species of seabirds, marbled and Kittlitz's murrelets. The world population of Kittlitz's murrelet is believed to number only a few tens of thousands of birds, many of which are in the oil-spill area. The marbled murrelet is federally listed as a Threatened species in Washington, Oregon, and California; it is also listed as Threatened in British Columbia.

The marbled murrelet populations in Prince William Sound was ~~were~~ in decline before the spill. The causes of the prespill decline are unknown, but may be related to changing food supplies. The oil spill probably increased the prespill rate of decline for this species in the spill area, although the incremental injury is difficult to estimate. ~~The population of marbled murrelets may be stabilizing or even increasing since the spill.~~ Carcasses of nearly 1,100 murrelets were found after the spill, and it is estimated that as much as __ percent of the Prince William Sound marbled murrelet population was killed by the spill. Population estimates for murrelets are highly variable, and postspill boat surveys do not yet indicate any statistically significant increase in numbers of marbled murrelets in Prince William Sound. The recovery status of Kittlitz's murrelet is not known.

Recovery Objective

Marbled murrelets will have recovered when population trends are stable or increasing. No recovery objective can be identified for Kittlitz's murrelet at this time.

Mussels

and interstitial habitat

Injury and Recovery

Mussels are an important prey species in the nearshore ecosystem throughout the oil-spill area, and beds of mussels provide physical stability in the intertidal zone. For these reasons, mussel beds were purposely left alone during *Exxon Valdez* clean-up operations. In 1991, high concentrations of relatively unweathered oil were found in the mussels and underlying byssal mats in certain dense mussel beds. ~~In 1991, relatively high concentrations of oil were found in mussels and in the dense underlying mat (byssal substrate) of certain oiled mussel beds. The beds were not cleaned nor was oil removed after the spill. The~~ The biological significance of oiled mussel beds is not known, but they ~~Oiled mussel beds~~ are potential pathways of ~~sources of fresh (unweathered)~~ oil contamination for local populations of harlequin ducks, black oystercatchers, river otters, and juvenile sea otters, all of which feed to some extent on mussels and show some signs of continuing injury. ~~The extent and magnitude of oiled mussel beds are unknown.~~ At least __ [70-?] mussel beds in Prince William Sound are known to still have oil residue; 12 beds were cleaned on an experimental basis in 1994. Subsistence users also continue to be concerned about contamination from oil mussel beds.

Recovery Objective

Mussels will have recovered when they do not contaminate their predators. ~~their populations and productivity are at prespill levels and they do not contain oil that contaminates higher trophic levels.~~

The majority of the spawning adults returning in 1989 swam through oiled areas.

PACIFIC HERRING

Injury and Recovery

Pacific herring spawned in intertidal and subtidal habitats in Prince William Sound shortly after the oil spill. As much as 10 percent of the intertidal spawning habitat and 40 percent of the herring staging areas in the sound may have been contaminated by oil. Field studies conducted in 1989 and 1990 showed increased rates of egg mortality and larval deformities in oiled versus unoiled areas. Laboratory studies confirm that these effects can be caused by exposure to *Exxon Valdez* oil, but the significance of these injuries in the field at a population level is not known.

In 1992, herring biomass in Prince William Sound was at a record level. In 1993, however, there was an unprecedented crash of adult herring. A viral disease and fungus were the probable agents of mortality, and the connection between the oil spill and the disease outbreak is under investigation. Numbers of spawning herring in Prince William Sound have remained depressed through the 1995 season. Pacific herring are extremely important ecologically as well as commercially, and the closure of the herring fishery from 1993 through 1995 has had serious economic impact on people and communities in Prince William Sound.

~~Pacific herring studies have demonstrated egg mortality and larval deformities. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, the stocks and dependent fisheries in Prince William Sound are not healthy, as indicated by the~~

~~low spawning biomass in 1993 and 1994 and the resultant elimination of the fisheries in those years.~~

including abnormally high disease incidence

Recovery Objective

Pacific herring will have recovered when indicators of population health, such as reproduction, growth, and recruitment, are within normal bounds and free of oil-related effects within Prince William Sound. ~~populations are healthy and productive and exist at prespill abundances.~~

PIGEON GUILLEMOT

Injury and Recovery

Although the pigeon guillemot is widely distributed, nowhere does it occur in large numbers or concentrations. Because guillemots feed in shallow, nearshore waters, both they and the fish they prey on are vulnerable to oil pollution. Like the marbled murrelet, the pigeon guillemot population in Prince William Sound was in decline before the spill. The causes of the prespill decline are unknown. It is estimated that 10-15 percent of the Gulf of Alaska population may have died in the spill, and declines along oiled shorelines in Prince William Sound were greater than along unoiled shorelines. Numbers of guillemots recorded on boat surveys are highly variable, and there is not yet any statistically significant evidence of a postspill population increase. The factors responsible for the guillemot's prespill decline may negate or mask recovery from the effects of the oil spill.

Recovery Objective

Pigeon guillemots will have recovered when the populations in Prince William Sound is ~~are~~ stable or increasing.

PINK SALMON

Injury and Recovery

About 75 percent of wild pink salmon in Prince William Sound spawn in the intertidal portions of streams and were highly vulnerable to the effects of the oil spill. Hatchery salmon and wild salmon from both intertidal and upstream spawning habitats swam through oiled waters and ingested oil particles and oiled prey as they foraged in the sound and emigrated to sea. As a result, three types of early life-stage injuries were identified: First, growth rates in juvenile salmon from oiled parts of Prince William Sound were reduced. Second, there was increased egg mortality in oiled versus unoiled streams. A possible third effect, genetic damage, is under investigation.

In the years preceding the spill, returns of wild pink salmon in Prince William Sound varied from a maximum of 21.0 million fish in 1984 to a minimum of 1.8 million in 1988. Since the spill, returns of wild pinks have varied from a high of about 14.4 million fish in 1990 to a low of about 2.2 million in 1992. There is particular concern about the Sound's southwest district,

where returns of both hatchery and wild stocks have been generally weak since the oil spill. Because of the tremendous natural variation in adult returns, however, it is difficult to attribute poor returns in a given year to injuries caused by oil. Injuries to salmon eggs and juveniles remain the best indicators of injury and recovery.

Evidence of reduced juvenile growth rates was limited to the 1989 season, but increased egg mortality persisted in oiled compared to unoiled streams through 1993. The 1994 and 1995 seasons were the first since 1989 in which there were no statistically significant differences in egg mortalities in oiled and unoiled streams. These data indicate that recovery from oil-spill effects is underway.

The Sound Ecosystem Assessment (SEA) Project is exploring physical and biological oceanographic factors that influence production of salmon and herring. These natural factors are likely to have the greatest influence over year-to-year returns in both wild and hatchery stocks of pink salmon.

~~Pink salmon studies have demonstrated egg mortality, fry deformities, and reduced growth in juveniles. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, there is evidence of continued damage in some stocks from exposure to oil, and there were unexpectedly poor runs of both wild and hatchery stocks of pink salmon in Prince William Sound in 1992 and 1993. In 1994, runs were still depressed but exceeded forecasts.~~

Recovery Objective

Pink salmon will have recovered when population indicators, such as growth and survival, are within normal bounds and there are no statistically significant differences in egg mortalities in oiled and unoiled streams for two years each of odd- and even-year runs in Prince William Sound. ~~populations are healthy and productive and exist at prespill abundance. An indication of recovery is when egg mortalities in oiled areas match prespill levels or levels in unoiled areas.~~

River Otters

Injury and Recovery

River otters have a low density and an unknown population size in Prince William Sound, and, therefore, it is hard to assess oil-spill effects. Twelve otter carcasses were found following the spill. Studies conducted during 1989-1991 identified several differences between otters in oiled and unoiled areas in Prince William Sound, including biochemical evidence of exposure to hydrocarbons or other sources of stress, reduced diversity in prey species, reduced body size (length-weight), and increased territory size. However, sample sizes were small, and it is not clear that these differences are the result of the oil spill. The Nearshore Vertebrate Predator project, now underway, will shed new light on the status of the river otters. In 1995 the Alaska Board of Game used its emergency authority to restrict trapping of river otters in western Prince William Sound to ensure that the results of this study are not compromised by the removal of

animals from study areas on Montague and Knight Islands. ~~River otters in Prince William Sound have suffered sublethal effects from the spill and may continue to be exposed to hydrocarbons.~~

Recovery Objective

The river otter will have recovered when biochemical indices of hydrocarbon exposure or other stresses and indices of habitat use are similar between oiled and unoiled areas of Prince William Sound, after taking into account any geographic effects. ~~Indications of recovery are when habitat use, food habitats and physiological indices have returned to prespill conditions.~~

ROCKFISH

Injury and Recovery

Very little is known about rockfish populations in the northern Gulf of Alaska. Dead adult rockfish were recovered following the oil spill, and chemical analysis of five specimens indicated that oil ingestion was the cause of death. Analysis of other rockfish showed exposure ~~were exposed~~ to hydrocarbons and ~~showed~~ sublethal effects. ~~Furthermore~~ In addition, closures to salmon fisheries apparently increased fishing pressures on rockfish, which may have affected ~~be affecting their~~ the rockfish population. However, the original extent ~~and mechanism~~ of injury and the current status of ~~to~~ this species are unknown.

Recovery Objective

Without further study, ~~a~~ recovery objective cannot be defined.

SEA OTTERS

Injury and Recovery

Surveys of sea otters in the 1970s and 1980s indicate that the population was expanding and about 10,000 animals lived in Prince William Sound prior to the spill. Based on the number of carcasses and other data, population models suggest that 3,500-5,500 otters died in the first few months following the spill. In 1990 and 1991, unusual numbers of prime-age adult otters were found dead and there was evidence of an increased death rate in recently weaned juveniles. By 1992-93, mortality rates for juveniles had decreased, but were still higher in oiled than in unoiled parts of Prince William Sound. Boat surveys conducted in March and July in 1993 and again in 1994 indicated a population of about 7,700 otters in the Sound, but there was no statistically significant evidence of a population increase following the spill (1990-1994). The Nearshore Vertebrate Predator project, which was started in 1995, should help clarify the recovery status of the sea otter in Prince William Sound. ~~Sea otters do not appear to be recovering, but are expected to eventually recover to their prespill population. Exactly what population increases would constitute recovery is very uncertain, as there are no population data from 1986 to 1989, and the population may have been increasing in Eastern Prince William Sound during that time. In addition, only large changes in the population can be reliably detected with current measuring techniques. However, there are recent indications that the patterns of~~

overwintering

~~juvenile and mid aged mortalities are returning to prespill conditions.~~

Recovery Objective

Sea otters will have recovered when the Prince William Sound population returns to its prespill abundance and distribution. An increasing population trend and normal reproduction and age structure in oiled parts of the sound will indicate that recovery is underway. ~~Sea otters will be considered recovered when population abundance and distribution are comparable to prespill abundance and distribution, and when all ages appear healthy.~~

SEDIMENTS

Injury and Recovery

With tidal action, oil penetrated deeply into cobble and boulder beaches that are ~~relatively~~ common on ~~the rocky islands of~~ shorelines throughout the spill area, especially in sheltered habitats. Cleaning removed much of the oil from the intertidal zone but subsurface oil persisted in many heavily oiled beaches and associated subtidal sediments. ~~in mussel beds, which were avoided during the cleanup.~~ Subsurface oil persists at least at ___ locations in Prince William Sound and as far away as the Alaska Peninsula. While much of this oil is probably not biologically active, it is of great concern to residents in oil-spill communities, and there are sites where sheening still occurs.

Following the oil spill, chemical analyses of oil in sediments were conducted at a small number of index sites in Prince William Sound. At these sites, oil in sediments reached its greatest concentrations at water depths of 20 meters, although elevated levels of hydrocarbon-degrading bacteria (associated with elevated hydrocarbons) were detected at depths of 40 and 100 meters in 1990 in Prince William Sound. ~~Chemical analyses show that *Exxon Valdez* oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases.~~ By 1993, however, there was little evidence of *Exxon Valdez* oil and related microbial activity at most index sites in Prince William Sound, except at those associated with sheltered beaches that were heavily oiled in 1989. These index sites--at Herring, Northwest, and Sleepy bays--were among the ___ at which subsurface oiling is still known to occur (see above).

Recovery Objective

Sediments will have recovered when ~~contamination causes no negative effects to the spill ecosystem~~ residues of subsurface oil at sheltered sites that were previously heavily oiled are declining or are biologically harmless.

SOCKEYE SALMON

still not recovered, especially if it is a wilderness area or a land of special cultural/recreational significance.

Injury and Recovery

Commericial fishing was closed in portions of Cook Inlet and near Kodiak in 1989 to avoid any possibility of contaminated salmon being sent to market. As a result, there were higher-than-usual numbers (i.e., overescapement) of spawning fish entering the Kenai River, Red and Akalura lakes on Kodiak Island, and other lakes on Afognak Island and the Alaska Peninsula. Initially these high escapements may have produced an overabundance of juvenile sockeye that consumed huge quantities of zooplankton, thus destroying planktonic food webs in the nursery lakes. Although the exact mechanism is unclear, the result was lost sockeye production as shown by declines in the returns of adults per spawning sockeye.

The effects of the 1989 overescapement have persisted in the Kenai River system through 1995. Although the overall escapement goal for that system was met in 1995, there is concern that the initial overescapement will continue to affect post-spill year-classes and that sockeye returns are yet not sufficient to fulfill the commericial, recreational, and subsistence demands on sockeye salmon in the Kenai River system.

Production of zoolplankton in both Red and Akalura lakes on Kodiak Island has returned to normal. There continues to be some problem in the rate of production of sockeye fry in Red Lake, which may or may not be linked to the overescapement at the time of the oil spill. Continuing low adult escapements at Akalura Lake are more likely the result of a mixed stock fishery harvest in the Kodiak vicinity than a result of the earlier overescapement.

~~Sockeye salmon in Red Lake, Akalura Lake, and lakes in the Kenai River system declined in population because of adult overescapement in 1989. The Red Lake system may be recovering because the plankton has recovered and fry survival improved in 1993. However, Akalura Lake and the Kenai River lakes have not recovered: smolt production has continued to decline from these lakes. In the Kenai River lakes, for example, smolt production has declined from 30 million in 1989 to 6 million in 1990 and to less than 1 million in 1992 and 1993.~~

Recovery Objective

Sockeye salmon in the Kenai River system and Red and Akalura lakes will have recovered when adult returns-per-spawner are within normal bounds. ~~affected lakes will have recovered when populations are able to support overwinter survival rates and smolt outmigrations comparable to prespill levels.~~

Subtidal Organisms

Injury and Recovery

Oil that was transported down to subtidal habitats apparently caused changes in the size and species composition of plant and animal populations below lower tides. Different habitats, including eelgrass beds, kelp beds, and deep water, were compared at oiled and unoiled sites. The greatest effects were detected at oiled sites with sandy sea bottoms under eelgrass beds, at which there were reduced numbers and diversity of helmet crabs, amphipods, and other

Sedimentary

crustaceans and mollusks. There also were sublethal effects on the eelgrass itself. Organisms living in sediment at depths of 3-20 meters were especially affected. Some opportunistic, such as *Musculus* mussels, a variety of polychaetes, and juvenile cod, apparently increased in numbers at oiled sites. Differences in oiled and unoiled sites were less evident by 1993.

~~Certain subtidal organisms, like eelgrass and some species of algae, appear to be recovering. Other subtidal organisms, like leather stars and helmet crabs, showed little signs of recovery through 1991.~~

Recovery Objective

Subtidal communities will have recovered when community composition in oiled areas, especially in association with eelgrass beds, is similar to that which would have prevailed in the absence of the spill. Indications of recovery are the return of keystone species, such as certain amphipods and other oil-sensitive crustaceans. ~~Subtidal communities will have recovered when the community composition, age-class distribution, population abundance of component species, and ecosystem functions and services in each injured subtidal habitat have returned to levels that would have prevailed in the absence of the oil spill.~~

Services

Commercial Fishing

Injury and Recovery

Commercial fishing is a service that was injured through injury to commercial fish species ~~(see individual resources)~~ and also through fishing closures. ~~In 1989, closures affected fisheries in~~ Prince William Sound, lower Cook Inlet, upper Cook Inlet, Kodiak, and Chignik. These fisheries opened again in 1990. Since then, there have been no spill-related district-wide closures, except for the Prince William Sound herring fishery, which was closed in 1993 and has remained closed since then due to the collapse of the herring population. These closures, including the on-going closure of the herring fishery in Prince William Sound, harmed the livelihoods of persons who fish for a living and the communities in which they live. To the extent that the oil spill continues to be a factor that reduces opportunities to catch fish, there is on-going injury to commercial fishing as a service.

On this basis, the Trustee Council continues to make major investments in projects to understand and restore commercially important fish species that were injured by the oil spill. These projects include: supplementation work, such as fertilizing Coghill Lake to enhance its sockeye salmon run and construction of a barrier bypass at Little Waterfall Creek; development of tools that have almost immediate benefit for fisheries management, such as otolith mass marking of pink salmon in Prince William Sound and in-season genetic stock identification for sockeye salmon in Cook Inlet; and research such as the SEA Project and genetic mapping which will enhance the ability to predict and manage fisheries over the long-term.

~~Continuing injuries to commercial fishing may cause hardships for fishermen and related businesses. Each year that commercial fishing remains below prespill levels compounds the injury to the fishermen and, in many instances, the communities in which they live or work.~~

~~The Trustee Council recognizes the impact to communities and people of the Prince William Sound region resulting from the sharp decline in pink salmon and herring fisheries in past years. In 1994, the Trustee Council committed over six million dollars to help address these issues through the development of an ecosystem based study for Prince William Sound. Some of the pink salmon and herring problems may be unrelated to the spill. However, the Council will continue to address these important problems.~~

Recovery Objective

Commercial fishing will have recovered when the commercially important fish species have recovered and opportunities to catch these species are not lost or reduced due to effects of the oil spill. population levels and distribution of injured or replacement fish used by the commercial fishing industry match conditions that would have existed had the spill not occurred. Because of the difficulty of separating spill-related effects from other changes in fish runs, the Trustee Council may use prespill conditions as a substitute measure for conditions that would have existed had the spill not occurred.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

The primary method for restoring commercial fishing is to restore the species that are fished commercially, such as pink salmon, Pacific herring, and sockeye salmon. These species are discussed elsewhere in this chapter. Three additional parts of the strategy for restoring commercial fishing are the following:

Promote recovery of commercial fishing as soon as possible. Many communities that rely on commercial fishing will be significantly harmed while waiting for commercial fish resources to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of commercial fishing. This objective may be accomplished through increasing availability, reliability, or quality of commercial fish resources, depending on the nature of the injury. For resources that have sharply declined since the spill, such as pink salmon, and Pacific herring in Prince William Sound, this objective may take the form of increasing availability in the long run through improved fisheries management. Another example is providing replacement fish for harvest.

Protect commercial fish resources from further degradation. Further stress on commercial fish resources could impede recovery. Appropriate protection can take the form of habitat protection and acquisition if a resource faces loss of habitat. The Trustee Council can also contribute to the protection of commercial fish species by providing information needed to improve their management.

Monitor recovery. Monitoring the recovery of commercial fishing will track the progress of

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

Passive Use

Injury and Recovery

Passive use of resources includes the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other nonuse values. Injuries to passive uses are tied to public perceptions of injured resources. [NOTE: THIS SAYS ALMOST NOTHING ABOUT INJURY. IS THERE ANYTHING TO SAY? PERHAPS A REFERENCE TO THE VALUATION SURVEYS DONE FOLLOWING THE SPILL?]

Recovery Objective

Passive uses will have recovered when people perceive that aesthetic and intrinsic values associated with the spill area are no longer diminished by the oil spill.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

Any restoration strategy that aids recovery of injured resources, or prevents further injuries, will assist recovery of passive use values. No strategies have been identified that 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.

this is the key point here for addressing perceptions

Recreation and Tourism

Injury and Recovery

The spill disrupted use of the spill area for recreation and tourism. Resources important for wildlife viewing and which are still injured by the spill include killer whale, sea otter, harbor seal, ~~bald eagle,~~ and various seabirds. Residual oil exists on some beaches with high value for recreation, and its presence may decrease the quality of recreational experiences and discourage recreational use of these beaches.

Closures of sport hunting and fishing also affected use of the spill area for recreation and tourism. Sport fishing resources include salmon, rockfish, Dolly Varden, and cutthroat trout. The Alaska Board of Fisheries restricted sport harvest of cutthroat trout in Prince William Sound in 1991 [?], and those restrictions remain in place. Harlequin ducks are hunted in the spill area. The Alaska Board of Game restricted sport harvest of harlequin ducks in Prince William Sound in 1991, and those restrictions remain in place.

Recreation was also affected by changes in human use in response to the spill. For example, displacement of use from oiled areas to unoiled areas increased management problems and facility use in unoiled areas. Some facilities, such as the Green Island cabin and the Fleming Spit camp area, were injured by clean-up workers.

In the years since the oil spill, there has been a general, marked increase in visitation to the spill area. There are still locations within the oil-spill area, however, avoided by recreational users because of the presence of residual oil.

Recovery Objective

Recreation and tourism will have recovered, in large part, when the fish and wildlife resources on which they depend have recovered, recreation use of oiled beaches is no longer impaired, and facilities and management capabilities can accommodate changes in human use.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

Preserve or improve the recreational and tourism values of the spill area. Habitat protection and acquisition are important means of preserving and enhancing the opportunities offered by the spill area. Facilities damaged during cleanup may be repaired if they are still needed. New facilities may restore or enhance opportunities for recreational use of natural resources. Improved or intensified public recreation management may be warranted in some circumstances. Projects that restore or enhance recreation and tourism would be considered only if they are consistent with the character and public uses of the area. However, all projects to preserve and improve recreation and tourism values must be related to an injured natural resource. See Policy 9 in Chapter 2.

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

Monitor recovery. Monitor the recovery of resources used for recreation and tourism. Also monitor changes in recreation and tourism in the spill area.

SUBSISTENCE

Injury and Recovery

Before the oil spill, the Alaska Department of Fish and Game had documented 15 Native Alaskan communities (with about 2,200 people) in Prince William Sound, lower Cook Inlet, Kodiak, and the Alaska Peninsula that relied heavily on subsistence resources, such as fish, shellfish, seals, deer, and waterfowl. Per capita subsistence harvest ranged from nearly 200 pounds to more than 600 pounds per year. Subsistence harvests of fish and wildlife in most of these villages declined substantially following the oil spill. The reasons for these declines included reduced

availability of fish and wildlife to harvest, concern about possible health effects of eating contaminated or injured fish and wildlife, and disruption of lifestyles due to clean-up and other activities.

Subsistence foods were tested for evidence of hydrocarbon contamination during 1989-1994, and the results indicated that most resources contained no or very low concentrations of petroleum hydrocarbons. Eating foods with low levels of hydrocarbons posed no risk to human health, although subsistence users were advised not to eat shellfish from obviously contaminated areas. Samples of ducks from the Chenega Bay area in 1994 showed that exposure to crude oil had decreased significantly compared to the exposure levels documented since 1990.

Residual oil exists on some beaches near subsistence communities, and, in general, there continues to be concern or at least uncertainty about the safety of fish and wildlife resources. Uncertainty about the safety of resources reduces their use and value for subsistence.

Surveys by the Alaska Department of Fish and Game indicate that in some communities subsistence resources appear to be harvested at prespill levels based on total pounds-per-person. It is important to note, however, that the composition of many diets has shifted to include more fish and fewer seals. Diet composition continues to be a serious concern to subsistence users.

Subsistence users say that maintaining their subsistence culture depends on uninterrupted use of fish and wildlife resources. The more time users spend away from subsistence activities, the less likely that they will return to these practices. Continuing injury to natural resources used for subsistence may affect the way of life of entire communities. There is particular concern that the oil spill disrupted opportunities for young people to learn subsistence culture, and that this knowledge may be lost to them in the future.

Recovery Objective

Subsistence will have recovered when injured resources used for subsistence are healthy and productive and exist at prespill levels. In addition, there is recognition that people must be ~~and when people are~~ confident that the resources are safe to eat~~. One indication that recovery has occurred is when~~ and that the cultural values provided by gathering, preparing, and sharing food need to be ~~are~~ reintegrated into community life.

[NOTE: THE FOLLOWING HAS NOT BEEN REVISED.]

Restoration Strategy

The primary way of restoring subsistence is to restore injured resources used for subsistence, such as clams, harbor seals, Pacific herring, pink salmon, sea otters, and sockeye salmon. These are discussed elsewhere in this chapter. Four additional parts of the strategy to restore subsistence are the following:

Promote recovery of subsistence as soon as possible. Many subsistence communities will be significantly harmed while waiting for resources used for subsistence to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of subsistence use. This objective may be accomplished through increasing availability, reliability, or quality of resources used for subsistence, or increasing the confidence of subsistence users. Specifically, if subsistence harvest has not returned to prespill levels because users doubt the safety of particular resources, this objective may take the form of increasing the reliability of the resource through food safety testing. Other examples are the acquisition of alternative food sources and improved use of existing resources. However, all projects to promote subsistence must be related to an injured natural resource. See Policy 9 in Chapter 2.

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

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

Monitor recovery. Monitor the recovery of resources used for subsistence. Also monitor subsistence harvest.

Core Reviewers Meeting
January 21, 1996

Draft Agenda

I. Annual Meeting and SEA Review

II. Revision of Chapter 5 of the Restoration Plan

III. FY97 Invitation

IV. Synthesis and Integration of EVOS Scientific Studies

V. Other business

21.1.2D

United States Department of the Interior

NATIONAL PARK SERVICE
Alaska Regional Office
2525 Gambell Street, Room 107
Anchorage, Alaska 99503-2892

IN REPLY REFER TO:

N36(AKSO-REQ)

January 10, 1996

Memorandum

To: Stan Senner, EVOS Restoration Office Science Coordinator

From: Bud Rice, NPS Liaison to EVOS Restoration Office Bud Rice

Subject: Comments on Preliminary Draft of Chapter 5 (Recovery Objectives)

Thank you for the opportunity to comment of the proposed wording of the Exxon Valdez Oil Spill Restoration Plan chapter on injury status and recovery objectives. In general the changes streamline and clarify the document. I have a few suggestions. I apologize for not getting these comments to you sooner. The recent federal furlough has hampered my ability to respond earlier. Comments are given below.

Some of this was carefully negotiated to begin with. And I need to be careful about changing.

Table 1. Injured Resources: Mussels are intertidal organisms, yet they are listed separately under the "Recovering" category. If we wish to keep them separate, then I suggest we note after intertidal organisms that this category does not include mussels.

Table 1, Page 2: The categories "Other" and "Services" just hang there without any connection to recovery status. The "other" category is confusing because it is not a biological resource or service. However, sediment is a geological resource, and our definition of "injured resource" need not be limited to biological forms. I recommend that sediment be put in with injured resources. Archeological resources and wilderness could be put in with services where they were considered in the habitat evaluations. Archeological resources were considered as a subset of cultural resources including archeological and historic properties.

possibly

Page 1, Resource list: Should Designated Wilderness Areas be listed as a resource or service?

Page 2, Objectives, Paragraph 2, Last three sentences: This discussion focuses on resources and omits consideration of services and "other". I recommend revising these sentences to clarify this somewhat. I suggest:

Will look at this later

> For resources where some prespill data are available, there can also be uncertainty associated with interpreting the significance of prespill population data because populations undergo natural fluctuations. Indicators of resource recovery include

increased numbers of individuals, reproductive success, improved growth and survival rates, and normal age and sex composition of the injured population.

I've made some changes to partly incorporate your suggestions and those of Ted Birkedal

Page 5-6, Archeological Resources: This section appears to downplay the suspected injury. See documents produced for the workshop "Five Years Later, 1994 What Have We Learned? EVOS Forum" and the 1994 EVOS Status Report. Sections on Archeological Resources note that the spill area is estimated to contain over 3,000 sites of archeological and historic significance. Though 24 are known to have been adversely affected as a result of EVOS, it is estimated that over 100 sites were similarly affected. Oil samples from the 2 of 14 sites have been analyzed, but not yet interpreted. In other words, lab analyses have been completed.

don't know

Page 7, Bald Eagles: This section, as others, waffles between discussion of the spill-wide area and Prince William Sound. I recommend starting with the spill-wide perspective then necking down to PWS. How many eagles are supported in the entire spill-affected region? Wasn't the 250 or so dead bald eagles from the entire spill-affected area? Could there have been other sublethal affects to bald eagles other than reduced productivity that were not detected?

No - only PWS

I've made some changes here

Page 7, Black Oystercatchers: This section properly starts with the spill-wide perspective and narrows to considerations in PWS.

Page 8, Common Loons, Recovery Objective: A recovery objective could be written now, but it would not be very accurate or effective. I recommend revising the statement slightly to:

I've made some change here, but do not want to use words that invite new proposals

More information is needed on injury to common loons and their recovery status is needed before a recovery objective can be articulated.

Only 30,000 of oiled birds. Other carcasses reflected other sources of mortality.

Page 8, Common Murres, Line 1: I thought over 36,000 carcasses of oiled birds were retrieved, or does that number include animals in addition to birds? Also, line 4, delete the first "at".

Page 9, Common Murres, Recovery Objective: The phrase "normal bounds" is vague. I found the former definition helpful. It seems that the term "level" would be better than "bounds", which connotes area more than population. "Level" implies something that is static; bounds implies a range of values, which is more appropriate for a natural system.

If the original studies had considered geographic variation in growth rates, we may have concluded that there was no injury to begin with.

Page 10, Dolly Varden, Recovery Objective: What exactly do we mean by the phrase "after taking into account geographic effects", and how is this accomplished?

The post-spill survey referred to computed 1989 to 1988.

Page 10, Harbor Seals: Did any seal deaths occur outside PWS as a result of EVOS? Sentences 3 and 4 are a bit confusing. If the postspill surveys were conducted in 1991, then an 11% drop in harbor seal numbers is about 6%/year after the 1989 spill. It would take 7 years to make a 43% drop in harbor seal numbers in oiled areas at a rate of 6%/year. Does the writer intend to state that since the 19__ postspill surveys, harbor seal populations in both oiled and unoiled areas continue to drop about 6%/year? Yes, for period of 1989-1994.

Page 11, Harlequin Ducks: P450 measurements were high for harlequin ducks at Chief Cove on Kodiak Island after EVOS too. Should we ignore the effects outside the sound? Also, it needs

Kodiak data now mentioned w/ contaminant data from PWS, but this is weak stuff. The "control" sample from Juneau was tiny.

to be emphasized somewhere that the spill occurred in early spring prior to out migration of harlequin ducks to their breeding grounds, so populations and reproduction of harlequin ducks outside of PWS may have been adversely affected too.

I have added this thought

Page 13, Killer Whales: The wording in this section seems slightly biased or overly cautious. Were the losses measured in British Columbia "apparent mortality" or documented deaths? I recommend deleting the word "only" before circumstantial, and replacing the phrase "apparent mortality" with **reduction**.

I deleted this term in reference to BC.

mortality can only be inferred.

Page 13, Killer Whale, Recovery Objective: Can we find a better word than "realistic" to describe an appropriate recovery objective? What is our goal, a short-term realizable recovery objective, or something else? I think we should consult carefully with the PIs on Killer Whales to define a "reasonable" recovery objective.

Monitor demise of AB pod?

They'll have their chance at the workshop.

If the AB pod is disintegrating, I don't know of a realistic ~~goal~~ objective.

Page 13, Murrelets: I don't know if "poorly studied" is the best descriptor; how about "poorly known"? The studies conducted recently were well done, it's just that not many studies of this secretive genus have been conducted. Also, Prince William Sound is a subset of the northern Gulf of Alaska. So, I recommend rewriting the first sentence to state something like:

> The northern Gulf of Alaska, including Prince William Sound, is a key area in the distributions of the poorly known marbled and Kittlitz's murrelets.

OK

In paragraph 1, give the % of Kittlitz's murrelets estimated to occur in the spill-affected area. Also, the Marbled Murrelet is a "Species of Concern" in Alaska. (It was formerly listed as a category 2 species for threatened and endangered status in Alaska before that list was put away.) I recommend deleting the word "prespill" before rate of decline in paragraph 2, line 3. Also, other types of murrelets perished in the spill (parakeet and ancient), so I recommend inserting the term Brachyramphus between 1,000 and murrelets.

not known with any confidence

whose list?

OK

Page 14, Mussels, Recovery Objective: This recovery objective seems too narrow. The previous phrase "do not contain oil that contaminates higher trophic levels" seems better. Also, mussels may contaminate predators by some means other than EVOS oiling.

The mussels themselves have never been a concern.

There are problems with this wording, but I've made some changes.

The evidence is no better or worse than for murrelets!

Page 15, Pigeon Guillemot: If survey numbers have been so variable, how can we state with any certainty that guillemots were in decline before the spill? What we do have are morgue counts of guillemots and the subsequent estimated population losses. So, the loss is more certain than any prespill decline or post spill recovery. This section, as with other sections, focuses on PWS and ignores impacts outside the sound. When did we ever determine that pigeon guillemot populations in the spill-affected area outside PWS were stable or increasing?

Not true. Decline mentioned is for GOA!

who said they were?

PWS will have to be a proxy for overall recovery.

Page 18, Sediments, Paragraph 1, Line 5: Replace "at least at" with **in at least.**

OK

Page 22, Passive Use, Injury and Recovery: I strongly endorse reference to the valuation surveys to define injury.

I suspect that others (i.e., legal counsel) will object.

At this point, I've not touched strategies for the services.

Page 22, Passive Use, Restoration Strategy: As we discussed at the retreat yesterday, I think more is needed than available scientific information, but the active outreach to and education of the public.

Page 22, Recreation and Tourism, Injury and Recovery, Paragraph 2: Affects to trapping of river otter are also being felt now. Does this fall into this category or under a commercial use or subsistence category?

probably.

FAX TRANSMISSION

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To: Stan Senner
Fax #: 276-7178

Date: 1/10/96
Pages 2, including this cover sheet.

From: Buddy Goatcher

Subject: HADU recovery objectives

Stan -

Denny + I included are in part in the following draft. Thanks!

Bud

cc: Ebbin Rice, Berg over e.mail

HARLEQUIN DUCKS

Injury and Recovery

Harlequin ducks feed in intertidal and shallow subtidal habitats where most of the spilled oil was initially stranded. More than 200 harlequin ducks were found dead in 1989, mostly in Prince William Sound, and many more actually died throughout the spill area. Contaminant samples from harlequin ducks collected from western Kodiak Archipelago and Prince William Sound post-spill had higher concentrations of hydrocarbon metabolites than samples from harlequins collected outside the spill affected area. Prespill data on harlequin populations and productivity are poor and complicated by possible geographic differences in habitat quality. However, the summer populations in spill affected areas in Prince William Sound and the Gulf of Alaska are small, only a few thousand birds, and there continues to be concern about poor reproduction and a possible decline in numbers of molting birds in all areas.

Recovery Objective

Harlequin ducks will have recovered when breeding and postbreeding season densities and production of young return to prespill levels for those spill affected areas where pre-spill data are available. For those spill affected areas where pre-spill data are not available recovery will be assumed to have been achieved when populations and breeding indices are increasing, concurrently with no statistical differences being found between population density and productivity indices of the oiled areas as compared to unoiled areas of like habitat. Because of the wide spread impacts of the spill over a large area of shoreline in Prince William Sound and the Gulf of Alaska several differing habitats holding harlequin ducks are impacted. A normal population-age-sex structure and reproductive success appropriate to the local habitat of each spill affected area will indicate that recovery is underway.

Comments on Draft Injury Status and Recovery Objectives

Archeological Resources

by

Ted Birkedal
National Park Service

The first part of this status report appears to ignore earlier reports(see Five Years Later: What Have We Learned and the Status Report for 1994). Our specific comments follow:

1. p.1, para. 1, first sentence: This sentence is misleading as written. It appears to imply that only 24 sites were injured. The 24 sites represent known sites that have yielded confirmed evidence of injury; they do not represent the entire universe of adversely impacted sites on public land in the oil spill area of effect. At no time have the Trustees funded a study to discover all or most of the injured archeological sites. Statistical studies suggest that over 100 additional sites experienced similar levels of injury. We suggest adding a second sentence, similar to one that appeared in the 1994 status report--"It is estimated that over 100 additional sites on public land were similarly affected during the course of the spill event."

2. p.6, para. 3: It would be helpful to provide some context to this injury data so it can be meaningfully interpreted by the public. If the historic preservation process and other protective constraints had not been put into place in 1989 the level of injury would have probably been significantly greater. This is an important lesson. Thus, we would suggest adding the following at the end of the third paragraph: "The majority of injuries to archeological sites occurred early in 1989, prior to the emplacement of what proved to be a very effective system of historic preservation contraints and protective actions. This system of constraints successfully limited injury to archeological sites from vandalism and oil spill cleanup actions in the subsequent months and years."

3. p.6, para. 3, last sentence: The Auke Bay Laboratory Report(1995) on sediment samples taken from two archeological sites in the oil spill study area show mixed results. All sediment samples from one site produced hydrocarbons that are "probably derived from spilled Exxon Valdez oil; the samples from the other site yielded oil but the hydrocarbon analytes were "too frequently below detection limits to identify sources." Other samples were collected, but these were not sent in for analysis because sample control or curation problems would make the results questionable.

We would suggest changing the wording of the last sentence to something like--"Oil was visible in the intertidal zones of two the 14 sites monitored in 1993, and hydrocarbon analysis has shown that the oil at one of the sites was most probably derived from the spilled Exxon Valdez oil. Hydrocarbon levels at the second site were not sufficient to permit identification of the source or sources of the oil."

21.1.2C

Exxon Valdez Oil Spill Trustee Council

Restoration Office
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Phone: (907) 278-8012 Fax: (907) 276-7178

MEMORANDUM

To: Restoration Work Force
Agency Liaisons
Legal Counsel

From: Molly McCammon
Executive Director

Re: Preliminary Revised Draft of Chapter 5 (Recovery Objectives)

Date: December 29, 1995

Pages 5 and 32 of the Restoration Plan note that the plan is a dynamic document, subject to updating based on new information. On that basis, I have attached for your review a preliminary revised draft of Chapter 5 of the Restoration Plan. The next step in this process is for agency staff to review this at a macro level in order to identify areas where you believe there may be significant errors in fact or concept. It would be helpful if you could return your comments to Stan Senner by January 9, the date of the next meeting of the Restoration Work Force.

Based on your comments and concerns, we will produce another, revised draft, which will be distributed to participants in the 1996 Restoration Workshop. This draft will be among the materials handed out at the workshop registration table on January 16th.

These revised recovery objectives will be discussed at the workshop in breakout sessions on Thursday, January 18th, and with the core peer reviewers before they leave Anchorage. Based on this feedback, the Restoration Office staff will then make additional revisions and copies will be circulated to you and the Trustees. I will looking for the Trustees' "informed consent" so that this can be sent out for public comment in February, along with the FY 1997 Invitation. Following public comment, a final version will be prepared for Trustee Council action, probably at the same time as they consider the FY 1997 Work Plan.

The primary focus of this revised Chapter 5 is on Injury Status and Recovery Objectives. We propose to delete the generic discussion of strategies, which is badly out of date, as well as the resource-specific strategies, which are better covered (and updated) through the annual Invitations. We propose to retain the strategies for the

services, although they may still need to be revised. With respect to the status of Injury and Recovery, the discussion for each resource is opened with a statement or two of context and a description of why the resource or service originally was considered to be injured. Each discussion is closed with a few sentences regarding current status. In regard to the Recovery Objectives, the goal was to identify a goal that is realistic and measurable, given what we know about a resource or service's current status.

An earlier draft of this document was reviewed by Dr. Spies and the core peer reviewers, but please identify where more work may be needed. Do not worry now about editorial details, although such comments are always welcome. Thank you for your help with this. Give Stan or me a call if you have any questions.

enclosure (1)

cc: Robert Spies
Core peer reviewers