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Chapter III.B.(7)(a) Injured Services

a. Archeological Sites and Artifacts

SUMMARY

The oil spill area has been home to Native peoples for at least 11,000 years and it also provided a geographical backdrop to much of Alaska's early history in the post-European contact era (Mobley 1990:55). Although not well studied, compared to other areas of Alaska, a draft cultural resource assessment study by Dekins et al. (1992:v) estimates that the oil spill area contains between 2600 and 3137 historic properties, including 1287 known sites, recorded in the Alaska Heritage Resources Survey.

An estimated 60 archeological sites were subjected to moderate to heavy oiling, and an estimated total of 155 sites were exposed to at least some degree of oiling. A conservative projection by McAllister (1992:43), based on the pattern of known injury to archeological sites documented by Jesperson and Griffin (1992:7-8), indicates that approximately 130 to 150 archeological sites have been adversely affected by oiling, clean-up activities, or looting and vandalism linked to the *Exxon Valdez* oil spill event. Of these 130 to 150 archeological sites, an estimated 113 suffered substantive injury as a consequence of either beach clean-up actions or vandalism (McAllister 1992:43).

INJURY

Injuries to archeological sites have clearly resulted from oil spill response and looting and vandalism. Important surface artifact distributions have been altered, subtle clues that archeologists use to identify and classify sites have been masked or eliminated, key diagnostic artifacts have been illegally collected, ancient burials have been violated, potholes dug by looters have destroyed critical evidence contained in subsurface archeological strata, and disturbed and trampled vegetation may have exposed sites to accelerated erosion. The effect of oil on archeological soil chemistry and organic remains that are dateable by means of radiocarbon dating is more problematic (Dekins et al. 1992; Mifflin and Associates 1991; Reger et al. 1992). Hard evidence of injury from the presence of the oil itself cannot be demonstrated at this time; yet, on the other hand, injury from this source cannot be entirely ruled out. Only further inquiry will resolve the question.

Some injuries, particularly looting and vandalism, are continuing to occur many years subsequent to the original oil spill event. Both looting and vandalism are on the rise in the spill area and are attributed to the *Exxon Valdez* oil spill.

RECOVERY

Archeological sites cannot recover in the same sense as biological species or organisms. They represent a category of finite, non-renewable resources. Injury to resources of this type results not only in the loss of important scientific data about the past, but also in an irrevocable loss of Alaska's cultural heritage. Restoration, therefore, cannot regenerate what has been destroyed, but it can successfully address the prevention of further degradation and loss of both sites and the scientific information they contain. Documentation of disturbed and vandalized sites can also partially recover and compensate for the data lost through injury.

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Option #1.0 - Site Stewardship

This concept involves the recruitment, training, coordination, and maintenance of a corps of local interested citizens to watch over threatened archeological sites located within their home districts. The option best addresses the injuries, which continue to occur, as a result of looting and vandalism. Local citizens' groups, Native villages and corporations will be brought into the program as cooperators to facilitate communications and operations. The Trustee Council began work on this option by approving a project for a Site Stewardship program in February 1992. However, to yield any beneficial results, the project must be carried out over several years.

Option #10.0 - Preservation of Archeological Sites and Artifacts

This option has three components. First, to conduct individual, site-specific restoration assessments at sites with documented injury, but where there is insufficient information upon which to determine appropriate treatment.

Second, to carry out the indicated restorative action -- either physical repair and/or data recovery. The initial focus would include the 24 archeological sites for which there is clear evidence of injury. This option addresses all types of oil spill injuries.

Third, after treating a known injury, the project would expand to identify other injured sites and apply appropriate treatment as indicated. This search effort will employ a stratified-random survey methodology to target the work toward the most likely zones to contain injured archeological sites in need of restorative treatment. It is important to emphasize, here, that the bulk of injury data, to date, derives from a study of oil spill response records; a comprehensive, independent assessment of injury has

never been conducted. The last component of this restoration project will address the problematic question of long-term injury from oiling. Ten known sites that have been exposed to heavy to moderate oiling will be monitored and sampled for a period of 10 years to determine the effect of oil on archeological soil chemistry, radiocarbon dating, and protective vegetation.

Option #35.0 - Replacement of Archeological Artifacts

This option would identify institutions (non-Alaskan) and individuals with archeological artifacts from the oil spill region who would be willing to donate some or all of their artifacts to the *Exxon Valdez* Oil Spill Trustees (member agencies). In turn, the Trustees would transfer acquired artifacts to appropriate public institutions within the oil spill area for public display (i.e. museums) and appropriate scientific uses and study. This option addresses those injuries resulting from looting by replacing lost artifacts to appropriate institutions within the region.

Steps to implement this option include: Identify owners of artifacts; prepare a list of available artifacts; determine public value of the list items (non-monetary value) and prioritize list of potential items; identify appropriate public institutions in the oil spill area for housing and public display of artifacts obtained; transfer artifacts to institutions in oil spill area.

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b. Subsistence

SUMMARY

Surveys conducted by the State of Alaska in 15 Native villages before the spill and in 7 villages in 1990 indicated that subsistence use in the oil spill area was significantly reduced in 1989, primarily because of concern for potential health effects associated with use of contaminated resources. While subsistence harvests began to recover in some Native communities (Ouzinkie, Port Graham, Nanwalek (English Bay), Larsen Bay, and Karluk) in 1990 and 1991, other Native communities (Chenega, Tatitlek) continued below average harvests. Based upon chemical analyses of a wide spectrum of subsistence resources (fish, shellfish, deer, ducks, marine mammals), most resources (with the exception of mussels and clams from oiled beaches) were determined to be safe for human consumption.

Proposed restoration options address the need to restore the confidence of subsistence users in the safety of subsistence resources within the oil spill area. Testing subsistence foods for residual petroleum hydrocarbons is designed to identify traditional subsistence areas still contaminated as well as measuring residual hydrocarbon levels in individual subsistence resources. Proposed restoration also assumes that recovery will be gradual and that there is a need to exploit alternative subsistence resources, either by providing access to subsistence areas not impacted by the spill, or by providing assistance in the development of shellfish mariculture to replace contaminated shellfish. The duration of the proposed programs will depend on the rate of recovery of subsistence services and perception of food safety.

INJURY

The Division of Subsistence, Alaska Department of Fish and Game, determined before the *Exxon Valdez* oil spill, that 15 Native Alaskan communities (with about 2200 people) of Prince William Sound, Lower Cook Inlet and the Alaska Peninsula relied heavily on subsistence resources. These resources included salmon, halibut, rockfish and Dolly Varden; marine invertebrates such as clams, crabs, and octopus; marine mammals (harbor seals and sea lions); land mammals such as deer (Prince William Sound and Kodiak Island), black bear and goats (Prince William Sound and Lower Kenai Peninsula); birds including ptarmigan, waterfowl, and gulls eggs; and wild plants. The mean number of resources used per household ranged from 10 to 25, and generally every household participated in subsistence harvests. The per capita subsistence harvest ranged from nearly 200 pounds to over 600 pounds per year.

Table 1 illustrates changes in harvest levels in the first year (April 1989 to March 1990) following the spill. Subsistence harvests of fish and wildlife in 9 of these villages (Chenega Bay,

Tatitlek, Nanwalek (English Bay), Port Graham, Karluk, Old Harbor, Ouzinkie, Port Lions, and Chignik Lagoon) declined from 4 to 78% compared to pre-spill averages (Fall 1991). The reasons for this decline varied among communities, households, and resources, but most dealt with the real or perceived consequences of the oil spill, especially the concern for potential health effects as a result of consuming subsistence resources from the spill area.

Chemical analytical studies conducted by the U.S. Food and Drug Administration (ADHSS 1989a) and the National Oceanic and Atmospheric Administration (Varanasi et al. 1990) measured levels of petroleum hydrocarbon and metabolites in the bile and edible tissues of subsistence foods. These studies found that most resources tested (fish, shellfish, deer, ducks, marine mammals) contained no or very low levels of petroleum hydrocarbons, and that eating foods with those levels posed no health risk. Exposure to oil did not necessarily render organisms unsafe to eat since some exposed animals were found to have low or non-existent levels of hydrocarbons and their metabolites in their edible tissues. Some samples of shellfish, however, had unacceptably high levels of petroleum hydrocarbons prompting an advisory that shellfish should not be collected from obviously oil-contaminated areas (ADHSS 1989b).

RECOVERY

Table 1 also summarizes changes in harvest levels in 7 Native villages following the oil spill. The finding that subsistence harvests had increased in 5 villages during the 1990-1991 timeframe suggested increased confidence in using some subsistence resources. However, the continued very low levels of harvest at Chenega Bay and Tatitlek, Nanwalek (English Bay) and Ouzinkie, and the continued concern in some households in all seven villages that some subsistence foods remained unsafe to eat, suggested that the injury persisted through the second year following the spill (Fall 1992).

While published reports are not yet available for the period of April 1991 to the present, it is believed that subsistence harvests have not returned to pre-spill averages in all affected Native communities, especially Chenega Bay and Tatitlek. Concern over potential long-term health effects of consuming resources from the spill area, a loss of confidence on the part of subsistence hunters and fishermen in their abilities to determine if traditional foods are safe to eat, and the real or perceived reduction in available resources, are all factors likely to affect recovery of subsistence use.

TABLE 1. Subsistence Harvests Before and After the ***Exxon Valdez*** Oil Spill: Per Capita Harvest in Pounds (Fall, 1991, 1992; Page, 1991). (see footnote a)

COMMUNITY	PRE-SPILL YEAR ONE	PRE-SPILL YEAR TWO	OIL SPILL YEAR	% CHANGE (see footnote b)	POST-SPILL YEAR ONE
Prince William Sound					
Chenega	308.8	374.2	148.1	-60.4	143.1
Tatitlek	351.7	643.5	214.8	-66.6	155.2
Lower Cook Inlet					
Nanwalek (English Bay)					
Port Graham	288.8	(c)	140.6	-51.3	181.1
	227.2	(c)	121.6	-46.5	213.5
Kodiak Island					
Akhiok	519.5	159.3	297.7	+86.9	(d)
Karluk	863.2	381.0	250.5	-34.3	395.2
Larsen Bay	403.5	200.9	209.9	+4.5	340.4
Old Harbor	491.1	419.3	271.1	-35.2	(d)
Ouzinkie	369.1	405.7	88.8	-78.1	204.9
Port Lions	279.8	328.3	146.4	-55.4	(d)
Alaska Peninsula					
Chignik Bay	187.9	(c)	208.6	+11.1	(d)
Chignik Lagoon	220.2	(c)	211.4	-3.7	(d)
Chignik Lake	279.0	(c)	447.6	+60.1	(d)
Ivanof Bay	455.6	(c)	489.8	+8.4	(d)
Perryville	391.2	(c)	394.2	+1.0	(d)

(a) Pre-spill study years are: Tatitlek 1987-88 and 1988-89; Chenega, 1984-85 and 1985-86; Nanwalek (English Bay) and Port Graham, 1987; Kodiak Island Borough, 1982-83 abd 1986; Alaska Peninsula, 1984. The "spill year" is 1989 for all communities, except Chenega and Tatitlek, for which it is April 1989-March 1990. "Post spill year one" is April 1990-March 1991.
(b) Based on most recent previous year.
(c) Only one previous measurement.
(d) Not determined.

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Some of the restoration options for restoring subsistence focus on restoring injured species. By restoring the species upon which the service depends, the service will also be restored. The species restoration options are described under the species injury summaries for intertidal areas, harbor seals, sea otters, harlequin ducks, pink and sockeye salmon, herring and rockfish.

However, five options are proposed which could be primarily used to mitigate lost subsistence opportunities and speed recovery of harvest levels. The options for testing subsistence foods and providing access to unoiled harvest areas do not benefit species recovery, but instead benefit subsistence users by providing information and access to traditional foods. The mariculture and shellfish hatchery options primarily benefit subsistence users by providing an alternative source of shellfish, but also could be used to speed recovery of injured shellfish populations. Alternative sources of subsistence food could also be provided by starting new salmon runs in subsistence harvest areas. These options are summarized below.

Option #18.0 - Replace Fisheries Harvest Opportunities by Creating New Salmon Runs

New subsistence harvest opportunities could be provided by starting new hatchery runs or stocking streams. Salmon is a traditional subsistence food and the new runs could compensate for reduced harvests salmon, as well as partially replacing harvests of marine mammals, shellfish, ducks and other species not fully utilized due to spill-related injuries or perceptions.

New salmon runs could take the form of terminal harvests at remote hatchery release sites or new, self-perpetuating runs in streams adjacent to subsistence communities. Either of these alternatives would have to be implemented with great care, especially in Prince William Sound, to avoid disruption of existing commercial and sport fisheries and to comply with ADF&G policies and guidelines on fish genetics. This option is applicable in harvest areas utilized by Native communities whose harvest levels remain low, such as Tatitlek, Chenega, Nanwalek (English Bay), and Ouzinkie.

Option #30.0 - Test Subsistence Foods for Residual Hydrocarbon Contamination

This option works to restore the confidence of subsistence hunters and fishers in the safety of subsistence resources within the spill area. Samples of mussels, clams, ducks, rockfish and other resources will be collected from the harvest areas of 16 locations (Chenega, Tatitlek, Nanwalek (English Bay), Port Graham, Ahkiok, Karluk, Old Harbor, Ouzinkie, Port Lions, Chignik Lagoon, Kodiak

City, Cordova, Valdez, Seldovia, Kenai, and Seward). Some of these sites may be eliminated as the project progresses. Community representatives will assist in site selection, as well as collection of samples. Additionally, bile and blubber samples will be taken from seals harvested by subsistence hunters in Prince William Sound. The samples will be analyzed for residual petroleum hydrocarbons. The results of these tests, along with the findings of other damage assessment and restoration studies, will be reported to the communities in an informational letter and community visits.

Sample collection, chemical analysis, and interpretation of results will take three years to implement. At the end of this period, the degree of recovery of the resources, as well as the subsistence economy, will be evaluated to determine if the program should continue. The confidence of the subsistence users in the safety of subsistence foods is likely to lag behind the recovery of individual resources to some extent. The Trustee Council has already begun work on this option by approving a subsistence testing program in January, 1993. However, it may be necessary to expand the scope or duration of the currently approved program.

Option #49.0 - Provide Access to Alternative Subsistence Foods

This option seeks to minimize interruption of subsistence activities at those Native communities most affected by the oil spill. As a result of the oil spill, some resource populations have declined, while others (especially shellfish) continue to be chronically contaminated by persistent pockets of buried oil. Funds will be provided for subsistence hunters from Chenega to travel to unimpacted areas to harvest traditional subsistence resources. Funding also would be provided to facilitate subsistence hunters in other Native communities to assist the Chenegans by gathering, preserving and sending subsistence foods to Chenega. This support will continue until the resources in the subsistence area traditionally used by the Chenegans are no longer contaminated by oil, the resource populations have recovered to pre-spill levels, or the Native community is no longer concerned that their traditional foods are contaminated.

Option #50.1 - Develop Subsistence Mariculture Sites

This program will provide the villages of Chenega, Tatitlek, Port Graham, Nanwalek (English Bay), Ouzinkie, and Ahkiok with a means to develop an alternative bivalve resource for both subsistence and commercial harvest. The basic strategy for the village mariculture program is to initially concentrate on oyster culture, and subsequently test the feasibility of culturing species native to Alaska, e.g., clams, mussels and scallops. The feasibility of culturing Alaskan species is largely dependent on developing a reliable source of spat, which is addressed in Option 50.2 (develop shellfish hatchery).

For those villages which already have mariculture permits (Eyak, Tatitlek, Chenega), settlement funds will be used to establish new oyster culture operations or increase existing operations to commercial production levels. A mariculture specialist will be hired to organize village operations, help initiate and sustain a training program, and prepare and implement mariculture development plans. For those villages without permits (Port Graham, Nanwalek (English Bay), Ouzinkie, Ahkiok), initial efforts will focus on identification of potential culture sites and the development of permit applications. Activities in ensuing years will include preparation of mariculture development plans, training, establishing production, and development of markets.

Option #50.2 - Develop Bivalve Shellfish Hatchery and Research Center

This option proposes the construction of a hatchery and a research facility which provide shellfish growers with a reliable, local source of shellfish spat. The hatchery would be operated by the private sector, using technology developed at a State-operated research center. The combination of the two facilities is necessary because of the lack of technology for culturing spat of indigenous species. Shellfish spat produced in the hatchery would either be seeded on beaches or grown out on rafts using longlines, lantern nets, trays or other appropriate means. In addition to restoring a subsistence food source, this could also aid in the recovery of injured wild stocks.

The first step of this option would be to complete a study designed to identify which Alaskan shellfish species best lend themselves to hatchery propagation, what types of facilities will be required, what potential uses will be served, where will they be sited, and what are the potential benefits and associated costs. The next stage would be to construct the actual hatchery and research facilities. Seward has been suggested as a possible site.

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c. Recreation and Tourism

SUMMARY

Published studies of the impact of the *Exxon Valdez* oil spill on recreation and tourism address the economic effect on tourism and recreation fishing during 1989. Both industries declined significantly in 1989 and improved markedly in 1990 although there were residual effects. Sport fishing is addressed in greater detail elsewhere in this chapter.

In 1992 a key informant study was conducted to glean current information about a broad range of recreation uses. The study found that about a quarter of the informants reported no change in their recreation experience, but others reported avoidance of the spill area, reduced wildlife sightings, residual oil, and more people. Furthermore, they reported changes in their perception of recreation opportunity in terms of increased vulnerability to future oil spills, erosion of wilderness, a sense of permanent change, concern about long-term ecological effects, and, in some, a sense of optimism.

Declines in recreation activities noticed in 1989 appear to have reversed, although there is no data to support or deny this perception.

INJURY

Approximately 43% of the tourism businesses surveyed felt their businesses had been significantly or completely affected by the oil spill in Summer 1989. The net loss in visitor spending in Southcentral and Southwest Alaska in 1989 was $19 million (McDowell 1990). An estimated 124,185 lost recreational fishing days were calculated for 1989 due to "closures, fear of contamination, the unavailability of boats, and congestion at some sites outside the spill area (Carson and Hanemann 1992)."

The key informant study canvassed 92 users in the following ten user groups: air taxi operators, camping/kayaking, conservation/education, lodgeowner, Native corporations, public recreation managers, sailing/motorboating, sportfishing/hunting, tour operators, and tourism associations. The response rate was 45%.

Informants were asked how their recreation experience had changed. About a quarter of the respondents reported no change in their experience. However, others reported the following changes: (1) avoidance of heavily oiled areas and displacement to less affected areas, primarily northern Prince William Sound and parts of Kenai Fjords; (2) reduced wildlife sightings and fewer fish; (3) residual oil in the form of tar balls and sheens that affect the enjoyment of coastal areas and raise concerns about tainted fish;

and (4) more interest in the spill area and more people using it (RPWG 1993). Recreational use of Prince William Sound and the Outer Kenai Coast, including Kenai Fjords National Park and Kachemak Bay State Wilderness Park, appeared to be most severely affected; less severe effects were reported in Kodiak and Kachemak Bay.

Informants were also asked whether there are changes not reflected in their experiences that concern the way they think about the area or perceive their recreation opportunities. Most of the respondents (80%) said their perceptions had changed. This group included at least half of each user group except air taxi operators. Those indicating a change in perception of recreation opportunities cited the following changes: (1) increased sense of vulnerability with regard to future oil spills, the fragility of the ecosystem, and threats to archaeological resources; (2) erosion of wilderness caused by the spill itself as well as the intrusion of cleanup and restoration activities; (3) a sense of permanent change; (4) a sense of unknown or unseen ecological effects that may alter the environment in the future; and (5) a sense of optimism about the future (RPWG 1993).

RECOVERY

By 1990 only 12% of the tourism businesses surveyed felt their businesses had been significantly or completely affected by the oil spill (McDowell 1990). By 1990 many of the conditions that had contributed to the severe decline in recreation fishing had changed and the situation had improved (Carson and Hanemann 1992).

Although the status of recovery of recreation was not asked in the key informant interview, respondents volunteered information. They reported seeing less oil now than in 1989 and subsequent years; a slow, but discernible increase in wildlife sightings; and each year a slight increase in people using the spill area for recreation activities (RPWG 1993).

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Restoration options that restore fish and wildlife whose populations declined because of the oil spill will also help restore recreation and tourism. In addition, a well-designed and executed public information program may improve management of the spill area and restore some of the damage done to the perception of recreational opportunities. Seven options are being considered that are specifically targeted to restore or enhance recreation.

Option #37.0 - Habitat Protection and Acquisition

Inholdings of various sizes exist in parks and refuges throughout the spill area. Purchase of inholdings in parks and refuges, and

key camping or fishing areas would provide long-term protection of recreation resources and instill confidence that recreation opportunities and some wilderness values will be preserved into the future.

Option #40.0 - Special Designation

Setting aside certain public lands and waters for special management has potential to protect recreation areas from future dramatic changes. Some key informants thought there were already enough special designations in the spill area; others supported additional special designations and cited certain areas that warrant such treatment. These include designation of the College Fjord/Nellie Juan Wilderness Study Area as wilderness with the additions proposed by the Chugach Forest Study Group; consideration of Harris Bay (Kenai Fjords National Park) and the area from Pt. Freemantle to the eastern side of Esther Passage (Prince William Sound) as a national marine sanctuary; and protection of Nuka Island. Although the Trustees could initiate a special designation and fund initial expense, they are usually established through legislative or congressional action.

Option #44.0 - Spill Prevention and Contingency Planning

Several key informants conveyed their sense of vulnerability because of the likelihood of future oil spills. Assurance that another spill will be averted or at least contained would instill a measure of trust to counteract this perception. Laws, funding, and local involvement abound in the area of spill prevention and contingency planning. Restoration funds could complement spill prevention and contingency planning activities being undertaken through other programs.

Option #34.0 - Marine Environmental Institute

A marine environmental institute would benefit recreation and tourism in two ways: 1) the research program would improve knowledge about the effects of the oil spill and preparedness for future spills and 2) the facility and its educational programs could serve as a visitor attraction. A research program could be undertaken through many different vehicles. Two possibilities are a research foundation and a marine environmental institute.

Option #12A - New Public Recreation Facilities

Construction of new public recreation facilities such as mooring buoys, boat ramps, picnic areas, outhouses, caches, cabins, campsites, and trails could create opportunities for public use and direct use of and access to the area. Well managed use could reduce resource damage, improve safety, and divert activity away from the spill area while it heals. On the other hand, construction of new public facilities could also attract more

people and increase use of a damaged ecosystem. Furthermore, this option changes a use or creates a new use but does not restore an injured use.

Most respondents in the key informant study thought that new public recreation facilities are inappropriate for wilderness areas, designated or otherwise. Among those who supported new public recreation facilities elsewhere in the spill area, support varied with the type of facility and location. Because these are fundamentally land use decisions, some recommended that the decision to fund new public recreation facilities with restoration funds be tied to a comprehensive plan. Finally, concern was raised that facilities be patrolled and maintained and that the decision to fund construction be complemented with a commitment to long-term maintenance and enforcement.

Option #33.0 - Visitor Centers

Visitor centers would be convenient outlets for educating the public about recreation opportunities, low-impact camping, various land use regulations and guidelines and other measures to protect the spill area. They also complement other visitor attractions in the area. Visitor centers exist in most communities in the spill area. However, it may be beneficial to expand existing facilities or construct a new visitor center in cities or villages that have no similar facilities.

Option #12B - Planning and Marketing for New Commercial Facilities on Public Land

This option consists of making appropriate public land available for commercial recreation facilities such as fuel stops, docks, campgrounds, and lodges, and also providing seed money for planning and marketing these sites. This proposal offers advantages and disadvantages similar to those of option 12A, that is, it could create opportunities for human use of the spill area and provide needed services, but could also attract more people and increase use of a damaged ecosystem. Furthermore, this option changes a use or creates a new use but does not restore an injured use. In addition, private landowners throughout the spill area could supply the land for commercial recreation facilities.

Among respondents to the key informant study who supported this option, support varied with the type of facility (fuel stops and private campgrounds were favored over lodges) and location (inappropriate in wilderness areas) and was conditioned on good siting and design.

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d. Wilderness and Intrinsic Values

SUMMARY

The oil spill area consists of relatively undeveloped uplands which are generally perceived to be "wilderness" by the public. Some areas have been formally designated as wilderness by either the United States or by the State of Alaska. Two federal areas are currently being formally studied for wilderness designation. The legislated areas include: Katmai National Park, Becharof National Wildlife Refuge and, Kachemak Bay State Wilderness Park. Study areas include: Kenai Fjords National Park, and the Nellie Juan/College Fjord area of the Chugach National Forest. Federal areas are managed according to the 1964 Wilderness Act and the Alaska National Lands Conservation Act (ANILCA) of 1980. State areas are managed according to individual enabling legislation and subsequent management plans. Generally, the areas are managed to maintain their natural landscape, a sense of solitude, and their wild character. Evidence of human presence is generally limited to temporary uses for short periods of time. Various state and federal lands not legislatively designated as wilderness are managed according to each agencies enabling legislation, subsequent regulations, and often, according to a management or master plan. These areas generally allow a broader range of allowable uses and increased human development when compared to the designated wilderness areas.

INJURY

The oil spill delivered oil in varying quantities to the adjoining waters of all the designated and un-designated wilderness areas. Oil was often deposited above the mean high tide line.[3] The national media displayed the event with an unprecedented amount of print and television coverage, carrying the event to every corner of the United States. As a result, the *Exxon Valdez* oil spill is now the event against which subsequent spills are measured. Many people, within Alaska and throughout the United States, believe that wilderness and other intrinsic values were lost or injured as a result of the oil spill.

During the intense cleanup seasons of 1989-1990, hundreds of workers and associated boats, aircraft and cleanup equipment were in these areas. This activity was an unprecedented imposition of people, noise and activity into the area's undeveloped and normally sparsely occupied natural landscape.

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[3]Wilderness designations include uplands generally above the mean high tide line.

RECOVERY

Oil remains in small isolated locations in these wilderness areas. Although the oil is degrading, it remains surprisingly tenacious in some locations. As a result, direct injury to wilderness and intrinsic values continue. The massive intrusion of people and equipment associated with oil spill cleanup has now ended.

To a lesser extent, there is some perception (RPWG, 1993) that continuing damage assessment and now restoration studies sponsored by the governments are so pervasive that they are intruding on the natural character of the area.

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Option # 37.0 - Habitat Protection/Acquisition

This option provides for the implementation of various techniques to protect and acquire lands that are linked to the resources and services injured by the oil spill. The option is designed to respond to both potential, long-term threats and to more immediate or imminent threats to injured resources and services. The intent of habitat protection or land acquisition is to prevent additional injury to resources and services or to acquire lands that contain resources equivalent to those injured by the spill.[4]

Option # 40.0 - Designate Protected Areas

This option provides various means to place existing government owned lands into management regimes which provide an increased level of resource protection relative to that now provided. Typically, designations first are implemented by an act of the Alaska Legislature or the U. S. Congress. An important feature of special designations is that they can provide a regulatory basis for managing areas on a large scale; one of an area's primary objectives could be to help restore spill injuries. Different designations provide for alternative mixes of emphasis on public use, resource protection and scientific study. Special designations under consideration include: Alaska State Parks, Alaska Department of Fish & Game Special areas, National Marine Sanctuaries, National Estuarine Research Reserves, Research Natural Areas, National Recreation Areas, and federal wilderness areas.

REFERENCES

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[4]Land acquisition could include acquisition of a range of property rights, from one property right to all rights i.e., fee simple acquisition.

e. Sport and Commercial Fishing

SUMMARY

Damages to fisheries consist primarily of several emergency closures, most of which occurred in 1989. Also, sport fishing decreased due to actual and perceived contamination of fishing areas. The largest impact may be from future reductions in the number of sockeye returning to the Kenai and Red Lake systems. Reduced returns of cutthroat trout to western Prince William Sound resulted in a 1992 closure of the area. Fisheries targeting pink salmon, herring and rockfish are not currently impacted, although these species are known to have been injured at some level. Restoration focuses primarily on restoring the species which support services. However, options which specifically target restoration of services include producing new runs of salmon to replace lost harvest opportunities, and providing new access points for sport fishermen.

INJURY

During 1989, emergency commercial fishery closures were ordered in Prince William Sound, Cook Inlet, and the waters around Kodiak Island and the Alaska Peninsula. Harvests were closed or restricted for salmon, herring, crab, shrimp, rockfish and sablefish. In 1990, a portion of Prince William Sound was closed to shrimp fishing for the same reason. All of the 1989 and 1990 closures were done to prevent harvest of oiled fish and were not triggered by population reductions in these species. There are currently no spill-related commercial fishery closures in effect.

While there were no sport fishery closures until 1992, ADF&G data documented a significant decline in sport fishing from 1989 to 1990 and quantified the losses at $31 million. Declines in the number of anglers, fishing trips and fishing days were noted for saltwater fisheries in Prince William Sound, Cook Inlet and the Kenai Peninsula areas. In addition, damages to public perception of the spill zone as a pristine environment may have been largely responsible for reductions in sport fishing activities. This aspect of injury is more fully discussed in the sections on injuries to wilderness and recreational activities.

The only spill-related sport fish closure has resulted from a 1992 emergency order restricting cutthroat trout fishing in western Prince William Sound due to low adult returns. This closure will remain in effect until runs return to a sustainable level. Damage assessment from 1991 studies indicate that growth and survival rates of both species continue to be lower in oiled areas. This could be due to injuries to the food chain, which result in insufficient food for fish feeding in nearshore marine waters.

Significant impacts on fisheries may result from too many fish returning to the Kenai River and Red Lake (Kodiak Island) systems in 1989. Since 1989 commercial sockeye fisheries were closed by the spill, large numbers of fish escaped harvest to spawn. This resulted in an unusually large number of fry moving into the lakes to feed. It is hypothesized that they overgrazed the zooplankton available to them in the upper layers of the lakes and were not able to maintain sufficient growth and survival rates. As a result, fry survival in the Kenai system was very poor for two years in a row and Red Lake fry may have stayed in the lake an extra year to feed. This will probably result in reduced adult returns to these systems starting in 1994. It is also likely that 1995 returns to the Kenai River will also be very low. Closure of Kenai River sockeye fisheries would have major impacts on multiple user groups.

The extent of injury to rockfish is not fully understood, although a few mortalities were caused by exposure to petroleum hydrocarbons and residual hydrocarbons have been found in tissues and bile. An additional, indirect injury may have been inflicted by significantly increased commercial fishing pressures. Following the multiple, spill-induced fishery closures, many commercial fishermen purchased new gear and re-directed harvest efforts towards rockfish. Little is known about current population levels and how well they will be able to withstand the increased pressure. However, rockfish are known to have low rates of reproduction and growth and have been seriously damaged by overfishing in other places. Thus, the possibility exists that population-level injuries caused by overfishing could necessitate closures of commercial and sport fishing for rockfish.

While injuries to pink salmon and herring were documented, there are no clear indications as of March, 1993, that these injuries will impact commercial or sport fishermen.

RECOVERY

Sockeye recovery depends on recovery and availability of zooplankton populations in the lakes used by rearing fry. This will probably occur sooner in Red Lake than the Kenai system. It is not yet known how many year classes of sockeye fry will be directly impacted by food shortages. However, the number of outmigrating Kenai River smolt was extremely low in 1991 and 1992, indicating that at least two consecutive year classes were impacted by overescapement. These smolt will return as adults in 1994 and 1995. The number of adults returning from these reduced outmigrations will almost certainly be lower than normal and may not be able to produce enough eggs to rebuild the runs within a single generation. If this turns out to be the case, adult returns in 1999 and 2000 may also be low.

Cutthroat trout fishing will probably remain closed or restricted in the western Sound in 1993, and will not reopen until populations recover. Their recovery may be contingent upon recovery of the ecosystem which supports the food chain in nearshore marine waters where these fish feed.

Insufficient data exist to determine whether rockfish continue to be impacted by hydrocarbon contamination or if they are being harmed by increased harvest pressure. The lack of data could result in additional damage to the species due to overfishing.

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Most of the options for restoring sport and commercial fishing injuries focus on restoring injured species. By restoring the species upon which the service depends, the service will also be restored or saved from future injury. These types of options are described under the species injury summaries for sockeye and pink salmon, cutthroat trout, Dolly Varden, rockfish and herring. Species restoration strategies include intensifying fishery management, improving or creating new salmon spawning and rearing habitat, improving salmon egg and fry survival, and acquiring and protecting fish habitat (Options 2, 11, 19, 37, 40 and 48).

However, two options are proposed which are solely intended to mitigate lost fishing opportunities. These options do not directly restore injured fish populations. Instead, they provide new sport and commercial fishing opportunities or provide new access routes for sport fishermen. The user groups which benefit would be determined by the species targeted by the option, where the options are implemented, and harvest allocations, which are ultimately determined by the Board of Fisheries. The options are described below.

Option #18.0 - Replace Fishing Harvest Opportunities by Establishing New Salmon Runs

This option entails starting new salmon runs to replace fishing opportunities lost due to fishing closures or reduced harvests of species injured by the spill. New salmon runs could take the form of terminal runs returning to hatcheries and remote release sites. All returning adults would be harvested every year or used for brood stock for the next year's run. Alternatively, self-perpetuating runs could be started in streams not currently used by spawning salmon. Vacant spawning habitat may have to be created in order to make stream stocking applicable on a significant scale. Either of these alternatives would have to be implemented with great care, especially within Prince William Sound, to avoid disruption of existing fisheries and to comply with ADF&G policies and guidelines on fish genetics and disease control.

The runs would probably be continued until wild-stocks recover. If the option is continued beyond this time, it will be in the context of enhancing the service above pre-spill levels. The option is applicable as direct restoration to all areas where fishermen are anticipated to be impacted by spill-related fishery closures or restrictions. This currently includes the Cook Inlet and Kodiak areas where sockeye runs are anticipated to decline drastically. However, it will not be possible to implement this option in time to mitigate the effects of a 1994 sockeye closure.

Option #28.0 - Acquire Access to Sport Fishing and Recreational Areas

Injuries to sport fishing can be partially restored by acquiring access to sport fishing and recreational areas. While much of the land in the spill area is publicly owned, some private lands exist where access is denied. Access could be created through fee simple purchase of lands or easements. This option could, but does not have to be, associated with other options to construct small-scale recreation facilities such as boat ramps, parking lots and sanitation facilities.

Acquisition of access corridors could replace or enhance lost fishing opportunities and also relieve fishing pressure on streams with injured fish stocks. For instance, if Kenai River sockeye fisheries are closed or restricted, sport fishing could be diverted to unaffected areas by providing improved access. This option could be used to directly restore fishing opportunities in areas where there are existing or anticipated spill-related sport fishing closures, i.e., Prince William Sound, Kenai Peninsula and Kodiak. If these access points were maintained after the sport fishery was fully recovered, it would constitute an enhancement of fishing opportunities above pre-spill levels.

REFERENCES

Michael Mills, Sport Fish Division ADF&G Special Publication #92-5 titled, Alaska Sport Fishing in the Aftermath of the *Exxon Valdez* Oil Spill, December 1992.

III. XX. Services: Summary of Results of Injury Assessment Studies

Table XX summarizes information about services injured by the spill. Much of the damage to services and the information about those damages is not quantitative. The information used for this table is taken from injury assessment studies, information from state and federal agency studies, agency managers, and, for recreation, a Key Informant Interview study conducted by the Restoration Planning Working Group in December 1992. The "Description of Injury" column recounts the situation for each service in the year(s) following the spill. The "Status of Recovery in 1992" shows the situation for that service at the end of 1992.

The "Geographic Extent of Injury" column shows whether the injury occurred in the geographic areas shown in figure X. (Injury may have been more extensive in some regions than others.)

RPWG
I

United States Department of the Interior

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Alaska Regional Office
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IN REPLY REFER TO:

TAKE PRIDE IN AMERICA

TO: RPWG members

From: Sanford P. Rabinowitch, RPWG Sandy

Subject: Review of Chapter III: Draft Restoration Plan Comments due to Sandy Rabinowitch COB April 5, 1993

Date: March 26, 1993

As you all know, chapter III has been written by many authors and began as a very long section. As directed by RPWG and with continuing coordination with our co-chairs, I have cut approximately 25 pages from the total length of the material I originally received. After my editing Steve Levi was given the chapter and he again edited it in it's entirety. Steve's has made some formatting changes and has made the language more user friendly. Thereafter I again went through the entire document this time making only small changes.

At this time I can see several things:

* The document is close, but not perfect in terms of consistent formatting. Some sections are too long and others are probably too short. In a few places we need material. All the section titles do not match - but we are close.

* A section titled "Comments" has been added to retain material that seemed important but did not fit well beneath other headings. I would like to shorten these comment sections down - or even make them disappear - can you suggest where this text fits or if it can be deleted?

* Because of changes the RT has made over the past eight weeks, to the three summary of injury tables and to the brochure, some things in the chapter need to be changed. For example, some terminology has been switched and some things, like archaeology, have been re-catorgorized. These changes need to be routed out in the text and marked so they are all found. Some areas will need re-writes.

* We have decisions to make. Should the "option" material stay in this section?

* We need to insure that important things have not been inadvertently deleted.

* We need to continue to delete text that goes beyond what is needed - so the chapter is shorten as much as possible.

* We need to ensure that the summary of injury tables and the text are consistent. Please compare tables and text for areas that you are most familiar and recommend corrections.

With this in mind the draft chapter is now in your hands for review. I expect their to be many comments. I would appreciate paper copies of your comments **(by March 5)** and for those of you that have substantial re-writes getting these on disk would be especially beneficial.

If you have any questions while reviewing please give me a call.

d:\sandy\dplan\covmemo.III

CHAPTER III. Injured Resources and Services

A. Background

This chapter answers the three basic questions involving restoration:

- *What was injured by the spill?*
- *What is the present status of recovery?*
- *What, if anything, can be done to aid recovery?*

INJURY TO NATURAL RESOURCES

The civil settlement specifies that restoration funds will be used to restore injuries resulting from the *Exxon Valdez* oil spill. The settlement requires that the funds be spent to "restore...natural resources injured as a result of the oil spill and the reduced or lost services provided by such resources..."

Natural Resources are defined in the settlement as the "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to [or] managed by...the state or federal governments." For example, any injury to pink salmon is an injury to a natural resource.

A natural resource fits this category if it has experienced injury -- or it has sustained a loss of quality -- due to exposure to oil spilled by the *Exxon Valdez*, or which otherwise can be attributed to the oil spill and cleanup.

Population-Level Injury. The most serious injuries are those that have reduced the population of a natural resource. For plant and animal species the injuries from the oil spill have resulted in a lower population of that species. For example, murres were the most severely affected bird species because several large colonies in the Gulf of Alaska lost 35 - 70% of the breeding adults. The population of murres in the oil spill area remains depleted. Thus, murres have suffered a population-level injury, IE., an injury that can be measured by comparing present day population with that prior to the oil spill.

Chronic or Sublethal Injury. A chronic or sublethal injury is an effect on one or more life stages of a species. An example would be the reduced survival of eggs or larvae. In many cases, such an injury may not be reflected in an overall population loss to the species. That is, the injury may be apparent but is statistically insignificant. However, injuries currently considered to be

sublethal may decrease long-term survival for enough individuals to result in population reductions.

There are a number of reasons why a sublethal or chronic injury may not result in a lower population. These include: the chronic or sublethal injury may not affect the productivity of the species, or the species may have some natural compensating mechanism for the injury. There may also be enough variability in the natural abundance of the species to mask the effect of the injury, or scientific measurement techniques may not be sensitive enough to measure the aberration.

Degradation of Habitat. The oil spill and cleanup altered and contaminated the flora, fauna, and physical components of the habitats of many species. This is most pronounced in intertidal and subtidal areas. The ongoing injury to plants and animals that live below high tide continues to affect the many natural resources that use these habitats.

Direct Mortality. Thousands of birds and lesser numbers of marine mammals, fish, shellfish, birds and organisms to the bottom of the food chain were found dead after the spill. While this direct mortality is the most obvious injury caused by the oil spill, it is not always the most serious. Some species endured significant mortality without causing a long-term effect on the population, such as loons or grebes.

Our knowledge of the pre- or post-spill populations is still coming into focus, and, in many cases, ecological relationships are unknown or unproven. The full impact of the oil spill will not be known for decades.

INJURY TO NATURAL RESOURCE SERVICES

In addition to restoring natural resources to their pre-spill population levels or qualities, the settlement requires restoration funds to restore reduced or lost **services.** For example, recreation that was damaged by injuries to fish and wildlife must be restored. Other damaged services include subsistence, commercial and sport fishing, tourism, designated wilderness and passive use values of the spill-affected areas.

A natural resource service has experienced injury if the *Exxon Valdez* oil spill or clean up:

- has significantly reduced the physical or biological functions performed by natural resources, including loss of human uses; or
- has significantly reduced aesthetic, intrinsic, or other indirect uses provided by natural resources; or, in

combination with either of these,

- has resulted in the continued presence of oil on lands integral to the use of special-purposes lands. (Special-purposes lands are those designated by the State of Alaska or the United States for the protection and conservation of natural resources and services. Examples are National or State Parks.)

This definition covers a wide range of injured natural resources and services. Some examples are commercial fishing, subsistence hunting, fishing, and gathering. Some recreation examples include kayaking and backcountry camping, sport fishing and hunting and designated wilderness areas.

CONCEPTS CRITICAL TO UNDERSTANDING RECOVERY

Natural Recovery. Many resources and services will recover to pre-spill levels without intervention. Others that were declining before the spill will continue to decline if present trends continue.

In a scientific sense, full ecological recovery will have been achieved when the pre-spill population of flora and fauna are again present, healthy and productive, and there is a full complement of age classes. Additionally, air, ground water and drinking water in the oil spill area must be brought back to its pre-spill quality. A fully recovered ecosystem is one which provides the same functions and services as were provided by the pre-spill, uninjured system.

Rate and Degree of Recovery. The rate of recovery is the number of years that a resource or service will require to return to its pre-spill level and quality. The degree of recovery is the target population size and quality of the recovery. Since the population of some species, such as the harbor seal, was in decline prior to the oil spill, it will not be possible to return to a population that is equivalent to the pre-spill model. Thus the degree of recovery for the harbor seals will not approach 100 percent. The degree of recovery varies from species to species and the rate of recovery varies from a few years to more than a century.

Some restoration options (presented in this plan, see chapter ___) will affect the rate of recovery. That is, they are not intended to alter the long-term population level of the species. Instead, they are designed to shorten the number of years it takes to reach the pre-spill population level. For example, if it were possible to eliminate the residual oil in mussel beds that are being consumed by harlequin ducks, it would speed the duck's recovery. However, the population of ducks will only return to its pre-spill level, cleaning mussel beds will not increase the population level beyond

its natural limit. Thus, cleaning mussel beds may change the rate but not the degree of recovery for harlequin ducks.

Other options include creating salmon spawning and rearing areas and have the potential to enhance population levels. They change the actual number of fish or animals in the long-term population. These options change the degree of recovery.

B. Conclusions

1. MARINE MAMMALS

Harbor seals, humpback whales, killer whales, sea lions, and sea otters were studied following the spill.

a. Harbor Seals (Genus species)

DESCRIPTION:

A harbor seal is an aquatic marine mammal. Adults average four feet in length and 200 pounds in weight. Seals are graceful swimmers and swim with an undulating, side-to-side motion. They are excellent divers, have been known to dive to depths of 1,000 feet and can stay submerged for half an hour at a time. They feed on fish, crab, shrimp, and squid and, in turn, are preyed upon by sea lion (?) and killer whale. Alaska Natives are allowed to take harbor seal for subsistence purposes. Prior to the oil spill, the harbor seal population was estimated at 2,000 to 5,000 in Prince William Sound [and perhaps double that for the entire oil spill area.?]

INJURY:

An estimated 200 harbor seals were killed by the oil spill in Prince William Sound alone. It is not known how many harbor seals in the spill area were affected. However, it is estimated that an additional 100 seals were killed by the spill at sites that were not monitored. A loss of harbor seal in this magnitude may be critical as the harbor seal population was in the midst of a severe decline before the oil spill. The fall 1989 survey showed that about 100 seals were missing from the 25 haul outs that were monitored.

[An examination of the carcasses of harbor seals indicated that death was caused by hypothermia. Oil from the spill fouled the seal's body's natural ability to insulate itself from the frigid waters which average 35 degrees (?).?] Harbor seal tissues from carcasses found in Prince William Sound showed many times the concentrations of oil than those

in the Gulf of Alaska in 1989. This disparity persisted into 1990 when surprisingly high concentrations of oil [continued to be ?] found in the bile of seals from the Sound.

The high concentrations of oil in the bile of surviving seals would be consistent with aromatic hydrocarbon exposure [suffocation?] causing death. In addition, there was damage to nerve cells in the thalamus of the brain, which would also be consistent with exposure to low molecular weight aromatic hydrocarbons. [What is "low molecular weight aromatic hydrocarbons?]

Following the spill, harbor seals were studied in Prince William Sound because major haul outs in the central part of the Sound were heavily oiled and pre-spill population counts were available for these haul outs. In the 25 haul outs in Prince William Sound that have been regularly surveyed since 1984, 86% of the seals seen in April of 1989, survey were extensively oiled and another 10% were lightly oiled -- including many pups. By late May, the percentage of heavily oiled animals had jumped to 74%.

RECOVERY

Because harbor seal populations have declined precipitously since 1984 -- for unknown reasons -- it is difficult to predict recovery from the oil spill. Since the oil spill there has been a decrease in the subsistence harvest which is expected to speed population recovery though no definitive time frame can be assigned to the recovery.

RESTORATION OPTIONS

There are few methods of actively aiding harbor seal recovery. The only effective restoration options are protective: protecting harbor seal haul outs from disturbance, cooperative programs with commercial fishing groups to protect harbor seals from fishing-related interactions, and cooperative programs with subsistence users to provide information, and if needed, develop voluntary guidelines for subsistence harvest.

Option #4.2 - Reduce Disturbance at Harbor Seal Haul-out Sites

The nature and frequency of disturbance at harbor seal haul outs in Prince William Sound is not recorded but appears to be minimal. However, recovery could be slowed if disturbance increases enough to affect major haul-out and pupping areas. This option would fund interagency coordination to ensure that harbor seal haul-out sites are considered and protected when

permitting coastal and marine activities require state or federal permits. Should monitoring detect poor recovery and significant disturbance, it may be effective to increase protection of harbor seal haul outs. In this case, funds would be used to develop protective measures.

Option #46 - Cooperative program with Commercial Fishermen

This option would initiate a cooperative observer program to investigate the interaction, and, if necessary, to develop cooperative guidelines with fishermen to protect harbor seals.

Option #47 - Cooperative with Subsistence Users

This option funds agency personnel to work with subsistence users to assess the levels of the local population of subsistence resources. If necessary, the managers would then work with villagers to agree on cooperative guidelines for harvest levels for seals.

Comments:

It is not known whether seals in the Gulf of Alaska were affected by the spill. Since there was a severe decline in the harbor seal population before the spill, it is difficult to determine when natural recovery will occur. However, the population may have stabilized in some areas within Prince William Sound but no growth is being reported.

b: Humpback Whales (Megaptera versabilis)

Found worldwide, the humpback varies in length from 25 to 53 feet. The whale is predominantly black with a white portion on its belly. It feed primarily on krill and can be found from southeast Alaska to as far west as Attu, the last island of the Aleutians. The humpback are a favorite of maritime tourists as they can be identified easily because of their flippers, which can grow to one-third of their body's length and are usually white.

INJURY:

The only known effect of the spill on humpback whales was displacement of some of the animals from Lower Knight Island Passage during 1989. Humpbacks returned the next year.

RESTORATION:

No restoration is proposed for humpback whales, although any

measure to minimize disturbance to marine mammals in the spill area might benefit this species.

COMMENTS:

Humpback whale studies, carried out in 1989 and 1990, included photo-documentation of individual whales, estimates of reproductive success and possible displacement from preferred habitats in Prince William Sound.

c. Killer Whales (Orcinus orca)

Killer whales, often called by the species name Orcas, may reach a length of 30 feet and weigh as much as 10 tons. The mammal can be visually identified by its high dorsal fin, which reaches six feet for the males, and the black body with a white area on the belly and two other white spots on either side of the head. Each animals also has a light gray "saddlemark" behind their dorsal fin. Killer whales range from the Arctic Ocean to the North Pacific, often traveling in groups, called "pods," of 25 to 30 individuals. With a top speed of 25 knots, killer whales have no difficulty catching a wide variety of prey including cod, flatfish, sardines, salmon, tuna, octopus, squid, seal, and other species of whale.

INJURY:

Thirteen killer whales disappeared from one pod of resident killer whales between 1988 and 1990. They are presumed dead. Circumstantial evidence points to the spill as the cause.

Approximately 140 killer whales forming nine pods regularly use Prince William Sound and there are some transient pods as well. The rate of natural mortality in killer whales in the North Pacific is about 2% per year, the equivalent of 3 or 4 whales per year. Pre-spill mortality was higher, however, for the resident AB pod, ranging from 3.1 - 9.1% from 1984 to 1988. In the summer of 1989 there were 9 whales missing from resident pods. The next fall, the AB pod was composed of 36 killer whales which was a loss of seven in a year, an unprecedented 19.4% mortality rate or 19.4%. In 1990 an additional 6 individuals were missing from AB pod, an annual mortality rate of 20.7% for this pod. Missing whales were either females or immature animals, and in several cases calves were orphaned. Due to loyalty of killer whales to their group and mothers to calves, the missing whales are most certainly dead. The bodies, which

almost always sink after death, have not been found.

RESTORATION:

Killer whales have started to recover from 1989-1990 losses. Recovery may take as long as 20 years. There is little that humans can do, except to protect the species from further stress and let the species recover on their own.

COMMENTS:

Despite the losses, AB pod is growing again. From a low point of 23 animals in 1991, there are now 25 animals in the pod. The AB pod is expected to fully recover to its pre-spill level of 32 to 36 individuals within 10 to 20 years from 1989.

Option #4.2 - Reduce Disturbance at Rubbing Beaches and Concentration Areas

Disturbance is not known to be a problem for killer whales in the AB pod. Initiating a program to reduce disturbance will only be useful if the AB pod does not recover, and if disturbance hinders reproductive success.

This option would fund research to determine the nature and extent of disturbance and develop protective measures.

Option #45.0 - Reduce Fisheries Interactions by Facilitating Changes in the Black Cod Fishery

This option would examine the feasibility of subsidizing [salmon?] fishermen who voluntary shift [to?] the black cod fishery to reduce interaction. Although these interactions have not been serious in recent years, there is potential that they may once again become significant -- if individual fishing quotas (IFQs) are instituted.

d. Sea Lions (Eumetopias jubatus)

DESCRIPTION:

Also known as the Steller sea lion, the males of this species reach 13 feet in length and can weigh up to 2,400 pounds. The sea lion's body is covered with short hair which ranges in color from yellowish-brown to black. Found

from Southeast Alaska as far north as the Pribilof Islands, sea lions prefer to forage for food in clear water that is less than 300 feet deep. Sea lions prey on rockfish, smelt, herring, salmon, halibut, octopus, shrimp and crab.

INJURY:

Ten sea lions were found dead in oiled areas, mainly on rocky beaches, but it is not known if any mortality was due to oil [even though some oil was found in the tissue samples of the carcasses?]

RESTORATION:

No effective restoration measures specific to sea lions are available, but general habitat protection measures could benefit sea lions.

COMMENTS:

Sea lions have experienced a severe population decline over the last 30 years in the north Pacific Ocean--as great as 93%. This decline combined with seasonal movements presented great obstacles to determining if the sea lion population in the Gulf of Alaska had been affected by the spill. Sea lions were counted at 8 oiled haul-out sites, located mainly in the Gulf of Alaska. Sea lions were observed swimming through oil.

e. Sea Otters (Enhydra lutris)

Because of their human-like face with frost white whiskers, the sea otter is known as the "Old Man of the Sea." This marine mammal grows to a length of 4 1/2 feet and can weigh up to 80 pounds. Found throughout Prince William Sound and the length of the Aleutian Islands, the sea otter feeds on clams, mussels, snails abalone, crab and octopus. The otter's appetite is voracious, requiring about 25 pounds of food per day for an adult, the highest known food requirement for an animal that size. It is estimated that there were 150,000 sea otters in Alaskan waters; 10,000 in Prince William Sound and 20,000 along the shores of the Gulf of Alaska.

INJURY:

Sea otters were particularly vulnerable to the effects of

the spill, as they rely on their fur for insulation. This was the most abundant marine mammal in the path of the oil. Calculations indicate that 3,500 to 5,500 sea otters died from acute exposure to oil. Not only were many sea otters killed in the spring of 1989, there is evidence that post-spill mortality continued for at least another year.

Sea otters spend most of their time on the surface of the water, often in large numbers, making them susceptible to floating oil. Since they do not have much fat, they depend on rapid metabolism to generate heat. Their luxurious fur and an entrapped air layer with dense, water-resistant underfur prevent heat loss to the cold Alaskan waters. To maintain the insulating properties of their fur, otters must groom constantly. When sea otters became fouled with oil, grooming because obsessive, resulting in ingestion of oil.

During 1989, 1013 sea otter carcasses were collected, including animals that died during capture and rehabilitation. Veterinarians determined that up to 95 percent of the deaths were attributable to oil. This information, coupled with estimates of the probability of finding carcasses, data from boat surveys, and computer models, indicate that the initial injuries were extensive, killing between 3,500 and 5,500 sea otters in the first month[s?] following the spill.

Data indicates that in 1990 and 1991, sea otters were still being affected by the spill. Carcasses found in these years included an unusually large proportion of dead prime-age adult otters, 2-8 year olds, rather than mainly juvenile and old otters, as found before the spill. And a study of survival of young sea otters just after weaning showed a 22% higher death rate during the winter of 1990-1991 and spring of 1991 in areas affected by the spill.

One possible cause of the apparently higher mortalities of weanling and prime-age animals would be eating oil-contaminated prey. During 1992 surveys fresh oil was found in protected dense beds of mussels. Since mussels form a large part of the diet of young otters, they are potentially at risk from foraging in these beds. It is not known to what extent young otters forage on mussels in the dense beds which have been oiled and to what extent they forage on more isolated mussels, which would be expected to be less of a risk.

RESTORATION:

Sea otters are expected to recover to 80 - 100% of their pre-spill population. Under ideal conditions, sea otters can increase their population at more than 10% per year. Sea otter populations already established in an area probably have a current growth rate of 2 - 3% per year. However, if the habitat remains degraded, the sea otter population may not recover for 35 to 40 years. If the habitat recovers rapidly, and there are no chronic or sublethal effects on the sea otter population, recovery may occur within 7 - 15 years from 1993.

Nature will play the largest role in recovery of sea otters, but there are a number of restoration actions that may help.

Option #47 - Cooperative Program with Subsistence Users

Subsistence hunting of sea otters is allowed only for Natives under the Marine Mammal Protection Act of 1972. The size of the harvest before the spill is unknown but it was probably been less than 20 animals per year in Prince William Sound. The utility of this option depends on current and anticipated harvest trends.

This option would fund agency personnel to work with subsistence users to assess the health of the local population of subsistence resources. If necessary, managers would then work with villagers to develop cooperative harvest guidelines for sea otters.

Option #4.2 - Reduce Disturbance at Sea Otter Haul-out Sites

Currently, disturbance at sea otter haul-out and pupping sites in Prince William Sound appears to be minimal and not to be affecting this species. [Therefore, reducing disturbance is not expected to significantly aid the rate or degree of recovery. Additionally, there is little information on how sea otters react to disturbance.?] However, should disturbance increase enough to affect major haul-out and pupping areas in the next 5 years, recovery could be slowed. Thus, it may be prudent to increase the level of protection at haulouts and pup-rearing sites. This option would fund research to determine the level and importance of human disturbance at sea otter haul-out and pupping sites, and to develop appropriate methods to protect those sites.

Option #13 - Cleanup of Oiled Mussel Beds

Mussels in the spill area are widely scattered. Some, however, are in dense aggregated beds. Some of these dense beds contain significant concentrations of unweathered oil. The exposure of young otters to oil from these oiled mussel beds is not known, nor is there information on how much oiled food can been eaten before the toxin levels cause an effect. Although mussels form a large part of the diet of juvenile sea otters, it is not known if they forage extensively in these dense, contaminated beds.

COMMENTS:

While scientists are unsure whether the populations in the oil spill area are stable, it is clear that they have not recovered to their pre-spill levels and recovery appears to be proceeding slowly, if at all.

[With specific regard to the benefits of cleaning the mussel beds, (Option 13,) could be substantial (25% to over 50% improvement in weanling survival and recruitment rates) for the rate of recovery if the connection between the dense mussel beds and poor weanling survival exists.

However, there is not an established means of cleaning mussel beds that will effectively remove the oil and not harm the mussel bed. Several types of clean-up techniques are being tried on a small scale in 1992. Because of the uncertain feasibility of this option, and the fact that it is potentially very effective, this option is recommended for special study to test its feasibility and effectiveness.

2. TERRESTRIAL MAMMALS

Some terrestrial mammals were exposed to oil through foraging in intertidal habitats. These included brown bear, river otters, Sitka black-tailed deer, and mink. There was a great deal of difficulty in deriving data on the spill on black bears because of the difficulty of finding, tagging or otherwise studying this species in dense vegetation. Further, unless the carcasses were found near the intertidal areas, there was no way to determine mortality.

a. **Brown Bear** (Ursus arctos)

DESCRIPTION:

Ranging throughout Alaska, the brown bear is the largest of the terrestrial mammals and can grow to a length of 9 feet and weighing as much as 1,500 pounds. Omnivorous, it eats

fruits, berries, shrubs, salmon, mice, caribou, moose, clams, insect larvae and carrion. It is also a cannibal.

INJURY:

On all the islands around Kodiak and down the Alaska Peninsula, brown bears forage in the intertidal zone, where clams are plentiful. After the spill, brown bears scavenged the carcasses of spill-killed sea otters and birds that washed ashore. Analyses of fecal material and some samples of bile show that brown bears were exposed to oil. High concentrations of oil were found in the bile of one yearling brown bear found dead in 1989. Since the mortality rates for cubs is close to 50% for the first two years, it is uncertain if this death was related to the exposure to hydrocarbons. There is no evidence that indicates a population level, sublethal or chronic effects from the oil spill occurred.

RESTORATION: No restoration options are proposed for brown bears.

b. River Otters (Lutra canadensis)

Growing to as large as five feet in length and weighing up to 25 pounds, the river otters can be found in all parts of Alaska except the extreme reaches of the Arctic. Though they prefer to live on fish, they will also eat shellfish, frogs, insects, birds, and even some vegetable matter.

INJURY:

Following the oil spill, eleven carcasses of river otters were found on beaches. Total mortality was impossible to estimate. An autopsy of the carcasses [?] revealed oil in their tissues, and there were differences in body weights, some blood parameters, and diversity of diet that may indicate continuing sublethal effects from oil exposure. Due to the lack of pre-spill data, the secretive nature of these animals and difficulties in live-trapping animals over a large geographical area, it was not possible to determine if the spill has reduced populations of river otters in the affected areas.

There is evidence that chronic oil exposure may be having effects on river otters in Prince William Sound. The river

otters captured in oiled areas after the winter of 1989-1990 weighed less than those captured in unoiled areas with the same overall length. Further blood samples taken in 1991 indicate that river otters from oiled areas may continue to suffer chronic effects from petroleum hydrocarbon exposure. These effects may include liver damage and anemia.

[Only a small number of oiled river otters were observed. Two live otters were captured in the spill area and their bile was analyzed and found to contain elevated [???] concentrations of oil, probably from eating contaminated food. Is this paragraph necessary?]

COMMENTS:

A reduction in the number of prey species was noted in the scat. Otters from unoiled habitat did not exhibit this differential. Further, river otter scat in latrine locations indicated that estimated populations sizes were not different between the study areas, but there is also considerable uncertainty about this conclusion since the sizes of the samples were relatively low and a number of assumptions were made in the study design. [Staff suggest a re-thinking of this paragraph as there were only 11 carcasses found.]

RESTORATION:

Without a reliable way to detect small changes in populations, it is difficult to tell when recovery will occur.

Option #8.0 - Develop Sport and Trapping Harvest Guidelines for River Otters

This option would provide funding for research to develop trapping harvest guidelines for river otters. While it would likely have limited benefit to river otter recovery, it would provide better information to agency managers which might allow the harvest to reopen sooner.

c. Sitka Blacktail Deer (Odocoileus hemionus sitkensis)

Found throughout Southeast Alaska and on Kodiak Island, the Sitka Blacktail deer has a reddish brown coat in summer which turns blue-during the winter. The deer feed on vegetation and berries during the summer and any vegetation they can find, including seaweed, during the winter. Its

primary predator is the wolf.

INJURY:

Deer often forage in the intertidal zone on seaweed. Deer taken by subsistence hunters and analyzed for oil contamination showed slightly elevated concentrations of oil. But the deer were determined to be safe to eat.

COMMENTS:

No evidence was found that Sitka blacktail deer were affected by the spill. Deer carcasses found after the spill in Prince William Sound were determined to have died from natural causes.

d. Mink (Mustela vison)

DESCRIPTION:

With the exception of the most northern reaches of the Arctic, the mink is found throughout Alaska. Though an adult mink only weighs about 5 pounds, it is voracious eater dining on whatever it can catch including fish, insects, ducks, birds, and crustaceans. Minks are solitary animals, except during breeding, and have musk which has a smell that rivals that of a skunk.

INJURY:

Mink often forage in the intertidal zone and were exposed to oil on their pelts and in their food. However, due to the lack of information on the populations of these animals before the spill and the difficulties of tabulating its population after the spill, it was impractical to assess the potential effects on these mammals through field studies. A laboratory study of mink was carried out to determine if oil-contaminated food might affect their reproduction. No reproductive effects were documented, even when high concentrations of weathered oil were added to the food.

RESTORATION: No restoration options are proposed for mink.

3. BIRDS

Birds were among the most vulnerable animals to the effects of the spill. Sea birds, which spend much of their time on the water, did little to avoid the spreading oil. Once their plumage became coated with oil, it lost its buoyancy and insulating properties. Birds died as a result of hypothermia and from oil

ingested while preening. There were more than 36,000 bird carcasses recovered. Large numbers of murres, sea ducks and bald eagles were recovered after the spill. Carcasses of loons, cormorants, pigeon guillemots, marbled murrelets, grebes and other species were also recovered from beaches in the spill area. This total was only a small portion of the birds killed by the spill. Other dead birds were washed out to sea, sunk, scavenged onshore, buried in the beach by wave action, decomposed or landed on a beach that was not searched. The results of a computer simulation based on recovered birds indicates that between 300,000 and 645,000 birds were killed by the spill with the best approximation being between 375,000 and 435,000.

a. Bald Eagles (Haliaeetus leucocephalus)

The symbol of the United States of America, there are more bald eagles in Alaska than in the rest of the nation combined. Found in all parts of Alaska except the Arctic, the bald eagle can reach 40 inches in height and have a wingspread of eight feet. Eagles are primarily scavengers and prefer fish but will also eat small mammals. There were an estimated 27,000 bald eagles in Alaska with 2,000 of them in Prince William Sound and 6,000 along the northern coast of the Gulf of Alaska.

INJURY:

About 150 eagles were killed by the oil spill, but the number of dead birds is uncertain and may be several times this number. It is possible that the number of eagles killed in Prince William Sound may have been as high as 430.

Bald eagles encountered oil while feeding on fish and heavy oiling of the plumage led to loss of body heat and the inability to fly. Preening caused the eagles to ingest oil. There is uncertainty as to the total number killed. Seventy-four percent of radio-tagged eagles that died of natural causes ended up in forest and other inland areas.

There was also a sharp decrease in productivity of eagles in 1989, with a greater rate of nest failure in oiled as opposed to unoiled areas.

RECOVERY:

Since the number of eagles lost appears to be less than the change that could be detected by common aerial survey techniques, it is not possible to measure the recovery of the eagle population to pre-spill numbers. Similarly, it

appears unlikely that the lost chick production in 1989 will have a measurable impact on the population. Bald eagles are expected to be fully recovered to their pre-spill population level between 4 to 6 years after the oil spill.

The only restoration options available to help eagle populations are protective.

COMMENTS:

The bald eagle population in Prince William Sound is believed to be at or near the habitat's carrying capacity. Loss of suitable, unused nesting habitat for additional or replacement eagle nests would likely constitute a corresponding decrease in the population. Agency and peer review experts indicated that habitat loss could result in natural recovery proceeding only to 85% of the pre-spill level. The effects may be greater in regions where nesting habitat is already limited by human activity, such as Afognak Island.

Option #37 - Habitat Protection and Acquisition

Purchase of additional habitat could afford protection beyond existing statutes and regulations.

b. Black Oystercatchers (Haematopus bachmani)

A jet-black bird with a flat, red bill, the black oystercatcher is about the size of a crow. A short-legged shorebird, it nests in beach gravel near the grass line. Approximately 950 black oystercatchers lived in Prince William Sound prior to the spill with another 2,000 in the rest of the spill area.

INJURY:

Nine black oystercatcher carcasses were recovered from beaches after the spill. It is somewhat uncertain how many additional birds may have been killed but it is estimated that 120 to 150 birds in Prince William Sound died as a result of the spill.

RECOVERY

Black oystercatchers are expected to recover to their pre-spill levels in 30 years. There is uncertainty regarding the rate of recovery because the actual impact of the injury

will not be known until the 1993 breeding season when chicks hatched during 1989 will become sexually mature. It is also unknown how much movement there is between areas so the effect of immigration into the oiled area may greatly accelerate the recovery.

Three restoration options will have effect on multiple species, but would also benefit black oystercatchers.

Option #13 - Eliminate of Oil from Mussel Beds

This option would provide funds to eliminate oil from dense mussel beds. The option is expected to increase the rate of recovery of the overall population by a little less than 10%. This option may be more effective in localized areas where breeding pairs feed more on the more densely aggregated and contaminated mussel beds.

Option #14 - Accelerate Recovery of the Upper Intertidal Zone

This feasibility option will test whether it is possible to re-establish *Fucus* which was the dominant intertidal species before the oil spill. (*Fucus* is the dominant seaweed which grows throughout the spill area. *Fucus* was destroyed in the upper intertidal areas by the spill and cleanup. Re-establishing *Fucus* could be instrumental in accelerating recovery of the upper intertidal zone.)

If feasible, this option could be locally effective for oystercatchers. Because this technique would have to be applied over at least 10% of the breeding area in order to produce a notable response in the injured black oystercatcher population, it is not practical to use it to recover the overall population.

Option #37 - Habitat Protection and Acquisition

Because black oystercatcher are concentrated along the intertidal zone already government owned, habitat acquisition will not significantly affect the rate or degree of population increase.

COMMENTS:

In addition to mortality there are differences in some reproductive parameters between black oystercatchers in oiled and unoiled environments. The egg volume and the weight gained by chicks raised in oiled areas were different in 1989 than in the unoiled area; however, there is no pre-

spill data for these areas and it is not known if these conditions existed before the spill.

c. Murres (Uria aalge)

A seabird which nests in colonies, the murre can grow to 16 inches in length. It is dark brown with white belly feathers and has small, narrow wings which it uses to swim underwater. Out of an estimated 12 million common and thick-billed murres in Alaska, there are 1.4 million in the Gulf of Alaska. Of these, 1.2 million live in the Semidi Islands which were not affected by the oil spill.

INJURY:

Murres were the most severely affected bird species, with several large colonies in the Gulf of Alaska loosing from 35 - 70% of breeding adults. With non-breeding birds possibly also affected, total mortality may have been as high as 300,000. Some colonies have lost so many breeding adults that there are not enough remaining individuals to fend off predators.

Murres are very susceptible to floating oil. Very few murres are found in Prince William Sound, so they were not affected until the oil entered the Gulf of Alaska and reached major breeding colonies. At the major colonies which were studied (Chiswell Islands, Barren Islands, Puale Bay, and the Triplets), it is an estimated 120,000 to 134,000 adult breeders were killed by contact with oil. If the rate of mortality is adjusted for birds not counted on the colonies, but feeding at sea, it is estimated that 170,000 to 190,000 breeding birds were killed. In general, it is estimated that between 35% and 70% of the breeding adults at the above colonies were killed by the spill. It is not known where pre-breeding juveniles were at the time of the spill, or if many were killed.

Since the spill the timing of reproduction has been abnormal in oil-impacted colonies. At the Barren Islands and at Puale Bay, egg laying has been about a month late in 1989, 1990 and 1991.

At the Chiswell Islands there was no egg laying in 1989, and laying was late in 1990. Due to the decimated nature of these colonies, it is likely that the [rate of predation? or the percentage of loss?] was much greater than normal, since these colonies rely on sheer numbers of birds to discourage predation by gulls and eagles. Further, the delay of egg

laying for a month in most affected colonies is likely to produce chicks that cannot survive. It has been estimated there has been a loss of 300,00 murre chicks due to the disruption of reproduction.

There were preliminary indications of recovery at the Barren Islands in 1991 and 1992, but it is not yet known when normal timing of reproduction will start again. Peer review and agency scientists estimate that *eventually* the injured common murre populations will return to between 80 - 100% of their pre-spill level. The degree of recovery may vary from pre-spill levels because of natural population fluctuations. Because recovery rates for this species are very slow and because of the current breeding problems, the scientists estimate that recovery will require between 50 and 120 years from 1989.

RESTORATION

Option #4.1 - Reduce Human Disturbance at Murre Colonies

Murres are sensitive to disturbance during the nesting period, especially loud noise. Sudden loud noises, such as gun shots, will scare murres off their nests, allowing gulls and other predators access to eggs and young chicks. There appears to a potential problem near the Barren Islands with disturbance. Halibut fisherman catch large halibut near the Barren Island murre colony and routinely shoot the fish before landing them. This appears to occur frequently during the summer nesting season. While such disturbance may not be a problem for a healthy population, it could delay the recovery of an affected colony, such as that at the Barren Islands. There is a good chance that elimination of gunshot noise within about a half mile of the Barren Island murre colonies would help aid recovery of this colony.

This option would fund a public education program to contact fisherman, party boat and charter boat captains and seek voluntary reduction of disturbance. If voluntary actions are not effective, formal regulations could be considered to control disturbance at the colonies. If regulations were promulgated, some increased enforcement may also be necessary.

This option could increase the rate of recovery by 10 - 24%. It is most likely to have its greatest affect at the Barrens Island or Puale Bay. It is thought that the Chiswell Islands colonies have habituated to the tour boats that frequent the Chiswell Islands, so protective measures aimed

at the Chiswells where gunshots are infrequent would have limited effectiveness.

Option #16.1 - Increase Murre Productivity through Enhanced Social Stimuli

This option has been classified as a "special study" because there are too many unknowns to evaluate its effectiveness. Seabird scientists believe that it could be effective at stimulating synchronized breeding on small portions of the injured colonies, however, they do not believe it can be implemented on a large enough scale to influence a large colony.

Option #16.1 - Improve Physical Characteristics of Nest Sites

Some scientists suggested modifying nests to minimize the loss of eggs. Examples could include placing sills around nesting ledges or adding partitions to reduce the number of eggs knocked off the ledges. This option would be used to "jump start" severely injured murre colonies.

Both agency staff and experts agree that while there is potential to effect the rate of recovery, it is unlikely that modification could be made over a large enough area to cause a colony-wide effect. In addition, the effectiveness of this technique is uncertain. Experts suggested that testing this option may be appropriate on a healthy colony to document the change in productivity.

Options #17.2 - Reduce Predator Access to Marine Bird Colonies

Predation can have a significant affect on the nesting productivity of murres. Gulls, ravens and eagles are known predators of murres and this option would temporarily reduce predation until the murres have returned to successful breeding patterns. Because this option injures predator populations, it should be terminated after a few years.

Agency and peer review experts indicated that if predation is lowered at the injured colonies, this option could improve the rate of recovery by 15 - 20 years. Documentation of the current predation levels is necessary before this option would be implemented.

Option #37 - Habitat Protection and Acquisition

Most murre colonies are under public ownership so purchasing private land will have limited application for their recovery. One exception is Gull Rock in Kachemak Bay, which

is privately owned. It continues to have a healthy colony but the ability to ensure the continued health of the colony would be enhanced if it were publicly managed.

Comments:

There are some signs that recovery may be beginning in 1991 in isolated parts of the Barren Islands, but the threshold to reproductive success has not been passed and recovery is expected to take many decades.

d. Glaucous-winged Gulls (Laurus glaucescens)

The traditional sea gull, the glaucous-winged gull can reach 26 inches in height, has grey wings with a white head and chest. It nests in colonies and has a habitat which includes tidal flats, garbage dumps, canning facilities, salmon streams and coastal communities.

INJURY:

RESTORATION:

e. Harlequin Ducks (Histrionicus histrionicus)

The male harlequin duck lives up to his name, taken from the "harlequin" or clown of Old England. Growing to a height of 17 inches, the male is slate-blue with white spots and stripes on his head, shoulders and wings with chestnut wings. The female is brown with three white spots on either side of her head.

INJURY:

Harlequin ducks appear to be the most affected of the six species of sea duck in the oil spill area. Both acute and sublethal effects have been documented. An estimated 600 harlequin ducks were killed by the spill. With few exceptions, neither breeding ducks nor fledgling chicks have been located within the oiled area of Prince William Sound since 1989. Breeding activity in the unoiled eastern Prince William Sound appears to be normal. The lack of reproductive activity of harlequin ducks in the oil spill area since 1989 appears to be the most lingering effect of the spill.

Elevated concentrations of oil in the bile of harlequin

ducks was collected in western Prince William Sound in 1989 indicates an oil-related effect on reproduction. However, there is so little known about the causes of reduced breeding, physiological changes induced by feeding on oiled invertebrate prey that recovery time cannot be predicted.

Of the six species of affected sea ducks, the harlequin feed highest in the intertidal zone where most of the stranded oil was initially deposited. Some oil still persists in many of these areas. Because they are most susceptible to accumulating oil from their feeding and preening activities in the upper intertidal zone, post-spill studies of sublethal effects focused mostly on harlequins.

Analysis of bile from harlequins from Prince William Sound in 1989 indicated that oil concentrations were five-times greater in the spill area. A 1989 comparison of body condition indicated that harlequins from eastern Prince William Sound had better body condition than those from western Prince William Sound which was oiled.

In 1991, mist netting of streams in oiled and unoiled areas provided an index of the reproductive activity because brooding ducks make frequent trips between their streamside nests and the saltwater forage areas. In the eastern Prince William Sound, 12 streams were netted for 149.5 hours and 23 ducks were captured. In the western Prince William Sound, 16 streams were netted for [132 hours 254 hours?] and no ducks were captured. In 1992, the comparable data were: 20 streams were netted in the eastern Sound for 485 hours, 44 ducks were captured; and 37 streams in the western Sound were netted for 254 hours, and only two ducks were captured. This data indicates a large difference in numbers of brooding birds between oiled and unoiled areas.

There is also data on the numbers of broods seen at end of summer molt surveys. These data indicate that in 1991 in eastern Prince William Sound, 1,234 ducks were sighted, 16 of which were hens with broods. In western Prince William Sound 666 birds were seen of which 5 were hens with broods. Of the 5 broods seen, only one was within the oil spill area -- in the Bay of Isles. Molting surveys carried out in 1992 show that in eastern Prince William Sound there were 1,050 harlequin ducks seen, 5 of which were hens with broods, and in western Prince William Sound there were 1,503 harlequin ducks seen which 3 were hens with broods. Again, only one of the broods was within the oil spill area of western Prince William Sound -- in Drier Bay. There are some data previous to 1989 that indicate that there was successful reproduction within the area that is now affected by the spill.

RECOVERY

Recovery has not begun. If oiled food is affecting the harlequins reproduction, fecundity should increase once the toxicity threshold is reached. [There should be another sentence here. This is the first time toxicity is mentioned.]

Experts disagree on the time it will take harlequin duck populations to recover to their pre-spill levels. Estimates range between 10 and 50 years from 1989. Experts expect harlequin ducks to *eventually* recover within 80 - 100% of their pre-spill levels (with the range being due to the natural variation in the population).

RESTORATION

There are three options that may aid natural recovery: protection of the streamside habitat to prevent further stress, maintaining existing hunting closures, and eliminating oil from mussel beds which may be the pathway through which oil is continuing to contaminate the harlequins.

Option #8 - Develop Sport-harvest Guidelines

During the late summer and early fall, the oil-spill area population of harlequins consists of the local breeding population. During the late fall, the breeding population is joined by a huge number of migrants on their way south.

The Alaska Board of Game closed the September hunting season in Prince William Sound and the outer Kenai Coast (Game Management Unit 6D and 7) to taking harlequin ducks by issuing an emergency closure in (1990?). Agency and peer review experts believe that maintaining the September closure will increase the population levels during recovery by 10 - 24%. However, additional late-season closures are expected to provide only minor benefits to recovery population levels because the migrants vastly outnumber the breeding harlequins at that time. Hunting at that time takes mostly the migrant harlequin rather than the oil-spill area's breeding population.

This option would fund research necessary to provide the Game Board with information concerning the impact of closure on the recovery of the harlequin duck population. It would also provide the game board with information necessary to make the decision to reopen the harvest, once recovery becomes imminent.

Option #13 - Eliminate Oil from Mussel Beds

Mussels are an important part of a harlequin's diet. Unfortunately, it is unknown whether cleaning widely scattered beds of these oiled mussels beds would substantially reduce the oil intake for harlequin ducks. For this and other reasons, there was wide disagreement between agency and peer review experts on the effectiveness of cleaning mussel beds. On a localized basis it may provide substantial improvement to the rate of recovery (25 - 50%), and it may allow the ducks to begin breeding again in the oil-spill area.

Because of the link between the mussel beds and the harlequin duck injury, and the toxicity level of oil in the harlequins is unknown, it is not possible to apply this option on a large enough scale to significantly accelerate recovery over the entire area. More information on the link between oiled mussels and harlequin duck feeding habits is needed before this option can be properly evaluated.

Option 37 - Habitat Protection and Acquisition

Studies in the Lower 48 have shown that harlequins are easily disturbed by nearby logging or other development activities. This option proposes to acquire land near nesting habitat to ensure that breeding will not be disrupted by loud noises. Protecting the shoreline and stream corridor habitat was recommended by agency and peer review scientists as the most effective option. It is a method of protecting the maximum natural recovery rate.

f. Marbled Murrelets (Brachyramphus marmoratus)

A small sea bird, the marbled murrelet grows up to 9 inches in length. It is a mottled brown in summer and, during the winter, has a black back and cap with a white chest. There were between 60,000 and 120,000 marbled murrelets in the oil spill area prior to March of 1989.

INJURY:

Approximately 600 marbled murrelets were killed because of the spill. Statistically this represents about 6,000 killed, between 5 and 10 percent of the population of the spill affected area. Unfortunately, baseline data is lacking to determine pre-spill population levels. Data from the early 1970s and mid-1980s indicate that marbled murrelets were in decline in Prince William Sound.

Marbled murrelets have a low reproductive rate and are unlikely to recover from the mortality of the spill. However, due to the [highly variable?] population counts made since the spill, it is not possible to determine population trends in the spill area. [Reference books dispute this? Armstrong's A GUIDE TO THE BIRDS OF ALASKA. Thus, protection of stands of old growth timber close to where this species is known to occur is a reasonable precaution for any continuing healthy population of marbled murrelets.??]

RECOVERY

Marbled murrelet population is not expected to return to pre-spill population levels. Estimates on when the population may stabilize vary widely between experts. Estimates of further declines range from an additional 20 to 50% loss with the population stabilizing at that reduced level between 11 to 50 years.

Option #9 - Minimize Incidental Take of Marbled Murrelets by Commercial Fisheries

Studies estimate that in 1991 there was no mortality of murres due to set nets in the spill area, but approximately 300 marbled murrelets died due to entanglement in drift nets. This option would study the extent of marine bird mortality in the oil-spill area coastal gillnet fishery to develop new strategies for reducing mortality and incorporation of reliable techniques into State regulation.

Agency and peer-review experts indicate substantial uncertainty over the effectiveness of this option. Most experts believe it would increase the likelihood that the population would stabilize at a larger population: closer to a 30% loss from existing levels rather than a 50% loss. Experts disagreed whether there would be any effect on the rate of stabilization. They felt that the option could generate substantial improvement in the rate of stabilization in local areas where mortality is high, but it would likely have a much smaller improvement on the time to stabilization for the population as a whole.

Option #37 - Habitat Protection and Acquisition

This option provides the greatest benefit in ensuring that the population can recover and that prime habitat is not developed in a way to adversely affect the marbled murrelet population. If this species is to recover, nesting habitat

and food supply must be protected. Since this species has been shown to favor old-growth timber protection of this habitat is a prudent step to ensuring recovery and continued protection.

Option #40 - Special Designations

Special designations that include both upland and marine habitats could provide substantial protection to marbled murrelet habitat. A large designation area that would limit development activities and pollution sources may have a positive effect on the marbled murrelets food sources. This added protection would also increase the confidence in a more rapid stabilization period. There is wide disagreement between experts on the benefit these designations may provide.

COMMENTS:

In the Pacific Northwest, marbled murrelets are a threatened species under the federal Threatened and Endangered Species Act. They are not listed under the act in Alaska.

Post-spill data indicate that there has been a decline in this species since the last censuses in the middle 1980s. However, it is not possible to separate the decline due to the spill from that due to other causes. Post-spill studies also confirmed the presence of oil in marbled murrelets collected near Naked Island in Prince William Sound. It is not known if there are sublethal effects of the oil on this species.

Population estimates in Prince William Sound since the spill show an uncertain pattern of recovery. The estimates for marbled murrelets were 107,000 in 1989, 81,000 in 1990, and 106,000 in 1991. The data taken in the 1970s and 1980s indicate a population decline occurring during this decade. Though there is great uncertainty about the decline, scientists expect it to continue.

In addition, the long-term declines in populations of other sea birds in the spill area indicate that there may be some sort of large-scale changes in food supply or predation that deserve careful study if the natural resources are to be wisely managed. Whether these changes might be related to the apparent growth of populations of predators or fishery interactions, bear examination.

g. **Pigeon Guillemot** (Cepphus grylle)

Black and plump-bodied with a reddish-orange feet, the pigeon guillemot turns grey and black in the winter. Growing to a length of 13 inches, it nests in cliffs and crevices high above the tide line. It forages along the shore and congregates on rocky beaches.

INJURY:

Five hundred and sixteen guillemot carcasses were recovered after the spill for an estimated total mortality of 1,500 to 3,000. The results of boat surveys in Prince William Sound indicate that the population of this species was 14,600 in 1973. After the spill the populations were 4,000, in 1989, 3,000 in 1990 and 6,600 in 1991. The survey data, however, indicate that the decline in the oiled areas were greater than in the unoiled areas of the Sound.

RECOVERY

Pigeon guillemots are not expected to return to their pre-spill population levels. The population was declining prior to the spill and the decline is expected to continue. The reasons for the long-term decline are unknown which makes predictions of future population trends extremely difficult. The population is expected to stabilize sometime in the next 50 years, but estimating the population size when it stabilizes is uncertain.

Option 17.2 - Reduce Predator Access to Marine Bird Colonies

Pigeon guillemots nest on the ground and are preyed upon by small mammals such as weasels and mink, and by large birds such as seagulls and ravens. This option would temporarily reduce local predator population until the pigeon guillemot populations have begun to recover. Because this option entails killing predator populations, it could only be continued for a few years and would only be used to "jump start" severely injured pigeon guillemot colonies. Before the option could be implemented, additional research would be necessary to determine the extent of the predation at the colonies, and to more fully evaluate its effectiveness.

Agency and peer review experts indicate that if predation is high at the injured colonies, this option could improve the degree of recovery by 25 - 50%. This decrease in predation would reap an increase in the productivity of the colony and thus slow the rate of population decline.

Option 37 - Habitat Protection and Acquisition

Pigeon guillemots are tolerant of human activity near nesting areas. However, it is important to protect the nesting sites from erosion or other degradation. Protecting upland habitat immediately adjacent to the coast would prevent the population decline from accelerating due to lost nesting habitat.

4. OTHER BIRDS

SUMMARY

There were numerous other birds affected by the spill. The most direct evidence of injury comes from the carcasses of birds found on the beaches in 1989. Some of the other species include ducks, sandpipers, phalaropes, gulls, terns, auklets, puffins, various passerines, loons, grebes, shearwaters, petrels, cormorants, and geese. Other data comes from boat surveys carried out after the spill using similar techniques to those used in 1972-1973 and 1984-1985 surveys. The following species declined more in oiled than in non-oiled areas since the early 1970s: harlequin duck, black oystercatcher, pigeon guillemots, northwest crow and cormorants. A similar comparison based on the 1984-1985 surveys showed declines in harlequin duck, black oystercatcher, murre, pigeon guillemots, cormorant, Arctic tern and tufted puffin.

There is a great deal of uncertainty about the recovery of populations of these species. Habitat protection may prevent further damage to these populations, although large-scale interactions in the marine ecosystem that may be linked to fishery and hatchery practices during the last ten years needs more study in relation to the high potential of having affected populations of marine birds dependent on the pelagic food web.

Injuries to murres, eagles, marbled murrelets, and sea ducks are discussed individually above; however, these are only three of the approximately 90 species of birds represented in the collections of dead birds recovered after the spill. In Table xx the species with more than yy bodies recovered after the spill are listed. In general, these numbers statistically represent about 10 - 15% of the total numbers of individuals killed. For most of these species there is not an available population census of the affected area at the time of the spill that will allow accurate assessment of the significance of these estimated losses.

5. FISH

In spite of the fact that few fish carcasses were recovered after

the spill, the broad spectrum of marine and estuarine species were affected. The egg and larval stages of fish are more sensitive to the effects of oil than adults and thus the oiling of habitat affected the fecundity of some streams and estuaries.

As an example, there were differences in mortality of pink salmon and herring eggs between oiled and unoiled areas. In addition, comparison of larval growth and abnormalities suggest that oil affected this life stage in both species. [However, there is disagreement in some cases as to whether egg and larval mortalities have resulted in declines in adult populations. Both pink salmon and herring reproduce along oiled shorelines and their eggs were exposed directly to oil, resulting in injuries to eggs and juveniles.

Further, the oil spill caused mortality to the bottom of the food chain which, in turn, affected the availability of food in the habitat. Dolly Varden and cutthroat trout, which use the intertidal and subtidal zones for foraging, both show differences in growth and survival between populations in oiled and unoiled areas.

Sockeye salmon were unique in that their primary injury was caused by overescapement in the Kenai River and Red Lake System (Kodiak) which resulted from closing commercial fisheries due to the spill. Unusually large numbers of overwintering sockeye fry apparently depleted available food sources, resulting in poor survival and very low numbers of outmigrating smolt. Impacts on rockfish are uncertain, although exposure and mortality were demonstrated.

There were no large fish kills observed at the time of the spill, as sometimes occur when fish are exposed to oil in confined habitats.

a. Cutthroat Trout and Dolly Varden

Salmo clarki Richardson and Salvelinus malma (Walbaum)

DESCRIPTION:

The cutthroat trout and Dolly Varden are anadromous game fish which live in fresh and estuarine waters. The Dolly Varden is the larger of the two species, growing to 3 feet in length and upwards of 40 pounds. Some cutthroats reach this size but most range between 1 and 4 pounds. Prince William Sound is the northern limit for cutthroat trout. Both Dolly Varden char and cutthroat trout feed extensively in the nearshore marine habitat during warmer months but return to freshwater in the autumn to overwinter.

INJURY:

Both cutthroat trout and Dolly Varden feed extensively in the shallow, estuarine waters which were affected by the spill.

Survival of adult Dolly Varden returning to oiled streams in 1989-90 was 40% [32% is used in another source] less than those returning to unoiled areas. Survival [appeared?] to be 28% less for adult cutthroat trout returning to oiled areas. In addition, in 1989-90 adult Dolly Varden grew 22% less in oiled areas. Measurement of hydrocarbons in the bile of Dolly Varden following the spill in 1989 showed that this species had the highest oil concentration of any fish species studied.

Adult cutthroat trout returning to oil areas grew 43% [57% is used in another source] less than those returning to unoiled streams.

The exact reason for these injuries is unclear. They may be due to exposure to oil, or to less abundant or damaged food supply in oiled areas. Sampling of water, sediment, and prey species all revealed [continued?] oil contamination in the oiled areas of Prince William Sound.

Recovery is expected to occur in 9 to 19 years. This estimate is largely dependent on the continued restriction of sport fishing for these species in western Prince William Sound.

RECOVERY:

Option #2.1 - Intensify Cutthroat and Dolly Varden Management to Protect Injured Stocks

This option would fund research to provide the Alaska Board of Fish with information to enact more detailed management of the cutthroat and Dolly Varden sport fisheries and study lakes and drainages in Prince William Sound as alternate sites to replace fishing opportunities lost as a result of the spill. Scientists estimate this option would enhance stocks 5 - 10% above pre-spill levels.

Option #19 - Update and Expand the State's Anadromous Waters Catalog and Atlas (This option applies primarily to cutthroat trout.)

This option would fund the Department of Fish and Game to update the State of Alaska's Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes and its associated atlas. Anadromous streams listed in the catalog are automatically afforded legal protection under Title 16 of Alaska Department of Fish and Game statutes. Many new streams were found during the spill response, others listed were never or incompletely surveyed. Implementing this option would result in a 10% increase in confidence that populations would fully recover to pre-spill levels, although it would not increase the rate of recovery.

Option #37 - Habitat Protection and Acquisition

Cutthroat trout may be especially sensitive to upland disturbance since they are at the northern end of their range. Undisturbed uplands and riparian vegetation provide important habitats and natural buffers that protect the quality of watersheds and the ecosystem as a whole. This option would not effect the rate of recovery, but could help ensure that full recovery to pre-spill levels is achieved.

COMMENTS:

b. Pacific Herring (Clupea harengus)

DESCRIPTION:

Pacific herring grow to 15 inches in length, they are found in such abundance that the fishing season is limited to hours. Herring spawn in intertidal and subtidal waters, the reason their eggs are so easily retrieved.

INJURY:

In 1989, herring spawned in Prince William Sound shortly after the oil spill. Comparing the 1989 class with those of later years, significant differences were found in the rates of egg fertilization and abnormalities in developing larvae. Larval abnormalities continued to be elevated in 1990, but not in 1991.

Although none of the herring spawning areas were heavily oiled, over 40% of areas used by herring to stage, spawn, or deposit eggs and 90% of the areas used for summer rearing and feeding were exposed to oil.

Studies carried out in 1989 and 1990 showed a slight but statistically significantly higher rate of egg mortality in the oiled areas, compared to unoiled areas. In addition,

rates of larval mortality, lethal and sublethal genetic damage, and physical deformities were greater in oiled than unoiled areas of Prince William Sound in 1989. All differences between herring sampled at oiled and unoiled study sites were less pronounced in 1990 and were not observed in 1991.

The lack of difference in egg and larval mortality between oiled and unoiled areas in 1991 may indicate that recovery has occurred. However, the complex population dynamics of Pacific herring make it impossible to predict the extent of injury or estimate natural recovery rates until fish spawned in 1989, and in subsequent years, are fully recruited into the adult spawning population. Population level injuries could take up to fifty years to recover, although there is a high level of uncertainty associated with this figure.

RECOVERY

Option #2.2 - Intensify Herring Management to Protect Injured Stocks

The Alaska Department of Fish and Game may want to recommend restricting fishing or redirecting it to an alternate stocks or sites. This option would fund the research to support those recommendations.

This option could improve the rate and degree of population recovery by over 50%. However, successful management will depend on determining if discrete stocks of herring spawn in Prince William Sound and if they can be separately fished in staging areas or on historic fishing grounds. This option develops stock-specific information such as age and size composition, natural mortality rates, seasonal movements, stock abundance and recruitment, and genetic identity, on which changes in management may be based.

COMMENTS:

Reproduction has probably recovered, but further study may confirm a very weak 1989 year class in the population.

Due to the large natural variability of herring populations, further evaluation and study would be needed to be able to conclude that the adult population has been significantly affected by the spill. There is also some evidence that four-year-old herring, which spawned in 1988, may have suffered some reproductive impairment.

c. Pink Salmon (Oncorhynchus gorbuscha)

DESCRIPTION:

Also known as a "humpback," the pink salmon is a highly prized commercial fish. Growing to a length of 30 inches it is found in most Alaskan waters.

INJURY:

The most apparent injury is to egg mortality. The difference in mortality rates between oiled and unoiled streams persists. For at least the first three years after the spill, the rate appears to be worsening, both in oiled and unoiled areas. While there is disagreement among experts on whether population level injuries exist, those who do believe that the spill reduced the adult population estimate that recovery should occur within 20 years of 1989. Estimates for recovery from population level injuries range from 50 to 100 years. Factors which may delay recovery include possible genetic damage to wild spawners and the impact of hatchery fish straying into wild streams.

Since 1989, significant differences have been found in the rate of egg mortality between oiled and unoiled streams in Prince William Sound. Some deformed embryos were found in heavily oiled intertidal spawning areas. Also, in 1989 the exposure of pink salmon fry to oil in Prince William Sound was correlated with decreases in their rate of growth. Impacts on natural, environmental variation and hatchery-wild stock interactions complicate conclusions.

About 75% of the wild pink salmon in Prince William Sound spawn in the intertidal zone. There was no apparent change in the use of this habitat in the summer of 1989, and many salmon deposited their eggs in the intertidal portion of oiled streams. Eggs incubated in oiled streams had mortalities 67% greater in 1989 than eggs incubated in unoiled streams, 51% greater in 1990, and 96% greater in 1991. In 1989 and 1990, increased egg mortality was confined to oil-contaminated areas. Additionally, in 1991, egg mortalities were also associated with unoiled areas leading experts to conclude that spawning populations suffered genetic damage which reduced the viability of their eggs.

Further, pink salmon fry released from hatcheries and left their natal streams in the spring of 1989 were also exposed to oil in the open water. Pink salmon larvae were exposed

to sufficient amounts of oil to induce the enzymes that metabolize oil. Also, juveniles that were exposed to oil in Prince William Sound coastal waters were shown to have a 25% slower rate of growth in 1989 than those unexposed, even after accounting for the effects of food supply and temperature. Reduced growth is generally correlated with reduced survival.

RESTORATION OPTIONS

Option 2.3 - Intensify Pink Salmon Management to Protect Injured Stocks

Restricting existing fisheries or directing other fisheries to alternate sites, while attempting to minimize impacts to human uses is the objective of this option.

This option could help ensure 100% population recovery and accelerate recovery up to 50% over the natural rate. The potential for enhancing wild populations up to 25% above pre-spill levels also exists. This would be the most effective method for restoring population level injuries.

Option #11.1 - Construct Salmon Spawning Channels

This option could accelerate recovery of wild pink salmon stocks by the installation and operation of artificial spawning channels. Since there are relatively few areas where this option could be implemented, the overall population would be increased by less than 10%. On a single stream, adult returns could be increased by up to 20%.

Option #11.3 - Improve Access to Fish Spawning Areas, Fish Passes, Remove Instream Barriers

This option will accelerate recovery of injured wild salmonids by construction of fish passes or removing instream barriers (log-jams) to provide access to unexploited spawning habitat. Because there are few sites where this option would benefit injured pink salmon populations, it could provide less than 10% gain in overall population recovery. However, the option could be more effective in restoring in individual salmon runs. The option has potential to raise populations above pre-spill levels.

Option #19 - Update and Expand the State's Anadromous Waters Catalog and Atlas

This option would fund the Department of Fish and Game to update the State of Alaska's Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes and its associated atlas. Anadromous streams listed in the catalog are automatically afforded legal protection under Title 16 of Alaska Department of Fish and Game statutes.

Updating these documents through additional stream surveys, particularly smaller tributaries, would increase protection of anadromous salmonids including wild pink salmon, their habitat, species that feed on them or rely on their nutrient contribution, and the services they provide. Anadromous streams listed in the catalog are automatically afforded legal protection under Alaska Department of Fish and Game statutes. Many new anadromous streams were found during the spill response, others listed were incompletely surveyed. This option could provide some degree of protection for recovering populations, especially outside the Sound where a larger percentage of pink salmon spawn above the intertidal zone.

Option #37 - Habitat Protection and Acquisition

Populations of salmonids, including wild pink salmon, are especially dependent upon anadromous streams and their adjacent riparian lands. Undisturbed uplands and riparian lands provide important habitats that protect the quality of watersheds and the ecosystem as a whole. By acquiring strategic areas, injured species can be safeguarded during recovery and various resources and services can be restored and enhanced. This option could protect 10 - 30% of the population from disturbances which would delay recovery. It is especially applicable in areas outside the Sound where a larger percentage of pink salmon spawn above the intertidal zone. Added protection has the potential to increase populations 10% above pre-spill levels.

Option #40 - Designate Protected Areas

Uplands used by wild pink salmon can be placed into special State or Federal designations which provide increased levels of regulatory protection. An important feature of special designations is that they can provide a regulatory basis for managing an area on an ecosystem level, with the primary objective of restoring spill injuries. This option would not increase the rate or degree of recovery but could protect up to 30% of the population from habitat degradation which would slow recovery.

Option #48 - Improve Survival Rates of Salmon Eggs and Fry

(This option should not be implemented without taking into account the ecological and fisheries management impacts of releasing additional fish.)

This option focuses on the implementation of proven fishery enhancement techniques to increase the rate of survival of egg and larvae of stocks of wild pink salmon injured by the oil spill. This includes remote fry rearing and artificial spawning techniques. This option also includes the provision to collect outmigrating fry and rear them in net pens and the hatchery rearing of wild eggs. This option would be expensive to implement on a wide scale. Localized efforts would help ensure recovery to pre-spill levels at a faster rate. However, the option could not be implemented until fish recover from all chronic injuries. There is also potential to enhance local population 10 -25% above pre-spill levels.

Option #51 - Relocate Existing Hatchery Runs

This option would relocate hatchery runs of salmon which overlap in timing or geography with runs of wild-stock pink salmon. Better separation of wild and hatchery runs will allow more precise management of fisheries and potentially decrease harvest pressures on injured fish, without closing or restricting fisheries. The option could apply to hatchery pink or sockeye salmon which support Prince William Sound fisheries that have historically intercepted significant numbers of wild salmon. This option could provide substantial localized benefits and reduce interception of runs by 25 - 50%.

COMMENTS:

Successful implementation of the management of pink salmon will depend on the ability to control stock-specific exploitation rates, for both wild and hatchery runs. Restoration based on stock-specific management will, in turn, depend upon better information on stock characteristics such as age and size composition, natural mortality rates, season movements, stock abundance and recruitment. Separation of discrete stocks using genetic markers is also needed. On the basis of this information, the Alaska Department of Fish and Game will recommend to the Alaska Board of Fish various changes to fishing regulations to further protect wild pink salmon stocks injured by the oil spill.

d. Rockfish

Unfortunately, little is known about rockfish populations, injury, or recovery. The spill did kill some rockfish and exposed others to oil. In addition, the commercial fishing salmon closures during the spill increased fishing for rockfish. Rockfish harvest is not currently limited by the Alaska Board of Game. There is concern that without limits, overfishing may be occurring.

Without knowledge of rockfish populations, injury, or recovery, there are few options available to address the species. However, more intensive fisheries management may prevent any overfishing resulting from the spill.

INJURY

Many (19) dead rockfish were reported after the spill, but only 5 were in good enough condition to analyze. All 5 fish died from oil ingestion. Other rockfish collected from oiled areas in Prince William Sound and the outer Kenai coast in 1989, 1990 and 1991 indicated exposure to oil and higher than normal incidence of oil-associated organ lesions. Population impacts are unknown.

Post-spill increases in fishing pressure may also be affecting rockfish. Partially due to numerous spill-related fishing closures in 1989, fishing pressure shifted to rockfish, and harvest levels increased. Rockfish harvests in Prince William Sound increased from approximately 93,000 pounds in 1989 to over 489,000 pounds in 1990. While harvest has decreased somewhat since 1990, it is still higher than the historic average. The increased harvest has caused concern because rockfish do not reproduce until they are ___ years old, produce relatively few young, and would not recover rapidly from overfishing.

RECOVERY

Option #2.4 - Intensify Rockfish Management to Protect Injured Stocks

> Increased research and changes in management practices, would determine whether harvest limits or other fishing techniques are needed to sustain rockfish populations. If so, the option will fund research to allow the Alaska Department of Fish and Game to recommend regulation changes to the Alaska Board of Fish. Research will focus on quantifying stock characteristics such as age and size composition, natural mortality rates, season movements, rockfish abundance and recruitment, and rockfish bycatch in other fisheries.

If rockfish populations have been reduced because of exposure to oil or overfishing, this is the only option which could provide significant benefit to rockfish.

COMMENTS:

e. Sockeye Salmon (Oncorhynchus nerka)

A highly-prized commercial and sport fish, it ranges from Southeast Alaska to Point Hope. It can grow as large as three feet in length and weigh 15 pounds. It is anadromous.

INJURY:

In 1989, the decision not to allow commercial fishing in portions of Cook Inlet resulted in too many spawning salmon returning to certain sockeye rearing lakes in the Kenai River system. The problem was compounded by the fact that too many fish returned in 1987 and 1988.

The Kenai River watershed is managed for an average return of 600,000 spawning salmon. Over 1,400,000 fish returned in 1987 and 1989. The cumulative effect of large numbers of spawning fish in the Kenai River system has been a decline in smolt production. This was probably caused by overgrazing of plankton by fry overwintering in Kenai and Skilak lakes. Smolt production fell as follows:

Year	Smolt Production
1987	30 million smolts
1988	6 million smolts
1989	2.5 million smolts
1990	<1 million smolts

Outmigration of smolt from the Kenai River system have been on the decline since 1990 and the forecasted returns in 1994 and 1995 are below minimum goals for returning salmon. If minimum goals are not met, at least some of the Kenai River fisheries will be closed.

Low juvenile survival may, in turn, cause all or part of the Kenai River fishery to be closed until it can regain its natural balance. Without intervention, Kenai River sockeye populations will not regain their long-term average population until at least 1999.

Overescapement also occurred in Red Lake in Kodiak in 1989 and resulted in similar problems. Two and five-tenths times

the average number of fish returned to spawn in 1989. Overgrazing by fry is assumed to have occurred and fry survival to have been reduced. Low adult returns are anticipated in 1993, 1994 and 1995.

RECOVERY

There are no indications of recovery in the Kenai River system. Estimates of population recovery vary between experts and ranges from 10 to 50 years after 1989.

Natural recovery of the Red Lake system on Kodiak Island is expected to be [more?] rapid since overescapement occurred only in 1989 and the food base may not have been seriously damaged. Without intervention, the Red Lake Sockeye are not expected to recover to pre-spill levels until 1996 or 1997.

RESTORATION OPTIONS

Option #2.5 - Intensify Sockeye Management to Protect Injured Stocks

A change in management practices could accelerate recovery of injured Kenai River sockeye stocks. Examples of possible changes are restricting existing fisheries, or directing other fisheries to alternate sites. Successful changes requires additional information on the way in which different fisheries exploit injured Kenai sockeye runs and information on population size, movements, and genetic composition.

This option will fund research to allow the Alaska Department of Fish and Game to recommend regulation changes to the Alaska Board of Fish. Agency and peer review scientist believe this option could reduce the risk of future overescapements from 25% to 10%. [This percentage is not consistent with others in **format**, not in substance.]

Option #11.3 - Improve Access to Fish Spawning Areas, Fish Passes, Remove Instream Barriers (Kodiak Only).

This option will accelerate recovery of injured sockeye salmon in the Red Lake system. It will fund a survey to locate sites for fishes passes, and then fund their construction, or fund removing instream barriers such as log-jams to provide access to unexploited spawning habitat. Although there are not many sites where this is known to be applicable, it could enhance sockeye populations in the Red

Lake by 25% above pre-spill levels.

This restoration option is only applicable to Kodiak since these activities are not permitted in the Kenai River drainage. The option should not be implemented without taking into account the ecological and management implications of increasing fish populations.

Option #37 - Habitat Protection and Acquisition

Sockeyes are especially dependent upon anadromous streams and their adjacent riparian lands. Undisturbed uplands provide important habitats and natural buffers that protect the quality of watersheds and the ecosystem as a whole. This option would not effect the rate of recovery, but could help ensure that full recovery to pre-spill levels is achieved.

Option #48 - Improve Survival Rates of Salmon Eggs and Fry

This option would fund implementation of proven fishery enhancement techniques to increase the survival sockeye egg and larvae in the Kenai River and Red Lake systems. Examples of these techniques include the use of egg boxes to increase survival of wild salmon eggs, net pens to collect outmigrating fry and rear them until conditions are optimal for their survival, or hatchery rearing of wild eggs.

This option would not be implemented without taking into account the ecological and fisheries management impacts of releasing additional fish. In addition, the option can be implemented only when the plankton populations in the lake systems returned to normal. Otherwise, increased numbers of fry would merely aggravate the injury. When plankton recover, the option has the potential to achieve recovery of the adult sockeye population in one generation by improving fry production up to 80%. One generation would be five years from 1995. However, this would require that the option be undertaken on a very large scale.

6. SHELLFISH

SUMMARY

Shellfish include clams, mussels, crab, oysters, sea urchins and shrimp. Intertidal clams and mussels, however, are dealt with in the section on intertidal communities. Injuries to crabs, shrimp, sea urchins and oysters were not documented and no restoration options are currently proposed.

INJURY

Dungeness crabs and shrimp studies ceased early in the damage assessment process because these species were scarce in Prince William Sound. No field studies were conducted on sea urchins, and oyster studies (on farmed oysters) were terminated after they were determined to be of limited value. However, since oil is known to have impacted subtidal sediments and communities, it is possible that undocumented exposure and injury occurred for several shellfish species.

RECOVERY

There is no information on recovery.

RESTORATION OPTIONS

There are no options proposed for shellfish.

7. INTERTIDAL COMMUNITIES

a. Intertidal Communities

DESCRIPTION:

Intertidal communities include the many plants and small animals that live in the area between low and high tide. Because so many other species feed and live in this area, the health of the intertidal community is important to the entire ecosystem.

Most of the documented damage to intertidal communities is in the middle and upper intertidal zones of sheltered rocky shores. These locations were the most heavily oiled, are where oil persists longest, and where most of the clean-up efforts occurred. The damage has been found mainly to the most common species: rockweed or popweed (*Fucus*), limpets, barnacles and periwinkles. Other damage includes an apparent transient effect on intertidal fishes and fewer clams in the lower intertidal zone.

INJURY:

Many hundreds miles of shoreline [over 1000?] were oiled including many national and state parks, refuges and forests. With tidal action, oil penetrated deeply into cobble and boulder beaches that are relatively common in the spill area. Cleaning removed much of the oil from the intertidal zone, but subsurface oil persisted in many

heavily oiled beaches, and in mussel beds, which were not cleaned during the clean-up efforts. Direct oiling killed many organisms, but beach cleaning, particularly high pressure, hot water washing, had a devastating effect on intertidal life.

The greatest damage was observed in the upper and middle intertidal zones of sheltered rocky shores, where the largest amounts of oil persisted and recovery is relatively slow. In the upper and middle intertidal zones of these rocky shores the seaweed *Fucus gardneri*, limpets, periwinkles, and barnacles were less abundant at oiled than unoiled sites. However, the ecological imbalances created by the spill damage apparently also resulted in increases of ephemeral algae after the spill and of limpets in 1991. The magnitude of the measured differences varied with degree of oiling and geographic area. In sheltered beaches the data on abundance of clams in the lower intertidal zone suggests strongly that little neck clams and, to a lesser extent, butter clams were negatively affected by the spill. Also, in 1990 contrasts of abundance of intertidal fishes indicated fewer fish in oiled areas, but such differences were not found in 1991.

RECOVERY

The lower and middle intertidal zones have recovered to a large extent, but effects linger most strongly in the upper intertidal zone, especially in rocky sheltered shores. Natural recovery of the upper intertidal zone will occur in stages as the different species in the community respond to improved environmental conditions.

Recovery in the upper intertidal appears to depend on the return of adult *Fucus* in large numbers to this zone. *Fucus* is the most common seaweed found throughout the spill area. It provides cover and stability for the many small plants and animals that inhabit the intertidal area. Agency and peer review scientists estimate that it may take as long as 6 to 15 years for *Fucus* to recover. Full recovery of the intertidal community may take from 8 to 25 years, since it may take several years for other species to return after the *Fucus* has recolonized an area.

RESTORATION OPTIONS

Option #14 - Accelerate Recovery of the Upper Intertidal Zone

This option provides funds to test and implement the most

effective method(s) for accelerating the rate of recovery of the upper intertidal zone, particularly the *Fucus* community.

Techniques being considered are largely experimental and will be initiated as a feasibility study. At specific locations, this option could increase the rate of recovery by 25 - 50%. This recovery rate would apply in areas showing few signs of Fucus recovery.

Option 30D - Bivalve Shellfish Hatchery and Research Center

The option would provide funds is to assess the feasibility of establishing a shellfish hatchery and mariculture technical center in the oil spill area to restore, replace, or enhance injured bivalve shellfish species native to Alaska. While initially aimed at restoration and enhancement of subsistence shellfish species, this option also could aid in the recovery of injured wild stocks, particularly native littleneck and butter clams.

COMMENTS:

In addition to the direct effect of the oil and cleanup on plants and animals of the intertidal zone, there may be indirect effects on animals feeding on the intertidal zone. Some data indicates that sea otter pups, harlequin ducks, and, to a lesser extent, river otters and black oystercatchers may still be affected by the spill by feeding on contaminated intertidal organisms, such as mussels

b. Subtidal Communities

SUMMARY

Subtidal communities include the plants and animals that live below low tide.

INJURY

Oil deposited intertidally was washed off the beaches by tidal and wave action, and by the massive cleanup. Much of it sank, associated with particles into the subtidal zone. This exposed the intertidal communities to oil for several years after the spill.

Several subtidal environments were studied after the spill: eel grass beds, *Laminaria* (kelp) beds, fjords and the deep benthos (40 to 100 meters). All these studies relied on contrasts between oiled and unoiled environments without the benefit of pre-spill data on populations of organisms. In

many cases several sites were contrasted with several unoiled sites and sites were matched for conditions likely to affect the abundance of organisms. The greatest differences were seen for small organisms living in the sandy sea bottom below eelgrass beds --they were less abundant in oiled environments. Among the affected groups were crustaceans known from previous studies to be sensitive to oil. In addition, there were larger organisms that showed differences in abundance, most notably the crab *Telemesus*. Two separate studies found that eelgrass in oiled areas did not bloom as well after the spill as in unoiled areas. Some organisms were more abundant in oiled areas, notably small mussels that live on eel grass and juvenile cod. [juvenile cod?]

The results of other subtidal studies produced much less certain information on injury. The results of chemical analyses show that oil did not penetrate deeper than about 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases. Differences were noted between abundance of organisms at 300 feet in several bays, but the exact cause of these differences is not clear. Some flatfish had elevated amounts of oil in their bile in 1989 and 1990, and slightly elevated occurrences of gill damage.

RECOVERY

Analysis of samples of invertebrates associated with eelgrass beds taken in 1991 indicated that differences noted in 1990 between oiled and unoiled areas had started to converge. Another year of study in 1993 may indicate if this trend has continued.

Because recovery has been observed in shallow (<20m) subtidal habitats, and because full recovery is expected in most cases in less than 10 years, there also is little that can be done to accelerate recovery. While transplantation of eel grass, seaweeds and invertebrates is technically possible, recovery has proceeded to where this approach is not now necessary. However, there is need to continue periodic monitoring of subtidal resources.

RESTORATION OPTIONS

No restoration options are proposed.

III. X. Resources: Summary of Results of Injury Assessment Studies

Table X summarizes the results of the injury assessment studies for all resources studied after the *Exxon Valdez* oil spill. Under "Description of Injury," columns focus on injury that took place during 1989 -- just after the spill. The table also shows whether there was initial mortality caused by the spill, whether the spill caused a population-level injury, and whether there is evidence of sublethal or chronic effects on the resource. For some resources, an estimate is available for the total number of animals initially killed by the spill. If available, that estimate is shown in parentheses under the initial mortality column. For many resources, the total number killed will never be known.

The "Status of Recovery" columns show the best estimate of recovery using information the from 1992. (Most information comes from the 1992 summer field season). The columns show resources' progress toward recovery to the population levels that scientists estimate would have occurred in the absence of the spill. The "Current Population Status" column shows a resource's progress from any "Decline in Population after the Spill." Similarly, the column labeled "Evidence of Continuing Sublethal or Chronic Effects" shows whether an initial chronic or sublethal injury is continuing.

The "Geographic Extent of Injury" shows whether the injury occurred in the geographic areas shown in Figure X. (Though the injury may have been more extensive in some regions than others.)

Chapter III.B.(7)(a) Injured Services

a. Archaeological Sites and Artifacts

SUMMARY

The oil spill area has been occupied by Native peoples for at least 11,000 years. The oil spill area has also provided a geographical backdrop to much of Alaska's early history in the post-European contact era (Mobley 1990:55). Although rarely studied when compared to other areas and eras of Alaska, a draft cultural resource assessment study by Dekins et al. (1992:v) estimated that the oil spill area contains between 2,600 and 3,137 historic properties, including 1,287 known sites that have been recorded in the Alaska Heritage Resources Survey.

At least 155 archaeological sites were exposed to some degree of oiling with an estimated 60 more sites subjected to moderate to heavy oiling. A conservative projection by McAllister (1992:43), based on the pattern of known injury to archaeological sites documented by Jesperson and Griffin

(1992:7-8), indicated that another 130 to 150 archaeological sites had been adversely affected by oiling, clean-up activities, or looting and vandalism linked to the *Exxon Valdez* oil spill. Of these, an estimated 113 suffered substantive injury as a consequence of either beach clean-up actions or vandalism (McAllister 1992:43).

INJURY

Injuries to archaeological sites include theft of surface artifacts and masking of subtle clues that archaeologists depend upon to identify and classify sites. Key diagnostic artifacts have been illegally taken, ancient burials have been violated and potholes dug by looters have destroyed critical evidence contained in the layered sediments. Additionally, vegetation has been disturbed which has exposed sites to accelerated erosion. The effect of oil on the soil chemistry and organic remains has reduced or eliminated the ability of radiocarbon dateability (Dekins et al. 1992; Mifflin and Associates 1991; Reger et al. 1992). Other injuries to archaeological sites have not yet been reported and the actual extent of damage will not be known for decades.

Some injuries, particularly looting and vandalism, are continuing and are on the rise in the spill area because of ongoing human intrusion into previously pristine areas.

RECOVERY

Archaeological sites cannot recover in the same sense as biological species or organisms. They represent a category of finite, non-renewable resources. Injury to this resource results not only in the loss of important scientific data, but in an irretrievable loss of Alaska's cultural heritage. Restoration cannot regenerate what has been destroyed, but it can successfully address the prevent further degradation of both sites and the scientific information. Documentation of injured sites is necessary to preserve the artifacts and scientific data which remains in the vandalized sites.

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Option #1.0 - Site Stewardship

This option involves the recruitment, training, coordination, and maintenance of a corps of citizens to safeguard archaeological sites near their residence. This option best addresses the injuries sustained as a result of looting and vandalism. Citizen groups, Native villages and local

corporations can be brought into the program. The Trustee Council initiated this option by approving the Site Stewardship Program in February, 1992. This is a long term project which is expected to last for several years. Thereafter, it is expected to continue under the leadership of local, state and/or federal auspices.

Option #10.0 - Preservation of Archaeological Sites and Artifacts

This option has three components. First, it will be critical to conduct site-specific restoration assessments at sites with documented injury. This is particularly important where there is insufficient information upon which to determine appropriate treatment.

Second, restorative action must be taken either in the form of physical repair or data recovery. The initial focus includes the 24 archaeological sites for which there is clear evidence of injury and time is critical to prevent further degradation of the resource.

Third, after responding to known injuries, the option would expand to identify other injured sites. This restoration effort will be on a priority basis with those sites most likely to suffer irrevocably to be restored first. It is important to emphasize that the bulk of injury data was derived from a study of the oil spill response records and a comprehensive, independent assessment of injury has never been conducted.

The last component of this restoration option will be to resolve the impact of long-term injury from oiling. Ten sites exposed to oiling will be monitored for a period of 10 years to determine the effect of the oil on soil chemistry, radiocarbon dating, and the recovery of protective vegetation.

Option #35.0 - Replacement of Archaeological Artifacts

This option will identify institutions and individuals with archaeological artifacts from the oil spill region who would be willing to donate their artifacts to the *Exxon Valdez* Oil Spill Trustees member agencies. In turn, the Trustees would transfer acquired artifacts to appropriate public institutions within the oil spill area for public display and appropriate scientific uses and study. This will serve to replace artifacts lost to looting and return them to their region of origin.

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b. Subsistence

SUMMARY

Surveys conducted by the State of Alaska in 15 Native villages before the spill and in 7 of those villages in 1990 indicated that subsistence use in the oil spill area was significantly reduced (injured) in 1989, primarily because of concern over health effects associated with use of contaminated resources. While subsistence harvests began to recover in some Native communities (Ouzinkie, Port Graham, Nanwalek (English Bay), Larsen Bay, and Karluk) in 1990 and 1991, other Native communities (Chenega and Tatitlek) had continued, below-average harvests. Based upon chemical analyses of a spectrum of subsistence resources (fish, shellfish, deer, ducks, marine mammals), most resources (with the exception of mussels and clams from oiled beaches) were determined to be safe for human consumption.

Proposed restoration options address the need to restore the confidence of subsistence users. Testing subsistence foods for the prepense of oil will identify those areas and resource still injured. Restoration also assumes that recovery will be gradual and that there is a need to exploit alternative subsistence resources, either by providing access to subsistence areas not impacted by the spill, or by providing

assistance in the development of shellfish mariculture to replace contaminated shellfish. The duration of the injury restoration will depend on the rate of recovery of subsistence services and perception of food safety.

INJURY

The Alaska Department of Fish and Game, Division of Subsistence, determined before the *Exxon Valdez* oil spill, that 15 Native Alaskan communities (with about 2,200 people) of Prince William Sound, Lower Cook Inlet and the Alaska Peninsula relied heavily on subsistence resources. These subsistence resources included salmon, halibut, rockfish and Dolly Varden; marine invertebrates such as clams, crabs, and octopus; marine mammals (harbor seals and sea lions); land mammals such as deer (Prince William Sound and Kodiak Island), black bear and goats (Prince William Sound and Lower Kenai Peninsula); birds including ptarmigan, waterfowl, and gulls eggs; and wild plants. The statistical mean number of resources categories used ranged from 10 to 25, and generally every household participated in subsistence harvests. The per capita subsistence harvest ranged from nearly 200 pounds to over 600 pounds per household per year.

Table 1 illustrates changes in harvest levels in the first year (April 1989 to March 1990) following the spill. Subsistence harvests of fish and wildlife in 9 of these villages (Chenega Bay, Tatitlek, Nanwalek (English Bay), Port Graham, Karluk, Old Harbor, Ouzinkie, Port Lions, and Chignik Lagoon) declined by poundage from 4 to 78% compared to pre-spill averages (Fall 1991). The reason for this decline varied from community to community and household to household. But most declines were attributed to perceived consequences of the oil spill, particularly the concern for potential health effects as a result of consuming contaminated foods.

Chemical studies conducted by the U.S. Food and Drug Administration (ADHSS 1989a) and the National Oceanic and Atmospheric Administration (Varanasi et al. 1990) measured levels of oil and metabolites in the bile and edible tissues of subsistence foods. These studies discovered that most of the resources tested (fish, shellfish, deer, ducks, marine mammals) contained no or very low levels of oil-related contamination and that eating foods with those levels posed no health risk. Exposure to oil did not necessarily render organisms unsafe to consume. However, some samples of shellfish had unacceptably high levels of oil prompting an advisory that shellfish should not be collected from oil-contaminated areas (ADHSS 1989b).

RECOVERY

Table 1 also summarizes changes in harvest levels in 7 Native villages following the oil spill. The finding that subsistence harvests had increased in 5 villages during the 1990-1991 timeframe suggested increased confidence in using some subsistence resources. However, the continued low levels of harvest at Chenega Bay, Tatitlek, Nanwalek (English Bay) and Ouzinkie, and the continued concern in some households in the 7 villages suggested that the injury persisted through the second year following the spill (Fall 1992).

While data is not yet available for the period of April, 1991, to present, resource managers suggest that subsistence harvests have not returned to pre-spill levels in all affected Native communities -- particularly Chenega Bay and Tatitlek. Concern over long-term health effects of consuming contaminated resources, a loss of confidence on the part of subsistence users, and the real or perceived reduction in available resources, are all factors likely to affect recovery of subsistence use.

TABLE 1. Subsistence Harvests Before and After the ***Exxon Valdez*** Oil Spill: Per Capita Harvest in Pounds (Fall, 1991, 1992; Page, 1991). (see footnote a)

COMMUNITY	PRE-SPILL YEAR ONE	PRE-SPILL YEAR TWO	OIL SPILL YEAR	% CHANGE (see footnote b)	POST-SPILL YEAR ONE
Prince William Sound					
Chenega	308.8	374.2	148.1	-60.4	143.1
Tatitlek	351.7	643.5	214.8	-66.6	155.2
Lower Cook Inlet					
Nanwalek (English Bay)					
Port Graham	288.8	(c)	140.6	-51.3	181.1
	227.2	(c)	121.6	-46.5	213.5
Kodiak Island					
Akhiok	519.5	159.3	297.7	+86.9	(d)
Karluk	863.2	381.0	250.5	-34.3	395.2
Larsen Bay	403.5	200.9	209.9	+4.5	340.4
Old Harbor	491.1	419.3	271.1	-35.2	(d)
Ouzinkie	369.1	405.7	88.8	-78.1	204.9
Port Lions	279.8	328.3	146.4	-55.4	(d)
Alaska Peninsula					
Chignik Bay	187.9	(c)	208.6	+11.1	(d)
Chignik Lagoon	220.2	(c)	211.4	-3.7	(d)
Chignik Lake	279.0	(c)	447.6	+60.1	(d)
Ivanof Bay	455.6	(c)	489.8	+8.4	(d)
Perryville	391.2	(c)	394.2	+1.0	(d)

(a) Pre-spill study years are: Tatitlek 1987-88 and 1988-89; Chenega, 1984-85 and 1985-86; Nanwalek (English Bay) and Port Graham, 1987; Kodiak Island Borough, 1982-83 and 1986; Alaska Peninsula, 1984. The "spill year" is 1989 for all communities, except Chenega and Tatitlek, for which it is April 1989-March 1990. "Post spill year one" is April 1990-March 1991.
(b) Based on most recent previous year.
(c) Only one previous measurement.
(d) Not determined.

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Some of the service restoration options focus on injured species because population increases will re-establish the subsistence services. These restoration options are described under the species injury summaries for intertidal areas, harbor seals, sea otters, harlequin ducks, pink and sockeye salmon, herring and rockfish.

Five options are proposed which could be used to mitigate lost subsistence opportunities and speed recovery of harvest levels. The mariculture and shellfish hatchery options primarily benefit subsistence users by providing an alternative source of shellfish, but also could be used to speed recovery of injured shellfish populations. Alternative sources of subsistence food could also be provided by starting new [and invigorating existing] salmon runs in subsistence harvest areas. These options are summarized below.

Option #18.0 - Replace Fisheries Harvest Opportunities by Creating New Salmon Runs

New subsistence harvest opportunities could be provided by establishing new hatchery runs or stocking streams. Salmon is a traditional subsistence food and the runs could compensate for reduced harvest salmon. These invigorated runs would also temporarily replace harvest of marine mammals, shellfish, ducks and other species not currently fully utilized due to spill-related injuries or perceptions.

Subsistence use could take the form of terminal harvests at remote hatchery release sites or new, self-perpetuating runs in streams adjacent to subsistence communities. Both of these actions must be implemented with great care, especially in Prince William Sound, to avoid disruption of existing commercial and sport fisheries and to comply with ADF&G policies and guidelines on fish genetics. This option is applicable in harvest areas utilized by Native communities whose harvest levels remain low, such as Tatitlek, Chenega, Nanwalek (English Bay), and Ouzinkie.

Option #30.0 - Test Subsistence Foods for Residual Hydrocarbon Contamination

This option will help to restore the confidence of subsistence users in subsistence foods. Samples of mussels, clams, ducks, rockfish and other resources will be collected from the harvest areas of: Chenega, Tatitlek, Nanwalek (English Bay),

Port Graham, Ahkiok, Karluk, Old Harbor, Ouzinkie, Port Lions, Chignik Lagoon, Kodiak City(?), Cordova(?), Valdez(?), Seldovia, Kenai(?), and Seward(?). Community representatives will be used in the collection of samples.

Additionally, bile and blubber samples will be taken from seals harvested by subsistence hunters in the spill area. The samples will be analyzed for residual oil and the results will be reported to the communities in an informational letter and on going community visits which will continue until the pre-spill subsistence activity level has been re-established.

The program would be expected to continue for 3 years. At the end of this period, the degree of recovery of the resources, as well as the subsistence economy, will be evaluated to determine if the program should continue. The Trustee Council began work on this option by approving a subsistence testing program in January, 1993.

Option #49.0 - Provide Access to Alternative Subsistence Foods

This option seeks to minimize interruption of subsistence lifestyle at those Native communities affected by the oil spill. Some resource populations have declined, while others (notably shellfish) suffer ongoing injury from buried oil. Funds will be provided for subsistence hunters from Chenega to travel to un-impacted areas to harvest traditional subsistence resources. Funding will also be provided to subsistence hunters in other Native communities to assist the Chenegans by gathering, preserving and sending subsistence foods to Chenega. This support will continue until the resources in the subsistence area used by the Chenegans have recovered to pre-spill population levels.

Option #50.1 - Develop Subsistence Mariculture Sites

This program will provide the villages of Chenega, Tatitlek, Port Graham, Nanwalek (English Bay), Ouzinkie, and Ahkiok with a means to develop an alternative bivalve resource for both subsistence and commercial harvest. The basic strategy for the village mariculture program is to initially concentrate on oyster culture, and subsequently test the feasibility of culturing species native to Alaska, e.g., clams, mussels and scallops. The feasibility of culturing Alaskan species is largely dependent on developing a reliable source of spat, which is addressed in Option 50.2.

For those villages which already have mariculture permits (Eyak, Tatitlek, Chenega), settlement funds will be used to establish new oyster culture operations or increase existing

operations to commercial production levels. A mariculture specialist will be hired to organize village operations, help initiate and sustain a training program, and prepare and implement mariculture development plans. For those villages without permits (Port Graham, Nanwalek (English Bay), Ouzinkie, Ahkiok), initial efforts will focus on identification of potential mariculture sites and the development of permit applications. Activities in ensuing years will include preparation of mariculture development plans, training, establishing production, and development of markets.

Option #50.2 - Develop Bivalve Shellfish Hatchery and Research Center

This option proposes the construction of a hatchery and a research facility which will provide a reliable, local source of shellfish spat. The hatchery would be operated by the private sector, using technology developed at a State-operated research center.

The first step of this option would be to complete a study designed to identify which Alaskan shellfish species best lend themselves to hatchery propagation, what types of facilities will be required, where the hatchery and resource center will be located, and what potential benefits and costs are associated with the project.

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c. Recreation and Tourism

SUMMARY

Published studies of the impact of the *Exxon Valdez* oil spill on recreation and tourism address the economic effect on tourism and recreation fishing during 1989. Both industries suffered significant declines in 1989 and improved markedly in 1990. However, residual effects linger.

In 1992, a key informant study was conducted to discover public awareness on a broad range of recreation issues. The study found that about one-quarter of informants reported no change in their recreation experience, but others reported avoidance of the spill area, reduced wildlife sightings, and residual oil. It was also noted that there were more people. Further, they reported changes in their perception of recreation opportunity. Informants also reported a concern for the increased vulnerability of the area to future oil spills, erosion of wilderness [values] and a concern about long-term ecological effects.

INJURY

About 1/2 of the tourism businesses surveyed felt their businesses had been significantly affected by the oil spill. The net loss in visitor spending in Southcentral and Southwest Alaska in 1989 was $19 million (McDowell 1990). An estimated 124,185 lost recreational fishing days were lost due to closures, fear of contamination of the resource, and lack of availability of boats. (Carson and Hanemann 1992).

The study canvassed 92 users in ten user categories: air taxi operators, camping/kayaking, conservation/education, lodgeowner, Native corporations, public recreation managers, sailing/motorboating, sportfishing/hunting, tour operators, and tourism associations. The response rate was 45%.

Informants were asked how their recreation business had changed. About a quarter of the respondents reported no change in their income. Others reported the following changes: (1) avoidance of [areas which were heavily oiled in 1989] and displacement to less affected areas, primarily northern Prince William Sound; (2) reduced wildlife sightings; (3) fewer fish; (4) visual sighting of residual oil in the form of tar balls and sheens that affected the enjoyment of coastal areas and raised concern about tainted fish; and (5) more interest in the spill area and more people visiting it (RPWG 1993). Recreational use of Prince William Sound and the

Outer Kenai Coast, including Kenai Fjords National Park and Kachemak Bay State Wilderness Park, appeared to be most severely impacted; less severe impacts were reported in Kodiak and Kachemak Bay.

Informants were also asked whether there were changes not reflected in their experiences that concern the way they think about the area or perceive their recreation opportunities. Most of the respondents (80%) said their perceptions had changed. This group included at least half of each user group except air taxi operators. Those indicating a change in perception of recreation opportunities cited the following changes: (1) increased sense of vulnerability with regard to future oil spills, the fragility of the ecosystem, and threats to archaeological resources; (2) intrusion of cleanup and restoration activities; (3) a sense of permanent change; (4) a sense of unknown or unseen ecological effects that will alter the environment in the future; and (5) a sense of optimism about the future (RPWG 1993).

RECOVERY

By 1990 only 12% of the tourism businesses surveyed felt their livelihood had been significantly affected by the oil spill (McDowell, 1990). Many of the conditions that had contributed to the severe decline in recreation fishing had changed and the situation had improved (Carson and Hanemann 1992).

Although the status of recovery of recreation was not asked in the key informant interview, respondents volunteered information. They reported seeing less oil now than in 1989 and subsequent years; a slow, but discernible increase in wildlife sightings; and each year a slight increase in people using the spill area for recreation activities (RPWG 1993).

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Restoration options to restore fish and wildlife to pre-spill population levels will also help restore recreation and tourism services. In addition, a well-designed and executed public information program will improve management of the spill area and help to restore recreational opportunities. Seven options are being considered that are specifically targeted to restore or enhance recreation.

Option #37.0 - Habitat Protection and Acquisition

Private lands (Inholdings) in various size tracts exist in

parks and refuges throughout the spill area. Purchase of inholdings in parks and refuges, and key camping or fishing areas would provide long-term protection of recreation resources and instill confidence that recreation opportunities and wilderness values will be preserved.

Option #40.0 - Special Designation

Setting aside some public lands and waters for special management will protect recreation areas from future dramatic changes. Some key informants thought there were already enough special designations in the spill area; others supported additional special designations and cited certain areas that warrant such treatment. These included designation of the College Fjord/Nellie Juan Wilderness Study Area as wilderness with the additions proposed by the Chugach Forest Study Group; consideration of Harris Bay (Kenai Fjords National Park) and the area from Pt. Freemantle to the eastern side of Esther Passage (Prince William Sound) as a national marine sanctuary; and protection of Nuka Island. Although the Trustees could initiate a special designation and fund initial expense, the areas of special treatment are usually established through the state or federal legislative processes.

Option #44.0 - Spill Prevention and Contingency Planning

Several informants conveyed their sense of vulnerability because of the likelihood of future oil spills. Assurance that another spill will be averted or at least contained faster would instill a measure of trust to counteract this perception. Laws, funding, and local involvement abound in the area of spill prevention and contingency planning. Restoration funds could complement spill prevention and contingency planning activities being undertaken through other programs.

Option #34.0 - Marine Environmental Institute

A Marine Environmental Institute would benefit recreation and tourism in two ways: 1) the research program would improve knowledge about the effects of the oil spill and preparedness for future spills and 2) the facility and its educational programs could serve as a visitor attraction. A research program could be undertaken through many different vehicles. Two possibilities are a research foundation and a marine environmental institute.

Option #12A - New Public Recreation Facilities

Construction of recreation facilities such as mooring buoys, boat ramps, picnic areas, outhouses, caches, cabins, campsites, and trails will create opportunities for public use and direct access to specific areas. Well managed use could reduce resource damage, improve safety, and divert activity away from the spill area while it heals. On the other hand, construction of new public facilities will also attract more people and increase use of a damaged ecosystem.

Most respondents in the study believe that new public recreation facilities were inappropriate for wilderness areas. Among those who supported new public recreation facilities in the spill area, conditions of support varied. Because these are fundamentally land use decisions, some recommended that the decision to fund recreation facilities with restoration funds be tied to a comprehensive plan. Finally, concern was raised that facilities be patrolled and maintained and that the decision to fund construction be complemented with a commitment to long-term maintenance and enforcement.

Option #33.0 - Visitor Centers

Visitor centers would be convenient outlets for educating the public about recreation opportunities, low-impact camping, various land use regulations and guidelines and other measures to protect the spill area. They would also complement other visitor attractions in the area. Visitor centers exist in most communities in the spill area.

Option #12B - Planning and Marketing for New Commercial Facilities on Public Land

This option consists of making public land available for commercial recreation facilities such as fuel stops, docks, campgrounds, and lodges, and also providing seed money for planning and marketing these sites. This proposal offers advantages similar to those of option 12A. Furthermore, this option changes a use but does not restore an injured use. In addition, private landowners throughout the spill area could supply the land for commercial recreation facilities.

Among respondents who favored this option, support varied with the type of facility (fuel stops and private campgrounds were favored over lodges) and location (inappropriate in wilderness areas) and was conditioned on good siting and design.

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d. Wilderness and Intrinsic Values

SUMMARY

The oil spill area consists of relatively undeveloped uplands[3] which are generally perceived to be "wilderness" by the public. Some areas have been formally designated as wilderness by either the United States or State of Alaska. Two federal areas are currently being formally considered for wilderness designation. The legislated areas include: Katmai National Park, Becharof National Wildlife Refuge, and Kachemak Bay State Wilderness Park. Study areas include: Kenai Fjords National Park, and the Nellie Juan/College Fjord area of the Chugach National Forest. Federal areas are managed according to the 1964 Wilderness Act and the Alaska National Lands Conservation Act (ANILCA) of 1980. State areas are managed according to enabling legislation and subsequent management plans. Generally, the areas are managed to maintain their natural landscape, a sense of solitude, and their wild character. Evidence of human presence is generally limited to temporary uses for short periods of time. Various state and federal lands not legislatively designated as wilderness are managed according to each agencies enabling legislation and subsequent regulations. These areas allow a broader range of uses and increased human development and thus have increased human presence.

INJURY

The oil spill delivered oil in varying quantities to the adjoining waters of all the designated and un-designated wilderness areas and oil was deposited above the mean high tide line in many areas. The national media covered the event and broadcast the disaster to every corner of the globe. As a result, the *Exxon Valdez* oil spill is now the event against which subsequent spills are measured. Many people, within Alaska and throughout the United States, believe that wilderness and other intrinsic values were lost or injured as a result of the oil spill.

During the intense cleanup seasons of 1989-1990, hundreds of workers and thousands of pieces of equipment were at work in the spill area. This activity was an unprecedented imposition of people, noise and activity on the area's undeveloped and normally sparsely occupied landscape.

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[3]Wilderness designations include uplands generally above the mean high tide line.

RECOVERY

Oil remains in isolated pockets in these wilderness areas. Although the oil is degrading, it will be decades before the wilderness returns to its pristine condition. As a result, direct injury to wilderness and intrinsic values continue. The massive intrusion of people and equipment associated with oil spill cleanup has now ended.

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Option # 37.0 - Habitat Protection/Acquisition

This restoration option is designed to respond to both potential, long-term threats and to threats to injured resources and services. The intent of habitat protection/acquisition is to prevent additional injury to resources and services and to acquire lands that contain resources equivalent to those injured by the spill.

Option # 40.0 - Designate Protected Areas

This option provides the Trustees the ability to designate government-owned lands into management regimes which provide an increased level of resource protection. Different designations provide for alternative mixes of emphasis on public use, resource protection and scientific study. Special designations under consideration include: Alaska State Parks, Alaska Department of Fish & Game Special areas, National Marine Sanctuaries, National Estuarine Research Reserves, Research Natural Areas, National Recreation Areas, and federal wilderness areas.

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e. Sport and Commercial Fishing

SUMMARY

Damages to fisheries consisted of several emergency closures, most of them occurring in 1989. Sport fishing decreased due to actual and perceived contamination of fishing areas. Perhaps the greatest impact may be reductions in the number of sockeye returning to the Kenai River and Red Lake systems. Reduced returns of cutthroat trout to western Prince William Sound resulted in a 1992 closure of the area. Fisheries targeting pink salmon, herring and rockfish are not currently

impacted, although these species are known to have been injured to some extent. Restoration focuses on restoring the species which support services.

INJURY

During 1989, emergency commercial fishery closures were ordered in Prince William Sound, Cook Inlet, and the waters surrounding Kodiak Island and the Alaska Peninsula. Harvests were closed or restricted for salmon, herring, crab, shrimp, rockfish and sablefish. In 1990, a portion of Prince William Sound was closed to shrimp fishing for the same reason. All of the 1989 and 1990 closures were to prevent harvest of oiled species and were not triggered by population reductions in these species. There are currently no spill-related commercial fishery closures in effect.

While there were no sport fishery closures until 1992, ADF&G data documented a significant decline in sport fishing from 1989 to 1990 and quantified the losses at $31 million. Declines in the number of anglers, fishing trips and fishing days were noted for saltwater fisheries in Prince William Sound, Cook Inlet and the Kenai Peninsula areas. Public perception of the spill zone, primarily with out-of-state sport fishermen, may have been largely responsible for reductions in sport fishing activities. This aspect of injury is more fully discussed in the sections on injuries to wilderness and recreational activities.

The only spill-related sport fish closure resulted from a 1992 State of Alaska emergency order restricting cutthroat trout fishing in western Prince William Sound due to low adult returns. This closure will remain in effect until runs return to a sustainable level. Damage assessment from 1991 studies indicate that growth and survival rates of both species [Dolly Varden and cutthroat trout continue to be lower in previously oiled areas which could be because of injuries to the food chain.

Significant impacts on fisheries may have resulted from too many fish returning to the Kenai River and Red Lake (Kodiak Island) systems in 1989. Since 1989 commercial sockeye fisheries have been closed and large numbers of fish escaped harvest to spawn. This resulted in an unusually large number of fry moving into the lakes to feed. It is hypothesized that the fry overgrazed the zooplankton available to them in the lakes and were not able to maintain sufficient growth and survival rates. As a result, fry survival in the Kenai system was very poor for two years in a row and Red Lake fry may have stayed in the lake an extra year to feed. This will probably

result in reduced adult returns to these systems starting in 1994. It is also likely that 1995 returns to the Kenai River will also be very low. Closure of Kenai River sockeye fisheries would have major impacts on multiple user groups.

The extent of injury to rockfish is not fully understood. Although mortalities were caused by exposure to oil, few carcasses have bene found primary because rock fish are bottom dwellers and their bodies would not be easily recovered. Additional injury may have been inflicted by significantly increased commercial fishing pressures. Following the spill-induced, commercial fishery closures, many fishermen purchased new gear and re-directed harvest efforts towards rockfish. Little is known about current population levels and how well they will be able to withstand this increased pressure. However, rockfish are known to have low rates of reproduction and growth and have been seriously damaged by overfishing in other places. Thus, the possibility exists that population-level injuries caused by overfishing could necessitate closures of commercial and sport fishing for rockfish.

While injuries to pink salmon and herring were documented, there are no clear indications that these injuries will impact commercial or sport fishermen.

RECOVERY

Sockeye recovery will depend directly on availability of zooplankton in the lakes used by rearing fry. This will probably occur sooner in Red Lake than the Kenai system but it is not yet known how many year classes of sockeye fry will be directly impacted by food shortages. Empirically, the number of outmigrating Kenai River smolt was extremely low in 1991 and 1992, indicating that at least two consecutive year classes will be impacted by overescapement. These smolt will return as adults in 1994 and 1995. The number of adults returning from these reduced outmigrations are expected to be lower than normal and may not be able to produce enough eggs to rebuild the runs within a single generation. If this turns out to be the case, adult returns in 1999 and 2000 will also be low.

Cutthroat trout fishing will probably remain closed in the western Sound in 1993, and will not reopen until populations recover.

Insufficient data exists to determine whether rockfish continue to be impacted by oil or if they are being harmed by increased harvest pressure. The lack of population data could result in additional damage to the species due to overfishing.

RESTORATION OPTIONS (For detailed description of applicable restoration options, see Appendix A).

Many of the options for restoring sport and commercial fishing injuries focus on restoring injured species population. These options are described under the species injury summaries for sockeye and pink salmon, cutthroat trout, Dolly Varden, rockfish and herring. Species restoration strategies include adjusting fishery management, improving or creating new salmon spawning and rearing habitat, improving salmon egg and fry survival, and acquiring and protecting fish habitat (Options 2, 11, 19, 37, 40 and 48).

However, two options are proposed which are solely intended to mitigate lost fishing opportunities. These options do not restore injured fish populations. Instead, they provide new sport and commercial fishing opportunities or provide new access routes for sport fishermen. The user groups which benefit would be determined by the species targeted by the option.

Option #18.0 - Replace Fishing Harvest Opportunities by Establishing New Salmon Runs

This option entails starting new salmon runs to replace opportunities lost due to fishing closures or reduced harvests. New salmon runs could take the form of terminal runs returning to hatcheries and remote release sites. All returning adults would be harvested every year or used for brood stock for the next year's run. Alternatively, self-perpetuating runs could be started in streams not currently used by spawning salmon. Spawning habitat could be created to make stream stocking applicable on a significant scale. Either of these alternatives would have to be implemented with great care, especially within Prince William Sound, to avoid disruption of existing fisheries and to comply with ADF&G policies and guidelines on fish genetics and disease control.

[The runs would be maintained] until wild-stocks recover. If the option is continued beyond this time, it will be in the context of enhancing the service above pre-spill levels. The option is applicable as direct restoration to all areas where fishermen are anticipated to be impacted by spill-related fishery closures or restrictions. This currently includes the Cook Inlet and Kodiak areas where sockeye runs are anticipated to decline drastically. However, it will not be possible to implement this option in time to mitigate the effects of a 1994 sockeye closure.

Option #28.0 - Acquire Access to Sport Fishing and Recreational Areas

Injuries to sport fishing can be restored by acquiring access to sport fishing and recreational areas. While much of the land in the spill area is publicly owned, some private lands exist where access is denied. Access could be created through fee simple purchase of lands. This option could be associated with other options to construct small-scale recreation facilities such as boat ramps, parking lots and sanitation facilities.

Access corridors will relieve fishing pressure on streams with injured fish stocks. For instance, if Kenai River sockeye fisheries are closed or restricted, sport fishing could be diverted to unaffected areas by providing access. This option could be used to directly restore fishing opportunities in areas where there are existing or anticipated spill-related sport fishing closures, i.e., Prince William Sound, Kenai Peninsula and Kodiak. If these access points were maintained after the sport fishery was fully recovered, it would constitute an enhancement of fishing opportunities above pre-spill levels.

REFERENCES

Michael Mills, Sport Fish Division ADF&G Special Publication #92-5 titled, Alaska Sport Fishing in the Aftermath of the *Exxon Valdez* Oil Spill, December, 1992.

III. XX. Services: Summary of Results of Injury Assessment Studies

Table XX summarizes information about services injured by the spill. Much of the damage to services and the information about those damages is not quantitative. The information used for this table is taken from injury assessment studies, information from state and federal agency studies, agency managers, and, for recreation, a Key Informant Interview study conducted by the Restoration Planning Working Group in December 1992. The "Description of Injury" column recounts the situation for each service in the year(s) following the spill. The "Status of Recovery in 1992" shows the situation for that service at the end of 1992.

The "Geographic Extent of Injury" column shows whether the injury occurred in the geographic areas shown in figure X. (Injury may have been more extensive in some regions than others.)

TABLE X Resources: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Resource	Description of Injury			Status of Recovery in December, 1992		Geographic Extent of Injury (a)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(b)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
MARINE MAMMALS										
Harbor Seals (c)	YES (200)	YES	YES	POSSIBLY STABLE, BUT NOT RECOVERING (a)	UNKNOWN	YES	YES (d)	UNKNOWN	UNKNOWN	Many seals were directly oiled . There was a measurable difference in populations between oiled and unoiled areas in PWS in 1989 and 1990. Population was declining prior to the spill and no recovery evident in 1992. Oil residues found in seal bile were 5 to 6 times higher in oiled areas than unoiled areas in 1990.
Humpback Whales	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Other than fewer animals being observed in Knight Island Passage in summer 1989, which did not persist in 1990, the oil spill did not have a measurable impact on the north Pacific population of humpback whales.
Killer Whales	YES (13)	YES	UNKNOWN	RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	13 Adult whales of the 36 in AB pod are missing and presumed dead. The AB pod has grown by 2 whales since 1990. Circumstantial evidence links whale disappearance to oiling.
Sea Lions (c)	UNKNOWN	UNKNOWN	NO	CONTINUING DECLINE	(e)	(e)	(e)	(e)	(e)	Several sea lions were observed with oiled pelts and oil residues were found in some tissues. It was not possible to determine population effects or cause of death of carcasses recovered. Sea lion populations were declining prior to the oil spill.

(a) There may have been an unequal distribution of injury within each region, see map for location of regions;
(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Resource	Description of Injury			Status of Recovery in December, 1992		Geographic Extent of Injury (a)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(b)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Sea Otters	YES (3,500 TO 5,000)	YES	YES	STABLE, BUT NOT RECOVERING	YES, POSSIBLY	YES	YES	YES (d)	YES (d)	Post-spill surveys showed measurable difference in populations and survival between oiled and unoiled areas in 1989, 1990 and 1991. Survey data have not established a significant recovery. Prime-age animals were still found on beaches in 1989, 1990 and 1991. Carcasses of sea otters feed in the lower intertidal and subtidal areas and may still be exposed to hydrocarbons in the environment.
TERRESTRIAL MAMMALS										
Black Bear	NO	UNKNOWN	UNKNOWN	(e)	(e)	(e)	(e)	(e)	(e)	No field studies were done.
Brown Bear	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Hydrocarbon exposure was documented on Alaska Peninsula in 1989 including high hydrocarbon levels in the bile of one dead cub. Brown bear feed in the intertidal zone and may still be exposed to hydrocarbons in the environment.
River Otters	YES (NUMBER UNKNOWN)	UNKNOWN	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Exposure to hydrocarbons and sub-lethal effects were determined, but no effects were established on population. Sub-lethal indicators of possible oil exposure remained in 1991. River otters feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Sitka Black-tailed Deer	NO	NO	NO	(e)	(e)	(e)	(e)	(e)	(e)	Elevated hydrocarbons were found in tissues in some deer in 1989.

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(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Resource	Description of Injury			Status of Recovery in December, 1992		Geographic Extent of Injury (a)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(b)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
BIRDS										
Bald Eagles	YES (614-902)	YES	YES	RECOVERING	UNKNOWN	YES	YES	YES (d)	YES(d)	Productivity in PWS was disrupted in 1989, but returned to normal in 1990. Exposure to hydrocarbons and some sub-lethal effects were found in 1989 and 1990, but no continuing effects were observed on populations.
Black-legged Kittiwakes	YES (NUMBER UNKNOWN)	NO	NO	NO CHANGE	NO	YES	YES (d)	YES (d)	YES (d)	Total reproductive success in oiled and unoiled areas of PWS has declined since 1989. Hydrocarbon contaminated tissues were detected in 1989. Hydrocarbon contaminated stomach contents were detected in 1989 and 1990. This species is known for great natural variation and reproductive failure may be unrelated to the oil spill.
Black Oyster-catchers	YES (129 ADULTS; UNKNOWN FOR CHICKS (f)	YES	YES	RECOVERING	YES	YES	YES (d)	YES (d)	YES (d)	Differences in egg size between oiled and unoiled areas were found in 1989. Exposure to hydrocarbons and some sublethal effects were determined. Populations declined more in oiled areas than unoiled areas in post-spill surveys in 1989, 1990 and 1991. Black oystercatchers feed in the intertidal areas and may be still be exposed to hydrocarbons in the environment.
Common Murres	YES (175,000 to 300,000)	YES	YES	DEGREE OF RECOVERY VARIES IN COLONY	YES	NO	YES	YES	YES	Measurable impacts on populations were recorded in 1989, 1990 and 1991. Breeding is still inhibited in some colonies in the Gulf of Alaska.

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(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Resource	Description of Injury			Status of Recovery in December, 1992		Geographic Extent of Injury (a)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(b)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Glaucous-winged gulls	YES (NUMBER UNKNOWN)	NOT DETECTED	NO	NO CHANGE	NO	YES (d)	YES (d)	YES (d)	YES (d)	While dead birds were recovered in 1989, there is no evidence of a population level impact when compared to historic (1972, 1973) population levels.
Harlequin Ducks	YES (423)	YES	YES	STABLE OR CONTINUING DECLINE	YES	YES	YES (d)	YES (d)	YES (d)	Post-spill samples showed hydrocarbon contamination and poor body conditions. Surveys in 1990-1992 indicated population declines and near total reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may still be exposed to hydrocarbons in the environment.
Marbled Murrelets (c)	YES (8,000 TO 12,000)	YES	UNKNOWN	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (d)	YES (d)	YES (d)	Measurable population effects on were recorded in 1989, 1990 and 1991. Marbled murrelet populations were declining prior to the spill. Hydrocarbon contamination was found in livers of adult birds.
Peale's Peregrine Falcons	UNKNOWN	UNKNOWN	NO	(e)	(e)	(e)	(e)	(e)	(e)	When compared to 1985 surveys a reduction in population and lower than expected productivity was measured in 1989 in the PWS. Cause of these changes are unknown.
Pigeon Guillemots (c)	YES (1,500 TO 3,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (d)	YES (d)	YES (d)	Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found in birds and, externally, on eggs.
Storm Petrels	YES (NUMBER UNKNOWN)	NO	AWAITING RESULTS	NO CHANGE	UNKNOWN	YES (d)	YES (d)	YES (d)	YES (d)	Few carcasses were recovered in 1989 although petrels ingested oil and transferred oil to their eggs. Reproduction was normal in 1989.

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(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Resource	Description of Injury			Status of Recovery in December, 1992		Geographic Extent of Injury (a)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(b)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Other Seabirds	YES (375,000-435,000)	VARIES BY SPECIES	UNKNOWN	VARIES BY SPECIES	UNKNOWN	YES (d)	YES (d)	YES (d)	YES (d)	Seabird recovery has not been studied. Species collected dead in 1989 include common, yellow-billed, pacific, red-throated loon; red-necked and horned grebe; northern fulmar; sooty and short-tailed shearwater; double-crested, pelagic, and red-faced cormorant; herring and mew gull; arctic and Aleutian tern; Kittlitz's and ancient murrelet; Cassin's, least, parakeet, and rhinoceros auklet; and horned and tufted puffin.
Other Sea Ducks	YES (875) (b)	NO	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (d)	YES (d)	YES (d)	Species collected dead in 1989 include Stellar's, king and common eider; white-winged, surf and black scoter; oldsquaw; bufflehead; common and Barrow's goldeneye; and common and red-breasted merganser. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil.
Other Shorebirds	YES (NUMBER UNKNOWN)	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (d)	YES (d)	YES (d)	Species collected dead in 1989 include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpiper; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.
Other Birds	YES (NUMBER UNKNOWN)	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES (d)	YES (d)	YES (d)	YES (d)	Species collected dead in 1989 include emperor and Canada goose; brant; mallard; northern pintail; green-winged teal; greater and lesser scaup; ruddy duck; great blue heron; long-tailed jaeger; willow ptarmigan; great-horned owl; Stellar's jay; magpie; common raven; northwestern crow; robin; varied and hermit thrush; yellow warbler; pine grosbeak; savannah and golden-crowned sparrow; white-winged crossbill.

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(d) Based on recovery of dead animals from this region of the spill zone;
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(f) Total body count, not adjusted for carcasses not found.

Resource	Description of Injury			Status of Recovery in December, 1992		Geographic Extent of Injury (a)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(b)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
FISH										
Cutthroat Trout	YES, SEE COMMENTS	POSSIBLY	YES	STABLE, BUT NOT RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Differences in survival and growth between anadromous adult populations in the oiled and unoiled areas persisted in 1991 despite the decrease in exposure indicators. This could be due to continuing injury to the food base.
Dolly Varden	YES, SEE COMMENTS	POSSIBLY	YES	STABLE, BUT NOT RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Differences in survival between anadromous adult populations in the oiled and unoiled areas persisted in 1991 despite the decrease in exposure indicators. This could be due to continuing injury to the food base.
Pacific Herring	YES, TO EGGS AND LARVAE	UNKNOWN	YES	UNKNOWN	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable difference in egg counts between oiled and unoiled areas were found in 1989 and 1990. Lethal and sublethal effects on eggs and larvae were evident in 1989 and to a lesser extent in 1990; in 1991 there were no differences between oiled and unoiled areas. It is possible that the 1989 year class was injured and could result in reduced recruitment to the fishery.
Pink Salmon (Wild) (c)	YES, TO EGGS	POSSIBLY	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial egg mortalituy in 1989. Egg mortality continued to be high in 1991, possibly due to genetic damage to spawners. Abnormal fry were observed in 1989. Reduced growth of juveniles was found in the marine environment, which can be correlated with reduced survival.

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(b) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost;
(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Resource	Description of Injury			Status of Recovery in December, 1992		Geographic Extent of Injury (a)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(b)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Rockfish	YES (20) (f)	UNKNOWN	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	Few dead fish were found in 1989 in condition to be analyzed. Exposure to hydrocarbons with some sublethal effects were determined in those fish, but no effects established on the population. Closures to salmon fisheries increased fishing pressures on rockfish which may be impacting population.
Sockeye Salmon	UNKNOWN	YES	YES	SEE COMMENTS	YES	UNKNOWN	YES	YES	NO	Smolt survival continues to be poor in the Red Lake and Kenai River systems due to overescapements in Red Lake in 1989, and in the Kenai River in 1987, 1988, 1989. As a result, future adult returns are expected to be low in 1994 and successive years. Trophic structures of Kenai and Skilak Lakes have been altered by overescapement.
SHELLFISH										
Clam	YES (NUMBER UNKNOWN)	UNKNOWN	POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	Native littleneck and butter clams were impacted by both oiling and clean-up, particularly high pressure, hot water washing. Littleneck clams transplanted to oiled areas in 1990 grew significantly less than those transplanted to unoiled sites. Reduced growth recorded at oiled sites in 1989 but not 1991.
Crab (Dungeness)	UNKNOWN	UNKNOWN	UNKNOWN	(e)	(e)	(e)	(e)	(e)	(e)	Crabs collected from oil areas were not found to have accumulated petroleum hydrocarbons.
Oyster	UNKNOWN	UNKNOWN	UNKNOWN	(e)	(e)	(e)	(e)	(e)	(e)	Although studies were initiated in 1989, they were not completed because they were determined to be of limited value.

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(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

Resource	Description of Injury			Status of Recovery in December, 1992		Geographic Extent of Injury (a)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(b)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Sea Urchin	UNKNOWN	UNKNOWN	UNKNOWN	(e)	(e)	(e)	(e)	(e)	(e)	Studies limited to laboratory toxicity studies.
Shrimp	UNKNOWN	UNKNOWN	NO	(e)	(e)	(e)	(e)	(e)	(e)	No conclusive evidence presented for injury linked to oil spill.
INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	YES	YES	YES	Measurable impacts on populations of plants and animals were determined. The lower intertidal and, to some extent, the mid intertidal is recovering. Some species (Fucus) in the upper intertidal zone have not recovered, and oil may persist in and mussel beds.
Subtidal Communities	YES	YES	YES	VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable impacts on population of plants and animals were determined in 1989. Eel grass and some species of algae appear to be recovering. Amphipods in eel grass beds recovered to pre-spill densities in 1991. Leather stars and helmet crabs show little sign of recovery through 1991.

(a) There may have been an unequal distribution of injury within each region, see map for location of regions;
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(c) Population may have been declining prior to the spill;
(d) Based on recovery of dead animals from this region of the spill zone;
(e) If no injury was detected or known, no assessment of recovery could be made;
(f) Total body count, not adjusted for carcasses not found.

TABLE XX Services: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

RPWG draft 3/18/93

Service	Description of Injury	Status of Recovery in December, 1992	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Passive Use	In 1991, over 90% of those surveyed (nation-wide) said they were aware of the *Exxon Valdez* oil spill. People report that values have been lost; their feelings about the spill area have changed. There is a wide-spread feeling that something has been lost.	Recovery status is unknown.	YES	YES	YES	YES	Over 50% of those surveyed believed that the spill was the largest environmental accident caused by humans anywhere in the world. The median household willingness to pay for future prevention was $31. Multiplying this by the number of U.S. household results in a damage estimate of $2.8 billion.
Recreation (e.g., hunting, fishing, camping, kayaking, sailboating, motorboating, environmental education)	The nature and extent of injury varied by user group and by area. About a quarter of key informants interviewed reported no change in their recreation experience, but others reported avoidance of the spill area, reduced wildlife sightings, residual oil, and more people. Overall, recreation use declined significantly in 1989. Between 1989 and 1990 a decline in sport fishing (number of anglers, fishing trips and fishing days) were recorded for PWS, Cook Inlet and the Kenai Peninsula. In 1992 an emergency order restricting cutthroat trout fishing was issued for western PWS due to low adult returns. Sport hunting of harlequin duck was affected by restrictions imposed in 1991 in response to damage assessment studies.	Declines in recreation activities reported in 1989 appear to be recovering for some user groups, but the degree of recovery is unknown. EVOS related sockeye over-escapement in the Kenai River and Red Lake system is anticipated to result in low adult returns in 1994 and 1995. These over-escapements may result in sport fishing closures or harvest restrictions during these and perhaps in subsequent years. The 1992 sport fishing closure for cutthroat trout is expected to continue at least through 1993. Harvest restrictions are expected to continue for harlequin duck through 1993.	YES	YES	YES	YES	Survey respondents also reported changes in their perception of recreation opportunity in terms of increased vulnerability to future oil spills, erosion of wilderness, a sense of permanent change, concern about long-term ecological effects, and, in some, a sense of optimism.

(a) There may have been an unequal distribution of injury within each region, see map for location of regions

TABLE XX Services: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Service	Description of Injury	Status of Recovery in December, 1992	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Commercial Fishing	During 1989, emergency commercial fishery closures were ordered in PWS, Cook Inlet, Kodiak and the Alaska Peninsula. This affected salmon, herring, crab, shrimp, rockfish and sablefish. The 1989 closures resulted in sockeye over-escapement in the Kenai River and in the Red Lake system (Kodiak Island). In 1990 a portion of PWS was closed to shrimp fishing.	Currently there are no area-wide oil spill-related commercial closures in effect. Management actions to try to compensate for the spill are still in effect. EVOS related sockeye over-escapement in the Kenai River and Red Lake system is anticipated to result in low adult returns in 1994 and 1995. These over-escapements may result in closure or harvest restrictions during these and perhaps in subsequent years.	YES	YES	YES	YES	Injuries and recovery status of rockfish, pink salmon, shellfish and herring are uncertain. Therefore, future impacts on these fisheries is unknown.
Commercial Tourism	Approximately 43% of the tourism businesses surveyed felt their businesses had been significantly affected by the oil spill in summer 1989. The net loss in visitor spending in the oil spill area in 1989 was $19 million.	By 1990, 12% of the tourism businesses surveyed felt their businesses had been significantly affected by the oil spill.	YES	YES	YES	YES	

(a) There may have been an unequal distribution of injury within each region, see map for location of regions

TABLE XX Services: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Service	Description of Injury	Status of Recovery in December, 1992	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Subsistence	Subsistence harvests of fish and wildlife in 10 of 15 villages surveyed declined from 4 - 78% in 1989 when compared to pre-spill levels. At least 4 of the 10 villages showed continued lower than average levels of use in the period 1990-1991; this decline is particularly noticeable in the Prince William Sound villages of Chenega and Tatitlek. In 1989-1991, chemical analysis indicated that most resources tested, including fish, marine mammals, deer, and ducks, were safe to eat. In 1989-1991, health advisories were issued indicating that shellfish from oiled beaches should not be eaten.	Many subsistence users believe that continued contamination to subsistence food sources is dangerous to their health. In addition, village residents believe that subsistence species continue to decline or have not recovered from the oil spill.	YES	YES	YES	NO	For detailed information on village subsistence use see table _, page__.

(a) There may have been an unequal distribution of injury within each region, see map for location of regions

TABLE XXX Other Natural Resources and Archaeology: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill (b)

RPWG draft 3/18/93

Resource	Description of Injury	Status of Recovery in December, 1992	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Air	Air quality standards for aromatic hydrocarbons were exceeded in portions of PWS. Health and safety standards for permissible exposure levels were exceeded up to 400 times.	Recovered	YES	NO	NO	NO	Impacts diminished rapidly as oil weathered and lighter factions evaporated.
Sediments	Oil coated beaches and became buried in beach sediments. Oil laden sediments were transported off beaches and deposited on subtidal marine sediments.	Patches of oil residue remain intertidally on rocks and beaches and buried beneath the surface at other beach locations. Oil remains in some subtidal marine sediments and has spread to depths greater than 20 meters.	YES	YES	YES	YES	Unweathered buried oil will persist for many years in protected low-energy sites.
Water	State of Alaska water quality standards may have been exceeded in portions of PWS. Federal and State oil discharge standards of no visible sheen were exceeded.	Recovered	YES	YES	YES	YES	Impacts diminished as oil weathered and lighter fractions evaporated.
Archaeological sites/artifacts	Currently, 24 sites are known to have been adversely affected by oiling, clean-up activities, or looting and vandalism linked to the oil spill. 113 sites are estimated to have been similarly affected. Injuries attributed to looting and vandalism (linked to the oil spill) are still occurring.	Archaeological sites and artifacts cannot recover; they are finite non-renewable resources.	YES	YES	YES	YES	
Designated Wilderness Areas	Many miles of Federal and State Wilderness and Wilderness Study Area coastlines were affected by oil. Some oil remains buried in the sediments of these areas.	Oil has degraded in many areas but remains in others. Until the remaining oil degrades, injury to Wilderness areas will continue.	YES	YES	YES	YES	

(a) There may have been an unequal distribution of injury within each region, see map for location of regions.

(b) This page has not yet been reviewed by the Chief Scientist.

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Exxon Valdez Oil Spill Trustee Council

Restoration Office
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TO: Trustee Council

DATE: February 8, 1993

FROM: Dave Gibbons
Interim Executive Director

TELE: 278-8012
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SUBJECT: Summary of Injury and Alternatives

This packet presents draft tables summarizing injury and alternatives for the draft restoration plan. The information is preliminary, and we expect that some of the details, format, and wording will change. However, assuming concurrence from the Trustee Council, the basic content and organization is unlikely to change.

The information, along with a significant amount of explanatory text, will be used for the "Alternatives Information Packet" scheduled for publication in March. It will also be used for public meetings in April.

The tables presented here have been prepared by the Restoration Planning Working Group and reviewed by the Restoration Team. The summary of injury to resources has been reviewed by the Chief Scientist.

Resources: Summary of Results of Injury Assessment Studies

The next few pages summarize the results of the injury assessment studies for resources completed after the *Exxon Valdez* oil spill. The table has been reviewed by the Restoration Team and the Chief Scientist.

The "Description of Injury," columns focus on injury that took place during 1989. The table shows whether there was initial mortality caused by the spill, whether the spill caused a population-level injury, and whether there is evidence of sublethal or chronic effects on the resource. For some resources, an estimate is available for the total number of animals initially killed by the spill. When available, that estimate is shown in parentheses under the initial mortality column. For many resources, the total number killed will never be known.

The "Status of Recovery" columns show the best estimate of recovery using information current through 1992. These columns show resources' progress toward recovery to the population levels that scientists estimate would have occurred in the absence of the spill. The "Current Population Status" column shows a resource's progress from any "Decline in Population after the Spill." Similarly, the column labeled "Evidence of Continuing Sublethal or Chronic Effects" shows whether a initial chronic or sublethal injury is continuing.

The "Geographic Extent of Injury" column shows whether the injury occurred in the geographic areas shown in Figure X. (Injury may have been more extensive in some regions than others.)

TABLE X Natural Resources: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Resource	Description of Oil Spill Injury			Status of Recovery in December, 1992		Geographic Extent of Injury (a)				Comments/Discussion
	Initial Oil Spill Mortality (total mortality estimate)(b)	Measured Decline in Population after the spill	Evidence of Sublethal or Chronic Effects (c)	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
MARINE MAMMALS										
Harbor Seals (d)	YES (345)	YES	YES	POSSIBLY STABLE, BUT NOT RECOVERING	NO	YES	YES (e)	UNKNOWN	UNKNOWN	Many seals were directly oiled . There was a measurable difference in populations between oile and unoiled areas in PWS in 1989 and 1990. Population was declining prior to the spill and r recovery evident in 1992. Oil residues found in seal bile were 5 to 6 times higher in oiled areas than unoiled areas in 1990.
Humpback Whales	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Other than fewer animals being observed in Knight Island Passage in summer 1989, which did not persist in 1990, the oil spill did not have a measurable impact on humpback whales.
Killer Whales	POSSIBLY (g)	POSSIBLY (g)	POSSIBLY (g)	RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	13 whales of the 36 in AB pod are missing and presumed dead. Circumstantial evidence links whe disappearance to oiling. Several adult males hav collapsed dorsal fins. Social disruption of fami units has been observed. In AB pod, no new birth were recorded in 1989 or 1990; one birth was recorded in 1991; and two births were recorded ir 1992.

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Sea Lions (d)	UNKNOWN	UNKNOWN	NO	CONTINUING DECLINE	(f)	(f)	(f)	(f)	(f)	Several sea lions were observed with oiled pelts and oil residues were found in some tissues in 1989. It was not possible to determine populatio effects or cause of death of carcasses recovered in 1989. Sea lion populations were declining pri to the oil spill.
Sea Otters	YES (3,500 TO 5,000)	YES	YES	STABLE, BUT NOT RECOVERING	YES	YES	YES	YES (e)	YES (e)	Post-spill surveys showed measurable difference i populations and survival between oiled and unoile areas in 1989, 1990 and 1991. Survey data have n established a significant recovery. Carcasses of prime-age animals were found on beaches in 1989, 1990 and 1991. Proportions of prime-age carcasse found on beaches in 1992 is not significantly different from pre- or post-spill data. Sea otte feed in the lower intertidal and subtidal areas a may still be exposed to hydrocarbons in the environment.

4

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TERRESTRIAL MAMMALS										
Black Bear	NO	UNKNOWN	UNKNOWN	(f)	(f)	(f)	(f)	(f)	(f)	No field studies were completed.
Brown Bear	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Hydrocarbon exposure was documented on Alaska Peninsula in 1989 including high hydrocarbon leve in the bile of one dead yearling, although it is unknown if this was the cause of death. Brown be feed in the intertidal zone and may still be exposed to hydrocarbons in the environment.
River Otters	YES (NUMBER UNKNOWN)	UNKNOWN	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Exposure to hydrocarbons and sub-lethal effects were determined, but no effects were established population. Sub-lethal indicators of possible oi exposure remained in 1991. River otters feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Sitka Black-tailed Deer	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Elevated hydrocarbons were found in tissues in so deer in 1989 in PWS.

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BIRDS										
Bald Eagles	YES (more than 200 to 300)	POSSIBLY	YES	RECOVERED OR RECOVERING	UNKNOWN	YES	YES	YES (e)	YES(e)	Productivity in PWS was disrupted in 1989, but returned to normal in 1990. Exposure to hydrocarbons and some sub-lethal effects were fou in 1989 and 1990, but no continuing effects were observed on populations. In 1989, 151 carcasses were recovered from beaches.
Black-legged Kittiwakes	YES (ESTIMATE UNKNOWN)	NO	NO	NO CHANGE	NO	YES	YES (e)	YES (e)	YES (e)	Total reproductive success in oiled and unoiled areas of PWS has declined since 1989. Hydrocarbc contaminated tissues were detected in 1989. Hydrocarbon contaminated stomach contents were detected in 1989 and 1990. This species is knowr for great natural variation and reproductive failure may be unrelated to the oil spill. In 1989, 1225 carcasses were recovered from beaches.
Black Oyster-catchers	YES (ESTIMATE UNKNOWN)	YES	YES	RECOVERING	YES	YES	YES (e)	YES (e)	YES (e)	Differences in egg size between oiled and unoilec areas were found in 1989. Exposure to hydrocarbc and some sublethal effects were determined. Populations declined more in oiled areas than unoiled areas in post-spill surveys in 1989, 199(and 1991. Black oystercatchers feed in the intertidal areas and may be still be exposed to hydrocarbons in the environment. In 1989, nine carcasses were recovered from beaches.

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Common Murres	YES (175,000 to 300,000)	YES	YES	DEGREE OF RECOVERY VARIES BY COLONY	YES	NO	YES	YES	YES	Measurable impacts on populations were recorded 1989, 1990 and 1991. Breeding was still inhibit in some colonies in the Gulf of Alaska in 1992. 1989, 10,428 carcasses were recovered from beach
Glaucous-winged gulls	YES (ESTIMATE UNKNOWN)	NOT DETECTED	NO	NO CHANGE	NO	YES (e)	YES (e)	YES (e)	YES (e)	While 555 dead birds were recovered in 1989, the is no evidence of a population level impact when compared to historic (1972, 1973) population levels.
Harlequin Ducks	YES (423)	YES	YES	STABLE OR CONTINUING DECLINE	YES	YES	YES (e)	YES (e)	YES (e)	Post-spill samples showed hydrocarbon contaminat and poor body conditions in 1989 and 1990. Surv in 1990-1992 indicated population declines and r total reproductive failure. Harlequin ducks fee in the intertidal and shallow subtidal areas anc may still be exposed to hydrocarbons in the environment. In 1989, 213 carcasses were recove from beaches.
Marbled Murrelets (d)	YES (8,000 TO 12,000)	YES	UNKNOWN	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Measurable population effects were recorded in 1989, 1990 and 1991. Marbled murrelet populatic were declining prior to the spill. In 1989, hydrocarbon contamination was found in livers of adult birds. In 1989, 612 carcasses were recove from beaches.

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Peale's Peregrine Falcons	UNKNOWN	UNKNOWN	NO	(f)	(f)	(f)	(f)	(f)	(f)	When compared to 1985 surveys a reduction in population and lower than expected productivity measured in 1989 in the PWS. Cause of these changes are unknown. In 1989, two carcasses were recovered from beaches.
Pigeon Guillemots (d)	YES (1,500 TO 3,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Pigeon guillemot populations were declining prio to the spill. In 1989, hydrocarbon contaminatio was found in birds and, externally, on eggs. In 1989, 614 carcasses were recovered from beaches.
Storm Petrels	YES (ESTIMATE UNKNOWN)	NO	UNKNOWN	NO CHANGE	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	Although 363 carcasses were recovered in 1989 an petrels ingested oil and transferred oil to thei eggs, reproduction was normal in 1989.
Other Seabirds	YES (ESTIMATE UNKNOWN)	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	Seabird recovery has not been studied. Species collected dead in 1989 include 216 common, 87 yellow-billed, 18 pacific, 5 red-throated loon; red-necked and 277 horned grebe; 426 northern fulmar; 360 sooty and 2,460 short-tailed shearwater; 38 double-crested, 418 pelagic, and red-faced cormorant; 8 herring and 33 mew gull; arctic and 1 Aleutian tern; 67 Kittlitz's and 31 ancient murrelet; 48 Cassin's, 5 least, 31 parakeet, and 141 rhinoceros auklet; and 139 hor and 361 tufted puffin.

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Other Sea Ducks	YES (ESTIMATE UNKNOWN)	NO	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Species collected dead in 1989 include 4 Stellar' 9 king and 17 common eider; 342 white-winged, 17! surf and 132 black scoter; 185 oldsquaw; 21 bufflehead; 6 common and 33 Barrow's goldeneye; a 2 common and 33 red-breasted merganser. Sea duck tend to feed in the intertidal and shallow subtic areas which were most heavily impacted by oil.
Other Shorebirds	YES (ESTIMATE UNKNOWN)	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Species collected dead in 1989 include 1 golden plover; 2 lesser yellowlegs; 1 semipalmated, 5 western, 4 least and 1 Baird's sandpiper; 3 surfbird; 1 short-billed dowitcher; 1 common snip 2 red and 7 red-necked phalarope.
Other Birds	YES (ESTIMATE UNKNOWN)	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	Species collected dead in 1989 include 2 emperor and 1 Canada goose; 3 brant; 11 mallard; 4 northe pintail; 5 green-winged teal; 27 greater and 2 lesser scaup; 1 ruddy duck; 1 great blue heron; ' long-tailed jaeger; 1 willow ptarmigan; 3 great-horned owl; 1 Steller's jay; 7 magpie; 18 common raven; 34 northwestern crow; 2 robin; 1 varied a 1 hermit thrush; 3 yellow warbler; 1 pine grosbe 1 savannah and 4 golden-crowned sparrow; 8 white-winged crossbill.

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FISH										
Cutthroat Trout	YES	POSSIBLY (g)	YES	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Differences in survival and growth between anadromous adult populations in the oiled and unoiled areas persisted from 1989 to 1991 despite decrease in exposure indicators. This could be c to continuing injury to the food base.
Dolly Varden	YES	POSSIBLY (g)	YES	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Differences in survival between anadromous adult populations in the oiled and unoiled areas persisted from 1989 to 1991 despite a decrease in exposure indicators. This could be due to continuing injury to the food base.
Pacific Herring	YES, TO EGGS AND LARVAE	UNKNOWN	YES	UNKNOWN	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable difference in egg counts between oiled and unoiled areas were found in 1989 and 1990. Lethal and sublethal effects on eggs and larvae were evident in 1989 and to a lesser extent in 1990; in 1991 there were no differences between oiled and unoiled areas. It is possible that th 1989 year class was injured and could result in reduced recruitment to the adult population.

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Pink Salmon (Wild) (d)	YES, TO EGGS	POSSIBLY (g)	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial egg mortality in 1989. Egg mortality continued to be high in 1990 and 1991. Abnormal fry were observed in 1989. Reduced gro of juveniles was found in the marine environment 1989 and 1991, which correlates with reduced survival.
Rockfish	YES (ESTIMATE UNKNOWN)	UNKNOWN	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	Twenty dead fish were found in 1989, but only a were in condition to be analyzed. Exposure to hydrocarbons with some sub-lethal effects was determined in those fish, but the effects on the population was unknown. Closures to salmon fisheries increased fishing pressures on rockfis which may be impacting population.
Sockeye Salmon	UNKNOWN	YES	YES	SEE COMMENTS	YES	UNKNOWN	YES	YES	NO	Smolt survival continues to be poor in the Red L and Kenai River systems due to overescapements i Red Lake in 1989, and in the Kenai River in 1987 1988, 1989. As a result, adult returns are expected to be low in 1994 and successive years. Trophic structures of Kenai and Skilak Lakes hav been altered by overescapement.

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SHELLFISH										
Clam	YES (ESTIMATE UNKNOWN)	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES	YES	YES	Native littleneck and butter clams were impacted both oiling and clean-up, particularly high pressure, hot water washing. Additional data ar still being evaluated.
Crab (Dungeness)	UNKNOWN	UNKNOWN	UNKNOWN	(f)	(f)	(f)	(f)	(f)	(f)	Insufficient data to determine injury.
Oyster	UNKNOWN	UNKNOWN	UNKNOWN	(f)	(f)	(f)	(f)	(f)	(f)	Although studies were initiated in 1989, they we not completed because they were determined to be limited value.
Sea Urchin	UNKNOWN	UNKNOWN	UNKNOWN	(f)	(f)	(f)	(f)	(f)	(f)	Studies limited to laboratory toxicity studies.
Shrimp	UNKNOWN	UNKNOWN	NO	(f)	(f)	(f)	(f)	(f)	(f)	No conclusive evidence presented for injury link to oil spill.

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INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	VARIABLE BY SPECIES	YES	YES	YES	YES	YES	Measurable impacts on populations of plants and animals were determined 1989 to 1992. The lower intertidal and, to some extent, the mid intertid is recovering. Some species (e.g. Fucus) in the upper intertidal zone have not recovered, and oi persists in and under mussel beds. Intertidal organisms were impacted by both oiling and clear up, particularly high pressure, hot water washir
Subtidal Communities	YES	YES	YES	VARIABLE BY SPECIES	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable impacts on population of plants and animals were determined in 1989. Eel grass and some species of algae appear to be recovering. Amphipods in eel grass beds recovered to pre-spi densities in 1991. Leather stars and helmet cra show little sign of recovery through 1991.

13

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TABLE XXX Other Natural Resources and Archaeology: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill (b)

RPWG draft 2/8/93

Resource	Description of Injury	Status of Recovery in December, 1992	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Air	Air quality standards for aromatic hydrocarbons were exceeded at the spill site. Health and safety standards for permissible exposure levels were exceeded up to 400 times.	Recovered	YES	UNKNOWN	UNKNOWN	UNKNOWN	Impacts diminished as oil weathered and lighter factions evaporated.
Sediments	Oil coated beaches and became buried in beach sediments. Oil laden sediments were transported off beaches and deposited on subtidal marine sediments.	Oil remains intertidally on rocks and beaches and buried beneath the surface at other beach locations. Oil concentrations have increased in subtidal marine sediments and have spread to greater depths (to 720 meters) over time.	YES	YES	YES	YES	Unweathered buried oil will persist for many years in protected low-energy sites in Prince William Sound.
Water	State of Alaska water quality standards were not exceeded in open sea conditions. In small bays and near shore, hydrocarbon concentrations may have exceeded the 10 micrograms per liter standard immediately after the spill. Federal oil discharge standards of no visible sheen were exceeded.	Recovered	YES	UNKNOWN	UNKNOWN	UNKNOWN	Impacts were patchy and transient during the early stages of the spill. Impacts diminished as oil weathered and lighter factions evaporated.
Archaeologic sites/artifacts	Currently, 24 sites are known to have been adversely affected by oiling, clean-up activities, or looting and vandalism linked to the oil spill. 113 sites are estimated to have been similarly affected. Injuries attributed to looting and vandalism (linked to the oil spill) are still occurring.	Archaeological sites and artifacts cannot recover, they are finite non-renewable resources.	YES	YES	YES	YES	* Injury studies are not yet complete (January 1993).

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(b) This page has not yet been reviewed by the Chief Scientist;

Services: Summary of Results of Injury Assessment Studies

The next few pages summarizes information concerning services damaged by the spill. The information in this table has not yet been peer reviewed and is subject to change.

Much of the damage to services, and the information about those damages, is not quantitative. The table reflects the qualitative content of the information. The "Description of Injury" column recounts the situation for each service in the year following the spill. The "Status of Recovery in 1992" shows the 1992 situation for that service.

The information used for this table is taken from injury assessment studies, information from agency managers, and, for recreation, a Key Informant Interview study conducted the Restoration Planning Working Group in December 1992.

TABLE XX Services: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

RPWG draft 2/8/93

WORKING DRAFT - NOT FOR PUBLIC RELEASE

Service	Description of Injury	Status of Recovery in December, 1992	Geographic Extent of Injury				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Passive Use Values (Option, existence and non-use values)	In 1991, over 90% of those surveyed (nation-wide) said they were aware of the Exxon Valdez oil spill. Over 50% believed that the spill was the largest environmental accident caused by humans anywhere in the world. The median household willingness to pay for future prevention was $31. Multiplying thus by the number of U.S. household results in a damage estimate of $2.8 billion.	Data is not available to determine the status of recovery.	N/A	N/A	N/A	N/A	The study, A Contingency Valuation Study of Lost Passive Use Values Resulting From the Exxon Valdez Oil Spill, was developed between July 1989 and January 1991, at which time it was put into the field. Respondents were comprised of people in the lower 48 states.
Recreation and Tourism	The nature and extent of injury varied by user group and by area. About a quarter of key informants interviewed reported no change in their recreation experience, but others reported avoidance of the spill area, reduced wildlife sightings, residual oil, and more people. They also reported changes in their perception of recreation opportunity in terms of increased vulnerability to future oil spills, erosion of wilderness, a sense of permanent change, concern about long-term ecological effects, and, in some, a sense of optimism. Overall, recreation, tourism and sport fishing declined significantly in 1989 and improved markedly in 1990 although there were residual effects. Sport hunting of harlequin duck was affected by restrictions imposed in 1991 in response to damage assessment studies.	Declines in recreation activities reported in 1989 appear to have reversed, although there is no data to support or deny this perception. Harvest restrictions are expected to continue through 1993.	YES	YES	YES	YES	

TABLE XX Services: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Service	Description of Injury	Status of Recovery in December, 1992	Geographic Extent of Injury				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Sport and Commercial Fishing	During 1989, emergency commercial fishery closures were ordered in PWS, Cook Inlet, Kodiak and the Alaska Peninsula. This affected salmon, herring, crab, shrimp, rockfish and sablefish. The 1989 closures resulted in sockeye over-escapement in the Kenai River and in the Red Lake system (Kodiak Island). In 1990 a portion of PWS was closed to shrimp fishing. Between 1989 and 1990 a decline in sport fishing (number of anglers, fishing trips and fishing day) were recorded for PWS, Cook Inlet and the Kenai Peninsula. In 1992 an emergency order restricting cutthroat trout fishing was issued for western PWS due to low adult returns.	Currently there are no oil spill-related commercial closures in effect. The 1992 sport fishing closure for cutthroat trout is expected to continue at least through 1993. EVOS related sockeye over-escapement in the Kenai River and Red Lake system is anticipated to result in low adult returns in 1994 and 1995. These over-escapements may result in closure or harvest restrictions during these and perhaps in subsequent years.	YES	YES	YES	YES	Injury in the Alaska Peninsula is for Commercial fishing only. Injuries and recovery status of rockfish, shellfish and herring are uncertain. Therefore, future impacts on these fisheries is unknown.

41

TABLE XX Services: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Service	Description of Injury	Status of Recovery in December, 1992	Geographic Extent of Injury				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Subsistence	Subsistence harvests of fish and wildlife in 9 of 15 villages surveyed declined from 4 - 78% in 1989 when compared to pre-spill averages. Approximately 7 of the 15 villages show continued declines in use in the period 1990-1991; this decline is particularly noticeable in the Prince William Sound villages of Chenega and Tatitlek. In 1989, chemical analysis indicated that most resources tested, including fish, marine mammals, deer, and ducks, were safe to eat, but that shellfish from oiled beaches should not be used. In addition, village residents believe that subsistence species continue to decline or have not recovered from the oil spill.	Many subsistence users believe that continued contamination to subsistence food sources is dangerous to their health.	YES	YES	YES	NO	For detailed information on village subsistence use see table _, page__.
Wilderness Values	There is a perception of lost values to designated federal and state wilderness areas in parks, refuges and forests. People report that their feeling about the spill area has changed. There is wide-spread feeling that something has been lost. Approximately _,___ miles of wilderness coastline were affected by oil. Some oil remains embedded in the sediments of these areas.	Some people's feelings of lost values are diminishing (recovery). To others the values remain injured (lack of recovery). Oil has degraded substantially in many areas but remains in others. Until oil is completely removed or degrades naturally, injury to wilderness values will continue.	YES	YES	YES	YES	

Draft Alternatives

These pages summarize the alternatives proposed for the draft restoration plan. Some of the details are likely to change, tables may be reformatted during publication, and much explanatory text will accompany the tables. But the tables contain the basic information proposed for the alternatives. With Trustee concurrence, these alternatives are intended for the draft restoration plan, and the "Alternative Information Package" scheduled for March publication.

Five tables are presented for each alternative.

1. Summary of the theme and policy variables that apply to that alternative.
2. The Resources and Services addressed in that alternative. Alternatives two, four, and five address all resources. Alternative three addresses only resources that show a population-level injury. All alternatives (except alternative #1, the "no-action alternative) address all services.
3. Restoration Options applicable to that alternative.
4. Geographic Distribution of Restoration Options
5. Cost Allocation
6. Option by Option Cost Summary

A Note About Costs. All costs are in thousands of 1993 dollars. The inflation-adjusted value of the remainder of the settlement is approximately $522 million in 1993 dollars (after deducting an estimate of reimbursements to governements). Inflation adjustments use the projection from mid-range scenario of the Alaska Department of Revenue's Fall 1993 revenue forecast.

Costs for each alternative are summarized into the broad categories described below.

1. **Administration and Information.** Includes costs for administration and public information.
2. **Monitoring**
3. **Habitat Protection**
4. **Other Restoration.** This category includes all restoration except habitat protection.
5. **Other Restoration Reserve.** The "other restoration" category includes the projected cost of all restoration options known today that fit into the policy variables of each alternative. Other effective options may be suggested. This reserve provides a source of funds for effective options that are not known today.

	Alternative 1 Natural Recovery	Alternative 2 Habitat Protection	Alternative 3 Limited Restoration	Alternative 4 Moderate Restoration	Alternative 5 Comprehensive Restoration
THEME	No action other than monitoring and normal agency management.	Protect injured resources and services from further degradation or disturbance.	Take highly effective actions to protect and restore injured services and resources whose population has declined. Maintain the existing character of the affected area.	Take highly effective actions to protect and restore all injured resources and services. Increase, to a limited extent, opportunities for human use in the affected area.	Take all effective actions to protect, restore, and enhance all injured resources and services. Increase opportunities for human use in the affected area.
VARIABLES					
Injuries Addressed	N/A	All injured resources and services.	Injured services and resources whose populations declined.	All injured resources and services.	All injured resources and services.
Status of Resource Recovery	N/A	Resources not recovered and resources recovered.	Resources not recovered.	Resources not recovered.	Resources not recovered and resources recovered.
Effectiveness of Restoration Actions	N/A	All effective habitat protection actions.	Only highly effective actions.	Only highly effective actions.	All effective actions.
Strategies for Public Use	N/A	Protect or increase existing use through habitat protection.	Protect existing use.	Protect or increase existing use.	Protect or increase existing use or encourage appropriate new use.

Monitoring and information programs are included in all alternatives.
Restoration actions may be undertaken for injured resources, services, or their equivalents in all alternatives.

Table ____. Summary of Draft Restoration Plan Alternatives

Table V-__ shows which resources showed a population decline, and which showed chronic or sublethal injury without a detectable change in population. The table shows the injuries that occurred as of 1989, the spill year and does not take into account recovery.

Table V-__. Degree of Injury

Resources whose populations declined because of the spill.	**Sublethal or Chronic Effects. No Detectable spill-related population decline**
Harbor seals	River otters
Sea otters	Bald eagles*
Common murres	Killer Whales*
Marbled murrelet	Pink salmon*
Pigeon Guillemots	Pacific herring
Harlequin ducks	Rockfish
Black oystercatchers	Dolly Varden*
Sockeye salmon smolts	Cutthroat Trout*
Intertidal organisms	
Subtidal organisms	

* For these species, the Trustees' scientists have considerable disagreement over the conclusions to be drawn from the results of the damage assessment studies.

Alternative 1 - Natural Recovery

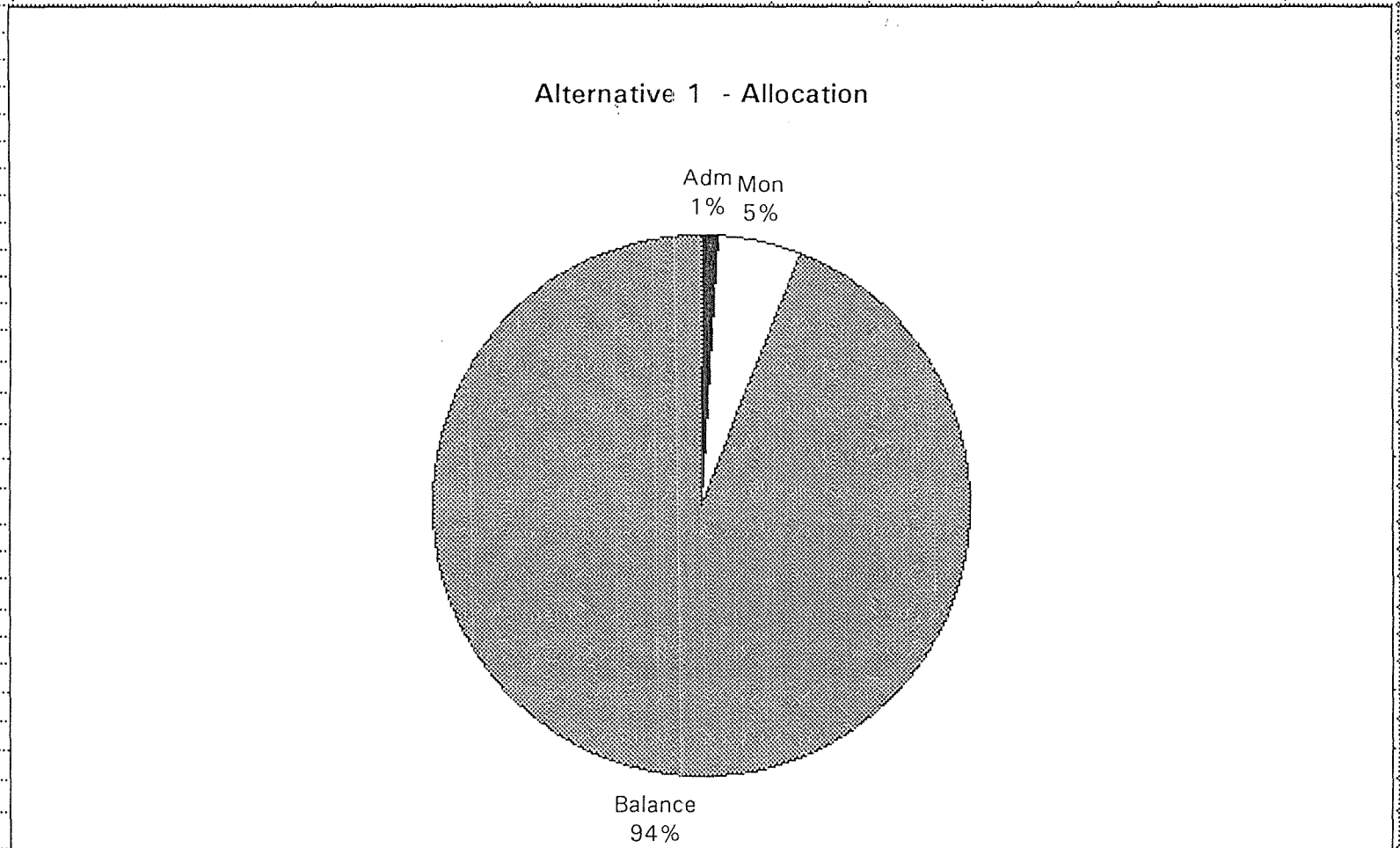
THEME	No action other than monitoring and normal agency management.
VARIABLES	
Injuries Addressed	N/A
Status of Resource Recovery	N/A
Effectiveness of Restoration Actions	N/A
Strategies for Public Use	N/A

Monitoring and information programs are included in all alternatives.
Restoration actions may be undertaken for injured resources, services, or their equivalents in all alternatives.

What would happen to resources and services within the Exxon Valdez oil spill area if no restoration options were implemented? Normal agency management continues, current trends in human use of the affected area continue, and planned development of private lands continue. These trends influence the environment that injured resources face in order to recover. Ideally, the exact injury would be known, and enough would be known about each resource to develop a population model. Unfortunately, such detailed information is not available for most resources; therefore, estimates are based on discussions with agency experts and peer reviewers, and from experience with similar species in different areas (Note: the literature synthesis information is not yet incorporated into this DRAFT!). Similarly, there is limited information on the injury to services.

The objectives of this alternative are to describe the potential rate and degree of recovery for the injured resources with only normal agency management; identify the missing information that make the recovery estimates uncertain; describe the recovery of services; and to describe the monitoring and public information program that would be funded through the Trustee Council.

Allocation of Remainder of Settlement Funds											Total $	%
	Adm										5200.0	1%
	Mon										25250.0	5%
	Balance										491550.0	94%



NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Alternative 1 - Natural Recovery														
				ANNUAL COST			DURATION					TOTAL COST		
								Years				10-Year Maximum		
Opt	DESCRIPTION	ResSvc	UNIT	Exp	Low	High	Type	E	L	H		Expected	Lower	Higher
P1.00	Administration	Multiple resources										5200.0	5200.0	36500.0
P2.00	Monitoring	Multiple resources										25250.0	25250.0	52500.0

24

NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Alternative 2 - Habitat Protection

THEME	Protect injured resources and services from further degradation or disturbance.
VARIABLES	
Injuries Addressed	All injured resources and services.
Status of Resource Recovery	Resources not recovered and resources recovered.
Effectiveness of Restoration Actions	All effective habitat protection actions.
Strategies for Public Use	Protect or increase existing use through habitat protection.

Monitoring and information programs are included in all alternatives.
Restoration actions may be undertaken for injured resources, services, or their equivalents in all alternatives.

The goal of this alternative is for the spill-affected area to return to prespill conditions on its own without further disturbance. This alternative addresses all injured resources and services whether or not they have recovered. Table _____ lists the resources and services addressed in this alternative. As these resources and services recover, protective actions would continue so that they are not subject to additional stress.

RESOURCES			SERVICES
Population Decline	**Sublethal/Chronic**	**Other**	
Black oystercatcher *Common murre Harbor seal Harlequin duck *Intertidal organisms Marbled murrelet *Pigeon guillemot *Sea otter Sockeye salmon *Subtidal organisms	Bald eagle Cutthroat trout Dolly Varden *Killer whale *Pacific herring Pink salmon *River otter *Rockfish	*Archaeology	*Commercial fishing Recreation *Sport fishing *Subsistence Wilderness

* Resources and services for which no restoration action(s) are included in this alternative.

Table _____. Resources and Services Addressed in Alternative 2

DRAFT 2/8/93 **Restoration Options for Alternative 2****

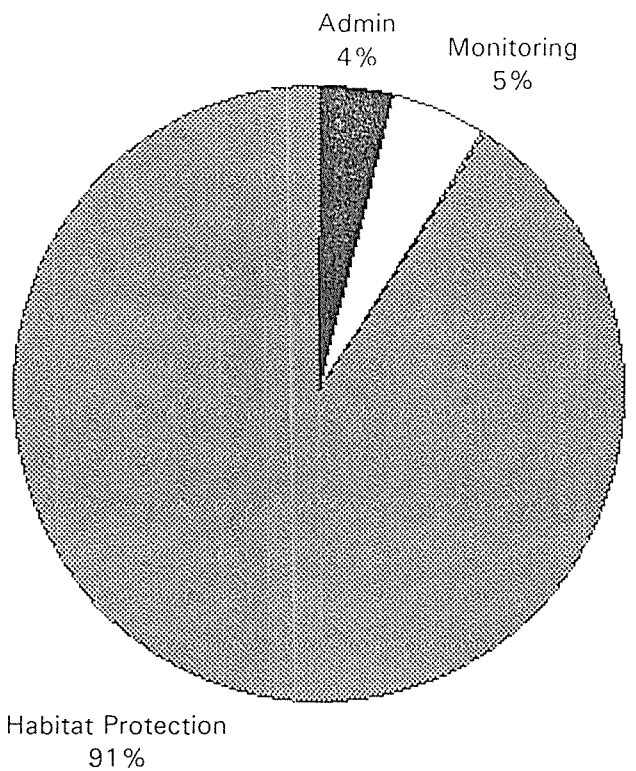
RESOURCE/SERVICE	RESTORATION OPTION
Black oystercatcher	40.0 Land and water management actions
Common murre	None identified
Harbor seal	37.0 Habitat protection and acquisition
Harlequin duck	37.0 Habitat protection and acquisition
Intertidal organisms	None identified
Marbled murrelet	37.0 Habitat protection and acquisition 40.0 Land and water management actions
Pigeon guillemot	None identified
Sea otter	None identified
Sockeye salmon	37.0 Habitat protection and acquisition
Subtidal organisms	None identified
Bald eagle	37.0 Habitat protection and acquisition
Cutthroat trout	37.0 Habitat protection and acquisition
Dolly Varden	37.0 Habitat protection and acquisition
Killer whale	None identified
Pacific herring	None identified
Pink salmon	37.0 Habitat protection and acquisition 40.0 Land and water management actions
River otter	None identified
Rockfish	None identified
Archaeology	None identified
Commercial fishing	None identified
Recreation	37.0 Habitat protection and acquisition 40.0 Land and water management actions
Sport fishing	None identified
Subsistence	None identified
Wilderness and non-use values	37.0 Habitat protection and acquisition 40.0 Land and water management actions

** Options 37 and 40 can potentially benefit <u>all</u> injured resources and services. The table above reflects those resources and services which are the <u>primary</u> targets of the proposed options.

ALTERNATIVE 2: GEOGRAPHIC DISTRIBUTION

RESOURCE OR SERVICE	OPTION NUMBER	OPTION NAME	Prince William Sound			Kenai/Cook Inlet			Alaska Penin.	Kodiak/Afognak		Outside EVOS
			North	East	West	Outer Kenai	Lower Cook In	Central Cook In		Afogn. Shuyak	Kodiak	
MULTI-SPECIES	37.0	Habitat protection and acquisition		x	x	x	x	x	x	x	x	
MULTI-SPECIES	40.0	Land and water management actions	x	x	x	x	x	x	x	x	x	

Allocation of Remainder of Settlement Funds	Total $	%
Admin	21000.0	4%
Monitoring	26000.0	5%
Habitat Protection	475000.0	91%



NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Alternative 2 - Protection														
				ANNUAL COST			DURATION				TOTAL COST		
								Years			10-Year Maximum		
Opt	DESCRIPTION	ResSvc	UNIT	Exp	Low	High	Type	E	L	H	Expected	Lower	Higher
37.00	Habitat protection/acquisition	Multiple resources									475000.0	234900.0	475000.0
40.00	Land and water mgmt actions	Multiple resources											
P1.00	Administration	Multiple resources									21000.0	5200.0	36500.0
P2.00	Monitoring	Multiple resources									26000.0	25250.0	52500.0

NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Alternative 3 - Limited Restoration

THEME	Take highly effective actions to protect and restore injured services and resources whose population has declined. Maintain the existing character of the affected area.
VARIABLES	
Injuries Addressed	Injured services and resources whose populations declined.
Status of Resource Recovery	Resources not recovered.
Effectiveness of Restoration Actions	Only highly effective actions.
Strategies for Public Use	Protect existing use.

Monitoring and information programs are included in all alternatives.
Restoration actions may be undertaken for injured resources, services, or their equivalents in all alternatives.

The goal of this alternative is for the worst-injured resources and services to return to prespill conditions as efficiently as possible. This is the only alternative that limits its scope to resources whose populations declined after the spill. Table _____ lists the resources and services addressed in this alternative. None of the resources whose populations declined after the spill has yet recovered. However, as resources recover, settlement funds would no longer be allocated to protecting or restoring them. This alternative includes only the most effective actions for protecting injured resources and restoring them to prespill conditions. It also includes only those actions that protect existing human uses that were injured and the resource base on which they depend. For example, a boat ramp in an area already used to launch boats would protect the beach that supports this type of recreational use.

RESOURCES		SERVICES
Population Decline	Other	
*Black oystercatcher Common murre Harbor seal Harlequin duck Intertidal organisms Marbled murrelet Pigeon guillemot Sea otter Sockeye salmon *Subtidal organisms	Archaeology	Commercial fishing Recreation Sport fishing Subsistence Wilderness

* Resources and services for which no restoration action(s) are included in this alternative.

Table _____. Resources and Services Addressed in Alternative 3

DRAFT 2/8/93 **Restoration Options for Alternative 3**

RESOURCE/SERVICE	RESTORATION OPTION
Black oystercatchers	None identified
Common murres	16.1 Study: Increase productivity with social stimuli 17.2 Temporary predator control
Harbor seals	46.0 Cooperative program with commercial fishermen 47.0 Cooperative program with subsistence users
Harlequin duck	13.1 Study: eliminate oil from mussel beds
	37.0 Habitat protection and acquisition
Intertidal organisms	14.0 Accelerate recovery of upper intertidal zone
Marbled murrelet	9.0 Minimize incidental take
	37.0 Habitat protection and acquisition 40.0 Land and water management actions
Pigeon guillemots	17.2 Temporary predator control
Sea otters	4.2 Study: Reduce disturbance at marine mammal haul-outs 13.2 Study: eliminate oil from mussel beds 47.0 Cooperative program with subsistence users
Sockeye salmon	2.5 Intensify sockeye management to protect injured stocks 48.0 Improve survival of salmon eggs and fry
Subtidal organisms	None identified
Archaeology	1.1 Site stewardship program 1.2 Site patrol and monitoring 10.0 Preserve archaeological sites and artifacts
Commercial fishing	18.0 Replace salmon harvest opportunities
Recreation	12.1 New backcountry public recreation facilities
	37.0 Habitat protection and acquisition 40.0 Land and water management actions
Sport fishing	18.0 Replace salmon harvest opportunities

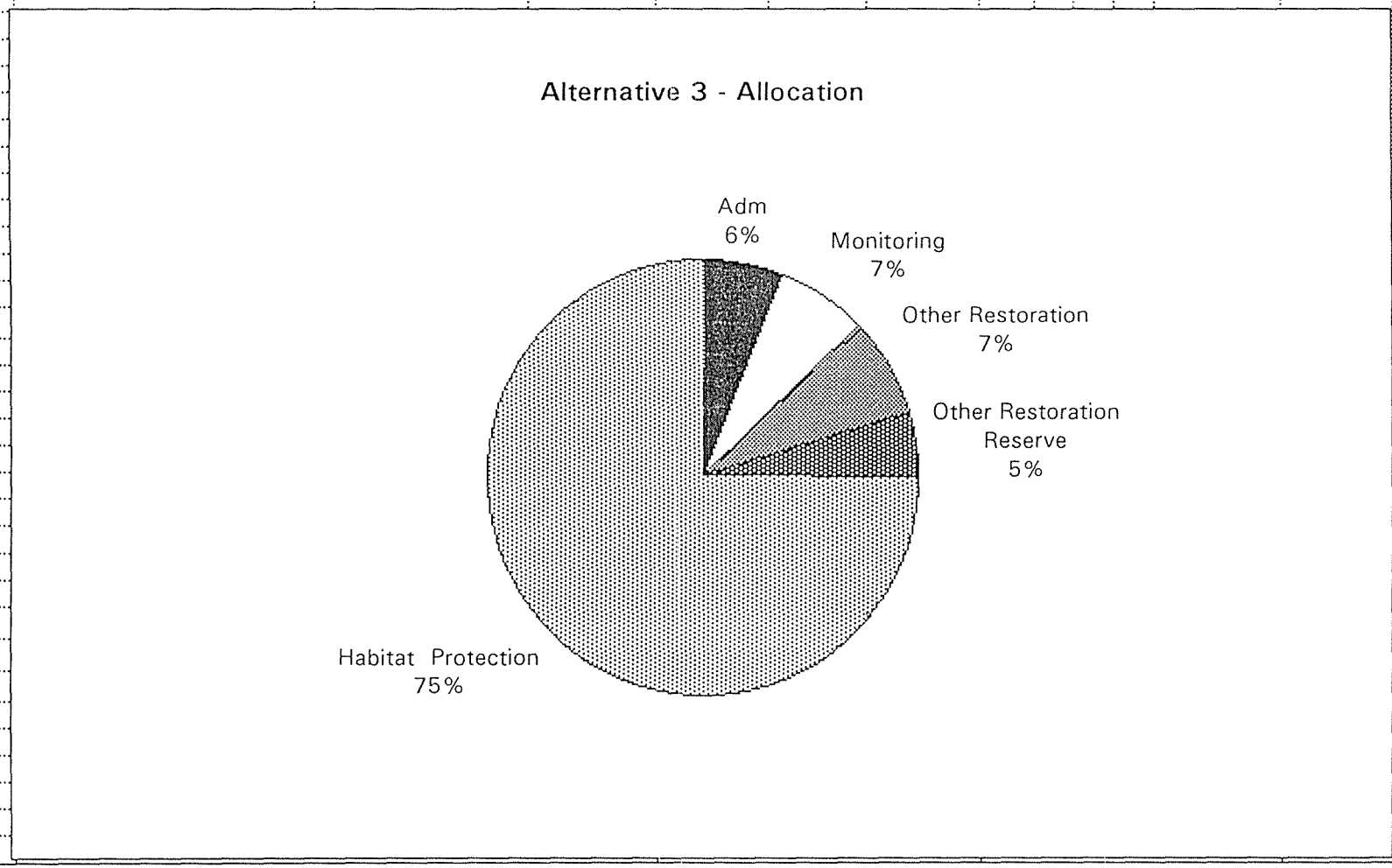
Subsistence	30.0 Test subsistence foods for hydrocarbon contamination 49.0 Provide access to traditional subsistence foods
Wilderness and non-use values	37.0 Habitat protection and acquisition 40.0 Land and water management actions
	Included in Alternative 2

ALTERNATIVE 3: GEOGRAPHIC DISTRIBUTION

RESOURCE OR SERVICE	OPT. No.	OPTION NAME	Prince William Sound			Kenai Cook/Inlet			Alaska Penin.	Kodiak/Afognak		Outside EVOS
			North	East	West	Outer Kenai	Lower Ck In	Central Ck In		Afg. Shuyak	Kodiak	
Archaeology	1.0	Archaeological site stewardship program	X	X	X	X	X	X	X	X	X	
Sockeye salmon	2.5	Intensify sockeye management to protect injured stocks						X				
Harbor seal	4.2	Reduce disturbance at marine mammal haul-outs	X	X	X	X	X	X				
Sea otter	4.2	Reduce disturbance at marine mammal haul-outs	X	X	X							
Marbled murrelet	9.0	Minimize incidental take by commercial fisheries	X	X	X	X	X	X	X	X	X	
Archaeology	10.0	Preserve archaeological sites and artifacts	X	X	X	X	X	X	X	X	X	
Sockeye salmon	11.2	Fertilize lakes to improve sockeye rearing success	X									
Recreation	12.1	Construct new backcountry public facilities	X	X	X	X	X	X	X	X	X	
Harlequin duck	13.1	Study: eliminate oil from mussel beds			X	X	X	X	X	X	X	
Sea otter	13.2	Study: eliminate oil from mussel beds			X							
MULTI-SPECIES	14.0	Accelerate recovery of upper intertidal zone			X	X	X	X	X	X	X	
Common murre	16.1	Increase murre productivity through enhanced social stimuli				X			X			
Pigeon guillemot/Common murre (replacement)	17.1	Removal of introduced species in the Aleutians										X
Common murre	17.2	Temporary predator control				X	X	X	X	X	X	
Pigeon guillemot	17.2	Temporary predator control	X	X	X	X	X	X	X	X	X	
Subsistence	30.0	Test subsistence foods for hydrocarbon contamination		X	X		X				X	
MULTI-SPECIES	37.0	Habitat protection and acquisition		X	X	X	X	X	X	X	X	
MULTI-SPECIES	40.0	Land and water management actions	X	X	X	X	X	X	X	X	X	
Killer Whale - AB pod	45.0	Study: Facilitate changes in black cod fishery gear	X	X	X	X						
Harbor Seal	46.0	Cooperative program w. comm. fishermen to reduce seal bycatch	X	X	X		X			X	X	
Harbor Seal & Sea otter	47.0	Cooperative program with subsistence users to assess harvest levels		X	X		X				X	
Sockeye Salmon	48.0	Improve survival of salmon eggs and fry						X			X	

RESOURCE OR SERVICE	OPT. No.	OPTION NAME	Prince William Sound			Kenai Cook/Inlet			Alaska Penin.	Kodiak/Afognak		Outside EVOS
			North	East	West	Outer Kenai	Lower Ck In	Central Ck In		Afg. Shuyak	Kodiak	
Subsistence	49.0	Provide subsistence users access to traditional subsistence foods			X							
Pink salmon	51.0	Relocate existing hatchery runs	X	X	X							

Allocation of Remainder of Settlement Funds	Total $	%
Adm	31500.0	6%
Monitoring	36500.0	7%
Other Restoration	38362.0	7%
Other Restoration Reserve	24138.0	5%
Habitat Protection	391500.0	75%



NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Alternative 3 - Limited Restoration

Opt	DESCRIPTION	ResSvc	UNIT	ANNUAL COST			DURATION				TOTAL COST 10-Year Maximum		
				Exp	Low	High	Type	E	L	H	Expected	Lower	Higher
1.10	Site stewardship program	Archaeology	Per 3 areas	195.0	195.0	195.0	Ltd	10	10	10	1950.0	1950.0	1950.0
1.20	Site patrol and monitoring	Archaeology		300.0	300.0	300.0	Ltd	4	3	5	1200.0	900.0	1500.0
2.50	Intensify management	Sockeye salmon		3000.0	2000.0	5000.0	Ltd	5	2	5	15000.0	4000.0	25000.0
4.30	Feas Study: Reduce disturb	Sea otter					Ltd				120.0	80.0	640.0
9.00	Minimize incidental take	Marbled murrelet									1625.0	1100.0	2000.0
10.00	Archaeol Res Protection	Archaeology									4072.0	3250.0	7000.0
12.10	New backcountry rec facilities	Recreation									1620.0	480.0	3256.0
13.01	Eliminate oil from mussel beds	Harlequin duck		491.0	340.0	641.0	Ltd	5	4	7	2455.0	1360.0	4487.0
13.02	Study: Elim oil fr mussel beds	Sea otter											
14.01	Accelerate recovery of UIT	Intertidal organisms		150.0	100.0	200.0	UR	5	4	7	750.0	400.0	1400.0
16.10	Feas Study: Social stimuli	Common murre					Ltd				850.0	800.0	5500.0
17.21	Temporary predator control	Common murres		350.0	300.0	400.0	Ltd	5	5	10	1750.0	1500.0	4000.0
17.22	Temporary predator control	Pigeon guillemot		200.0	150.0	250.0	Ltd	4	4	6	800.0	600.0	1500.0
18.01	Replace harvest opportunities	Comm fishing	5 projects	750.0	500.0	1000.0	Ltd	2	1	5	1500.0	500.0	5000.0
18.02	Replace harvest opportunities	Sport fishing	5 projects	750.0	250.0	1000.0	Ltd	2	1	5	1500.0	250.0	5000.0
30.00	Test subsistence foods	Subsistence		330.0	300.0	350.0	Ltd	3	2	5	990.0	600.0	1750.0
37.00	Habitat protection/acquisition	Multiple resources									391500.0	234900.0	475000.0
40.00	Land and water mgmt actions	Multiple resources											
46.00	Coop prgm-fishermen	Harbor seal		50.0	30.0	100.0	Ltd	3	1	5	150.0	30.0	500.0
47.01	Coop prgm-subsistence users	Harbor seal		30.0	30.0	30.0	UR	10	10	10	300.0	300.0	300.0
47.02	Coop prgm-subsistence users	Sea otter					UR						
48.02	Improve survival rates	Sockeye salmon	4 projects	400.0	200.0	600.0	Ltd	3	1	5	1200.0	200.0	3000.0
49.00	Access to traditional foods	Subsistence	Per village	53.0	50.0	60.0	UR	10	5	10	530.0	250.0	600.0
P1.00	Administration	Multiple resources									31500.0	5200.0	36500.0
P2.00	Monitoring	Multiple resources									36500.0	25250.0	52500.0

NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Alternative 4 - Moderate Restoration

THEME	Take the most effective actions to protect and restore all injured resources and services. Increase, to a limited extent, opportunities for human use in the affected area.
VARIABLES	
Injuries Addressed	All injured resources and services.
Status of Resource Recovery	Resources not recovered.
Effectiveness of Restoration Actions	Only highly effective actions.
Strategies for Public Use	Protect or increase existing use.

Monitoring and information programs are included in all alternatives.
Restoration actions may be undertaken for injured resources, services, or their equivalents in all alternatives.

The goal of this alternative is for all injured resources and services to return to prespill conditions as efficiently as possible. Table _____ lists the resources and services addressed in this alternative. None of the resources whose populations declined after the spill has yet recovered. However, as resources recover, settlement funds would no longer be allocated to protecting or restoring them. This alternative includes actions that protect existing human uses that were injured and the resource base on which they depend and also those actions that would increase existing use. An example of the latter is a new hatchery run that may increase opportunities in an existing fishery.

RESOURCES			SERVICES
Population Decline	Sublethal/Chronic	Other	
*Black oystercatcher Common murre Harbor seal Harlequin duck Intertidal organisms Marbled murrelet Pigeon guillemot Sea otter Sockeye salmon *Subtidal organisms	Bald eagle Cutthroat trout Dolly Varden Killer whale Pacific herring Pink salmon *River otter Rockfish	Archaeology	Commercial fishing Recreation Sport fishing Subsistence Wilderness

* Resources and services for which no restoration action(s) are included in this alternative.

Table _____. Resources and Services Addressed in Alternative 4.

DRAFT 2/8/93 Restoration Options for Alternative 4

RESOURCE/SERVICE	RESTORATION OPTION
Black oystercatcher	None identified
Common murre	16.1 Study: Increase productivity with enhanced social stimuli
	17.1 Removal of introduced species in the Aleutians
	17.2 Temporary predator control
Harbor seal	46.0 Cooperative program with fishermen 47.0 Cooperative program with subsistence users
Harlequin duck	13.1 Study: eliminate oil from mussel beds 37.0 Habitat protection and acquisition
Intertidal organisms	14.0 Accelerate recovery of upper intertidal zone
Marbled murrelet	9.0 Minimize incidental take 37.0 Habitat protection and acquisition 40.0 Land and water management actions
Pigeon guillemot	17.1 Removal of introduced species in the Aleutians 17.2 Temporary predator control
Sea otter	4.2 Study: Reduce disturbance at marine mammal haul-outs 13.2 Study: Eliminate oil from mussel beds 47.0 Cooperative program with subsistence users
Sockeye salmon	2.5 Intensify sockeye management to protect injured stocks
	11.2 Fertilize lakes to improve sockeye rearing success
	48.0 Improve survival of salmon eggs and fry
Subtidal organisms	None identified
Bald eagle	37.0 Habitat protection and acquisition
Cutthroat trout	2.1 Intensify management to protect injured stocks 37.0 Habitat protection and acquisition

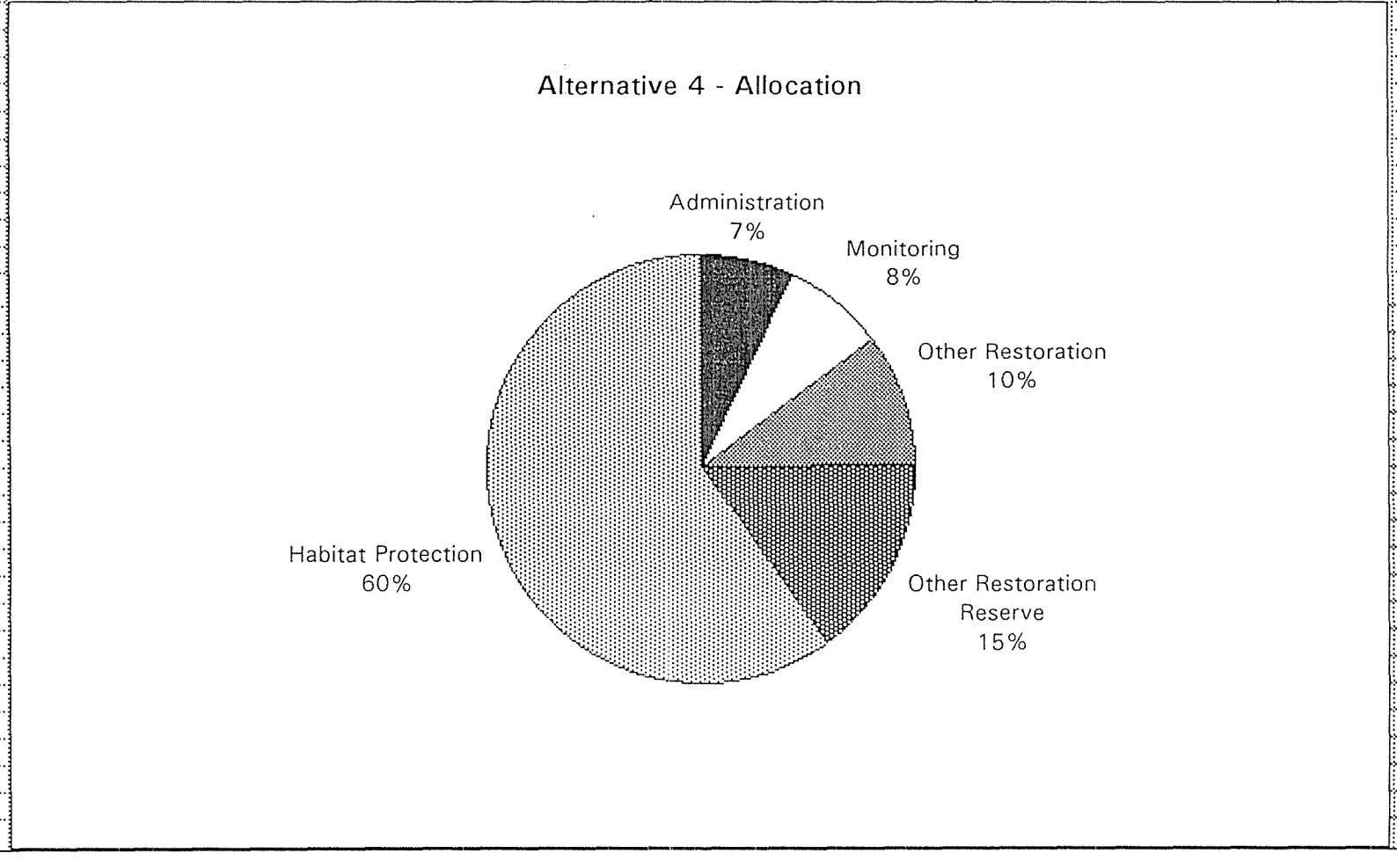
Dolly Varden	2.1 Intensify management to protect injured stocks 37.0 Habitat protection and acquisition
Killer whale	45.0 Study: Changes in black cod fishery gear
Pacific herring	2.2 Intensify herring management to protect injured stocks
Pink salmon	2.3 Intensify salmon management to protect injured stocks 51.0 Relocate existing hatchery runs
River otter	None identified
Rockfish	2.4 Intensify rockfish management to protect injured stocks
Archaeology	1.1 Site stewardship program 1.2 Site patrol and monitoring 10.0 Preserve archaeological sites and artifacts
	35.0 Acquire replacements for artifacts from the spill area
Commercial fishing	18.0 Replace salmon harvest opportunities
Recreation	12.1 New backcountry public recreation facilities 37.0 Habitat protection and acquisition 40.0 Land and water management actions
Sport fishing	18.0 Replace salmon harvest opportunities
Subsistence	30.0 Test subsistence foods for hydrocarbon contamination 49.0 Provide access to traditional subsistence foods
Wilderness and non-use values	37.0 Habitat protection and acquisition 40.0 Land and water management actions
	Included in Alternatives 2 or 3

ALTERNATIVE 4: GEOGRAPHIC DISTRIBUTION

RESOURCE OR SERVICE	OPT. No.	OPTION NAME	Prince William Sound			Kenai/Cook Inlet			Alaska Penin.	Kodiak/Afognak		Outside EVOS
			North	East	West	Outer Kenai	Lower Ck In	Central Ck In		Afg. Shuyak	Kodiak	
Archaeology	1.0	Archaeological site stewardship program	X	X	X	X	X	X	X	X	X	
Cutthroat trout/ Dolly Varden	2.1	Intensify managment to protect injured stocks	X	X	X							
Herring	2.2	Intensify herring management to protect injured stocks	X	X	X							
Pink salmon	2.3	Intensify pink salmon management to protect injured stocks	X	X	X							
Rockfish	2.4	Intensify rockfish management to protect injured stocks	X	X	X	X	X					
Sockeye salmon	2.5	Intensify sockeye management to protect injured stocks						X				
Harbor seal	4.2	Reduce disturbance at marine mammal haul-outs	X	X	X	X	X	X				
Sea otter	4.2	Reduce disturbance at marine mammal haul-outs	X	X	X							
Marbled murrelet	9.0	Minimize incidental take by commercial fisheries	X	X	X	X	X	X	X	X	X	
Archaeology	10.0	Preserve archaeological sites and artifacts	X	X	X	X	X	X	X	X	X	
Sockeye salmon	11.2	Fertilize lakes to improve sockeye rearing success	X									
Sockeye salmon	11.3	Improve access to salmon spawning areas with fish passes, etc.									X	
Recreation	12.1	Construct new backcountry public facilities	X	X	X	X	X	X	X	X	X	
Harlequin duck	13.1	Study: eliminate oil from mussel beds			X	X	X	X	X	X	X	
Sea otter	13.2	Study: eliminate oil from mussel beds			X							
MULTI-SPECIES	14.0	Accelerate recovery of upper intertidal zone			X	X	X	X	X	X	X	
Common murre	16.1	Increase murre productivity through enhanced social stimuli				X			X			
Pigeon guillemot/Common murre (replacement)	17.1	Removal of introduced species in the Aleutians										X
Common murre	17.2	Temporary predator control				X	X	X	X	X	X	
Pigeon guillemot	17.2	Temporary predator control	X	X	X	X	X	X	X	X	X	

RESOURCE OR SERVICE	OPT. No.	OPTION NAME	Prince William Sound			Kenai/Cook Inlet			Alaska Penin.	Kodiak/Afognak		Outside EVOS
			North	East	West	Outer Kenai	Lower Ck In	Central Ck In		Afg. Shuyak	Kodiak	
Commercial Fishing	18.0	Replace fisheries harvest opportunities by creating new salmon runs	X	X	X		X	X		X	X	
Sport Fishing	18.0	Replace fisheries harvest opportunities by creating new salmon runs	X	X	X		X	X		X	X	
Subsistence	30.0	Test subsistence foods for hydrocarbon contamination		X	X		X				X	
Archaeology	35.0	Negotiate with museums to acquire replacements for looted artifacts	X	X	X	X	X	X	X	X	X	X
MULTI-SPECIES	37.0	Habitat protection and acquisition		X	X	X	X	X	X	X	X	
MULTI-SPECIES	40.0	Land and water management actions	X	X	X	X	X	X	X	X	X	
Killer Whale - AB pod	45.0	Study: Facilitate changes in black cod fishery gear	X	X	X	X						
Harbor Seal	46.0	Cooperative program with commercial fishermen	X	X	X		X			X	X	
Harbor Seal and Sea Otter	47.0	Cooperative program with subsistence users		X	X		X				X	
Sockeye Salmon	48.0	Improve survival of salmon eggs and fry						X			X	
Subsistence	49.0	Provide subsistence users access to traditional subsistence foods			X							
Pink salmon	51.0	Relocate existing hatchery runs	X	X	X							

Allocation of Remainder of Settlement Funds	Total $	%
Administration	36500.0	7%
Monitoring	41750.0	8%
Other Restoration	51204.0	10%
Other Restoration Reserve	79346.0	15%
Habitat Protection	313200.0	60%



NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Alternative 4 - Moderate Restoration														
				ANNUAL COST			DURATION				TOTAL COST		
								Years			10-Year Maximum		
Opt	DESCRIPTION	ResSvc	UNIT	Exp	Low	High	Type	E	L	H	Expected	Lower	Higher
1.10	Site stewardship program	Archaeology	Per 3 areas	195.0	195.0	195.0	Ltd	10	10	10	1950.0	1950.0	1950.0
1.20	Site patrol and monitoring	Archaeology		300.0	300.0	300.0	Ltd	4	3	5	1200.0	900.0	1500.0
2.10	Intensify management	Cutthroat/Dolly		255.0	200.0	300.0	Ltd	2	2	2	510.0	400.0	600.0
2.20	Intensify management	Pacific herring		457.0	440.0	500.0	Ltd	3	2	4	1371.0	880.0	2000.0
2.30	Intensify management	Pink salmon		3000.0	2000.0	5000.0	Ltd	2	2	4	6000.0	4000.0	20000.0
2.40	Intensify management	Rockfish		593.0	550.0	700.0	Ltd	2	1	4	1186.0	550.0	2800.0
2.50	Intensify management	Sockeye salmon		3000.0	2000.0	5000.0	Ltd	5	2	5	15000.0	4000.0	25000.0
4.30	Feas Study: Reduce disturb	Sea otter					Ltd				120.0	80.0	640.0
9.00	Minimize incidental take	Marbled murrelet									1625.0	1100.0	2000.0
10.00	Archaeol Res Protection	Archaeology									4072.0	3250.0	7000.0
11.20	Fertilize lakes	Sockeye salmon	Per lake	190.0	150.0	220.0	Ltd	3	1	5	570.0	150.0	1100.0
12.10	New backcountry rec facilities	Recreation									1620.0	480.0	3256.0
13.01	Eliminate oil from mussel beds	Harlequin duck		491.0	340.0	641.0	Ltd	5	4	7	2455.0	1360.0	4487.0
13.02	Study: Elim oil fr mussel beds	Sea otter											
14.01	Accelerate recovery of UIT	Intertidal organisms		150.0	100.0	200.0	UR	5	4	7	750.0	400.0	1400.0
16.10	Feas Study: Social stimuli	Common murre					Ltd				850.0	800.0	5500.0
17.10	Remove introduced species	Common murre					UR				2500.0	1500.0	3500.0
17.21	Temporary predator control	Common murres		350.0	300.0	400.0	Ltd	5	5	10	1750.0	1500.0	4000.0
17.22	Temporary predator control	Pigeon guillemot		200.0	150.0	250.0	Ltd	4	4	6	800.0	600.0	1500.0
18.01	Replace harvest opportunities	Comm fishing	5 projects	750.0	500.0	1000.0	Ltd	2	1	5	1500.0	500.0	5000.0
18.02	Replace harvest opportunities	Sport fishing	5 projects	750.0	250.0	1000.0	Ltd	2	1	5	1500.0	250.0	5000.0
30.00	Test subsistence foods	Subsistence		330.0	300.0	350.0	Ltd	3	2	5	990.0	600.0	1750.0
35.00	Aquire archaeol. artifacts	Archaeology		225.0	150.0	300.0	Ltd	3	3	3	675.0	450.0	900.0
37.00	Habitat protection/acquisition	Multiple resources									313200.0	234900.0	475000.0
40.00	Land and water mgmt actions	Multiple resources											
45.00	Feas Study: Black cod gear	Killer whale		30.0	30.0	30.0	Ltd	1	1	1	30.0	30.0	30.0
46.00	Coop prgm-fishermen	Harbor seal		50.0	30.0	100.0	Ltd	3	1	5	150.0	30.0	500.0
47.01	Coop prgm-subsistence users	Harbor seal		30.0	30.0	30.0	UR	10	10	10	300.0	300.0	300.0
47.02	Coop prgm-subsistence users	Sea otter					UR						
48.02	Improve survival rates	Sockeye salmon	4 projects	400.0	200.0	600.0	Ltd	3	1	5	1200.0	200.0	3000.0
49.00	Access to traditional foods	Subsistence	Per village	53.0	50.0	60.0	UR	10	5	10	530.0	250.0	600.0
51.00	Relocate existing hatchery runs	Pink salmon	Per project				Ltd						
P1.00	Administration	Multiple resources									36500.0	5200.0	36500.0
P2.00	Monitoring	Multiple resources									41750.0	25250.0	52500.0

NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Alternative 5 - Comprehensive Restoration

THEME	Take all effective actions to protect, restore and enhance all injured resources and services. Increase opportunities for human use in the affected area.
VARIABLES	
Injuries Addressed	All injured resources and services.
Status of Resource Recovery	Resources not recovered and resources recovered.
Effectiveness of Restoration Actions	All effective actions.
Strategies for Public Use	Protect or increase existing use; or encourage appropriate new use.

Monitoring and information programs are included in all alternatives.
Restoration actions may be undertaken for injured resources, services, or their equivalents in all alternatives.

The goal of this alternative is for all injured resources and services to return or exceed prespill levels. Table _____ lists the resources and services addressed in this alternative; they are identical to those addressed in Alternatives 2 and 4. This alternative includes actions that protect existing human uses that were injured and the resource base on which they depend and also those actions that would increase existing use or create new uses. An example of the last item is a new commercial facility on public land that attracts different types of uses than had previously existed there.

RESOURCES			SERVICES
Population Decline	**Sublethal/Chronic**	**Other**	
Black oystercatcher Common murre Harbor seal Harlequin duck Intertidal organisms Marbled murrelet Pigeon guillemot Sea otter Sockeye salmon *Subtidal organisms	Bald eagle Cutthroat trout Dolly Varden Killer whale Pacific herring Pink salmon River otter Rockfish	Archaeology	Commercial fishing Recreation Sport fishing Subsistence Wilderness

* Resources and services for which no restoration action(s) are included in this alternative.

Table _____. Resources and Services Addressed in Alternative 5.

DRAFT 2/8/93 **Restoration Options for Alternative 5**

RESOURCE/SERVICE	RESTORATION OPTION
Black oystercatcher	14.0 Accelerate recovery of upper intertidal zone
	37.0 Habitat protection and acquisition 40.0 Land and water management actions
Common murre	4.1 Reduce disturbance at marine bird colonies
	16.1 Study: Increase productivity with enhanced social stimuli
	16.2 Study: Improve physical characteristics of nest sites
	17.1 Removal of introduced species in Aleutians 17.2 Temporary predator control
Harbor seal	4.2 Reduce disturbance at marine mammal haul-out areas
	46.0 Cooperative program with commercial fishermen 47.0 Cooperative program with subsistence users
Harlequin duck	8.1 Develop sport harvest guidelines
	13.1 Study: Eliminate oil from mussel beds 37.0 Habitat protection and acquisition
Intertidal organisms	14.0 Accelerate recovery of upper intertidal zone
Marbled murrelet	9.0 Minimize incidental take 37.0 Habitat protection and acquisition 40.0 Land and water management actions
Pigeon guillemot	17.1 Removal of introduced species in the Aleutians 17.2 Temporary predator control
Sea otter	4.2 Study: Reduce disturbance at marine mammal haul-outs 13.2 Study: eliminate oil from mussel beds 47.0 Cooperative program with subsistence users

Sockeye salmon	2.5 Intensify sockeye management to protect injured stocks 11.2 Fertilize lakes to improve sockeye rearing success
	11.3 Improve access to spawning areas with fish passes, etc.
	37.0 Habitat protection and acquisition 48.0 Improve survival of salmon eggs and fry
Subtidal organisms	None identified
Bald eagle	37.0 Habitat protection and acquisition
Cutthroat trout	2.1 Intensify management to protect injured stocks
	19.0 Anadromous stream catalogue
	37.0 Habitat protection and acquisition
Dolly Varden	2.1 Intensify management to protect injured stocks 37.0 Habitat protection and acquisition
Killer whale	45.0 Study: Changes in black cod fishery gear
Pacific herring	2.2 Intensify herring management to protect injured stocks
Pink salmon	2.3 Intensify salmon management to protect injured stocks
	11.1 Construct spawning channels and instream improvements 11.3 Improve access to spawning areas with fish passes, etc. 19.0 Anadromous streams catalogue
	37.0 Habitat protection and acquisition 40.0 Land and water management actions
	48.0 Improve survival of salmon eggs and fry
	51.0 Relocate existing hatchery runs
River otter	8.2 Develop trapping harvest guidelines
Rockfish	2.4 Intensify rockfish management to protect injured stocks

Archaeology	1.1 Site stewardship program 1.2 Site patrol and monitoring 10.0 Preserve archaeological sites and artifacts 35.0 Acquire replacements for artifacts from the spill area
Commercial fishing	18.0 Replace salmon harvest opportunities
Recreation	12.1 New backcountry public recreation facilities
	12.2 Plan and market public land for commercial recreational facilities 33.0 Visitor centers 34.0 Marine environmental institute
	37.0 Habitat protection and acquisition 40.0 Land and water management actions
Sport fishing	18.0 Replace salmon harvest opportunities
Subsistence	18.0 Replace salmon harvest opportunities
	30.0 Test subsistence foods for hydrocarbon contamination 49.0 Provide access to traditional subsistence foods
	50.1 Develop subsistence mariculture sites 50.2 Develop bivalve shellfish hatchery and research center
Wilderness and non-use values	37.0 Habitat protection and acquisition 40.0 Land and water management actions
	Included in Alternatives 2, 3 or 4

ALTERNATIVE 5: GEOGRAPHIC DISTRIBUTION

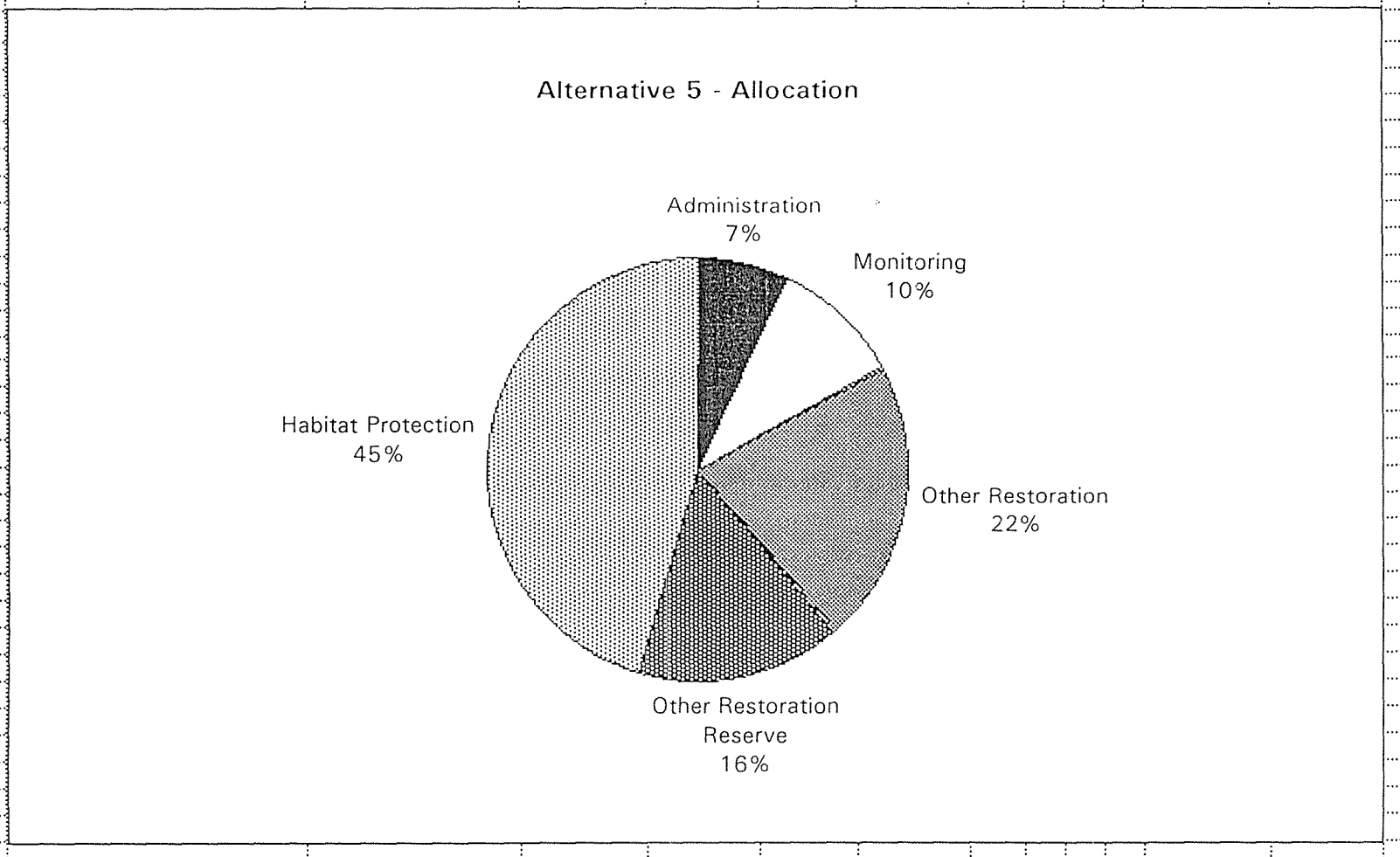
RESOURCE OR SERVICE	OPT. No.	OPTION NAME	Prince William Sound			Kenai/Cook Inlet			Alaska Penin.	Kodiak/Afognak		Outside EVOS
			North	East	West	Outer Kenai	Lower Ck In	Central Ck In		Afg. Shuyak	Kodiak	
Archaeology	1.0	Archaeological site stewardship program	X	X	X	X	X	X	X	X	X	
Cutthroat trout/ Dolly Varden	2.1	Intensify managment to protect injured stocks	X	X	X							
Herring	2.2	Intensify herring management to protect injured stocks	X	X	X							
Pink salmon	2.3	Intensify pink salmon management to protect injured stocks	X	X	X							
Rockfish	2.4	Intensify rockfish management to protect injured stocks	X	X	X	X	X					
Sockeye salmon	2.5	Intensify sockeye management to protect injured stocks						X				
Common murre	4.1	Reduce disturbance at marine bird colonies				X	X	X	X			
Harbor seal	4.2	Reduce disturbance at marine mammal haul-outs	X	X	X	X	X	X				
Sea otter	4.2	Reduce disturbance at marine mammal haul-outs	X	X	X							
Harlequin duck	8.1	Develop sport harvest guidelines for injured species	X	X	X	X						
River otter	8.2	Develop trapping guidelines for injured species	X	X	X							
Marbled murrelet	9.0	Minimize incidental take by commercial fisheries	X	X	X	X	X	X	X	X	X	
Archaeology	10.0	Preserve archaeological sites and artifacts	X	X	X	X	X	X	X	X	X	
Pink salmon	11.1	Construct salmon spawning channels and instream improvements	X	X	X							
Sockeye salmon	11.2	Fertilize lakes to improve sockeye rearing success	X									
Pink salmon	11.3	Improve access to salmon spawning areas with fish passes, etc.	X	X	X							
Sockeye salmon	11.3	Improve access to salmon spawning areas with fish passes, etc.									X	
Recreation	12.1	Construct new backcountry public facilities	X	X	X	X	X	X	X	X	X	
Recreation	12.2	Plan and market new public facilities on public land	X	X	X	X	X	X	X	X	X	

RESOURCE OR SERVICE	OPT. No.	OPTION NAME	Prince William Sound			Kenai/Cook Inlet			Alaska Penin.	Kodiak/Afognak		Outside EVOS
			North	East	West	Outer Kenai	Lower Ck In	Central Ck In		Afg. Shuyak	Kodiak	
Harlequin duck	13.1	Study: eliminate oil from mussel beds			X	X	X	X	X	X	X	
Sea otter	13.2	Study: eliminate oil from mussel beds			X							
MULTI-SPECIES	14.0	Accelerate recovery of upper intertidal zone			X	X	X	X	X	X	X	
Common murre	16.1	Increase murre productivity through enhanced social stimuli				X			X			
Common murre	16.2	Improve physical characteristics of murre nest sites				X			X			
Pigeon guillemot/Common murre (replacement)	17.1	Removal of introduced species in the Aleutians										X
Common murre	17.2	Temporary predator control				X	X	X	X	X	X	
Pigeon guillemot	17.2	Temporary predator control	X	X	X	X	X	X	X	X	X	
Commercial Fishing	18.0	Replace fisheries harvest opportunities by creating new salmon runs	X	X	X		X	X		X	X	
Sport Fishing	18.0	Replace fisheries harvest opportunities by creating new salmon runs	X	X	X		X	X		X	X	
Subsistence	18.0	Replace fisheries harvest opportunities by creating new salmon runs		X	X		X				X	
Cutthroat Trout	19.0	Anadromous stream catalogue	X	X	X							
Pink salmon	19.0	Anadromous stream catalogue	X	X	X					X	X	
Subsistence	30.0	Test subsistence foods for hydrocarbon contamination		X	X		X				X	
Recreation	33.0	Visitor centers	X	X	X	X	X	X	X		X	
Recreation	34.0	Marine environmental institute	X	X	X	X	X	X	X	X		
Archaeology	35.0	Negotiate with museums to acquire replacements for looted artifacts	X	X	X	X	X	X	X	X	X	X
MULTI-SPECIES	37.0	Habitat protection and acquisition		X	X	X	X	X	X	X	X	
MULTI-SPECIES	40.0	Land and water management actions	X	X	X	X	X	X	X	X	X	
Killer Whale - AB pod	45.0	Study: Facilitate changes in black cod fishery gear	X	X	X	X						
Harbor Seal	46.0	Cooperative program with commercial fishermen	X	X	X		X			X	X	
Harbor Seal and Sea Otter	47.0	Cooperative program with subsistence users		X	X		X				X	
Pink Salmon	48.0	Improve survival of salmon eggs and fry	X	X	X							

-274

RESOURCE OR SERVICE	OPT. No.	OPTION NAME	Prince William Sound			Kenai/Cook Inlet			Alaska Penin.	Kodiak/Afognak		Outside EVOS
			North	East	West	Outer Kenai	Lower Ck In	Central Ck In		Afg. Shuyak	Kodiak	
Sockeye Salmon	48.0	Improve survival of salmon eggs and fry						X			X	
Subsistence	49.0	Provide subsistence users access to traditional subsistence foods			X							
Subsistence	50.1	Develop subsistence mariculture sites		X	X		X				X	
Subsistence	50.2	Develop bivalve shellfish hatchery and research center				X						
Pink salmon	51.0	Relocate existing hatchery runs	X	X	X							

Allocation of Remainder of Settlement Funds	Total $	%
Administration	36500.0	7%
Monitoring	52250.0	10%
Other Restoration	114678.0	22%
Other Restoration Reserve	83672.0	16%
Habitat Protection	234900.0	45%



NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Alternative 5 - Comprehensive Restoration														
				ANNUAL COST			DURATION	Years			TOTAL COST 10-Year Maximum		
Opt	DESCRIPTION	ResSvc	UNIT	Exp	Low	High	Type	E	L	H	Expected	Lower	Higher
1.10	Site stewardship program	Archaeology	Per 3 areas	195.0	195.0	195.0	Ltd	10	10	10	1950.0	1950.0	1950.0
1.20	Site patrol and monitoring	Archaeology		300.0	300.0	300.0	Ltd	4	3	5	1200.0	900.0	1500.0
2.10	Intensify management	Cutthroat/Dolly		255.0	200.0	300.0	Ltd	2	2	2	510.0	400.0	600.0
2.20	Intensify management	Pacific herring		457.0	440.0	500.0	Ltd	3	2	4	1371.0	880.0	2000.0
2.30	Intensify management	Pink salmon		3000.0	2000.0	5000.0	Ltd	2	2	4	6000.0	4000.0	20000.0
2.40	Intensify management	Rockfish		593.0	550.0	700.0	Ltd	2	1	4	1186.0	550.0	2800.0
2.50	Intensify management	Sockeye salmon		3000.0	2000.0	5000.0	Ltd	5	2	5	15000.0	4000.0	25000.0
4.10	Reduce disturbance	Common murre					Ltd				330.0	185.0	640.0
4.20	Reduce disturbance	Harbor seal					Ltd				330.0	185.0	640.0
4.30	Feas Study: Reduce disturb	Sea otter					Ltd				120.0	80.0	640.0
4.40	Reduce disturb public info	Multiple resources		40.0	30.0	50.0	Ltd	1	1	1	40.0	30.0	50.0
4.50	Reduce disturb field presence	Multiple resources		438.0	390.0	486.0	Ltd	10	10	10	4380.0	3900.0	4860.0
8.10	Sport/trap harvest guidelines	Harlequin duck		15.0	10.0	30.0	UR	2	1	2	30.0	10.0	60.0
8.20	Sport/trap harvest guidelines	River otter		15.0	10.0	30.0	UR	2	1	2	30.0	10.0	60.0
9.00	Minimize incidental take	Marbled murrelet									1625.0	1100.0	2000.0
10.00	Archaeol Res Protection	Archaeology									4072.0	3250.0	7000.0
11.10	Salmon spawn channels etc	Pink salmon	9 total	579.0	579.0	579.0	Ltd	6	6	6	3474.0	3474.0	3474.0
11.20	Fertilize lakes	Sockeye salmon	Per lake	190.0	150.0	220.0	Ltd	3	1	5	570.0	150.0	1100.0
11.31	Fish passes and access	Pink salmon	5 passes	250.0	64.0	1900.0	Ltd	6	6	10	1500.0	384.0	19000.0
11.32	Fish passes and access	Sockeye salmon	2 passes	100.0	25.0	800.0	Ltd	6	6	10	600.0	150.0	8000.0
12.10	New backcountry rec facilities	Recreation									1620.0	480.0	3256.0
12.20	Pln/mkt comm rec facilities	Recreation		275.0	200.0	350.0	Ltd	1	1	1	275.0	200.0	350.0
13.01	Eliminate oil from mussel beds	Harlequin duck		491.0	340.0	641.0	Ltd	5	4	7	2455.0	1360.0	4487.0
13.02	Study: Elim oil fr mussel beds	Sea otter											
14.01	Accelerate recovery of UIT	Intertidal organisms		150.0	100.0	200.0	UR	5	4	7	750.0	400.0	1400.0
14.02	Accelerate recovery of UIT	Black oystercatchers											
16.10	Feas Study: Social stimuli	Common murre					Ltd				850.0	800.0	5500.0
16.20	Feas Study: Impr nest sites	Common murre					Ltd				850.0	800.0	5500.0
17.10	Remove introduced species	Common murre					UR				2500.0	1500.0	3500.0
17.21	Temporary predator control	Common murres		350.0	300.0	400.0	Ltd	5	5	10	1750.0	1500.0	4000.0
17.22	Temporary predator control	Pigeon guillemot		200.0	150.0	250.0	Ltd	4	4	6	800.0	600.0	1500.0
18.01	Replace harvest opportunities	Comm fishing	5 projects	750.0	500.0	1000.0	Ltd	2	1	5	1500.0	500.0	5000.0
18.02	Replace harvest opportunities	Sport fishing	5 projects	750.0	250.0	1000.0	Ltd	2	1	5	1500.0	250.0	5000.0
18.03	Replace harvest opportunities	Subsistence	5 projects	750.0	250.0	1000.0	Ltd	4	1	10	3000.0	250.0	10000.0

NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

Opt	DESCRIPTION	ResSvc	UNIT	ANNUAL COST			DURATION				TOTAL COST		
								Years			10-Year Maximum		
				Exp	Low	High	Type	E	L	H	Expected	Lower	Higher
19.01	Anad Stream Catalogue	Cutthroat trout	PWS	335.0	300.0	400.0	Ltd	1	1	1	335.0	300.0	400.0
19.02	Anad Stream Catalogue	Pink salmon	PWS/Afog	650.0	600.0	800.0	Ltd	1	1	1	650.0	600.0	800.0
30.00	Test subsistence foods	Subsistence		330.0	300.0	350.0	Ltd	3	2	5	990.0	600.0	1750.0
33.00	Visitor center	Recreation	Per 5000 sf				Ltd				1000.0	750.0	1750.0
34.00	Marine environmental institute	Recreation					Ltd				42000.0	42000.0	42000.0
35.00	Aquire archaeol. artifacts	Archaeology		225.0	150.0	300.0	Ltd	3	3	3	675.0	450.0	900.0
37.00	Habitat protection/acquisition	Multiple resources									234900.0	234900.0	475000.0
40.00	Land and water mgmt actions	Multiple resources											
45.00	Feas Study: Black cod gear	Killer whale		30.0	30.0	30.0	Ltd	1	1	1	30.0	30.0	30.0
46.00	Coop prgm-fishermen	Harbor seal		50.0	30.0	100.0	Ltd	3	1	5	150.0	30.0	500.0
47.01	Coop prgm-subsistence users	Harbor seal		30.0	30.0	30.0	UR	10	10	10	300.0	300.0	300.0
47.02	Coop prgm-subsistence users	Sea otter					UR						
48.01	Improve survival rates	Pink salmon	4 projects	400.0	200.0	600.0	Ltd	3	1	5			
48.02	Improve survival rates	Sockeye salmon	4 projects	400.0	200.0	600.0	Ltd	3	1	5	1200.0	200.0	3000.0
49.00	Access to traditional foods	Subsistence	Per village	53.0	50.0	60.0	UR	10	5	10	530.0	250.0	600.0
50.10	Subsistence mariculture sites	Subsistence		550.0	180.0	600.0	Ltd	3	2	4	1650.0	360.0	2400.0
50.20	Bivalve shellfish hatchery etc	Subsistence		1000.0	1300.0	2500.0	Ltd	3	2	4	3000.0	2600.0	10000.0
51.00	Relocate existing hatchery runs	Pink salmon	Per project				Ltd						
P1.00	Administration	Multiple resources									36500.0	5200.0	36500.0
P2.00	Monitoring	Multiple resources									52250.0	25250.0	52500.0

NB: All costs are expressed in units of $1,000 (1993 $). The inflation-adjusted value of the remainder of the settlement is about $522 million.

COMPARISON OF ALTERNATIVES

Alternatives:	1	2	3	4	5
Administration	1%	4%	6%	7%	7%
Monitoring	5%	5%	7%	8%	10%
Other Restoration	--	--	7%	10%	22%
Other Restoration Reserve	--	--	5%	15%	16%
Habitat Protection	--	91%	75%	60%	45%
Uncommitted Balance	94%	--	--	--	--

Table ____. Comparison of Alternatives by Allocation of Cost

RPWG
I

12-15-89
@EPA-10th flr E

Oil Spill Mtg - La Juana and
NRDC / NWF / Wilderness Soc.

1

Sarah (Chasis)
NY Off of NRDC
on Conf. phone

Sign-up sheet passed

La Juana - Intro - + Thanks.
State of Alt + Trustees invited.
EPA's role is coordinator, while
St + Fed Trustees are ultimate
decisionmakers. (Alt not here tho)

[Doug Miller
now head of Anch.
NWF office
(907) 258-4800
(Anne Rothe still
there)]

Bob Alder - Main purpose of mtg is agenda or their letter -
+ groups have been frustrated w/ NRDA w/r/t to
opportunities for public input - want to start off better
w/ Restn. What procedures will we be following?

LaJ - Is still developing, but this is oppty to receive the
group's input. Litig. is a constraint to discussions.
We (Feds) have been deeply involved in NRDA w/r/t to
what impacts have been, + what can be done for restn.
No cook book avail. for restn. Will require much thought
to come up w/ best overall plan. We've talked to St.
+ have conceptual ideas, but we don't have a detailed
restn plan yet.

Kain - Is there a schedule?

LaJ - No firm conclusion about what we need to do + when yet
but working on it. Bal. of knowing what's been
damaged, as well as need not to wait too long to start restn

Alder - appreciate need to ~~not~~ know NRDA results, but concern ~~that~~ if wait until NRDA done, may lose some SHORT-TERM opportunities for restoration.

~~Intros~~ —
~~—~~ Ah showed up late

NOAA OGC - what opp'ty is being lost, specifically?

Olson - assumption ~~that~~ much damage won't be recoverable, so may have to go to acquisition of equivalent resources. Some resources ~~that~~ may be considered equivalent are at risk now from logging (for example).

NOAA - prob. is ~~this~~ assumes $ is available. At ~~this~~ time there is none.

Olson - this is one Q - what are possibilities for early recovery of any monies, from suits, etc?

Diane K. - can't speak to ~~that~~ directly - [Alder - any early recovery of response costs, etc?] - No complaint ~~that~~ Exxon hasn't been paying response bills. Re NRDA, other ~~than~~ orig $15 MM, no ongoing reimbursement of study costs.

Olson - Planning to prepare final D.A. plan, in a public way?

Diane K - Think that's the plan - but 60+ studies to look at, and comment response (in addition to scientific review) is being coordinated now.

BofA Chasis - are PIs getting to see comments? @ DAT meetings w/ PIs - seemed they hadn't been aware of public comments. (+ these address far more detailed plans than public comments on) So - concern is that public comments won't be considered except up-to-the-fact.

La J – orig. plans "sketchy" because of timing (needed to be in field right away)

Diane – Arch. meetings are "1st step" mtgs – first chance for RTs + Mgmt to get together. Not only opptty for public input to be considered in time to make diffce

Alder – will detailed study plans, being circulated, be reviewable by the public.

Diane – unsure yet if there will go to public. Plans are being peer reviewed

La J – re: Rextn, Framewk Comm + Tr mtgs have talked openly about how to have public + native gp. participation. Still being developed, but recognized as a need. (Asked ah rep ~~group~~ for input on how best to do native village outreach).

Ak rep – is a real need – best is to go where they are.

Olsen – best overall is to have a public scoping process + then go into drafting plans. (And local hearings during scoping.)

NOAA OGC – NRDA public plan really more historical than anything else, since all but a few studies were already underway. Rextn planning will be more open + orderly + won't be under same time constraints. [Re pilot projs, + discuss.]

La J. – Emphasize that no final conclusion has been reached. But in terms of being orderly, need understanding of what damages have occurred, + what has been done in terms of rextn elsewhere (incl non-oil spill rextn). Also, we're looking at doing pilot studies in short term where can do some things to do

that don't need to or can't wait until entire process is completed. Restn process can involve "everyday people" that have been affected, whereas NRDA devel't was more technical & scientific. (asked for input)

Alder – I thought it is to have a conference in Anch to to address some of these issues – public, native, environ'l groups, experts to brainstorm.

LaJ – technical papers?

Alder – that, and public input into what resources should be restored or, maybe more significantly, aquired as equivalent resources.

DOI rep – lack of "aquire equiv resources" statement in NRDA plan doesn't reflect policy decision that that can't be done. Simply that the authors weren't highly familiar w/ the regs...

Karin – in this sense, what is endpoint (when is a resource "restored"?

LaJ – not at point to know that yet.

Tudor – Trying to do it better for Restn than for NRDA – we are taking restn seriously & need groups' help now.

Alder – Re: Aquisition – things that can be done now:

Low cost 1) Inventory since know types of habitat, can inventory inholdings in Fed land that hold some types if need to aquire

Low cost 2) Cancellation of leases – in order to keep options open for aquisition, until plan is complete.

mod. cost 3) Aquire options now, on property, to purchase several years later if necessary.

LaJ - how to quantify the need though?

Olsen - we're trying to make sure options are kept open before timing closes options. Similarly, they are afraid many damages won't be documented (by lack of long term DA guarantee) & that this will severely curtail restn planning study.

Diane K - Q we're asking about studies w/ 1/1 to 2-28-90 data, is, if damages have (or will) occur will this study have picked it up by now? If not, study should continue.

Olson - This will be a critical decision/junction that public should be involved in. Detailed docts should be made avail. to public before final decision being made.

State Rep - danger in looking to quickly to "equivalent resources" - need to know what's restorable & first do everything possible to restore actual losses first.

Kain/Bob - completely agree. Acquisition of equiv. should be "last gasp" restn.

LaJ - easiest thing may be to just come up w/ a $ figure & go out & buy something. But EPA & think the Trustees are committed to doing best actual restn plan we can. Acquisition won't be first focus, but we are keeping in mind will probably have some situations where direct restn can't be done.

Adler - don't forget lost uses over time - so even if can restore a resource in 5 yrs, still charge for the 5 yrs loss of use, & take that money & do other related work (eg, stream rehab on forest).

Alder – More specifically, what techniques are being considered w/r/to what species are amenable to restocking & which not, etc.

Karin – Important to have public input built into the process as go along, rather than have them slow or stop the process at the end.

– Priorities for Restn. What do you do first?

LaJ – Trying to do that right now. EPA, AK, Trustees are trying to work closely to set up the process right, & to avoid dupl. of effort at the same time. Trying to agree on a unified process right now, outlined, w/ target dates. Then to have scientists get to work on the specifics. But still, need some NRDA results for basis to actually get started. Unified, agreed framework is getting high-level attention from everyone; be assured.

Karin – what factors have you looked at w/r/to process? ID most sensitive resource, or what?

LaJ – Not that far yet. [GREYSON NOAA OGC] Still trying to devel. process to do this. Had big mtg in January, & more coming up. We'd like groups' input as we go thru it.]

Karin – but during spill itself, had priority to protect the salmon, for ex. Are you doing that for Restn?

Tudor – Yes, but need more input from NRDA studies to help ID what our "Restn Triage" needs to be.

Alder – Any conclusions about next spring – will Exxon be back, etc.?

Conrad – A rich. conference – High exposure beaches diff't from low energy

Cont, cont – but unclear yet exactly what state of the shorelines will become spring. Need public input during the process...

Me – overview of current status – low vs high energy shorelines – but won't have "big picture" of how to focus restn efforts until spring survey results, + NRDA results, etc.

Olsen – very concerned about $ – appropriations agencies have received so far + lack of prospect for early recovery. Concern has been that decisions will be made for lack of funding, + not based on science 1 way or other. What's status of funding?

NOAA-OGC – $15mm was only partial, + they will be asked for more, most likely. But once they've given all they will, agencies must either reprogram or go to Congress. So, any public pressure on Congress to appropriate more $ to agencies would help!

Olsen – difficult to lobby Congress w/o real #'s to go by, + public doesn't have access

NOAA-OGC – that info won't be sensitive, + will be available (what addl money will be needed). Reasonable request for groups to have input to the NRDA plans for next year that are being developed now.

[Alder – sidelight – enviro'l groups didn't get notice about oral testimony – their postcards all were lost in mail! – + a few days is too short notice to prepare much. Also concerned that decisionmakers won't be there.]

Chris – had heard EPA was focusing on short term restn, not long term. Hearing by 1992, would all be overwith.

LeJ/Tudor – NO EPA's position & that restn will should begin as soon as poss & not wait until entire NRDA is over.

Want to do what can do, as quickly as can do it, based on good info.

LeJ – If you think we're going too fast, please tell us!

LeJ – Sees restn plan as a dynamic doc that will have to be reeval'd. When it comes out, won't be the end of it.

NOAA – Salmon will req – long term monitoring & study;

Alder – There will be strong pressure from ST, Fishermen, & somewhat from Natives to focus on salmon, & hatcheries as a focus. Groups don't view hatcheries as good as 1 maj. focus. Want focus on ecosystem, incl aesthetics & wilderness values.

Kain – this is what she meant by priorities – want priority focus to be on ecological/biological, not economic issues & who has biggest stick as a lobby.

State – need your groups to help counter any such pressures that come about.

LeJ – But in discussions to date, focus has been on ecological focus, incl habitat, food chain, WQual, etc.

Me – lack of existing knowledge of this ecosystem, though is a problem. So there will be some BPJ, & will be looking for help from anyone who can provide it.

12-15

Karin – as wrap-up, they can only give best help when they have the info to give it. Please keep informed..

PRWG
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Natural Resources
Defense Council

1350 New York Ave., N.W.
Washington, DC 20005
202 783-7800
FAX 202 783-5917

December 13, 1989

LaJuana Wilcher (WH-556)
Assistant Administrator, Office of Water
U.S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

re: Exxon Oil Spill Meeting

Dear LaJuana:

We appreciate very much the opportunity to meet with you and Dan Este on Friday, December 15, 1989, at 1:00 in your office. Attending the meeting will be me, Sarah Chasis from NRDC's New York Office (by conference call), Karin Sheldon of the Wilderness Society, Erik Olson of the National Wildlife Federation, and possibly John Fitzgerald of Defenders of Wildlife.

We would like to discuss the following issues, in addition to any areas you and Dan would like to cover:

(1) The schedule and procedures for planning and implementing the restoration effort, including opportunities for timely public participation in this process, and the possibility of a conference in Alaska to explore restoration options;

(2) Current thinking on possible components of the restoration program (both short-term and long-range restoration options), and how they will be funded;

(3) The current status of the cleanup process, and EPA's involvement in cleanup (as opposed to restoration) issues (bioremediation techniques, approval of chemical products, etc.);

(4) Environmental group comments on the Draft Natural Resources Damage Assessment, and any EPA reactions.

If possible, we would like to be briefed on items (1), (2) and (3).

Thank you again for meeting with us. I look forward to seeing you on Friday.

Sincerely,

Robert W. Adler

Robert W. Adler
Senior Attorney

cc: Dan Este
Meeting Participants

RPWG
I

April 16
RPWG / Afognak Joint Venture

Name	Affiliation	Phone
Linda Comerci	USEPA	271-2461
Kep Rice	USFS	278-8012
Stan Senner	ADF+G	271-2461
Sandy Rabinowitch	DOI	257-2653
ART WERNER	ADNR	762-2515
Howard Valley	AJV	486-6014
JIM CARMICHAEL	AJV	486-6014
TIM MAHONEY	AJV	703-846-7349

4/16

Afognak Joint Venture

Jim Carmichael
Tim Mahoney
Howard Lilley

Creation of ANILCA
Native Corp are partners; weaker than Native Corp. → have right to pull out
northwest, north, east side of Afognak Is.
$200M aquisit. cost
Land-Water Conserv. Fund
↳ 200M. (total for all US purcheses -
study for aquis, - not approved
Cg. Miller + staff interest in Afognak

Study: to provide info to Congress, state, etc: examine habitat consistent w/ other lands being analyzed.
USFWS possible canandate to do study
timing of study ⇒ done within a year (after Bill passes - Oct.)
Submerged lands study
Habitat
avail of land for purchase

original plan → 200,000 acres

< 3 partners left J.V. – 2 going thru formal partition + tentative settlmt Tonkebay peninsula

leaves ~ 150,000 acres - ~~reduced~~
< some lands in SW portion are being lossed;

Afog, Native Corp / Koniag ⇒ partners.

want coordinated effort @ state/Fed (combinat. of oil spill $ +

Red Peaks – NW

& state ownership → SE area (small

150-180 yR rotation.

DON YOUNG
CONGRESSMAN FOR ALL ALASKA

WASHINGTON OFFICE
2331 RAYBURN BUILDING
TELEPHONE 202/225-5765

COMMITTEES:
INTERIOR AND INSULAR AFFAIRS
MERCHANT MARINE AND FISHERIES
POST OFFICE AND CIVIL SERVICE

Congress of the United States
House of Representatives
Washington, D.C. 20515

DISTRICT OFFICE
222 WEST 7TH AVENUE, SUITE
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TELEPHONE 907/271-5978

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KETCHIKAN, ALASKA 99902
TELEPHONE 907/225-6880

120 TRADING BAY
SUITE 260
KENAI, ALASKA 99611

BOX 177
KODIAK, ALASKA 99615

P.O. BOX 1860
NOME, ALASKA 99762

April 9, 1991

Honorable Sidney R. Yates
Chairman
Subcommittee on Interior and Related Agencies
Committee on Appropriations
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

I would greatly appreciate it if, when the Subcommittee on Interior and Related Agencies prepares appropriations for FY 1992, it include report language directing the Fish and Wildlife Service to study acquisition of lands on Afognak Island, Alaska, for inclusion in the Kodiak and Alaska Maritime National Wildlife Refuges.

The Afognak Joint Venture (AJV), a partnership of Alaska Native corporations, owns over 150,000 acres on Afognak Island. This unique coastal forest ecosystem, formerly part of the Chugach National Forest, surrounds the Red Peak Unit of the Kodiak NWR. Numerous small islands of the Alaska Maritime NWR are immediately offshore. The AJV is interested in seeing these lands protected from development since the southern portion of the island is committed to logging. Income from land sales would allow the Corporation (AJV) to diversify business initiatives. However, the present financial condition of the Joint Venture is such that without projected income from land sales, logging activities on all its lands will become necessary.

It may be possible for the federal government to use funds stemming from the Exxon settlement for such acquisitions. However, unlike federal inholdings considered as part of the "Submerged Lands Act" study, Afognak lands have never received a comprehensive examination of their acquisition value as wildlife habitat.

I believe that an agency study of the AJV lands could provide a plan of acquisitions to the Congress and to the trustees of the settlement fund by identifying important wildlife habitat and priorities for acquisition -- a plan to protect deserving wildlife habitat and guide AJV in its financial responsibilities to its shareholders.

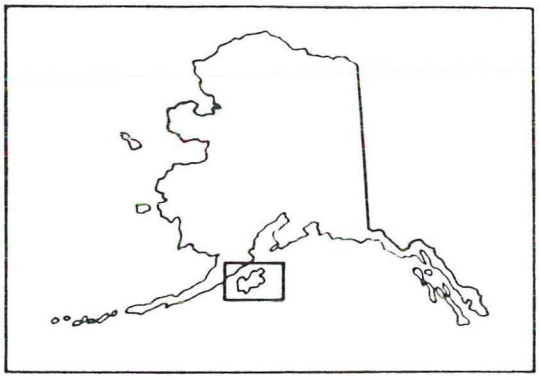
I want to thank you and the Committee for considering this request.

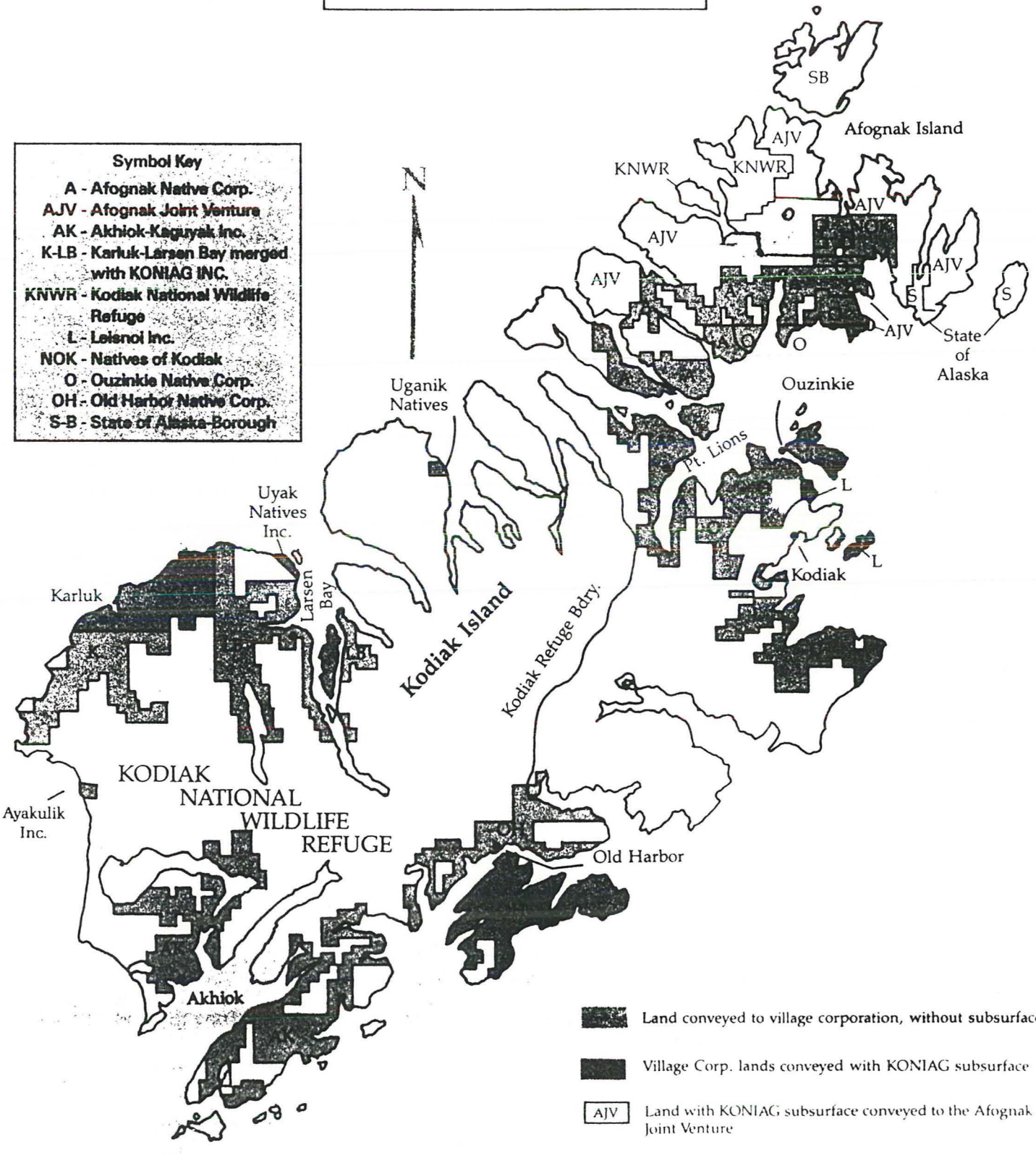
With warm personal regards,

Sincerely,

DON YOUNG
Congressman for All Alaska

LAND AND RESOURCES





RPWG
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Restoration Subgroup
c/o CACI
645 "G" Street
Anchorage, Alaska 99501

MEMORANDUM **23 JANUARY 1992**

TO: Restoration Subgroup

FR: Stan Senner Stan

RE: Proceedings and Summary of Marine Habitat Protection Workshop

We now have at CACI 179 copies of the proceedings and summary from last August's marine habitat workshop. Susan MacMullin received an additional 20 copies in DC.

We need to decide how and to whom these are distributed in order to make good and strategic use of our copies. This is especially important since I anticipate that in about March the NOAA marine sanctuary people, Miles Croom specifically, will be coming to the state to discuss adding some Alaska areas to the Site Evaluation List. What can we do to encourage objective consideration of marine sanctuaries as a tool in the restoration program?

I would appreciate your suggestions by telephone or fax. If everyone will be at the TNC/Lands Committee meeting on Tuesday the 28th, perhaps we can huddle briefly?

enclosure (1)

JONES & STOKES ASSOCIATES, INC. / 2820 NORTHUP WAY, SUITE 100 / BELLEVUE, WA 98004

206/822-1077

FAX 206/822-1079

January 10, 1992

Ms. Karen Klinge
Regional Planning Work Group
c/o CACI
645 G Street
Anchorage, AK 99501

SUBJECT: Work Assignment No. 10 - Delivery of Final Products

Dear Ms. Klinge:

Enclosed please find 179 copies each of the Proceedings of the Workshop on Programs to Protect Marine Habitats and the Summary Report on Programs to Protect and Manage Marine Habitats. I have also sent one copy of each to Mr. John Armstrong at Region 10 headquarters in Seattle, and 20 copies of each to Ms. Susan MacMullin in Washington, DC.

I have also sent Ms. Kim Lesveque's original notes, and copies of the tapes that were recorded during the workshop to Ms. MacMullin. I have copies of each which I will archive at my office.

As usual, it has been both interesting and rewarding to work with the Regional Planning Work Group during its scoping process. I look forward to the opportunity of working with the group on future projects.

Sincerely,

Richard K. Oestman

Richard K. Oestman
Project Manager

RKO:lr
Enclosures

USEPA/WA 10, WORKSHOP 2
01/10/92

File

OIL SPILL RESTORATION PLANNING OFFICE

437 E Street, Suite 301 Anchorage, Alaska 99501
(907) 271-2461 FAX: (907) 271-2467

RPWG
I

26 June 1991

Debra L. Clausen, Habitat Biologist
Habitat Division, Region II
Alaska Department of Fish and Game
333 Raspberry Road
Anchorage, AK 99518

Dear Debbie Ms. Clausen:

The Restoration Planning Work Group (RPWG) is holding a workshop to review and discuss different systems for the protection and management of marine habitats as possible components in the Exxon Valdez restoration program. The purpose of this letter is to invite your participation in this workshop on August 1-2 in Anchorage, Alaska.

We are now compiling notebooks with background information on different marine habitat protection systems (e.g., federal Marine Sanctuaries, state Marine Parks). This material will aid RPWG and, ultimately, state and federal Natural Resource Trustees, in evaluating how best to restore resources and services injured by the oil spill. Although this background will help, RPWG believes that it is crucial to hear first-hand from people with practical experience in creating and managing protected marine habitats. This is where you come in.

The workshop will be informal, and we hope you will come prepared to share your insights about creating and managing protected marine habitats. The workshop is not a public event, and, in order to maximize participation, we plan to strictly limit attendance. If you personally are not able to attend, please let us know and we can discuss an alternate to represent your agency and expertise.

Please confirm your availability by calling Ms. Ruth Yender at the RPWG office, 907-271-2461, no later than Tuesday, 9 July. We will circulate an agenda and other pertinent information shortly. Thank you for your consideration, and we hope to see you in Anchorage on Thursday and Friday, August 1-2.

Sincerely,

John Strand
NOAA

Stan Senner
ADF&G

cc: Frank Rue
Lance Trasky

Debra L. Clausen, Habitat Biologist
Habitat Division, Region II
Alaska Department of Fish and Game
333 Raspberry Road
Anchorage, AK 99518

Al Meiners, Regional Manager
Southcentral Region
Division of Parks and Outdoor Recreation
Alaska Department of Natural Resources
P.O. Box 107001
Anchorage, Alaska 99510-7001

Mack Shaver, Superintendent
Channel Island National Park
1901 Spinker Drive
Ventura, California 93001

Anne Castellina, Superintendent
Kenai Fjords National Park
P.O. Box 1727
Seward, Alaska 99664

John Martin, Manager
Alaska Maritime N.W.R.
202 Pioneer Avenue
Homer, Alaska 99603

Dr. Terry Stevens, Manager
Padilla Bay National Estuarine Research Reserve
1043 Bayview-Edison Road
Mt. Vernon, WA 98273

Ed Ueber
Manager, Gulf of the Farallones
National Marine Sanctuary
Fort Mason, Building 201
San Francisco, CA 94123

Rafael V. Lopez
Pacific Reginal Manager
Sanctuaries and Reserves Division
National Ocean Service
Office of Ocean and Coastal Resources
National Oceanic and Atmospheric Administration
1825 Connecticut Avenue NW (N/ORM2)
Washington, D.C. 20235

RPWG
I

Coastal Habitats Team Meeting

Location: Department of Natural Resources - Phone 561-2020
Frontier Building
3601 C Street
Anchorage, Alaska

Dates and Time: May 23-25 8:00 am - 5:00 pm

Attendees: Coastal Habitat Team Members plus Everett Robinson - Wilson, Hydrocarbon Analysis Team. Team members may bring principal investigators as desired. (Principal investigators attendance is optional if Team Members can negotiate needed changes in DRAFT proposals.)

Objectives:

1. Incorporate Management Team guidelines into Reconnaissance, Comprehensive, and Cleanup Impact Assessment Plans

2. Review and adjust DRAFT detailed proposals to assure all plan objectives are met. Develop proposals to fill any resulting gaps.

3. Develop project coordination scheme for the studies.

4. Prepare a revised project budget based on detailed implementation plans and schedules.

Bring: DRAFT proposals (2 page maximum) which address the objectives of the three assessment plans. (If possible, prepare using WORDPERFECT 5.0 Version and also bring the 5 1/4 inch disk.)

Coastal Habitat's Committee Meeting
May 23 - 25
Anchorage Alaska

~~NAME~~ Name	Organization	Phone #
Bill Edwards	US Forest Service	586-7862
STEPHEN TALBOT	U S FISH + WILDLIFE SERVICE	
GARY AHLSTRAND	NPS	257-2564
Priscilla Wohl	DNR	762-2295
Ray Highsmith	UAF	474-~~7836~~ OFFICE 789-6018
Mahri Babcock	NOAA/NMFS/Auke Bay Lab	
BILL COPELAND	PROJ. MGR OIL SPILL COORD OFFICE DNR	762-2295
ROB LIPKIN	US EPA	271 5083
Kim Sundberg	ADF&G habitat	
Steve MacLean	IAB/UAF	474-7172
Trish Wurtz	USFS/ Inst. Northern Forestry	474-672.
JEFF HOCK	ADEC	364-2155

Summary of Management Team Reaction and Direction for Coastal Habitats Team

Reaction:

The name change from Lands/Plants (intertidal) to Coastal Habitats was approved

The Mgt. Team is strongly supportive of the proposals and views these plans as the means to track the oil spill through the food chain as well as integration mechanism to focus other damage assessment results to the entire spill area.

Direction:

The Department of Natural Resources and the Forest Service are designated as the Lead Agencies for this Project

long-term det. recovery?

The duration of the projects will be for three years. Provide a means of escape if results are not significant.

The Reconnaissance and Comprehensive plans must be representative of the spill area and include include low productivity habitats for complete characterization of spill impacts.

Cost estimates will NOT include overhead for the agencies. This issue will be dealt with seperately by the Mgt. team.

The University of Alaska will be treated as a co-equal to other agencies for planning purposes.

Shore based camps will be authorized for these studies to save costs.

Planned budgets need to be revised to reflect planned implementation actions.

The budget must be apportioned to the cooperating agencies in the final submission.

The Coastal Habitat Team should consider whether or not rate of recovery information beyond 3 years can be obtained through a smaller study that will still quantify recovery rates.

Trophic studies must be coordinated with species studies for mammals, fish, birds, etc. to assure that food chain linkages can be directly demonstrated.

Hydrocarbon analysis is a big ticket item and plans must take this into consideration by minimizing the numbers needed.

Proposal Guidelines

We are asking team members and principal investigators to review previously submitted proposals in light of the objectives in the enclosed injury assessment plans. Please make any needed revisions and submit 2 page proposals per the following guidelines.

1. A copy of the format is attached.

2. Proposals should not be more than 2 pages.

3. Proposals have to clearly address damage assessment (not long term research or monitoring); however proposal may include damage assessments not specifically addressed in the Team's plan.

4. All samples taken for histopathological and hydrocarbon analysis will be centralized and follow strict procedures for chain of custody, collection, storage, and processing as outlined by the respective committees. Taxonomic identification will be required for voucher collection of all plants and animals used in the project.

5. Logistic costs (aircraft charters, large vessel costs) do not need to be included in your budget but you need to indicate an estimate of hours/days of use of each. Similarly indicate your needs for a field camp (timeframe, number of people, etc.)

Please call Bill Edwards 907 586-7862 with any questions and to confirm your attendance. We look forward to seeing you next week.

Bill Edwards and Dick LeFebvre
Cochairs

5/12/89

I. Project Title: Reconnaissance to Initiate Coastal Habitat Injury Assessment

II. Justification: Natural resource damage assessment methodologies require that studies focus on areas where injuries to natural resources linked to human use can be demonstrated and quantified. To ensure the study areas selected for injury assessment are representative of the coastal habitats throughout the Exxon Valdez Oil Spill (EVOS) area, a reconnaissance level study is required. Over 700 miles of coastal habitats (including the shallow sub-tidal, inter-tidal and portions of the supra-tidal zones) in three geographic areas (Kodiak-Alaska Peninsula - Cook Inlet-Kenai Peninsula - Prince William Sound) have received light to heavy oil impingement from the EVOS. A comprehensive assessment of injuries to coastal habitat resources and rates of recovery requires consideration of the various coastal morphology types, biotic assemblages, trophic interactions, degree of oiling and persistence of oil. A review of existing information indicates that such an assessment can be accomplished by identifying study areas within five ~~representative~~ coastal habitat types having ~~three~~ degrees of oiling. These study areas and their associated control (non-oiled) areas need to be intensively sampled to determine the type, magnitude and duration of injuries to natural resources at risk (biological, geological and water). The injuries determined in the study areas can then be extended to all coastal habitats affected by the EVOS to derive a total assessment of injuries to coastal habitats.

III. Objectives:

1. Establish a statistically valid strategy to extend site specific information to the entire EVOS area.
2. Identify ~~up to~~ 50 candidate study sites (including control sites) using existing classification and mapping of coastal morphology types (Hayes and Grundlach), EVOS ~~oil impingement~~ maps (DEC, NOAA), and other relevant information.
3. Ground truth candidate study sites and evaluate their suitability for more intensive sampling.
4. Establish ~~20 or~~ more study sites (including control sites) and initiate sampling for injury assessment.

Timing - ASAP

eg. re: OBJ. 1, 2.

IV. Methods:

1. Overlay oil impingement maps on coastal morphology type maps for the area affected by the EVOS. Review all existing information on coastal habitats and study sites including response assessments, baseline studies, ongoing studies, and clean-up activities and assessments.
2. Select appropriate blocks of study sites plus associated control sites in each of five coastal types. ~~(Note: The five coastal types are derived from ten coastal types described and mapped by Hayes and Grundlach with consideration of similarities in morphology, biotic community composition, and oil persistence.)~~ The candidate study sites in each coastal type must be representative of ~~three~~ degrees of oiling: light, moderate, ~~and~~ heavy. The control sites must be from non-oiled areas. ~~To the extent possible, candidate sites will be clustered to reduce logistical costs and to use existing study sites where relevant baseline and/or ongoing data is being collected~~. This will be done in consultation with a biometrician and other principal investigators to determine validity of this approach.
3. Ground truth candidate study sites using interdisciplinary team to photograph and sample shoreline morphology, biotic assemblages, degree of oiling, and overall suitability for more detailed injury assessment study. Include sub-tidal zone (to -20m MLLW), inter-tidal zone, and supra-tidal zone (to upland limit of observeable injury). Collect sediment samples at control sites and determine presence/absence of oil.
4. ~~Select study sites for detailed injury assessment based on 3.~~
5. Establish and define boundaries of study sites. Prepare site descriptions, maps and photographs to describe study sites.

V. Summary of Analyses:

1. Existing information, including mapping.
2. Visual ground truthing.
3. Taxonomic analysis of samples for voucher collection.
4. Hydrocarbon screening of sediment samples to establish validity of controls.

VI. Lead Agency:

State of Alaska (DFG - biological, DNR - geological, DEC - water, oil impingement)

VII. Cooperating Agency: DOI (FWS, NPS)
DOA (FS)
DOC (NOAA, NMFS)
EPA
UA

VIII. Timeframe: 60 days (including 30 field days)

IX. Budget:

	FY 90	FY 91
Line 100 (salaries and benefits) Team (inter-tidal biologist, supra-tidal biologist, 2 diver-biologists, coastal geologist x 3) Includes Biometrician.	200	0

	FY 90	FY 91
Line 200 (Travel and per diem)	25	10
Line 300 (Contractual)		
Recognized shore zone habitat expert	25	
Vessels and helicopters	240	0
Mapping (GIS, aerial photos)	100	
Line 400 (Commodities & expendables) Maps, Photos	15	0
Line 500 (Equipment) Diving Gear Radios Cameras	10	0
TOTAL	625	10

Number of hydrocarbon samples
(presence/absence - 50)

I. Project Title: Comprehensive Injury Assessment in Coastal Habitats

II. Justification: Coastal habitats (from sub- through supra-tidal zones) are used by many aquatic (fish and shellfish) and terrestrial (birds and mammals) creatures of great service to man. These habitats are also used directly by man for recreation, fishing, mining, etc. For these reasons, it is essential to assess the impact of spilled oil on the functioning of coastal habitats. High productivity sites, including mixed gravel-cobble beaches, sheltered headlands, and wetlands (including estuarine tidelands and salt marshes) as well as low productivity sites are targeted for intensive study based on the following criteria:

a) Importance (vital habitat for animals of human concern, high biological productivity, used by humans directly).
b) Sensitivity to the effects of oiling.
c) Areas of oil persistence.
d) Ability to characterize the entire spill area

III. Objectives:
1. Target study on the critical trophic levels and interactions, and assess changes in:
a) Quantity (biomass and productivity/activity of population)
b) Quality (vigor, and utility to other trophic levels)
c) Composition (composition of communities; diversity and standing crop of key species)
2. Establish the response of these parameters to varying degrees of oiling.
3. Estimate the rate of recovery of these habitats and their potential for restoration.

IV. Methods:
1. Establish a project coordination group co-chaired by DNR and the FS and consisting of study participants to maintain coordination and focus of the individual working groups.
2. Establish study plots in blocks containing unoiled control plots and plots with various degrees of oiling. Permanent site selection will be based on the results of the reconnaissance study. Three replicate blocks of plots will be established for each habitat type.
3. Establish transects from -20m depth through the inter-tidal zones to inland (supra-tidal) extent of observable injury.
4. Determine chemical/physical characteristics of sites, including salinity, soil/sediment testure, degree of oiling (% covered, depth, hydrocarbon composition), etc.
5. Determine community composition, cover, and standing crop by trophic level; take voucher samples.
6. Identify key species (dominant producers and food sources) for determination of trophic level quantity, quality, and composition; collect samples for determination of hydrocarbon contamination.
7. Identify injuries caused by oil.

8. Measure annual productivity or activity of key species by trophic level.
9. Determine changes in oil composition and distribution over time.
10. Using a geographic information approach, integrate the impact by habitat type and oil dose over the entire affected zone; and field verify.

V. Analyses: As appropriate for particular method, hydrocarbon analyses will include soil/sediments, plants, invertebrates, and animals as necessary.

VI. Lead Agency: DNR and FS Distribution of subprojects to be determined by the coordinating subcommittee.

VII. Time Frame: Three years.

VIII. Budget:

	FY 90	FY 91	FY 92	FY 93	FY 94
		(thousands of dollars)			
Salary	2,991.00				
Travel	232.00				
Contracts	2,148.00				
Commodities	290.00				
Equipment	464.00				
	6,125.00	5,894.00	5,894.00		

Number of Hydrocarbon Samples: 3,500 per year

Histopathiological Samples: 100 per year.

I. Project Title: Assessment of the injury caused by clean-up techniques on coastal habitats.

II. Justification: Applications of oiled beach clean-up techniques could injure shoreline areas impacted by Exxon Valdez Oil Spill (EVOS). Assessment of secondary injury is an essential component of overall damage assessment.

III. Objectives:

1. To assess the injury and recovery following oil spill clean-up activities on coastal habitats including supra-tidal, inter-tidal and shallow sub-tidal plant and animal community composition, standing crop, and productivity.
2. To assess injury to beach sediments and soils from clean up activities, and recovery of these sites after cleaning.

IV. Methods:

1. Select study sites on light-, medium-, and heavily-oiled shores where different clean-up techniques will be employed based on information from EVOS shoreline committee. Study sites will be coordinated with the coastal habitat proposal wherever possible.
2. Document the percent coverage and depth of penetration of oil on the study sites before and after clean-up.
3. Sample quadrats along established transects, from MLLW through the supra-tidal zone (to upland limit of observable injury) to sample each zone.
4. Photograph each quadrat.
5. Measure and record species composition, percent cover, and standing crop for each quadrat.
6. Sample quadrats just prior to clean-up and for a minimum of three periods after clean-up. The same control beaches will be used as in the coastal habitat proposal wherever possible.

V. Analyses:

1. Community classification and species identification.
2. Taxonomic identification required for voucher collection.
3. Photographic analysis of beach morphology and quadrats.

VI. Lead Agency: State of Alaska - DEC

VII. Cooperating Agencies: ADF&G, FS, DNR, FWS, NPS

VIII. Timeframe: Three years

IX. Budget:

	1989	1990	1991
Salaries	200,000		
Travel	25,000		
Equipment	5,000		
Commodities	25,000		
Contract (boats, aircraft mapping, photos, taxonomic identification)	125,000		
Total	380,000	380,000	380,000

Note: 200 hydrocarbon samples planned per year.

No histopathological samples planned.

I. Project Title: THE IMPACT OF CRUDE OIL SPILL ON TERRESTRIAL AND AQUATIC INSECT POPULATIONS THAT SERVE AS A SOURCE OF FOOD FOR SHORE BIRDS AND PASSERINES

II. Justification:

Insects are good indicators of changes in environmental conditions that impact ecotones such as the supratidal and upper intertidal areas of coastal habitats such as wetlands and estuaries. Terrestrial and aquatic insects comprise a major part of the diet of various species of birds that inhabit these ecotones and are a major part of the coastal food chain. The depletion or reduction of populations of insects could severely affect the development, growth, and survival of shore bird and passerine populations. Oil is toxic to insects and at one time was used to control insect pests of vegetables, trees, shrubs, and biting flies and mosquitoes. Oil dispersed on freshwater streams and throughout the supratidal and upper intertidal habitats could affect the level of insect populations that inhabitat and comprise part of the food chain in those specific ecotones.

Objective

To assess the injury caused by crude oil on levels of terrestrial and aquatic insect populations that are a food source for shore birds and waterfowl and part of the food chain of vertebrates that inhabit the supratidal and intertidal habitats of wetland and estuarine areas.

Methods

veg. & inv, plots?

Insect populations will be sampled and inventoried on two levels of estuarine and wetland vegetation: ground level vegetation of upper intertidal and supratidal areas and grassland of estuarine habitats next to freshwater deltas. Insects will be collected by different methods depending on the type of vegetation. Ground level vegetation will be sampled using a D-Vac vacuum system; shrub and grass vegetation using a sweep net, and upper intertidal areas using sand, gravel, and water sampling methods. All vegetation in a square meter plot will be sampled. Plots will be located along a transect that runes from the intrtidal to supratidal areas and will be located at four different sites on a light, medium, and heavily oiled shoreline, and non-oiled areas.

Insects collected in this study will be identified to species level, counted, and stored in 70 percent ethanol. Species and density data will be recorded for each level of vegetation on each of the five sites.

How do we document recovery est's? Est. of dens. to birds etc?

Recommended Lead Agency

Forest Service, Institute of Northern Forestry, Fairbanks.

Cooperators: University of Alaska, Institute of Arctic Biology; Alaska Department of Fisg and Game

Time Frame: Three Years

Budget

	FY89
Salaries	
Professional	40,000
Technician	30,000
Equipment/Supplies	15,000
Travel	20,000
General Operating Costs	15,000
Total By Fiscal Year	$120,000

Total Project Costs for 3 Years: $360,000

Logistical Needs: Camp - lodging and subsistence, skiff.

Personnel Needs

Research Entomologist	6 months
Biological Technician	12 months

Hydrocarbon Analysis: None
Histopathological Analysis: None

Again — Temporal control vs. Geog. paired, C-3 1 of 4

April 8, 1989

I. ASSESSMENT OF AQUATIC PRODUCTIVITY OF FLORA AND FAUNA COMPONENTS OF THE INTERTIDAL ECOTONE

II. Concern/Justification:

The massive oil in Prince William sound has inundated the shoreline and intertidal zones of the mainland and uninhabited islands of the Chugach National Forest in the Sound. Along with numerous other reaches including Eleanor Island and the Knight Island group, Green Island has been one of the Islands effected. Baseline information is available on the intertidal and terrestial communities and characteristics. The aquatic community is an important component of the island and the Prince William Sound region, profoundly affected by oil pollution. Comprehensive assessment of the effects of the oil spill on freshwater and intertidal systems addressing the physical, chemical, and biological components of the ecosystem is neccessary to assess impacts and will provide a short and long-term data base for environmental studies. A preliminary survey of the region was conducted by personnel from the U.S. Forest Service March 31. A follow-up study was begun May 8 and is continiung to May 12. Permanent plots are established on Eleanor and Green Islands from intertidal to freshwater habitats. A freshwater stream on Green Island has been identified as a potential short and long term site. Cooperation with Alaska Dept. of Fish and Game will enhance the value of primary and secondary producer impacts and water quality.

III. Objectives:

1. To assess the physical chemical effects and fate of crude oil spills on the primary and secondary biological productivity of algae and diatoms of freshwater stream deltas in the supratidal and intertidal marine ecotones.

2. To assess the physical or biotic transfers of oil from the marine surface to intertidal and freshwater systems.

IV. Methods:

Why just here — need to include all the areas.

Locations would encompass impacted and unimpacted areas of Eleanor and Green Islands. Close monitoring of cleaning methods, timing, and effectiveness will provide a basis for comparative studies within the three aquatic study types; intertidal, freshwater streams, and freshwater ponds near the beach zone likely to be effected.

Intertidal Studies

1. A detailed documentation of the time of arrival of oil and the extent to which oil covers different parts of the coastline is necessary in order to draw conclusions from any impact assessment studies. Conduct visual surveys of the perimeter selected areas of Eleanor, Green, and Little Green Islands in order to rate severity of oil impact and select sites with light, medium, and heavy oiling, and no oiling.

2. Identify initial ecosystem consequences of oil/sludge deposition in the intertidal zone in cooperation with the University of Alaska Institute of Marine Sciences and Institute of Arctic Biology. Studies will include mutual utilization of plots. Forest Service would assess possible oil migrations as relates to changes in status and composition of community structure with on site investigation techniques and establish photo plots where appropriate.

3. Determine the transfer and fate of oil, including depth coring of fine and coarse sediments along a transect from shore to tidal reach. Analysis will provide a record of scope, severity, and fate and transport of oil and by-products.

4. Assess the distribution of benthic diatoms over time to determine species composition, community structure and standing crop which can be related to physical and chemical components for analysis of effect scope, severity, and duration.

Freshwater Streams ? = BST? = Not beyond Exhall

1. Determine the immediate and future effects of oil on the chemical composition of water and sediment. Analyze basic water quality parameters, nutrients and metals, hydrocarbon residues and selected by-products will be analyzed as needed in affected areas.

2. Determine standing crop, species composition, and community structure of periphyton in various stream substrates (cobbles, gravels, sands). Periphyton are very responsive to perturbations and represent the primary production in stream systems of Alaska.

3. Determine periphyton growth, coupled with analysis of species and community structure by monitoring introduced artificial substrates (standardized ceramic spheres). Results will indicate primary production over the growing season as relates to impact effects and duration.

4. Determine macroinvertebrate standing crop, species composition, and community structure by multiple (at least 3 per site) Surber samples of the streambed habitat. The macroinvertebrate community, representing the majority of secondary production in Alaskan streams, is sensitive to perturbation and provides a valuable tool in environmental assessment as well as crucial food material for anadromous fish. Riparian litter input can drive community structure and production. Overstory loss or excessive input can have profound effects.

Ponds??

1. Chemical analysis as above.

2. Determine primary productivity of phytoplankton utilizing cell counts per volume, species composition and community structure.

3. Determine secondary production of zooplankton utilizing organism densities, species composition, and community structure.

Visitation of the islands to be examined yielded a series of three pairs of ponds near the shore which would be feasable sampling sites. In each case there is a pond immediately above high tide line which is freshwater but has large driftwood logs, indicating occasional tidal and storm input. Inshore of each of the ponds is another pond apparently uneffected by high tides and storm influx. Comparison of these pairs will be valuable to determine effects of any pollution input to the nearshore pond systems.

V. Summary of analyses to be performed:

Sampling and analysis will determine timing and scope of oil impact on intertidal regions, and duration of impact. Coupled with these sites is a transect to terrestial zones and impacts on freshwater systems near shore (ponds) and streams terminating in the marine habitat. Emphasis will be placed on primary (periphyton) and secondary producers (macroinvertebrates) utilizing species abundance, biomass, composition, and community structure.

VI. Lead Agency:

U.S. Forest Service, Pacific Northwest Research Station, Institute of Northern Forestry.

Cooperating agencies: University of Alaska Institute of Marine Sciences, Institute of Arctic Biology, University of Alaska Museum, Alaska Department of Fish & Game, Alaska Cooperative Fisheries Unit.

Time Frame

3 years

Project Budget

	Annual
Salary:	
Professional:	30,000
Technician	34,000
Graduate Students	32,000
Equipment:	7,500
Supplies:	5,000
Travel:	10,000
Chemical analyses:	15,000
General Operating Costs:	10,000
Total:	143,500

Total for 3 Years: 430,500

Added logistical support

On-shore camp:	8,000

Float plane or boat charter: 15,000

Personnel requirements

	Annual
Aquatic biologist	3 months
Biological technicians (2)	12 months
Graduate Student (2)	12 months

Hydrocarbon analyses will depend on extent of oiling of freshwater habitats. Estimated samples per year would be 25-50.

May 22, 1989

I. Project Title: Assessment of Oil on Activity of Mycorrhizae on Roots of Vegetation Vital as Habitat for Coastal Shorebirds, Waterfowl, Mink, and River Otters

II. Justification: Oil deposition on soil organic horizons may seriously affect the formation, longevity, and function of normal mycorrhizal associations, since fibrous root systems are typically concentrated within the surface layer of decomposed organic matter. Mycorrhizal fungi perform a critical role in the nutrition of most plant species by enhancing root uptake of those elements that do not occur in the soil in readily available forms. The role of mycorrhizae can be particularly important on sites with young, nutrient-poor soils that frequently occur near tide zones. Reductions in phosphate ion uptake, for example, as a result of impaired mycorrhizal function, might result in both reduced biomass production and reduced browse quality of affected vegetation. Restorative measures would be most effective if the mechanisms of plant injury were more completely understood.

III. Objectives:

1) Determine the extent to which the standing crop of mycorrhizae on a selected indicator plant species has been reduced by impact of light, moderate, and heavy oil deposition in the supra-tidal zone compared to control plots.

2) Determine whether there have been qualitative and quantitative changes in mycorrhizal vigor in the standing crop of mycorrhizae as a result of oil deposition.

3) Determine the extent to which the nutrient content of foliage (and fruit) is reduced in relation to oil deposition effects on mycorrhizae.

IV. Methods:

1) Mycorrhizal studies will be performed in cooperation with proposed studies on the soil microbiota, and plant nutrition in order to provide a more complete understanding of effects of oil deposition on plant health.

2) For each combination of coastal habitat type (2) and level of oiling (none, light, moderate, heavy), three replicate plots (24 plots total) will be selected from the study sites selected by the Comprehensive Injury Assessment.

3) A soil core (5 cm diameter, 30 cm length) and 10 g foliage sample will be collected from each of ten one-meter-square subplots per plot that represent a specific micro-habitat for the selected plant species.

V. Analyses:

What will this tell us about mech-?

1) Number and biomass of total fine roots, and mycorrhizal fine roots, using standard laboratory methods of mycorrhizal assay (240 cores/year).

2) Macronutrient composition of foliage (240 samples/year on contract).

3) Standard statistical methods will be used to assess significance of effects due to oiling compared to control plots.

VI. Lead Agency: Forest Service (Institute of Northern Forestry).

VII. Cooperators: University of Alaska, Agricultural & Forestry Experiment Station.

VIII. Time Frame: 3 years.

IX. Budget:

	1989
Salary	50,000
Travel	10,000
Contracts	5,000
Supplies	5,000
Equipment	5,000
Operations	10,000
TOTAL	85,000

Total for three years: 255,000

Number of hydrocarbon samples: 240 per year.

Number of tissue samples on contract: 240 per year.

Logistical Needs: Camp - lodging and subsistence, skiff, freezer, freeze dryer.

I. PROJECT TITLE: Effects of the Oil Spill on Microbial Biomass and Organic Matter Decomposition in Shoreline and Estuarine Ecotones

II. JUSTIFICATION: Microorganisms are responsible for the decomposition of organic matter and for key aspects of the cycling of some nutrients, especially C, N, and P. Microorganisms control the rate of cycling of most plant nutrients in soil and are thus important in the maintenance of stability of plant communities. Shoreline and estuarine ecotones form the interface between terrestrial and marine ecosystems and are used by both land and sea animals. These zones can be major sites of exchange of nutrients between terrestrial and marine ecosystems. Terrestrial oil spills in cold environments have been shown to have long lasting detrimental effects on plant and microbial communities (for example, we found found in interior Alaska that oil and its effects persisted for at least 10 years in a spruce forest). Crude will be trapped in some shoreline and estuarine habitats and is likely to persist there. Also, some oil clean-up procedures may have major detrimental and possibly long-lasting effects on shoreline plant and microbial communities. In order to fully assess the total impact of the Exxon Valdez oil spill on the coastal Alaska ecosystem, information on its effects on the soil microbial biomass and activity in the shoreline and estuarine ecotones is needed.

III. OBJECTIVES: 1) Assess short-term (first growing season) and longer-term impacts of crude oil or oil clean-up procedures on soil microbial biomass, organic matter decomposition rates, and net N and P mineralization rates, in wetland habitats.

2) Determine changes over time in the content of plant available and total C, N, and P in oil-affected soil along and near the shoreline.

IV. METHODS: Permanent, replicated plots will be established in shoreline areas with low and high oil impact and in nearby unimpacted control areas. In order to make data coordination simpler and to avoid duplication of sample analyses, we will, when appropriate, use the same plots as other researchers studying the same habitats. Most of the research will be concentrated in grassy wetlands near the high water line, but some work will be extended up into the coastal shrub thickets if visible impact is found there. Also, sites in which major clean-up activity has occurred will be sampled. Soil samples will be collected monthly during the snow-free season. Wooden spatulas and fine-mesh nylon bags containing dead plant litter or filter paper will be placed in the soil and retrieved periodically to determine in situ decomposition rates. The buried plastic

bag technique will be used to measure in situ net N and P mineralization rates. We plan to coordinate this study with other coastal habitat studies, especially those dealing with plants and mycorrhizae and with oil clean-up impacts.

V. ANALYSES SUMMARY: Microbial biomass, total and extractable C, N, and P, and hydrocarbons.

VI. LEAD AGENCY: U.S. Forest Service, Institute of Northern Forestry

VII. COOPERATING AGENCY: Agricultural and Forestry Experiment Station, University of Alaska Fairbanks

VIII. TIME FRAME: Three years

IX. BUDGET:

	Per Fiscal Year
Salaries	
Soil scientist	$65,000
Technician	38,000
Travel (Fbks/Valdez/Fbks, per diem)	15,000
Supplies	20,000
Total costs per fiscal year	138,000
Project costs for three years	414,000

Number of hydrocarbon samples per year: 300
Number of histopathological samples per year: none

Logistical Needs: Camp - lodging and subsistence, skiffs, freezer.

I. ASSESSMENT OF EFFECTS OF THE EXXON VALDEZ OIL SPILL ON INTERTIDAL AND SHORELINE ECOSYSTEMS ON GREEN ISLAND RESEARCH NATURAL AREA

II. Concern/Justification: Is there any?

The islands of outer Prince William Sound, local centers of marine productivity and diversity, were some of the first shorelines to be inundated by the Exxon Valdez oil spill. The waters of the outer Sound receive less freshwater input and sediment from rivers and melting glaciers than the inner Sound, serve as overwintering areas for marine birds, are important habitat for marine mammals and fishes, and are an important recreational, scientific, and educational resource. Linkages between forests, beach fringe ecosystems, and the marine ecosystem are significant and numerous. Direct observations of wildlife mortality around Green Island indicate that the early toll of otters and sea birds has been heavy. Intertidal species particularly at risk in the next stage include barnacles, surfgrass, limpets, high intertidal crevice fauna, and mussels; assessments of the effects of oil on these organisms is needed. The effects of oil on terrestrial beach fringe vegetation has not been defined adequately and may include seepage into the rooting zone, indirect effects through animal mortality, and physical or biotic transport up the beach profile. A portion of Green Island and all of Little Green Island Island were approved for use as a Research Natural Area (RNA) in the Chugach National Forest land use plan. Baseline data were collected in the RNA on species composition of intertidal and terrestrial flora and fauna in 1986. Five intertidal transects and two forest reference monitoring plots were established, photo locations were established, and specimens collected and archived in the University of Alaska Museum and the Forest Service Herbarium. Several factors make Green Island a particularly suitable location to assess effects of the oil spill:

1. The previous and continuing commitment to long-term monitoring through the RNA designation,
2. The diversity of oiling conditions on Green Island (light sheen to very heavy oil cover),
3. The existence of pre-spill data from the 1986 RNA site documentation, and a study of recovery from surface uplift after the 1964 great earthquake
4. A focus on assessments of damage to a number of resources on Green Island early in the spill,
5. Conduct of beach clean-up operations (another damage risk factor) on Green Island and,
6. The presence of a diversity of habitats on Green Island.

III. Objectives:

1. To assess the effects of oil on the species diversity in intertidal communities and record the patterns of mortality by taxonomic group associated with different levels of oiling.

2. To assess the effects of oil on the composition and structure of lower beach zone vascular vegetation.

IV. Methods:

Five intertidal transects on Green and Little Green Island that were surveyed in 1986 will be resurveyed for species presence/absence and total species richness. Additional transects in heavily oiled rocky intertidal and surfgrass habitats will be surveyed. Size and abundance measures of selected intertidal taxa will be taken on permanently marked locations. Patterns of mortality by taxon will be noted. A reference grid system will be established along the beach perimeter and permanently marked with metal posts at 50 m intervals. At least 1 km of beach perimeter will be selected in each of 3 zones of oil accumulation (heavy, moderate, and light sheen or none). Areas affected by beach clean-up operations will be included. Vegetation community boundaries and oil affected zones (mortality) will be mapped. Coordinate position, size, and condition of beach logs and woody vegetation will be measured and mapped.

V. Summary of analyses to be performed:

Voucher specimens will be identified and archived. Permanent photo monitoring locations will be established. A coordinate reference system will be established and marked along the beach. Structural characteristics of shrub and other vegetation communities will be calculated. Patterns of herbaceous vegetation mortality will be mapped. Abundance/cover data of intertidal and beach organisms will be calculated. Hydrocarbon analyses will be performed at key locations.

VI. Lead Agency:

USDA Forest Service, Pacific Northwest Research Station, Institute of Northern Forestry and Juneau Forestry Sciences Laboratory.

VII. Cooperating Agency

University of Alaska Museum and Agricultural and Forestry Experiment Station.

VIII. Time Frame

3 years

IX. Budget

	Annual
Salary:	
Professional	$35,000
Technician	45,000
Equipment:	9,000
Supplies:	6,000
Travel:	20,000
Services:	10,000
Total	135,000

Total for 3 Years : 405,000

Added Logistical Support

Maximum of 7 people in field (boat or shore camp) for 2 work weeks,
3 technicians on site for 1 month continuously, plus misc. site work,
Total of 170 work days in field.

Transportation from Valdez to Green Island and return for 7 people during main site documentation visit, 2 additional round trips for 3 technicians, plus short-term site work for 3 investigators,
Total of 24 trips Valdez-Green Island (boat or air) plus occasional aerial recon.

Personnel requirements

	Annual
Invertebrate biologist	3 months
Plant ecologists (2)	3 months
Biological technicians (3)	4 months
Graduate student	12 months

5 soil/plant hydrocarbon samples per year

FAX - 563-1853
Contact - 762-2295

COMPREHENSIVE:

1. Marine, Rocky Intertidal (FS) Sharman
2. Terrest/Acquatic Insects (FS) Warner
3. Fresh water acquatic productivity (FS) Hilgert
4. Mycorrhizae of Shoreline shrubs Reynolds (FS)
5. Soil Microbial biomass + decomposition (FS) Barlow
6. Green Island effects on Shoreline Ecosystems (FS/Judy)
7. Injury Assessment in Coastal Wetland Habitats (UA) McClean et.al (5)
8

RECONNAISSANCE:

1. Supra + Intertidal Tidal Plant Comm. FWS (Talbot)
2. Recon Coastal Archeus FWS (Talbot)

Comph. (continued)

8. Comprehensive Intertidal Plants + ANIMALS (UA) Highsmith et al.

9. Subtidal invertebrates + plants (UA) Jewett + Stekoll.

Reconn page 2 5/23

3 Intertidal / Baseline Mussels + SEDIments (NOAA) Karinen

4. Reconnaissance (UA) Highsmith et al

PM (P-1) 5/23

FAX - 563-1853

CONTACT - 762-2295

C 8 Intertidal

C-1 - limited proposal / limited / need a AREA / expansive) limited VALUES for injury.

C-6 - Site specific to GREEN Island
Comparison w/ Baseline
DATA

C-3

Supra — Intertidal — Subtidal

Supra → Wetland / Nonwetland

Nonwetland — Extensive area
- Not much impact observed
- USE Recon to decide if further work justified

RECON ✕
Expand wetlands
Seperate Pkg

General Project Schedule

Reconnaissance June 20th Start

(Assumes logistics can be arranged
Vessels, Aircraft, Camps Finish July 6

Phase I Maps & Descriptive Data
Underway but needs coordination
& evaluation of what have now

Phase II - General Reconn Finish: Aug 1

Phase III - Final Selection Finish: Sept 15
Ground plots etc.
Actual site descriptions

STRATEGY PHASE II + III

Recon - USE 3 GROUPS - Work together in first WEEK SO CALIBRATE GROUPS - THEN BREAK INTO 3 ZONE TEAMS

PHASE III WILL GATHER 1st YEAR DATA FOR COMPREHENSIVE STUDIES

USE HELICOPTERS EXTENSIVELY FOR THIS PROJECT

P.I.S NEED MORE MOBILITY TO Become familiar with whole area.

Cleanup project (Still? Damage or Response)

- NEED TO ASSURE HAVE GOOD INFO FROM OBSERVERS TO DOCUMENT FOR STATISTICAL REPLICATIONS

- DO NOT WANT TO ASSUME CLEANUP RESPONSIBILITIES.
- FOLD WITH COMP. SITES to USE SAME METHODS, etc.
- MAY GENERATE ADDITIONAL DATA FROM Comp. Project from EXXON CLEAN UP

- USDA (FS) LEAD AGENCY

  COOPERATORS: FWS DF&G
  NPS
  DEC
  DNR
  UA

Al
Diane
Dan
Gene
Cathy
Carl
Gary
Lin
Val
Joe
Tom
Ken
Kent
Marcia
Brian
Me

Management Scheme

Coastal Habitats Injury Project

Draft 5/19/89 wge

Management of the coastal habitat injury assessment projects in a wide variety of locations is expected to be a complex task. Provision must be made for coordination of scientific standards, periodic progress reports, correlation and sharing of results as well as providing logistical support to field operations. The Alaska Department of Natural Resources and the USDA Forest Service are assigned lead agency responsibility for these activities. Other agencies and individuals participate in specific studies.

OVERALL PROJECT MANAGEMENT

CHAIR - DNR & FS

MEMBERS - 3 GEOGRAPHIC ZONE COORDINATORS (DNR & MAJOR IMPACTED FEDERAL AGENCY)
- XX SITE LEADERS (MAJOR SITE INVESTIGATORS)

FUNCTIONS - scientific and legal standards - sole by
- periodic progress reports
- correlation of results
- repository for voucher collection
- program management
- budget management
- logistics oversight

PERIODIC MEETINGS - FALL AND SPRING

ZONE MANAGEMENT

CHAIR - DNR & MAJOR IMPACTED FEDERAL AGENCY

MEMBERS - LOGISTICS COORDINATOR (MAJOR IMPACTED AGENCY)
- XX SITE LEADERS (MAJOR SITE INVESTIGATORS)

FUNCTIONS - provide logistical support
- periodic progress reports
- correlation of results
- prepare and administer contracts
- program management
- budget management

PERIODIC MEETINGS - FALL AND SPRING

SITE MANAGEMENT

SITE MANAGER (MAJOR IMPACTED AGENCY - provides field logistics and support)

MEMBERS - XX SITE INVESTIGATORS

FUNCTIONS - logistical support
- legal standards
- periodic progress reports
- correlation of results
- repository for voucher collection
- program management
- budget management

PERIODIC MEETINGS - FALL AND SPRING

25 May

COASTAL HABITAT DAMAGE ASSESSMENT

I. Project Title: Reconnaissance Survey of Supratidal and Intertidal Plant Communities in Coastal South-Central Alaska to Initiate Habitat Injury Assessment.

II. Justification: Classification provides a framework for comprehensive and systematic categorization of resources for mapping and inventory (Driscoll 1980). Classification of the vegetation would aid in identification of candidate study sites, provide a means to ensure selected sites are representative of the coastal habitats throughout the oil spill area, and determine the extent of observable injury. Specifically the two basic purposes served by vegetation classification are to provide (1) stratification for increased sampling efficiency and improved cost-effectiveness of sampling strategies and (2) location-specific data which allow alternatives for selecting the most suitable areas.

Lichens and bryophytes have human value as pollution monitors. They are extremely sensitive pollution indicators because they lack protective cuticle found in flowering plants. Oil pollution effects may vary according to oil type, degree of weathering, amount of oil, time of year, species and plant age (Baker 1971). In addition to the potential damage caused by direct contact with the oily spray, there is a volatile component to oil that may be toxic; however, there are no published studies reporting the toxic effect of the volatile component on lichens or bryophytes.

III. Objectives: The goal of this study is to determine the extent of observable injury, gather location-specific data for each community type, and determine if more detailed studies are needed. The specific objectives of the reconnaissance survey are to: (1) record the floristic composition and structure of the vegetation to determine the variety of plant communities present in the spill area; (2) classify the vegetation on an ecosystem basis; (3) document species zonation in the intertidal and supratidal zone and correlate the zonation with gradients in the environment, including soil texture (percent sand, silt and clay), salinity, pH, organic matter, total hydrocarbons (oil and grease), soil nutrients (Ca++, Mg+, K+ and Na+) and distance from mean high tide: (4) stratify the location-specific sites on a small scale map (scale=1:500,000) into vegetation types; (5) describe and classify coastal bryophyte and lichen communities from the sites selected to represent the spectrum of environmental variation within the area affected; and (6) document species abundance of lichens and bryophytes on coastal rocks and selected tree and shrub species and explore the data through phytosociological analysis to determine if patterns of similarity are related to levels of beach oiling.

IV. Methods:

1. Sampling sites representing the spectrum of environmental variation will be selected in the project "Reconnaissance to Initiate Coastal Habitat Injury Assessment."
2. Inventory the vegetation units on a local and regional scale using the Braun-Blanquet reconnaissance method.
3. Collect soil samples from each sample stand (releve) to measure soil nutrients, pH, salinity, total organic matter, texture, total hydrocarbons.
4. Classify and analyze the plant communities and relate them to environmental factors using a number of multivariate techniques including those of Ter Braak (1988, CANOCO), Orloci (1975) and Hill (1979, TWINSPAN and DECORANA).
5. Record site variables for lichens and bryophytes such as shoreline type, rock type, habitat substrate, tree species, tree dbh, tree age, plant community type, distance form oiled beach, degree of oiling, visible damage to lichens and bryophytes.

V. Summary of Analysis:

1. Determination of species (taxonomy)
2. Computer classification of plant communities and multivariate analysis
3. Soils analysis (texture, hydrocarbons, organic matter, nutrients, salinity, pH)

VI. Lead Agency:

DOI; Principal Investigator: Stephen S. Talbot (FWS)

VII. Cooperating Agency:

DOI (NPS); DOA(FS); DOC (NOAA, NMFS); EPA; State of Alaska (UA, DFG, DNR, DEC).

VIII. Time Frame:

1.5 years

IX. Budget:

	FY89	FY90
Salary	33.6	52.0
Travel and per diem	6.0	0.5
Contract		
Helicopter	50.0	--
Soils analysis	21.0	--
Plant identification	7.5	--
Miscellaneous	--	3.0
Commodities		
Computer and Software	8.0	--
Maps	0.5	
Equipment	5.0	
Expendables	3.0	1.0
TOTAL	134.6	56.5

Number of hydrocarbon samples (ppm--405)

Exp. To incl. veg. types by oil/habitat/Region R3

EXXON VALDEZ Oil Spill Fisheries Impact Assessment Program

TITLE: Intertidal baseline of hydrocarbons in mussels and sediment.

JUSTIFICATION: Mussels, located in intertidal and subtidal habitats are a major source of carbon and energy for several species of commercial fish and shellfish and sea otters in Prince William Sound (PWS) and the Gulf of Alaska, and they contribute larvae to the plankton; some molluscs support a low volume subsistence and personal use fisheries. Mussels are a widely used indicator species for oil pollution because they integrate oil concentrations in the water column by accumulating and retaining hydrocarbons in soft tissues. Other intertidal mollusc and crustacean species may be sampled to reflect damage assessment and recovery from the hydrocarbon contamination.

OBJECTIVES: 1. Measure the hydrocarbon concentration in mussels and other species, and compare pre- and post- spill contamination levels and measure cover using photographic quadrates;
2. Determine the level of oil contamination in sediments, and compare pre- and post- hydrocarbon contamination levels.

METHODS: Ten intertidal sites in PWS were sampled for sediments and mussels annually from 1977 to 1981 to establish a baseline against which future changes in hydrocarbon concentrations could be measured. These sites (and several additional ones established) were resampled in March 1989 immediately before several of them were impacted by the EXXON VALDEZ oil spill. Four sites on the Kenai Peninsula have also been established. These sites will be re-sampled several times in 1989 and 1990. Because of documented persistence of hydrocarbons in sediments in temperate and subarctic intertidal and subtidal areas, sampling should continue for several years to follow depuration and recovery.

Sites are accessible at low tides only and are generally at the 0 - 1.5 ft. level. Mussels and sediments are collected (composite, triplicate samples) along 30m horizontal transects. One-sixteenth m. quadrates are photographed every 2 or 4 m along each transect line for estimating cover.

SUMMARY OF ANALYSES TO BE PERFORMED: Hydrocarbon analyses on mussels and sediments; cover as shown by photographic quadrates.

LEAD AGENCY: National Marine Fisheries Service-Karinen/Babcock

COOPERATING AGENCIES: None, except as needed for coordination.

TIME FRAME: Three years; ideally, should be followed for many years.

BUDGET:

	Pers.	Trav.	Cont.	Supp.	Equip.	TOTAL
1989	34.0	12	65	8	9	128
1990						90
1991						90

LOGISTIC SUPPORT (included in Cont., above):
1989 Helicopter support: 40 days
1990 Vessel Support: Number of Days: 40 or
Helicopter support: 40 days

Hydrocarbon Samples: 1989 20x3x2x5 = 600
1990 20x3x2x4 = 480
1991 20x3x2x2 = 240

Note: Not all samples need be analyzed; not GS-MS full scan need be done on all samples analyzed.

Histopathological Samples: None anticipated SITE LOCATIONS

— [illegible] — temporal vs. geog; paired control —

SITES

Intertidal baseline of hydrocarbons in mussels and sediment.

Prince William Sound

*Original Baseline

<u>Port Valdez</u>*
1. Dayville Flats
2. Mineral Creek
3. Gold Creek
4. Sawmill Creek

1?

<u>Unakwik Inlet</u>*
5. Siwash Bay

<u>Bligh Island</u>*
6. West Bay

<u>Naked Island</u>*
7. Outside Bay

<u>Perry Island</u>
8. South Bay

<u>Knight Island</u>
9. Bay of Isles, South Arm
10. Drier Bay, Barnes Cove

<u>Evans Island</u>
11. Crab Bay

<u>Montague Island</u>*
12. Rocky Bay

<u>Hinchinbrook Island</u>*
13. Constantine Harbor

<u>Port Gravina</u>*
14. Olsen Bay

<u>Latouche Island</u>
15. Sleepy Bay

<u>Elrington Island</u>
16. Elrington Passage

Gulf of Alaska

<u>Kenai Peninsula</u>

17. Quicksand Cove, Aialik Bay
18. Verdant Cove (oiled), Aialik Bay
19. Harris Bay
20. Petrof Point, Nuka Passage

++
PROPOSED ADDITIONAL SITE LOCATIONS (10 - 15 sites to be chosen)
(Charts in Alaska Intertidal Survey Atlas - Sears and Zimmerman)

Eastern Gulf of Alaska

<u>Hinchinbrook Island</u>
5. Boswell Bay (North entrance) Chart EG 24

<u>Montague Island</u>
16. Patton Bay (Chart EG 31)
17. MacLeod Harbor (Chart EG 32)

<u>KENAI PENINSULA</u>
18. Puget Bay (Chart EG 34)
19. Johnstone Bay (Chart EG 35)

20. Whidbey Bay (Chart EG 35)
21. Cape Manesfield (Blying Sound) Chart EG 36)
22. Day Harbor (Chart EG 37)
23. Quicksand Cove (Chart EG 39)
24. Harris Bay (Chart EG 40)
25. Nuka Passage (Chart EG 45)
26. Gore Point (Chart EG 46)

COOK INLET
27. McNeil Cove (Kamishak Bay) Chart CI 35

KODIAK GROUP
28. Ushagai Island (Chart K 1)
29. Little Raspberry Island (Chart K 12)
30. Halibut Bay (Chart K 28)
31. Cape Chiniak (Chart K 23)
32. Cape Alitak (Alitak Lagoon) Chart K 47)

Alaska Peninsula
33. Sukoi Bay (Chart AP 1)
34. Kukak Bay (Chart AP 5)
35. Mud Bay (Chart AP 25)
36. Flying Eagle Harbor (Chart AP 42)
37. Ikatan Bay (Chart AP 77)

May 25

I. Project Title: Injury Assessment in Coastal Wetland Habitats

II. Justification:

Coastal and estuarine wetlands (near-shore communities on at least periodically saturated soils, and dominated by hydrophyllic graminoid vegetation) are highly productive coastal habitats in the area affected by EVOS. These wetlands are critical habitats for many birds and mammals, and are used directly by humans as well. Wetlands are also the terrestrial habitat type most sensitive to oil, and are the areas where oil is most persistent. For these reasons, they have been designated as a high priority for intensive study.

III. Objectives:

1. Target study on the primary producers and detritivores (which drive both the utility of the habitat to animals, and its recovery from damage); assess changes in quantity, quality, and composition of these trophic levels, as the base of wetland food chains. Establish use of coastal wetland habitat and vegetation by herbivores.

2. Establish the responses of coastal wetlands to varying intensity of oiling.

3. Estimate the overall damage to coastal wetlands and their use by humans as a result of EVOS.

4. Estimate the rate of recovery of wetland habitats and their potential for restoration.

IV. Methods:

1. Use study sites selected by the reconnaissance study in each of the three geographic sectors affected by EVOS (number of sites = 3 geographic regions x 3 treatments [control, light, and moderate to heavy oiling] x 3 replicates = 27).

2. At each site, establish transects across the inter- and supratidal zones dominated by wetland vascular vegetation, to the limit of observable injury.

3. Determine chemical/physical characteristics of the sites, including soil texture, organic matter content, etc.; determine degree of oiling, changes in hydro-carbon composition and distribution over time.

4. Determine plant community composition; identify key plant species (dominant producers and food sources for important herbivore species); collect samples for hydrocarbon analysis; take voucher samples for documentation; establish permanent reference quadrats to determine rate of recovery.

5. Measure rate of photosynthesis and annual productivity of key plant species and activity of the detritivores.

6. Measure quality of annual production as food for herbivores using inorganic and organic nutrient analysis, in vitro dry matter digestability, and bioassay procedures.

7. In coordination with bird and mammal study groups, record use of coastal wetlands by resident and migratory herbivores.

8. Identify injuries caused by oil by comparing unoiled control plots with plots receiving light and moderate to heavy oil deposition.

9. Using a geographical information approach, integrate the impacts of varying oil dose on wetland habitats across the entire affected zone; field verify.

V. Analyses:

Primary Producers:

Quantity - Standing crop from clip quadrats; rate of photosynthesis, and annual production.

Quality - Organic and inorganic nutrient content; hydrocarbon contamination; digestibility by herbivores.

Composition - Species distribution in the plant community from clip quadrats and permanent reference quadrats.

Detritivores:

Quantity, quality, and composition will be integrated by measuring the rate of decomposition of organic matter and mineralization of nutrients.

Hydrocarbons: ~360/year

Histopathology: none

VI. Lead Agency: University of Alaska, Institute of Arctic Biology

VII. Cooperating agencies:

VIII. Time Frame: (Note: Fiscal year = 1 July - 30 June)

Fy 89: Proposal preparation; coastal habitat working group coordinating meetings; preparation for reconnaissance study.

FY 90: Reconnaissance study - summer '89
Analysis of samples
Initiate '90 field season

FY 91: Complete '90 field season
Analysis of samples
Initiate '91 field season

FY 92: Complete '91 field season
Analysis of samples and preparation of final report to trustees.

IX. Budget:

Direct Costs:

	FY 89	FY 90	FY 91	FY 92
Salaries and Benefits	15	333	419	363
Travel	3	18	18	18
Equipment	0	48	0	0
Expendables	2	15	15	15
Contracts	0	35	34	35
TOTAL	20	448	486	431

Administrative Cost / Overhead: To be negotiated.

1.4 mm for 3 rows

309K Equip Cost

400K (+ $100, replacement)

Personnel stuff @ 100/day Personnel $1.1 million

Transport

+ Cleanup Project

AC/Boats 1.2 million

.1 million

2.4 million

4 equip

$ 2.4 million

2.8 million

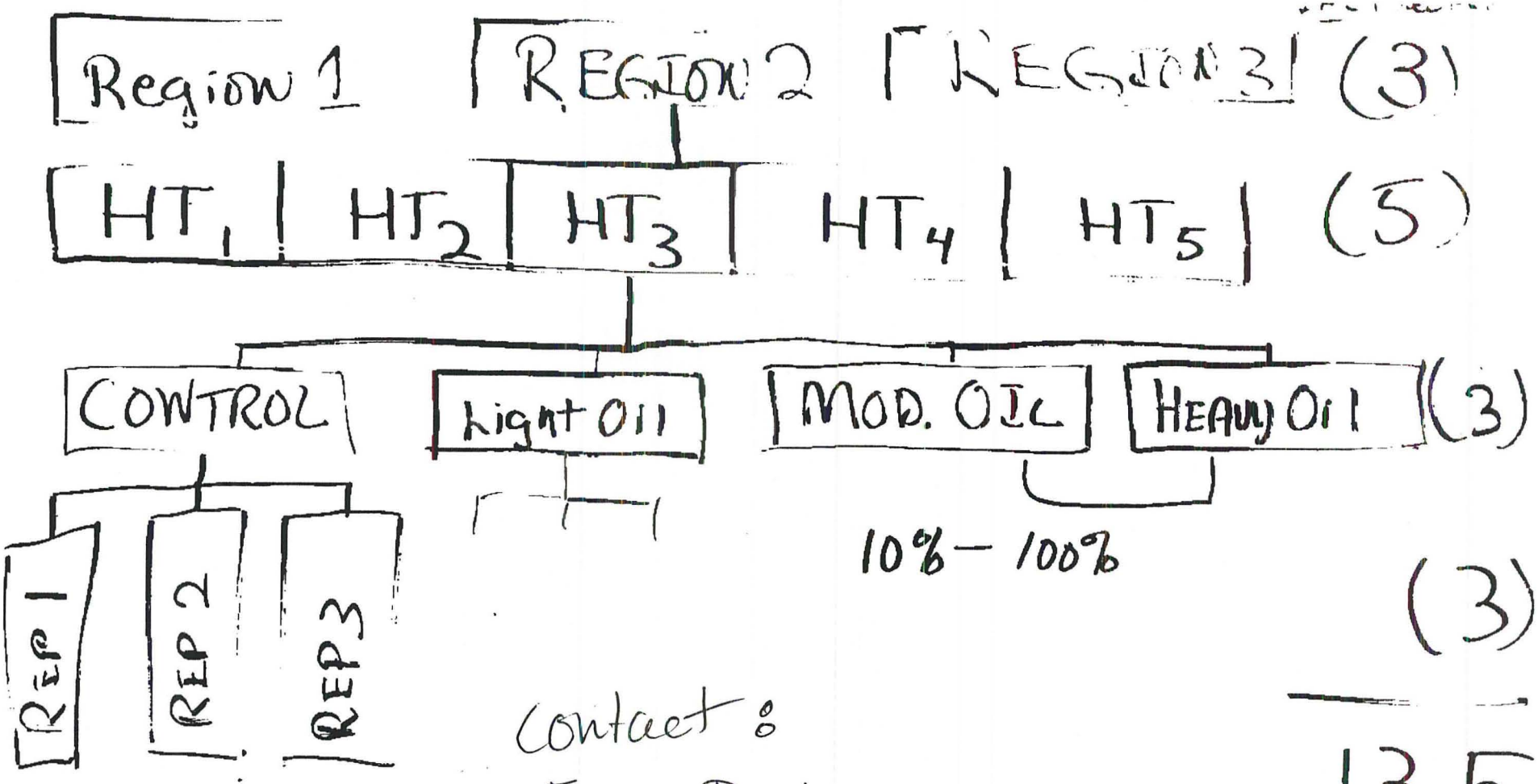
5/24

Method for Choosing Study Sites (3 REGIONS + 5 Habitat Types)

1. Using ESI maps of Habitat Types, make up 15 lists of potential study sites.
2. Assign each beach a number. (1-x for each list). Generate 15 lists of random #s (between 1-x). Order the initial list based on random #s
3. Go to DEC maps of oiling and tally the level of oiling of the beaches in the initial list. As oil treatment categories fill up, begin rejecting beaches from initial list; continue 'til all categories filled. This has generated the secondary list.
4. Ground truth secondary list. If beaches inaccessible, or misclassified, throw them out. Go back to choosing from initial random list.

3A. Analyse & photo interpret selected beaches } beach = contiguous segment of coast assigned to habitat type

5/24.



Contact:
EARL Becker
ADF&G
344-0541

p 5 5/24 (am)

Cleanup Timeframe: Info: Phase June 1
FIELD: July 1

* Note USE Geo Region instead of ZONES

METHODS NEED WORK

COORDINATE W/ RECONN GROUP

COORDINATE W/ COMP GROUP

USING SAME METHODS + SITES + ANALYSIS Methods

HOW MANY DIFFERENT TECHNIQUES TO STUDY?

#6 - WORK WITH PRECLEANUP ASSESSMENT PEOPLE TO GET ESSENTIAL DATA

- ADD to -20 m to samples
  PLAN ON DIVER BIOLOGISTS

Alaska Department of Environmental Conservation (ADEC)
Rating System

Beach impacts are evaluated solely on the amount of area covered or penetrated by oil between the mean high tide and mean low tide lines. The ADEC rating system is as follows:

Amount of Oil

Less than 1 m wide band on beach = very light
1 to 3 m wide band = light
3 to 6 m wide band = moderate
Over 6 m wide band = heavy

OR

Percent of Total Beach Area Covered or Penetrated

Less than 1% coverage/penetration = very light
1 to 10% coverage/penetration = light
10 to 50% coverage/penetration = moderate
More than 50% coverage = heavy

CALL BILL EDW.
→ STATE ASSUMPTIONS ABOUT PRIORITY LEVELS –

EXXON VALDEZ OIL SPILL DAMAGE ASSESSMENT PROJECT

COASTAL HABITATS COMMITTEE REPORT

(LANDS, PLANTS, INTERTIDAL)
May 12, 1989

SUMMARY OF COMMITTEE STRATEGY

Goals: Assess the damage to public resources important to human use in the shallow subtidal, intertidal, and supratidal zones in the area affected by the Exxon Valdez oil spill.

Conduct damage assessment on coastal habitats and associated resources efficiently.

Provide information on changes in food chains and habitats that will contribute to the assessment of damages to uses, fish, and wildlife.

1. Define scope of studies.

   Other groups are focusing on specific physical, chemical, or biological components of the coastal ecosystems. The Coastal Habitats Committee focused on ecosystem dynamics in the shallow subtidal, intertidal, and supratidal zones. This committee also addressed property values other than those associated with recreation.

   The committee's approach will provide information on changes in flora that are directly translatable into losses to human use. It will also provide information on food chain impacts that are essential for estimating the losses identified through other studies on uses, terrestrial mammals, marine mammals, birds, and fish.

2. Adopt classification of coastal habitat types.

   A consistent set of coastal types will facilitate coordination among coastal habitat studies and between coastal habitat studies and other animal and human use studies. The committee adopted a modified version of the Hayes and Gundlach classification.

3. Review mechanisms by which oil can damage coastal habitats.

   Understanding mechanisms is essential to tying changes in coastal habitats to oil spill and clean-up impacts. The committee listed potential damage mechanisms for each trophic level within the shallow subtidal, intertidal, and supratidal zones. (See Table 1.)

4. Establish study priorities.

   To make the assessment cost-effective, studies should focus on those habitat types most important to human use and most susceptible to oil impacts. The committee rated each habitat for study priority. (See Table 2.)

5. Identify key species and characteristics for each trophic level.

   Preliminary identification of key species and characteristics will help focus research proposals for detailed studies and link changes in habitats to loss of human use. The committee listed key species and important functions of each trophic level for each

moderate or high priority habitat type. (See Table 2.)

6. Design study proposals.

The committee identified four studies to meet the goals. These studies incorporate the priorities for assessment, the emphasis on an ecosystem approach, and the requirement that damages be linked to oil impacts and to loss in human use. Studies measure changes in the quantity, quality, and composition of communities in each of the targeted habitats and changes in land values. The study proposals are attached. They are:

- -- Reconnaissance of the Shore Zone to Initiate Coastal Habitat Injury Assessment
- -- Comprehensive Injury Assessment in Coastal Habitats
- -- Assessment by the Injury Caused by Clean-up Techniques on Intertidal and Subtidal Plant and Animal Communities
- -- Effects of Oil Spill on Land Values.

SCOPE OF STUDIES

The Coastal Habitats Committee addressed lands, waters, and organisms from a depth of 20m below mean lower low water, through the intertidal zone, to the extent of observable damage above mean high water.

Studies proposed by the Coastal Habitats Committee focus on ecosystems, habitats, and food chains rather than populations. Assessment of insect, marine invertebrate, and small mammal populations are included in the study proposals.

Populations of fish, large terrestrial mammals, marine mammals, and birds were not addressed by the Coastal Habitats Committee. These studies are covered by their respective committees. Studies proposed by the Coastal Habitats Committee extend to the point at which organisms are consumed by fish, large mammals, or birds.

Water and sediment sampling programs below mean lower low water (MLLW) will be designed by the Air and Water Committee. Sampling needed above MLLW will be identified in the Coastal Habitats Committee study proposals.

Studies assess damages from the oil spill and from oil clean-up activities.

Studies include estimates of the potential for site recovery and restoration.

Studies address the entire extent of the spill area, including Prince William Sound, the Kenai Peninsula, lower Cook Inlet, Kodiak Island, and the Alaska Peninsula. If oil reaches into other areas such as Bristol Bay or the Aleutian Islands, these areas should be included in the study proposals.

The Coastal Habitats Committee will address changes in land value due to the oil spill that are not associated with recreation. Changes in land value for recreation will be addressed by the Uses Committee.

ASSUMPTIONS

The Coastal Habitats Committee assumes that maps of the location and intensity of oil impact will be provided by the mapping committee and will be at a scale usable for field studies. **GIS support is essential for the proposed studies.**

ADEC definitions of impact intensity (i.e., high-moderate-low-no impact classes) will be used to identify impacted areas for coastal habitat studies.

RECOMMENDATIONS TO THE MANAGEMENT TEAM

Studies from all committees should adopt a common coastal type classification wherever possible. The Coastal Habitats Committee recommends the Hayes and Gundlach system with the following additions: 1) cobble beaches should be added as a subclass of the gravel beach type, and 2) estuarine types should include adjacent freshwater wetlands. The committee subdivided the shallow subtidal zone (<20m below MLLW) into soft bottom (mud) and hard bottom (sand, gravel, cobble, bedrock) types. The Hayes and Gundlach system has been used to map much of the affected coastline and relates coastal morphology to severity of oil impacts.

The management team should adopt a common set of regional boundaries to coordinate sample stratification wherever possible. The Coastal Habitats Committee recommends three subregions: 1) Prince William Sound, 2) Kenai-Lower Cook Inlet, and 3) Kodiak-Alaska Peninsula.

Common study sites should be used wherever possible. The reconnaissance study proposed by the group should be used to identify appropriate sites for the comprehensive coastal habitats study, clean-up study, and associated studies recommended by other committees.

The field work for the reconnaissance and comprehensive coastal studies should start immediately.

A 6-member coordinating committee with representatives of the trustees and the University of Alaska should be established to oversee the comprehensive coastal habitats study. Oversight of this project should not be assigned to a single agency. To ensure that the committee's intent is carried out, coordinating committee members should be chosen from participants in the Coastal Habitats Committee for the damage assessment.

If the proposals of the committee are approved by the management team, coastal habitat study proposals submitted prior to the committee sessions should be returned to their authors. Authors are encouraged to revise the proposals to be fit the assessment design and resubmit them for consideration by the full committee or coordinating committee.

COASTAL HABITATS COMMITTEE

MEMBERSHIP

Gary Ahlstrand	USDI Natl. Park Service	Anchorage	
Malin Babcock	USDC NOAA	Juneau	
S. Neal Crozier*	USDI Bureau of Land Mgmt.	Anchorage	
Bill Edwards	USDA Forest Service	Juneau	co-chair
Larry Ethelbah	USDI Bureau of Indian Affairs	Juneau	
John Goering	University of Alaska	Fairbanks	
Jeff Hock	AK Dept. of Env. Conservation	Douglas	
Dick Lefebvre*	AK Dept. of Natural Resources	Anchorage	co-chair
Rob Lipkin	US Environmental Prot. Agency	Anchorage	
Steve MacLean	University of Alaska	Fairbanks	
Josh Schimel	University of Alaska	Fairbanks	
Paul Schmidt*	USDI Fish & Wildlife Service	Anchorage	
Jim Sedinger*	University of Alaska	Fairbanks	
Kim Sundberg	AK Dept. of Fish & Game	Anchorage	
Stephen Talbot	US Fish & Wildlife Service	Anchorage	
Lance Trasky*	AK Dept. of Fish & Game	Anchorge	
Skeeter Werner	US Forest Service	Fairbanks	
Marty Welbourn	AK Dept. of Natural Resources	Anchorage	
Frank Williamson*	University of Alaska	Fairbanks	
Priscilla Wohl*	AK Dept. of Natural Resources	Anchorage	

*Present for a portion of the committee sessions

TABLE 1: MECHANISMS OF INJURY BY TROPHIC LEVEL

The mechanisms for oil injury to coastal habitats and organisms vary by trophic level and ecological zone. This chart is a preliminary summary of potential mechanisms for oil injury in shallow subtidal, intertidal, and supra-tidal zones in the spill area.

	TROPHIC LEVEL			
ZONE	PRIMARY PRODUCERS	HERBIVORES	CARNIVORES*	DETRITIVORES
SUBTIDAL (≤20m below MLLW)	Direct toxicity Light deprivation Reproductive impairment Abnormal growth and development Changed nutrient supply Inhibition of algal settlement Substrate instability Internal water balance alterations Smothering	Direct toxicity Reproductive impairment Abnormal growth and development Changed food availability Bioaccumulation of hydrocarbons Inhibition of larval settlement Loss of habitat	Direct toxicity Reproductive impairment Abnormal growth and development Loss of prey Behavioral changes Bioaccumulation of hydrocarbons Inhibition of larval settlement Loss of habitat Smothering Physiological changes	Same mechanisms as carnivores plus: Use of oil as food Change in substrate quality
INTERTIDAL	Same list as subtidal producers plus: Reduced tolerance to dessiccation Reduced tolerance to changes in salinity Mechanical damage from clean-up activities	Same list as subtidal herbivores plus: Reduced tolerance to dessiccation Reduced tolerance to freezing Mechanical damage from clean-up activities	Same list as subtidal carnivores plus: Increased dessiccation (loss of cover) Increased freezing (loss of cover) Mechanical damage from clean-up activities	Same list as subtidal detritivores plus: Mechanical damage from clean-up activities

TABLE 1: MECHANISMS OF INJURY BY TROPHIC LEVEL (continued)

ZONE	TROPHIC LEVEL: PRIMARY PRODUCERS	HERBIVORES	CARNIVORES*	DETRITIVORES
SUPRATIDAL	Direct toxicity Impacts of volatile compounds Smothering Inhibition of establishment Reduced tolerance to dessiccation Reduced tolerance to changes in salinity Light deprivation Reproductive impairment Abnormal growth and development Changed nutrient supply and uptake (including mycorrhizae) Internal water balance alterations Smothering	Direct toxicity Reproductive impairment Abnormal growth and development Changed food avail. Bioaccumulation of hydrocarbons Inhibition of larval settlement Loss of habitat (incl. escape cover Mechanical damage from clean-up activities	Direct toxicity Loss of prey species Smothering of insects Physiological effects Altered energy balance Bioaccumulatio of hydrocarbons Loss of habitat Reproductive changes Abnormal growth and development Behavioral changes Mechanical damage from clean-up activities	Direct toxicity Bioaccumulation of hydrocarbons Physiological effects Loss of habitat Reproductive changes Abnormal growth and development Use of oil as food Change in substrate quality Smothering Changes in habitat from clean-up activities

*Omnivores, predators, and filter feeders are included in this category

Notes: Some of these mechanisms have been studied in laboratory experiments. Others have not been documented; additional laboratory research may be needed to demonstrate whether or not these mechanisms cause measurable damage.

Changes in property values due to oil stem from the biological injuries described in this table, physical or geological changes (e.g., beach erosion), and changes to site productivity that reduce the value of the land for sale, lease, or permit.

TABLE 2: KEY ORGANISMS AND STUDY PRIORITY BY COASTAL TYPE AND TROPHIC LEVEL

Based on assumptions in Gundlach & Preliminary inform. May need to revise based on Recon.

Priorities for detailed study of impacts to coastal types were assigned based on the abundance, human use, productivity, sensitivity to oil, and persistence of oil impacts in each type. A preliminary list of key organisms is included for moderate and high priority coastal types. The comprehensive coastal study proposed by the Coastal Habitats Committee would refine these lists.

COASTAL TYPE: STUDY PRIORITY	KEY CHARACTERISTICS	KEY ORGANISMS: PRIMARY PRODUCERS	HERBIVORES	CARNIVORES	DETRITIVORES
SUBTIDAL ZONE					
SOFT BOTTOM AREAS: MOD.-HIGH PRIORITY	Oil deposits as layer with sediments Decomposition largely anaerobic and slow: oil persists Currents weak: oil layers not removed Eelgrass beds common Productive sites May be extensive in protected bays	Eelgrass	Isopods Gammarids Harpactoids Sea urchins	Fish Starfish Sea otter	Marine worms Clams Bacteria Amphipods
MIXED SAND AND GRAVEL BOTTOM: LOW PRIORITY	Relatively low productivity Oil sediments could deposit on bottom		low priority		
HARD BOTTOM (GRAVEL, COBBLE, AND BEDROCK) AREAS: HIGH PRIORITY	High productivity: epifauna, epiphytes, & juvenile crustaceans Abundant kelp and algae May serve as sources for recolonization of damaged intertidal areas May be affected by by flushing from adjacent beaches Used by salmon fry	Kelp	Sea urchins Starfish Isopods	Salmon Marine mammals Starfish Crabs Snails Anemones Mussels (High species diversity)	(Few detritivores in this type)

INTERTIDAL ZONE					
STRAIGHT ROCKY HEADLANDS AND ERODING, WAVE-CUT BEACHES: **LOW PRIORITY**	Relatively low oil impact predicted: little oil adheres or persists Logistically hard to study Common type in impact area May get marine mammal use	- - - - - - - - - - - - low priority - - - - - - - - - - -			
FLAT FINE-GRAIN BEACHES, STEEP MED.- TO COARSE-GRAINED BEACH, & EXPOSED TIDAL FLATS: **LOW PRIORITY**	Relatively low oil impact predicted: little oil penetrates Small percentage of total coastline May have recreational or subsistence use	- - - - - - - - - - - - low priority - - - - - - - - - - -			
MIXED SAND AND GRAVEL BEACHES, GRAVEL BEACH, AND COBBLE BEACHES: **MOD.-HIGH PRIORITY** (includes associated sand beaches and dunes above tideline)	Large part of impacted zone Difficult to clean up Oil gets buried under new deposition Impacts are persistent Important use by terrestrial mammals Clam, mussel, and crab habitat High fish values adjacent to these sites Recreational and subsistence use Susceptible to damage from clean-up activities	Macroalgae Mosses Herbaceous plants — strand plants	Sea urchins Starfish Isopods (less diverse invertebrates than tidal zone) Deer & terrestrial grazers	Same list as subtidal-hard bottom plus: Polychaetes Amphipods Barnacles Mink, river otter, bear Birds	Clams
SHELTERED ROCKY HEADLANDS AND ASSOCIATED: POCKET BEACHES: **HIGH PRIORITY**	High species diversity High recreational use Important bird habitat Severe, persistent oil damage Common habitat type Oil deposition in EVOS area has been heavy	Macroalgae Mosses and lichens Herbaceous plants Pockets of eelgrass	Sea urchins Isopods Starfish Isopods Insects (high species diversity & abundance)	Same list as subtidal-hard bottom plus: Mink & river otter Mink and ~~river otter~~	Clams Microbes (mostly in pocket beaches) Polychaetes

PROTECTED ESTUARINE TIDE-FLATS & PROTECTED ESTRUARINE SALT MARSHES: **HIGH PRIORITY** (This type includes adjacent freshwater wetlands and grasslands)	Highly productive sites Seasonal use by grazers, browsers, and birds Crossed by salmon streams High sensitivity to oil damage Oil impacts persist (≥ 10 years) Relatively rare in Sound and Kenai, more abundant on Kodiak and Peninsula Human use: hunting, clams, fishing	Sedges Grasses Fucus & filamentous green algae Eelgrass	Migrating birds Terrestrial herbivores Insects Littorine snails Amphipods	Clams & mussels Barnacles Insects Crabs Shorebirds & raptors Bear	Microbes, bacteria, fungi Clams Polychaetes Diptera larvae Nematodes
SUPRATIDAL					
AQUATIC (LAKES AND STREAMS): **LOW PRIORITY**	Little direct impact from oil Freshwater streams important salmon habitat Freshwater areas flush into tidal zone	- - - - - - - - - - - low priority - - - - - - - - - -			
COASTAL FOREST & SHRUBLANDS: **LOW PRIORITY**	Impacts limited to near-shore areas Impacts from volatiles could extend inland Most severe impacts likely to be from volatiles -- difficult to isolate Lichens and bryophytes sensitive to volatiles Possible mycorrhizal impacts near the shore	Lichens possible indicator of damage from volatiles - - - - low priority - - - - - - - - -			

RPWG
I

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
WASHINGTON, DC 20460
USA

FACSIMILE TRANSMISSION COVER SHEET

TO: Brian Lops TEL NO. 271-2464

OFFICE: Al Restoration Office FAX NO. 8-907-271-2467

FROM: Ken Hood TEL NO. 382-5976

OFFICE: OMEP/ORD DATE: 2/1/90

This Transmission Consists of 2 Page(s) including This Cover Sheet.

MESSAGE: Brian, this is the lit review work-scope. Please note any needed changes and let me know a.s.a.p. As you know, we have $ to conduct the review, so we don't want to miss any bases! Conrad and I have looked at it. (I wrote it.); a copy has gone to Hal/Kathy.

Ken Hood

FAX MACHINE: (202) 382-6370
FTS 382-6370

CONFIRMATION: (202)382-5945
FTS 382-5945

DRAFT
Good copy

WORK STATEMENT FOR SCOPE OF LITERATURE REVIEW RELATIVE TO RESTORATION OF VALDEZ AND PRINCE WILLIAM SOUND

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RPW 6
I

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Environmental Research Laboratory
CORVALLIS OR 97333

EPA

FACSIMILE REQUEST AND COVER SHEET

PLEASE PRINT IN BLACK INK ONLY

TO: BRIAN ROSS

OFFICE/PHONE: 907-271-2464

FAX #: 907-271-2467
CONF. #: NONE

REGION/LAB: REGION X - ALASKA.

FROM: HAL KIBBY

PHONE: 420-4625

MAIL CODE:

OFFICE: ERL-Corvallis

DATE: 2-2-90

NUMBER OF PAGES TO INCLUDE THIS COVER SHEET:

Please number all pages

INFORMATION FOR SENDING FACSIMILE MESSAGES

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TRANSMITTED

_____ / _____
(Date) (Time)

CONFIRMED: _____

CERL-24

PAGE ____ OF ____ PAGES

February 2, 1990

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To: Ken Hood

From: Hal Kibby

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WASHINGTON, DC 20460
USA

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TO: Brian Rops TEL NO. 271-2464

OFFICE: Al Restoration Offic FAX NO. 8-907-271-2467

FROM: Ken Hood TEL NO. 382-5976

OFFICE: OMEP/ORD DATE: 2/1/90

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DRAFT
Hard copy

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RPW6
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OFFICE OF RESEARCH AND DEVELOPMENT
WASHINGTON, DC 20460
USA

FACSIMILE TRANSMISSION COVER SHEET

TO: Brian Lops TEL NO. 271-2464

OFFICE: al Restoration Offic FAX NO. 8-907-271-2467

FROM: Ken Hood TEL NO. 382-5976

OFFICE: OMEP/ORD DATE: 2/1/90

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FTS 382-5945

DRAFT
Hoodcopy

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RPWG I Brian

DRAFT

Restoration Technologies Review Project (Dec 89 - Feb 91)

Short Term "Endpoint" (through March 90)

Develop proposals for pilot projects to be implemented summer 1990.

Note: The focus of the early efforts is more on developing the pilot projects than on specifying the process and doing the research necessary to completely and adequately support development of the full restoration plan.

Project Objectives

1. Complete a thorough literature review encompassing all potential techniques and approaches.

2. Identify guidelines for choosing restoration techniques and restoration pilot projects.

3. Assure full ecosystem consideration.

4. Assure restoration of ecosystem function (not just structure).

5. Input information on available technologies and applicability to specific resources to the development of restoration pilot projects and the overall restoration plan.

Products

Literature Review
Library/Clearinghouse
Conference/Workshop Reports
Project/Technique Selection Guidelines

Milestones

- Assemble information base (literature search, clearinghouse/ library, conferences, etc.)

- Identify initial list of potential restoration alternatives for resources at risk.

DRAFT

Activities

• Maintain close coordination and communication with State and Federal Trustee agencies. [Ongoing]

• Develop a public outreach, education, and participation plan for the restoration pilot project planning and selection process. [Dec89]

• Conduct broad-ranging literature search. [Dec89 - Mar90]
  - Initial scoping search by EPA staff.
  - Thorough search by contractor.

• Collect information on ongoing restoration-relevant activities and studies both within and outside government. [Dec89 - Jan90]
  - Includes visits as necessary to EPA labs.

• Develop a mechanism to compile and transmit all information collected through literature review, phone conversations, workshops, or other activities as well as information collected by the individual trustee agencies. [Jan90 - Apr90]
  - Developed (and implemented) by contractor with detailed input from trustee agencies.

• Host workshop with restoration experts on known restoration technologies and project selection guidelines. [Jan90 or early Feb90]
  - Presentations by governmental and non-governmental groups with ongoing studies.
  - Brainstorming session on ecological criteria and guidelines for pilot project selection.

• Develop, with the Restoration Framework Committee and Trustee Council, guidelines and principles to focus and guide the pilot project selection process. [early Mar90]

• Attend or co-host a meeting/workshop with the Trustee Council to review results of literature searches, present proposed pilot projects, and select projects for the summer 1990. [Mar90]

DRAFT

Immediate Tasks

1. Approve strategy and direction with trustee agencies.

2. Determine role of Region X - Alaska office in effort.

3. Determine availability of funding.

4. Develop public participation strategy.

5. Consult DOJ regarding possible litigation sensitivity and other limitations on information dissemination, etc.

6. Conduct initial scoping search of literature with assistance of EPA HQ library.

7. Identify existing contract vehicle(s) within which we can get full literature search and technology workshop accomplished.

8. Develop task/work order for contractor to do literature search.

9. Contact EPA laboratories as well as other governmental and non-governmental groups with ongoing studies or activities in the restoration field.

10. Determine need for restoration technologies workshop and plan and implement as appropriate.

02/07 11:59 7307137 #01

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Environmental Research Laboratory
CORVALLIS OR 97333

EPA

FACSIMILE REQUEST AND COVER SHEET

PLEASE PRINT IN BLACK INK ONLY

TO: BRIAN ROSS

OFFICE/PHONE: (907) 271-2464

FAX #: (907) 271-2467
CONF. #:

REGION/LAB:

FROM: Hal Kibby

PHONE: FTS-420-~~4622~~ 4625

MAIL CODE:

OFFICE: ERL - CORVALLIS

DATE: 2/7/90

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(Date) (Time)

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PAGE 1 OF 2 PAGES

02 OF 02 #02 7307137 02/07 11:59

Subcontract to Clayton — Williams Contact — Hicks Kel Kelly · 919 781-3150

WORK ASSIGNMENT ENVIRONMENTAL PROTECTION AGENCY HEADQUARTERS	CONTRACT NO. 68-D9-0052 CONTRACTOR KEA ASSIGNMENT NO. K1-10 ASSIGNMENT CHANGE
TITLE: Oil Spill Survey and Summary	

Background: OEPER has been charged with developing a research program that will provide the scientific basis for oil spill site recovery analysis and/or enhancement. As a first step, OEPER requires a thorough survey and critical summary of published and where possible, in-progress research dealing with the restoration of oil spill locations. This must, at a minimum, include consideration of attempts to improve the speed of site recovery as well as post insult monitoring of species. This should build on prior work (KB-13), but not repeat it.

The Contractor Shall:

Conduct a comprehensive survey of published scientific literature to determine the extent of existing information regarding the ecological recovery of oil spill sites, compile all appropriate citations categorized according to research emphasis, and provide a descriptive summary of data collection. The summary should clearly indicate the particular areas of major research effort and laboratories involved and identify those areas where little or no evidence of research activity were found.

The literature survey shall be complemented by inquiry to major interest groups, e.g., the American Petroleum Institute, for currently supported research activity on ecological restoration. Such groups will have been identified in the course of the literature review described above.

Deliverables:
a. 3 drafts of the final report — DUE: January 2, 1990
b. 10 copies the final report. — DUE: January 15, 1990

MARCH 1
MARCH 15

ESTIMATE OF	GOVERNMENT ESTIMATE	CONTRACTOR ESTIMATE
LABOR HOURS	219	
START DATE	Dec 8, 1989	
COMPLETION DATE	January 31, 1990	

REQUESTOR'S SIGNATURE	ORG CODE	TELEPHONE	DATE
Bob Fredrick	RD-682	382-2389	11/30/89

APPROVALS (as applicable)	SIGNATURE	DATE
TEAM LEADER Sam Williams, MET	Sam Williams	11/30/89
STAFF DIRECTOR Tony Janetos, MEWMS		11/30/89
PROJECT OFFICER David C. Kelley		11/30/89
CONTRACTING OFFICER		

CONTRACTOR'S REPRESENTATIVE ACKNOWLEDGEMENT

NOTICE TO CONTRACTOR: Please sign, date, and provide estimates in spaces indicated above, and return one copy to the Contracting Officer.

02/02 17:03 #01 7307137

PPWG I

EPA

Environmental Research Laboratory
CORVALLIS OR 97333

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OFFICE/PHONE: (907) 271-2464

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CONF. #:

REGION/LAB:

FROM: Hal Kibby

PHONE: FTS-420-~~4625~~ 4625

MAIL CODE:

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DATE: 2/2/90

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(Date) (Time)

CONFIRMED:

PAGE 1 OF 2 PAGES

February 2, 1990

Brian -

Since we didn't make contact on the phone would you jot down on a piece of paper those natural resources that in your opinion were most significantly damaged in the oil spill. A simple list would be fine. Then Fax them to Ken Hood in OEPER Headquarters. I think you have his fax number.

I am going to be with Ken on Tuesday and try to convince him and Conrad that we can put together a more specific literature search that first concentrates on restoration of those resources most damaged.

I have a plane reservation to Anchorage on Monday February 12. Unfortunately I can't get in before 2:55. My return home is on Wednesday departing at 9:35. Look forward to meeting you and listening to a shoreline committee meeting.

Please let me know how to find your office!

RPWG
I

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