Exxon Valdez Oil Spill Trustee Council

Restoration Office
645 "G" Street, Anchorage, AK 99501
Phone: (907) 278-8012 Fax: (907) 276-7178

RPWG I

TO: Trustee Council

DATE: February 8, 1993

FROM: Dave Gibbons
Interim Executive Director

TELE: 278-8012
FAX: 276-7178

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 wha 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.

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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, 175 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 ir 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 oile 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.

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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.

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

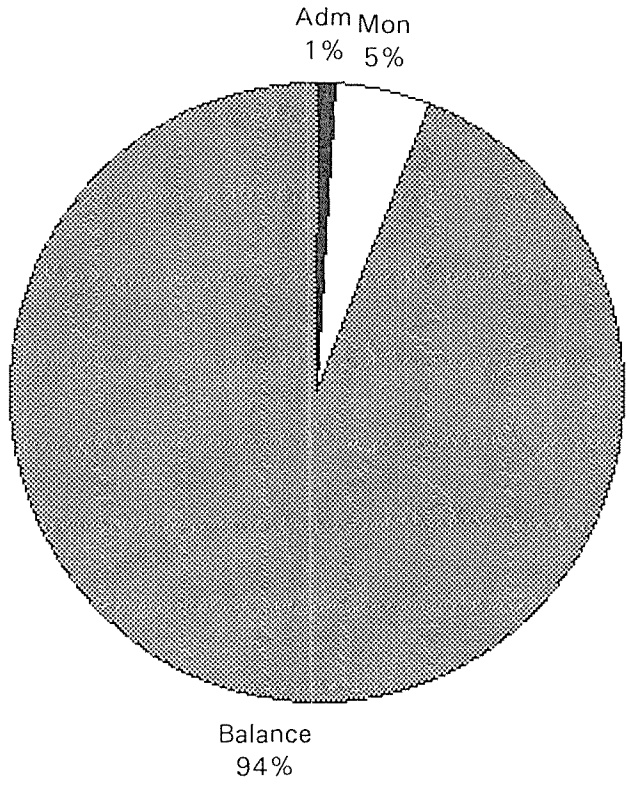
THEME	No action other than monitoring and normal agency management.
VARIABLES	
Injuries Addressed	N/A
Status of Resource Recovery	N/A
Effectiveness of Restoration Actions	N/A
Strategies for Public Use	N/A

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

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****

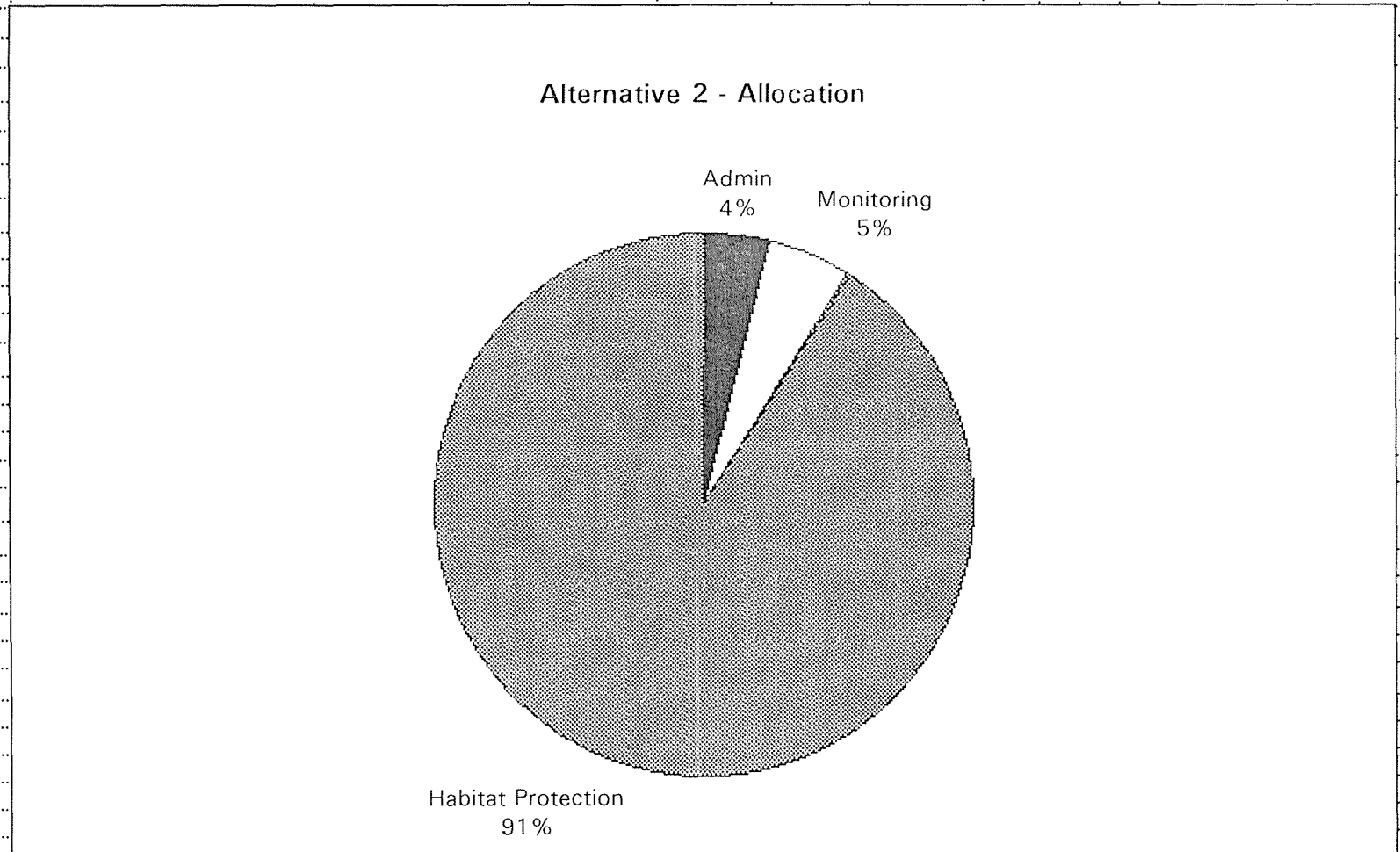
RESOURCE/SERVICE	RESTORATION OPTION
Black oystercatcher	40.0 Land and water management actions
Common murre	None identified
Harbor seal	37.0 Habitat protection and acquisition
Harlequin duck	37.0 Habitat protection and acquisition
Intertidal organisms	None identified
Marbled murrelet	37.0 Habitat protection 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

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

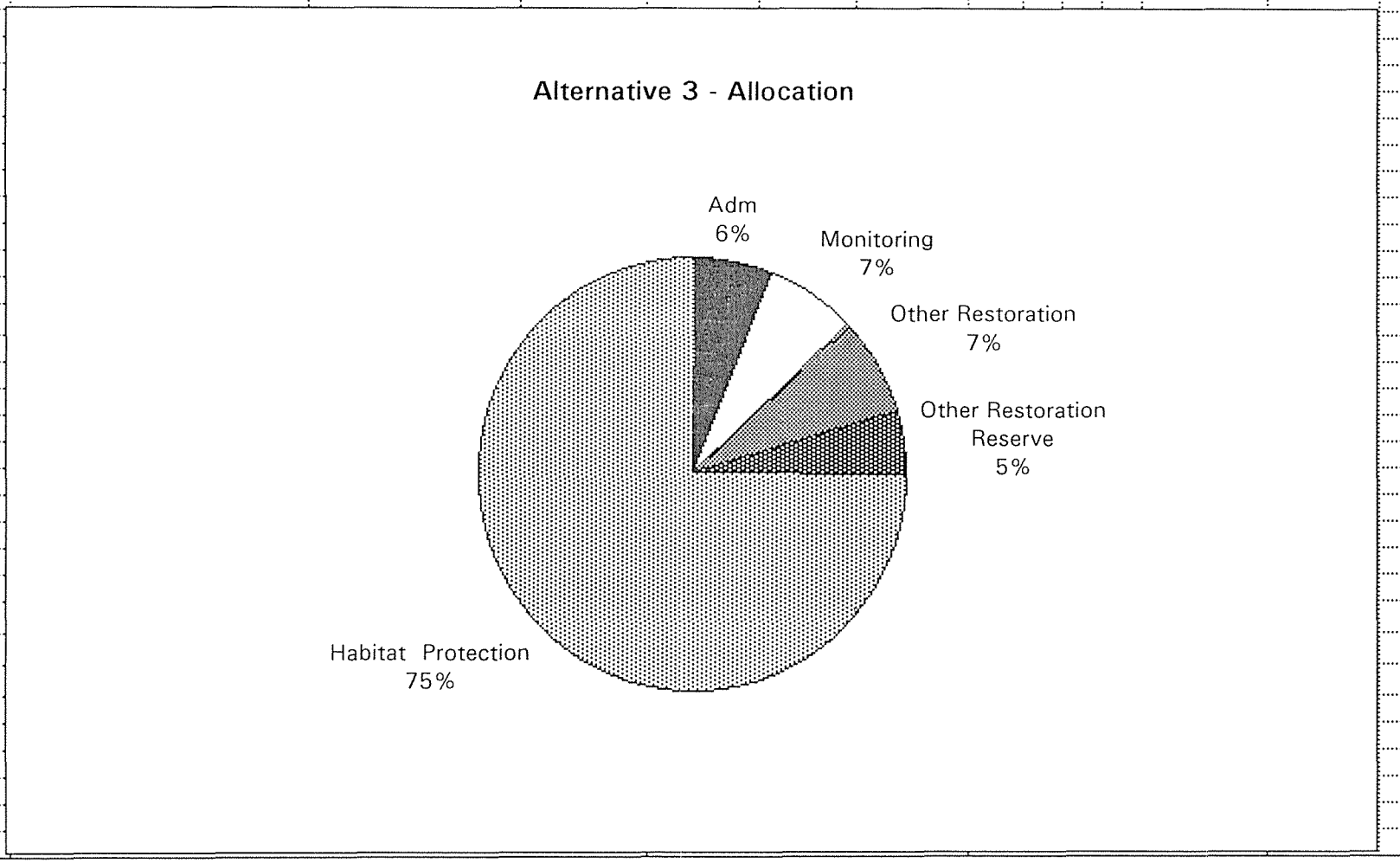
Subsistence	30.0 Test subsistence foods for hydrocarbon contamination 49.0 Provide access to traditional subsistence foods
Wilderness and non-use values	37.0 Habitat protection and acquisition 40.0 Land and water management actions
	Included in Alternative 2

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		
								Years			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

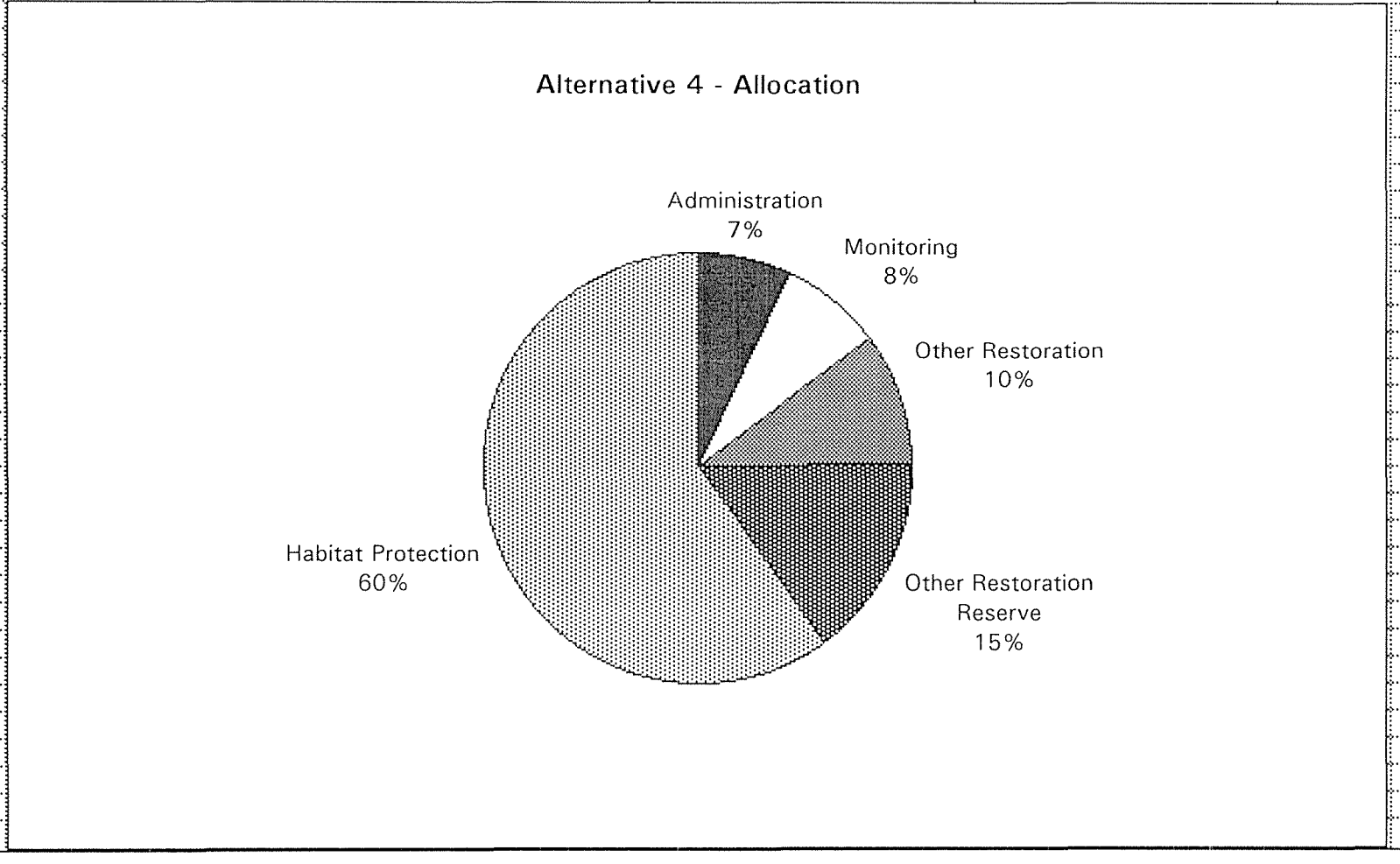
Dolly Varden	2.1 Intensify management to protect injured stocks 37.0 Habitat protection and acquisition
Killer whale	45.0 Study: Changes in black cod fishery gear
Pacific herring	2.2 Intensify herring management to protect injured stocks
Pink salmon	2.3 Intensify salmon management to protect injured 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.

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

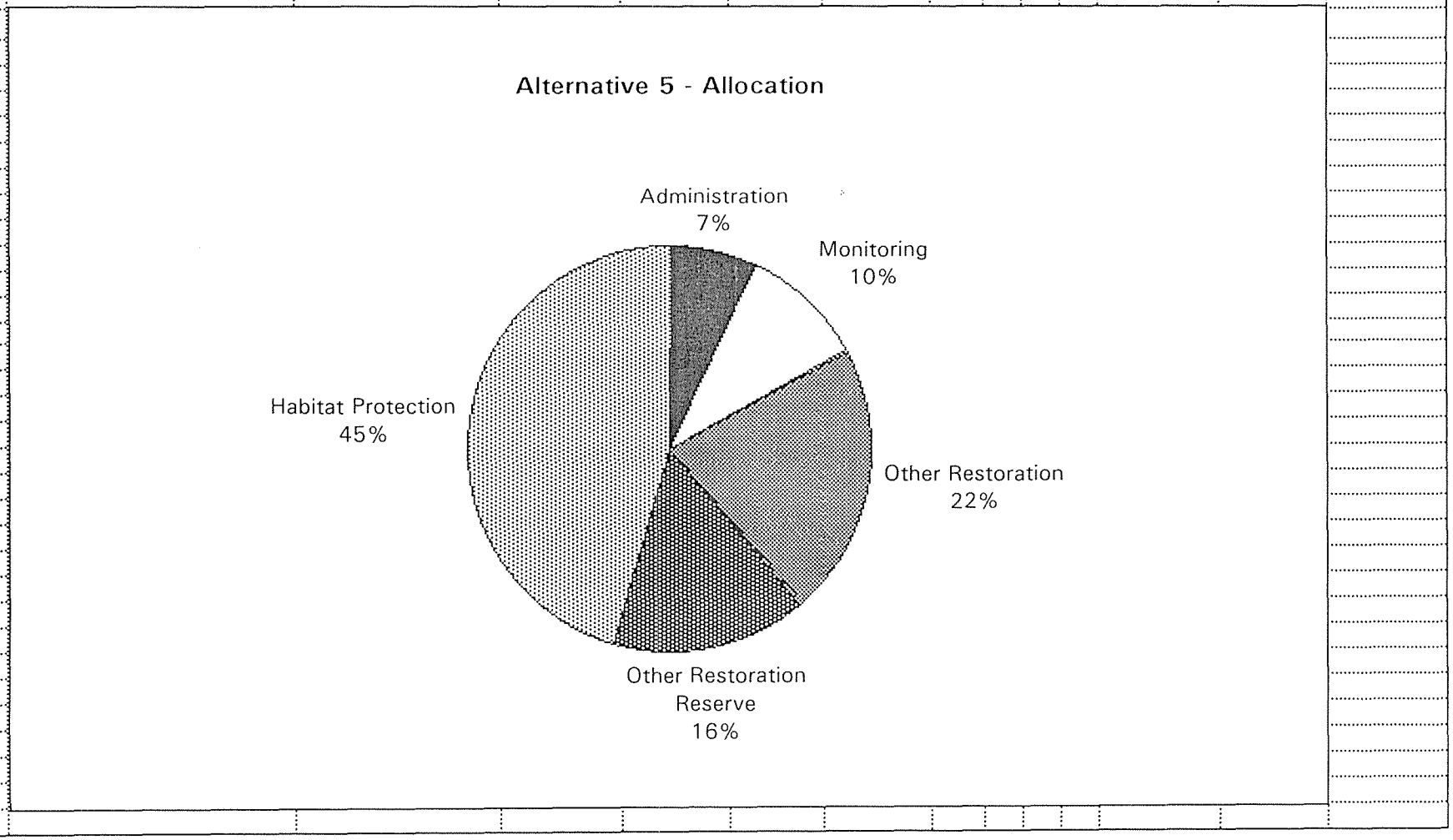
ALTERNATIVE 5: GEOGRAPHIC DISTRIBUTION

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							

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				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	
4.10	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 10-Year Maximum		
								Years					
				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

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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 3/10/93

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 20 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).
Designated Wilderness Areas	Over 1,000 miles of wilderness coastline were affected by oil. Some oil remains embedded in the sediments of these areas.	Oil has degraded substantially in many areas but remains in others. Until oil is completely removed or degrades naturally, 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;

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

RPWG draft 3/10/93

Service	Description of Injury	Status of Recovery in December, 1992	Geographic Extent of Injury				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.	Data is not available to determine the status of recovery.	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 thus by the number of U.S. household results in a damage estimate of $2.8 billion. 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 (e.g., boating, camping, fishing, hunting)	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 use declined significantly in 1989. 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. 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 are no data to support or deny whether they have returned to prespill levels. 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	

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.	
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 oil spill-related commercial closures 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 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.	By 1990 only 12% of the tourism businesses surveyed felt their businesses had been significantly or completely affected by the oil spill.	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.	
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__.

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Restoration Planning Work Group

Exxon Valdez Oil Spill Restoration Office
645 "G" Street
Anchorage, Alaska 99501

DATE: December 22, 1992

TO: David Gibbons
Interim Administrative Director
Restoration Team

FROM: Bob Loeffler, Co-Chair
for John Strand, Co-Chair
Restoration Planning Work Group

SUBJECT:
1) Tabular Summary of Injury Assessment Results
2) Map of the EVOS Affected Area
3) Endowment Proposals

Enclosed for your review and comment are several interim products recently completed by the Planning Group. The tabular summary of injury assessment results is a revision of the table first submitted to the Restoration Team on November 5th. As such, it includes the comments provided by individual members of the Restoration Team as well as comments provided by Bob Spies. Also, the table now includes results of an assessment of injury for important services within the oil spill area.

Please coordinate a final review of this summary table at the earliest opportunity. Perhaps final Restoration Team comments could be provided during the teleconference on December 29th. If the Restoration Team has comments, we would like a consolidated set of comments, rather than potentially conflicting comments authored by individual Restoration Team members. We would like to present the summary table to the Public Advisory Group at their scheduled January 6-7 meeting, and discuss the intended use of this information in the Draft Restoration Plan. RPWG members will be present at that meeting to discuss the intended use of this information in the Draft Restoration Plan.

Also enclosed for your review and comment is a map that represents our first attempt to define the "affected" area for the oil spill. The Draft Restoration Plan presently uses "within the EVOS area" as a variable for purposes of distinguishing among restoration alternatives. Some of the alternatives focus on restoration options within the EVOS area; other alternatives allow for application outside the EVOS area. Perhaps we also can discuss this concept during the December 29th teleconference.

Finally we enclose, for your review and comment, endowment proposals that could be included in the Draft Restoration Plan. These endowment proposals are intended for use with some of the alternatives. It is our view that not all alternatives are appropriate with an endowment, however, and some alternatives could include more than one. While you may want to discuss this topic on December 29th, please provide comments by January 11th. Thank you.

cc: RT
RPWG

December 22, 1992

To: Restoration Team

From: Restoration Planning Work Group

Subject: Injury Summary Table

Attached is an injury summary table which has been reviewed and approved by Dr. Spies and the RPWG. We are providing it to you for your approval.

The RT requested several changes during their last review. The following changes were incorporated:

-Add estimated number of mortality, if available;
-Footnote "Geographic Extent..." column to reflect that there may have been an unequal distribution of injury within each region;
-Clarify the footnote ** to indicate that dead animals were recovered from that region of the spill zone;

The RT also recommended changes that have not been incorporated into the table for the following reasons:

-Deal with abiotic resources in the table;
A footnote was added noting that a discussion of sediments, water column and air can be found in the text;

-Add source material;
A reference list was not added to the table. Although a reference list is not currently part of the RP outline, the RT may wish to add one. The information used to develop this table includes draft final reports currently under peer review. RPWG and Spies felt that it was premature to try to document the sources of this table but it may be appropriate at a later date.

Please review this table and provide comments back to RPWG by January 4, 1993. RPWG hopes to provide this to the Public Advisory Group at their January meeting with the RT's approval.

Attachments
1-Summary table showing deleted text and added text. Added text is shaded.
2-"Clean" summary table.

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

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
MARINE MAMMALS										
Harbor Seals*	YES (200)	YES*	YES	POSSIBLY STABLE, BUT NOT RECOVERING*	UNKNOWN	YES	YES**	UNKNOWN	UNKNOWN	Many seals were directly oiled and over 200 seals were estimated to have been killed. There was a measurable difference in populations between oiled and unoiled areas in PWS. 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	--	--	--	--	--	--	
Killer Whales	YES	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. It is not certain that the disappearance of whales was due to the oil spill.
Sea Lions*	~~YES~~ UNKNOWN	UNKNOWN	~~YES~~ NO	CONTINUING DECLINE*	--	--	--	--	--	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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Sea Otters	YES (3,500 TO 5,500)	YES	YES	STABLE, BUT NOT RECOVERING	YES, PROBABLY	YES	YES	YES**	YES**	Although about 1000 dead sea otters were found, 3500 to 5500 were estimated to have been killed. Post-spill surveys showed measurable difference in populations and survival between oiled and unoiled areas. Survey data have not established a significant recovery. Prime-age animals are still being found on beaches. 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	--	--	--	--	--	--	No field studies were done.
Brown Bear	NO	NO	~~YES~~ NO	--	--	--	--	--	--	~~Hydrocarbon exposure documented on Alaska Peninsula in 1989.~~ Hydrocarbon exposure was documented on Alaska Peninsula in 1989 including high hydrocarbon levels in the bile of a dead cub. Brown bear feed in the intertidal zone and may still be exposed to hydrocarbons in the environment.
River Otters	YES	~~NOT DETECTED~~ UNKNOWN	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Significant exposure to hydrocarbons and sub-lethal effects determined, but no effects 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	~~YES~~ NO	--	--	--	--	--	--	Elevated hydrocarbons found in tissues in some deer in 1989.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality ~~(total mortality estimate)~~	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
BIRDS										
Bald Eagles	YES	NO	YES	RECOVERING	UNKNOWN	YES	YES	YES**	YES**	Productivity disrupted in 1989. Population estimates and productivity returned to normal in 1990. Significant exposure to hydrocarbons and some sub-lethal effects found in 1989 and 1990, but no continuing effects established on populations.
Black-legged Kittiwakes	YES	NO	~~YES~~ NO	NO CHANGE	NO	YES	YES**	YES**	YES**	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 the reproductive failure may be unrelated to the oil spill.
Black Oyster-catchers	YES	YES	YES	RECOVERING	YES	YES	YES**	YES**	YES**	Differences in egg size between oiled and unoiled areas persist. Significant exposure to hydrocarbons and some sub-lethal effects determined. Populations declined more in oiled areas than unoiled areas in post-spill surveys. Black oystercatchers feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Common Murres	YES (175,000 to 300,000)	YES	YES	STABLE, BUT NOT RECOVERING ~~CONTINUING DECLINE~~	YES	NO	YES	YES	YES	Measurable impacts on populations with comparisons to pre-spill conditions. Adult mortality 175,000-300,000. Breeding is still inhibited in some colonies in the Gulf of Alaska.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
--- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Glaucous-winged gulls	YES	NOT DETECTED	NO	NO CHANGE	NO	YES**	YES**	YES**	YES**	
Harlequin Ducks	YES	YES	YES	STABLE OR CONTINUING DECLINE	YES	YES	YES**	YES**	YES**	Post-spill samples showed hydrocarbon contamination and poor body conditions. Surveys indicate population declines and near total reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Marbled Murrelets*	YES (8,000 TO 12,000)	YES	~~YES~~ NO	STABLE OR CONTINUING DECLINE	NO	YES	YES**	YES**	YES**	Measurable affect on populations with comparisons to pre-spill conditions. Estimated adult mortality 8,000 to 12,000. Marbled murrelet populations were declining prior to the spill. Hydrocarbon contamination was found in livers of adult birds.
Peale's Peregrine Falcons	YES	~~NOT DETECTED~~ UNKNOWN	~~YES~~ NO	--	--	--	--	--	--	
Pigeon Guillemots*	YES (1,500 TO 3,000)	YES	~~YES~~ NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES**	YES**	YES**	Over 500 carcasses were recovered. Between 1500 and 3000 were estimated to have been killed by the spill. Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found in birds and, externally, on eggs.
Storm Petrels	YES	NO	AWAITING RESULTS	NO CHANGE	UNKNOWN	YES**	YES**	YES**	YES**	

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality ~~(total mortality estimate)~~	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Other Seabirds	YES	VARIES BY SPECIES	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	~~Adult mortality of 375,000 to 435,000 birds.~~ Total seabird recovery has not been measured. Species collected dead 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	~~YES~~ NO	~~YES~~ NO	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	More than 2,000 sea duck carcasses were recovered. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil. Species collected dead 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.
Other Shorebirds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	Species collected dead include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpiper; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Other Birds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Species collected dead 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.
FISH										
Cutthroat Trout	~~NO~~ YES, SEE COMMENTS	~~YES~~ NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead bodies were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Dolly Varden	~~NO~~ YES, SEE COMMENTS	~~YES~~ NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead fish were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Pacific Herring	YES, TO EGGS AND LARVAE	UNKNOWN	YES	UNKNOWN	~~YES~~ NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable difference in egg counts between oiled and unoiled areas. 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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality ~~(total mortality estimate)~~	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Pink Salmon	YES, TO EGGS AND LARVAE	NOT DETECTED	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial mortality of eggs and larvae, but adult mortality was not detected. Significant exposure to hydrocarbons by adults, sub-adults, and eggs. Some sub-lethal effects determined on juveniles. Egg mortality continues to be high in oiled streams of PWS in 1991.
Rockfish	YES	UNKNOWN	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	~~A large number of~~ Approximately 16 dead fish were found but only a few were in condition to be analyzed. Significant exposure to hydrocarbons with some sub-lethal effects were determined in those fish, but no effects established on the population. Spill increased fishing pressures which may be impacting population.
Sockeye Salmon	~~UNKNOWN~~ YES, TO SMOLT	YES	YES	SEE COMMENTS	YES	UNKNOWN	YES	YES	NO	~~Assumed loss of juveniles in oiled areas.~~ Smolt survival continues to be poor in the Red Lake and Kenai River systems due to overescapements. As a result, future adult returns are expected to be low. Trophic structures of Kenai and Skilak Lakes altered by overescapement.
SHELLFISH										
Clam	UNKNOWN	UNKNOWN	~~YES~~ POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality ~~(total mortality estimate)~~	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Crab (Dungeness)	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	~~Subtidal sediments collected in 1989 were found to be contaminated at 5 of 8 locations hypothesized to be oiled. Crabs from these locations, however, were not found to contain hydrocarbons.~~
Oyster	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	Although studies were initiated in 1989, they were not completed because they were determined to be of limited ~~litigative~~ value.
Sea Urchin	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	~~Lab study demonstrated significant reduction in fertilization when exposed to both fresh and weathered Prudhoe Bay crude oil.~~
Shrimp	UNKNOWN	UNKNOWN	~~YES~~ NO	--	--	--	--	--	--	~~In 1990, total number of eggs per female at given size appears to be less in oiled areas. In 1990 a greater number of dead eggs occurred when compared to 1989 or unoiled areas.~~
INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	~~STABLE, BUT NOT RECOVERING (VARIES BY SPECIES)~~ VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	YES	YES	YES	Measureable impacts on populations occurred in comparison to pre-spill conditions. The lower intertidal and, to some extent, the mid intertidal is recovering. Some species in the upper intertidal zone have not recovered. ~~Upper intertidal zone has not yet recovered.~~

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Subtidal Communities	YES	YES	YES	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Recovery is not known but there were measurable differences between oiled and unoiled areas in 1990.

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*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

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

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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*	YES (200)	YES*	YES	POSSIBLY STABLE, BUT NOT RECOVERING*	UNKNOWN	YES	YES**	UNKNOWN	UNKNOWN	Many seals were directly oiled and over 200 seals were estimated to have been killed. There was a measurable difference in populations between oiled and unoiled areas in PWS. 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	--	--	--	--	--	--	
Killer Whales	YES	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. It is not certain that the disappearance of whales was due to the oil spill.
Sea Lions*	UNKNOWN	UNKNOWN	NO	CONTINUING DECLINE*	--	--	--	--	--	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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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 5,500)	YES	YES	STABLE, BUT NOT RECOVERING	YES, PROBABLY	YES	YES	YES**	YES**	Although about 1000 dead sea otters were found, 3500 to 5500 were estimated to have been killed. Post-spill surveys showed measurable difference in populations and survival between oiled and unoiled areas. Survey data have not established a significant recovery. Prime-age animals are still being found on beaches. 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	--	--	--	--	--	--	No field studies were done.
Brown Bear	NO	NO	NO	--	--	--	--	--	--	Hydrocarbon exposure was documented on Alaska Peninsula in 1989 including high hydrocarbon levels in the bile of a dead cub. Brown bear feed in the intertidal zone and may still be exposed to hydrocarbons in the environment.
River Otters	YES	UNKNOWN	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Significant exposure to hydrocarbons and sub-lethal effects determined, but no effects 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	--	--	--	--	--	--	Elevated hydrocarbons found in tissues in some deer in 1989.

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*** For a discussion of sediments, water column and air, see text;
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-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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	NO	YES	RECOVERING	UNKNOWN	YES	YES	YES**	YES**	Productivity disrupted in 1989. Population estimates and productivity returned to normal in 1990. Significant exposure to hydrocarbons and some sub-lethal effects found in 1989 and 1990, but no continuing effects established on populations.
Black-legged Kittiwakes	YES	NO	NO	NO CHANGE	NO	YES	YES**	YES**	YES**	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 the reproductive failure may be unrelated to the oil spill.
Black Oyster-catchers	YES	YES	YES	RECOVERING	YES	YES	YES**	YES**	YES**	Differences in egg size between oiled and unoiled areas persist. Significant exposure to hydrocarbons and some sub-lethal effects determined. Populations declined more in oiled areas than unoiled areas in post-spill surveys. Black oystercatchers feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Common Murres	YES (175,000 to 300,000)	YES	YES	STABLE, BUT NOT RECOVERING	YES	NO	YES	YES	YES	Measurable impacts on populations with comparisons to pre-spill conditions. Adult mortality 175,000-300,000. Breeding is still inhibited in some colonies in the Gulf of Alaska.

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**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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	NOT DETECTED	NO	NO CHANGE	NO	YES**	YES**	YES**	YES**	
Harlequin Ducks	YES	YES	YES	STABLE OR CONTINUING DECLINE	YES	YES	YES**	YES**	YES**	Post-spill samples showed hydrocarbon contamination and poor body conditions. Surveys immediately after the spill indicated population declines and near total reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Marbled Murrelets*	YES (8,000 TO 12,000)	YES	NO	STABLE OR CONTINUING DECLINE	NO	YES	YES**	YES**	YES**	Measurable affect on populations with comparisons to pre-spill conditions. Estimated adult mortality 8,000 to 12,000. Marbled murrelet populations were declining prior to the spill. Hydrocarbon contamination was found in livers of adult birds.
Peale's Peregrine Falcons	YES	UNKNOWN	NO	--	--	--	--	--	--	
Pigeon Guillemots*	YES (1,500 TO 3,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES**	YES**	YES**	Over 500 carcasses were recovered. Between 1500 and 3000 were estimated to have been killed by the spill. Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found in birds and, externally, on eggs.
Storm Petrels	YES	NO	AWAITING RESULTS	NO CHANGE	UNKNOWN	YES**	YES**	YES**	YES**	

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-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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	VARIES BY SPECIES	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Total seabird recovery has not been measured. Species collected dead 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	NO	NO	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	More than 2,000 sea duck carcasses were recovered. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil. Species collected dead 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.
Other Shorebirds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	Species collected dead include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpiper; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.

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-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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 Birds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Species collected dead 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.
FISH										
Cutthroat Trout	YES, SEE COMMENTS	NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead bodies were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Dolly Varden	YES, SEE COMMENTS	NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead fish were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
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. 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.

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-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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.	
Pink Salmon	YES, TO EGGS AND LARVAE	NOT DETECTED	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial mortality of eggs and larvae, but adult mortality was not detected. Significant exposure to hydrocarbons by adults, sub-adults, and eggs. Some sub-lethal effects determined on juveniles. Egg mortality continues to be high in oiled streams of PWS in 1991.
Rockfish	YES	UNKNOWN	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	Approximately 16 dead fish were found but only a few were in condition to be analyzed. Significant exposure to hydrocarbons with some sub-lethal effects were determined in those fish, but no effects established on the population. Spill increased fishing pressures which may be impacting population.
Sockeye Salmon	YES, TO SMOLT	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. As a result, future adult returns are expected to be low. Trophic structures of Kenai and Skilak Lakes altered by overescapement.
SHELLFISH										
Clam	UNKNOWN	UNKNOWN	POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	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	--	--	--	--	--	--	

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-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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.	
Oyster	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	Although studies were initiated in 1989, they were not completed because they were determined to be of limited value.
Sea Urchin	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	
Shrimp	UNKNOWN	UNKNOWN	NO	--	--	--	--	--	--	
INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	YES	YES	YES	Measureable impacts on populations occurred in comparison to pre-spill conditions. The lower intertidal and, to some extent, the mid intertidal is recovering. Some species in the upper intertidal zone have not recovered.
Subtidal										

* Population may have been declining prior to the spill;
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-- If no injury was detected or known, no assessment of recovery could be made.

RPWG I

Fax Message

To: RPWG Injury to Services - Subgroup

John Strand	fax # 789-6608
Ray Thompson	fax # 276-7178
Veronica Gilbert	fax # 276-7178
Chris Swenson	fax # 276-7178

From: Sanford P. Rabinowitch, Restoration Program Manager
National Park Service
2525 Gambell Street - Anchorage, Alaska 99503
phone: 907-257-2653 - fax: 907-257-2510

Date: January 15, 1992 -- pages follow --

Message: Draft Text - "Services Injury" for Draft Restoration Plan

As previously agree by RPWG I am circulating the attached draft texts for subgroup review. I would like any comments you have by close of business Wednesday Jan. 20. If it appears that anyone has considerable substantive comment I may try to convene a brief meeting on Thursday the 21st so we can discuss such comments and move forward. If comments are relatively minor I will merely ask each author to consider them and make appropriate changes. I will communicate with each of you after I get the comments from the group Wednesday.

Please remember, that our next deadline is to complete the package and give it to the full RPWG on Friday, Jan. 22. After that review (no dates yet set) this will move along to the RT level review.

If you have any questions regarding the above please give me a call.

Attachments:

* Subsistence
* Archaeology
* Wilderness and Intrinsic Values
* Commercial Fishing
* Sport Fishing

** Not attached: "Recreation" (draft is expected Tuesday Jan. 19) This will be delivered to subgroup members immediately upon receipt

d:sandy\fax\servgrou.fax

DRAFT

II. Injured Resources and Services

B. Conclusions - Subsistence

SUMMARY

Surveys conducted by the State of Alaska before the spill and 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, English Bay, Larsen Bay, 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 and oiled seals) were determined to be safe for human consumption. Warnings were issued in 1989 to avoid consumption of shellfish from oiled beaches.

Proposed restoration options address the need to restore the confidence of subsistence hunters and fishers 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 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 the 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.

In the first year (April 1989 to March 1990) following the spill, subsistence harvests of fish and wildlife in 10 of these villages (Chenega Bay, Tatitlek, English Bay, Port Graham, Karluk, Old Harbor, Ouzinkie, Port Lions, Chignik Lagoon) declined from 14 to 77% 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.

The Expert Toxicological Committee of the Oil Spill Health Task Force (OSHTF) tested the safety of using subsistence foods 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 polycyclic aromatic hydrocarbons (PAHs) and other hydrocarbon 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 PAHs, 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 hydrocarbon metabolites in their edible tissues. Some samples of shellfish, however, had unacceptably high levels of PAH's prompting the OSHFT to conclude that shellfish should not be collected from obviously oil-contaminated areas (ADHSS 1989b).

RECOVERY

In the second year following the spill (April 1990 to March 1991), Fall (1992) determined that the per capita harvest of subsistence resources in Chenega remained unchanged (143.1 lbs). In Tatitlek, the per capita harvest was even lower (155.2 lbs) than the 214.5 lbs reported the previous year. In contrast, five other villages studied during the second year showed an increased subsistence harvest. At English Bay, the per capita harvest was 181.1 pounds during the second year compared to 141.0 lbs for the first post-spill year. Ouzinkie's per capita harvest increased to 204.9 pounds per person from a low of 88.8 pounds per person, but this was significantly below the pre-spill baseline of 402.8 pounds per person. In Port Graham, the harvest increased from 122.0 pounds in 1989 to 213.5 lbs, essentially the pre-spill harvest level. The Larsen Bay harvest also increased significantly from 209.0 lbs to 340 lbs, but is still below the pre-spill level of 403.5 lbs. Karluk's harvest of 395.2 lbs in 1990-1991 essentially matched the 385.2 pound harvest of 1986. This was substantially lower than an 1982-1983 estimate of 863.0 lbs.

The finding that subsistence harvests had increased in five villages during the 1990-1991 timeframe suggested a renewed confidence in using some subsistence resources. However, the

continued very low levels of harvest at Chenega Bay and Tatitlek, 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 not believed that subsistence harvests have 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.

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.

30A - Test Subsistence Foods for Residual Hydrocarbon Contamination

This option is designed 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, English Bay [Nanwalek], Port Graham, Ahkiok, Karluk, Old Harbor, Ouzinkie, Port Lions, Chignik Lagoon, Kodiak City, Cordova, Valdez, Seldovia, Kenai, and Seward). Community representatives will assist in site selection, as well as collection of samples. Additionally, bile and blubber samples will be taken from five 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 interpreted by the OSHTF, and 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 and cost approximately $1,000,000. 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.

30B - Provide Access to Alternative Subsistence Foods

The goal of this option is to mininize 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. This project will provide funds for subsistence hunters from Chenega to travel to eastern Prince William Sound to harvest traditional subsistence resources not injured or contaminated by the oil spill. Funding also would be provided to facilitate subsistence hunters in other native communities to assist the Chenegans by gathering, preserving and forwarding subsistence foods to Chenega. This support will continue until the resources in the subsistence area traditionally used by the Chenagans 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. Cost to implement this option is approximately $53,000 per year. If the program continued for 10 year, the total cost of the option would be $530,000.

30C - Develop Shellfish Mariculture in Impacted Subsistence Areas

*** May need to re-write if villages not interested in culturing native shellfish species, i.e., turn into a beach-seeding option.***

This program will provide the villages of Chenega, Tatitlek, Port Graham, 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 establishing clam and scallop mariculture.

Tatitlek, Eyak and Chenega Bay already have begun to develop oyster culture. Seed of Pacific oyster has been obtained from Washington and Oregon, and excellent growth rates have been achieved with bag

and net culture techniques in eastern Prince William Sound. A good market exists for oysters grown in Alaska, and oysters have proven to be an acceptable substitute for local subsistence shellfish species (oysters are not native to Alaska).

For those villages already permitted (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, 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.

The bulk of costs for this program is associated with developing a mariculture management structure in each village and training village residents in mariculture techniques. The intent is to develop a self-sustaining program in three years at a cost of approximately $600,000.

30D - Bivalve Shellfish Hatchery Research Center

The initial objective of this program 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. The first task 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. A consultant with both biological and engineering background will be hired to conduct the feasibility analysis. Costs of this one-year project are estimated to be $56,000. Native communities and organizations in the affected area are expected to participate in the design and conduct of the feasibility project. The next stage would be to construct the actual hatchery facility. Seward has been suggested as a possible site, although Prince William Sound, Lower Cook Inlet and Kodiak are also possibilities. Construction costs have been roughly estimated at $2 million. Shellfish spat produced in this facility 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.

18 - Replace Fisheries Harvest Opportunities by Establishing 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 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 to avoid disruption of existing commercial and sport fisheries and to comply with ADF&G policies and guidelines on fish genetics.

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Chapter II. Injured Resources and Services
draft: Sandy Rabinowitch - 1/11/93

Conclusions - Wilderness and Intrinsic Values

SUMMARY

The oil spill area contains large blocks of state and federal lands of relatively undeveloped uplands which are generally perceived to be "wilderness" by the public. Some areas have been formally designated as wilderness by the U. S. Congress and by the Alaska Legislature, 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 area of the Chugach National Forest.

Federal areas are to be 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.

INJURY

The oil spill brought oil in varying quantities to the adjoining waters of all the designated and un-designated wilderness areas. In isolated areas oil was deposited above the mean high tide-line.[1] 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 all 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. State of Alaska economic studies support this perspective.

>>Do we want to get into miles of wilderness shoreline oil here?? If so, we need to agree to criteria and then have each agency give me figures for their area - NPS, FWS, DNR<<

During the more intense clean-up seasons of 1989-1990, hundreds of workers and associated boats, aircraft and clean-up 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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[1]Wilderness designations include uplands generally above the mean high tide land.

RECOVERY

In small isolated areas oil remains in designated and un-designated wilderness areas. Although the oil, in general is degrading, it remains surprisingly tenacious in some locations, as a result, injury to wilderness and intrinsic values continue. The massive intrusion of people and equipment associated with oil spill clean - up has now ended. To a lesser extent, there is some perception, 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 (people report finding stakes in beaches).

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

Option # 37 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.[2]

Option # 40 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:

* state economic study -- get correct title etc...

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

Chapter II. Injured Resources and Services

Conclusions - Archeological Sites

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, cleanup 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 cleanup 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 - Site Stewardship

This option 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 and Native villages and corporations will be brought into the project as cooperators to facilitate communications and operations. The Trustee Council has already begun 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 - Preservation of Archeological Sites and Artifacts

The purpose of this option is three-fold. 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 or 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 - 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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II. Injured Resource and Services

B. Conclusions - Sport Fishing

INJURY

Several species targeted by sport fishermen were injured by the spill, including pink and sockeye salmon, cutthroat trout, Dolly Varden, and rockfish. The only spill-related sport fish closure to date has been the 1992 emergency order restricting Dolly Varden and cutthroat trout fishing in western Prince William Sound. However, sockeye closures are anticipated in the Cook Inlet and Kodiak areas.

Spill-related sockeye overescapements in the Kenai River and Red Lake (Kodiak Island) systems altered the trophic structures of lakes used for fry rearing. This resulted in extremely low fry escapements from the Kenai River in ********** and delayed the emigration of Red Lake sockeye fry ***by a year. It is anticipated that this could result in reduced adult returns to these systems starting as early as 1993, which may require closing or restricting sport, commercial and subsistence fishing for these runs. Closure of the Kenai River sockeye runs would have major impacts on sport fishing.

Pink salmon egg mortality and reduced juvenile growth rates were observed in Prince William Sound.*********

ADF&G data documented a significant decline in sport fishing from 1988 to 1989 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. This information is contained in a December 1992 ADF&G Special Publication #92-5 titled, Alaska Sport Fishing in the Aftermath of the Exxon Valdez Oil Spill, by Michael Mills, Sport Fish Division.

Sport fishing for cutthroat trout and Dolly Varden in western Prince William was restricted or closed by emergency order in 1992 due to lowered growth and survival rates of these species. It is hypothesized that the injury is due to decreased availability of food in nearshore areas caused by injuries to the food chain.

The injury to rockfish is not fully understood, although exposure to petroleum hydrocarbons was demonstrated and residual hydrocarbons have been found in tissues. An additional, indirect injury may have been inflicted by significantly increased commercial fishing pressure on rockfish. 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.

RECOVERY

Cutthroat trout and Dolly Varden fishing will probably remain closed or restricted in the western Sound in 1993, and will not reopen until populations recover. The impact of sockeye overescapements on adult returns has not yet been seen, but is anticipated to begin in 1993 and may continue for multiple generations. Pink salmon *******. The recovery of rockfish from direct spill effects is unknown. Insufficient population and harvest data exist to determine whether and to what degree rockfish populations are being diminished by overfishing.

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

Many of the options for restoring sport fishing injuries focus on restoring injured sport species. By restoring the species upon which the service depends, the service will also be restored. These types of options are described under the species injury summaries for sockeye and pink salmon, cutthroat trout, Dolly Varden and rockfish. Species restoration strategies include enhancing fisheries management plans, improving habitat and fry survival, and acquiring and protecting fish habitat (Options 2, 11, XX***, 19, 37 and 40).

However, three options are proposed which could be primarily used to mitigate lost sport fishing opportunities. These options do not directly restore injured fish populations. Instead, they provide new fishing opportunities or provide new access routes for fishermen. Most of these options could also benefit commercial and subsistence 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 11.2: Fertilize Lakes to Improve Sockeye Fry Survival

This option entails fertilizing lakes used by rearing sockeye fry. Adding nutrients stimulates blooms of phytoplankton, in turn supporting zooplankton, which are the primary food source for rearing sockeye. Plentiful food helps ensure good juvenile growth and survival rates and can increase adult returns to

levels of maximum sustainable yield. Care must be taken, however, not to exceed the environmental carrying capacity of the spawning and rearing habitat.

For a variety of reasons, this option is not applicable in the Kenai and Kodiak lake systems which suffered trophic injuries due to overescapement. Therefore, it can only be used to enhance existing sockeye runs in other areas, such as Coghill Lake. The option does not restore known spill injuries to sockeye runs but instead provides sport, commercial and subsistence fishing opportunities to replace those lost due to fishery closures throughout the spill area.

Currently, Coghill Lake is the only candidate for fertilization, although there may be others in the future. The option would continue until either returning adults became abundant enough to fertilize the lake with their carcasses, or injured runs in other areas had recovered to the point that they could again sustain harvest pressures. It would take approximately 5 years to complete this option for Coghill Lake, at a total cost of approximately $192 K.

Option 18: 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. In addition, new runs could potentially prevent fishing closures by diverting fishing pressure from injured runs before it became necessary to close fisheries. The option could benefit sport, subsistence and commercial fisheries.

New salmon runs could either take the form of terminal runs returning to hatcheries and remote release sites or new, self-perpetuating runs returning to streams. Either of these alternatives would have to be implemented with great care to avoid disruption of existing fisheries and to comply with ADF&G policies and guidelines on fish genetics.

The runs would probably be continued until wild-stocks recover. If they continue beyond this time, it will be in the context of enhancing the service level above pre-spill levels. The option is applicable to all areas where fishermen are anticipated to be impacted by spill-related fishery closures or restrictions. This currently includes the Kenai and Kodiak areas where sockeye runs are anticipated to decline drastically. Two to three new runs could be established in each of these regions. Starting new runs in Prince William Sound is problematic due to potential overlaps in timing and fishing areas for existing runs. At a cost of $**** to $**** for each run, the total cost of the option ranges from $**** to $****.

Option 28: Acquire Access to Sport Fishing and Recreational Areas

Injuries to sport fishing can be partially restored by acquiring access for sport fishing and recreational areas. While much of the land in the spill area is publicly owned, some is owned by private parties who do not always allow access across their lands. Access could be created through fee simple purchase of lands or negotiation of easements. This option could, but does not have to be, associated with other options to construct small-scale facilities such as boat ramps and parking lots. Environmental impacts of increased use could be minimized by siting access points in areas which currently receive heavy use.

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. Two to three new access point could be established in each of these three areas. At a cost of $*** to $*** for each land or easement purchase, the total option cost is from $*** to $***. The time required to negotiate easements or purchase land is highly variable but can often be accomplished in under a year.

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II. Injured Resource and Services

B. Conclusions - Commercial Fishing

INJURY

The oil spill resulted in 1989 emergency fishery closures in Prince William Sound, Cook Inlet, and the waters around Kodiak and the Alaska Peninsula. This included closures for salmon, herring, crab, shrimp, rockfish and sablefish. In 1990, a portion of Prince William Sound was closed to shrimp fishing. There are currently no spill-related fishery closures in effect. However, Kenai River and Red Lake sockeye runs may be closed or restricted as early as 1993.

Several species targeted by commercial fishermen were injured by the spill. Spill-related sockeye overescapements in the Kenai River and Red Lake (Kodiak Island) systems altered the trophic structures of lakes used for fry rearing. This resulted in extremely low fry escapements from the Kenai River in ********** and delayed the emigration of Red Lake sockeye fry ***by a year. It is anticipated that this could result in reduced adult returns to these systems starting as early as 1993, which may require closing or restricting sport, commercial and subsistence fishing for these runs. Closure of the Kenai River and Red Lake sockeye runs would have major impacts on commercial fishing.

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The injury to rockfish is not fully understood, although exposure to petroleum hydrocarbons was demonstrated and residual hydrocarbons have been found in tissues. An additional, indirect injury may have been inflicted by significantly increased commercial fishing pressure on rockfish. 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.

RECOVERY

There are currently no spill-related fishery closures. However, the impact of sockeye overescapements on adult returns has not

yet been seen, but is anticipated to begin in 1993 and may continue for multiple generations. Pink salmon *****. The recovery of rockfish from direct spill effects is unknown. Insufficient population and harvest data exist to determine whether and to what degree rockfish populations are being diminished by overfishing.

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

Many of the options for restoring commercial fishing injuries focus on restoring injured commercial species. By restoring the species upon which the service depends, the service will also be restored. These types of options are described under the species injury summaries for sockeye and pink salmon and rockfish. Species restoration strategies include enhancing fisheries management plans, improving habitat and fry survival, and acquiring and protecting fish habitat (Options 2, 11, XX***, 19, 37 and 40).

However, two options are proposed which could be primarily used to mitigate lost commercial fishing opportunities. These options do not directly restore injured fish populations. Instead, they provide new fishing opportunities. Most of these options could also benefit sport and subsistence fishermen. The user groups which benefit would be determined by the species targeted, where the options are implemented, and harvest allocations, which are ultimately determined by the Board of Fisheries. The options are described below.

Option 11.2: Fertilize Lakes to Improve Sockeye Fry Survival

This option entails fertilizing lakes used by rearing sockeye fry. Adding nutrients stimulates blooms of phytoplankton, in turn supporting zooplankton, which are the primary food source for rearing sockeye. Plentiful food helps ensure good juvenile growth and survival rates and can increase adult returns to levels of maximum sustainable yield. Care must be taken, however, not to exceed the environmental carrying capacity of the spawning and rearing habitat.

For a variety of reasons, this option is not applicable in the Kenai and Kodiak lake systems which suffered trophic injuries due to overescapement. Therefore, it can only be used to enhance existing sockeye runs in other areas, such as Coghill Lake. The option does not restore known spill injuries to sockeye runs but instead provides sport, commercial and subsistence fishing opportunities to replace those lost due to fishery closures throughout the spill area.

Currently, Coghill Lake is the only candidate for fertilization, although there may be others in the future. The option would

continue until either returning adults became abundant enough to fertilize the lake with their carcasses, or injured runs in other areas had recovered to the point that they could again sustain harvest pressures. It would take approximately 5 years to complete this option for Coghill Lake, at a total cost of approximately $192 K.

Option 18: 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. In addition, new runs could potentially prevent fishing closures by diverting fishing pressure from injured runs before it became necessary to close fisheries. The option could benefit sport, subsistence and commercial fisheries.

New salmon runs could either take the form of terminal runs returning to hatcheries and remote release sites or new, self-perpetuating runs returning to streams. Either of these alternatives would have to be implemented with great care to avoid disruption of existing fisheries and to comply with ADF&G policies and guidelines on fish genetics.

The runs would probably be continued until wild-stocks recover. If they continue beyond this time, it will be in the context of enhancing the service level above pre-spill levels. The option is applicable to all areas where fishermen are anticipated to be impacted by spill-related fishery closures or restrictions. This currently includes the Kenai and Kodiak areas where sockeye runs are anticipated to decline drastically. Two to three new runs could be established in each of these regions. Starting new runs in Prince William Sound is problematic due to potential overlaps in timing and fishing areas for existing runs. At a cost of $**** to $**** for each run, the total cost of the option ranges from $**** to $****.

Option 2: Enhance Fishery Management Plans

This option targets Dolly Varden and cutthroat trout in Prince William Sound and sockeye salmon in the Kenai River and Red Lake systems, assuming future adult sockeye returns are so low as to require emergency fishery closures or restriction of bag limits. Other species requiring spill-related emergency closures could be included later.

The Alaska Department of Fish and Game (ADF&G) manages fish to ensure that a sufficient number escape each year to spawn and maintain the population at a maximum sustainable level. When populations are damaged or harvest levels threaten to reduce this level, ADF&G can order emergency closures of the fishery. Spill injuries have already resulted in emergency closures for cutthroat trout and may occur for sockeye. These closures will remain in effect until populations recover. In addition, the Board of Fisheries can also impose long term closures if populations are too low to sustain harvest.

The recovery of the species is aided by the closure, but the fisheries dependent on the species suffer. With more complete and precise management information, resource managers may be able to re-open fisheries at an earlier date or re-direct harvest to other stocks which can sustain increased harvest pressure. Managers who do not have accurate or complete biological data take a conservative management approach and will not risk opening or redirecting closed fisheries

Management plan enhancement entails gathering detailed biological data. This is the most expensive, time-consuming and important part of the option. Additional research can focus on quantifying stock characteristics such as abundance, age and size composition, natural mortality rates, seasonal movements, migration routes, and juvenile recruitment rates.

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

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
MARINE MAMMALS										
Harbor Seals*	YES (200)	YES*	YES	POSSIBLY STABLE, BUT NOT RECOVERING*	UNKNOWN	YES	YES**	UNKNOWN	UNKNOWN	Many seals were directly oiled and over 200 seals were estimated to have been killed. There was a measurable difference in populations between oiled and unoiled areas in PWS. 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	--	--	--	--	--	--	
Killer Whales	YES	YES	UNKNOWN	RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	13 adult whales of the 36 in AB pod are missing and presumed dead. The AB pos has grown by 2 whales since 1990. It is not certain that the disappearance of whales was due to the oil spill.
Sea Lions*	~~YES~~ UNKNOWN	UNKNOWN	~~YES~~ NO	CONTINUING DECLINE*	--	--	--	--	--	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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Sea Otters	YES (3,500 TO 5,500)	YES	YES	STABLE, BUT NOT RECOVERING	YES, PROBABLY	YES	YES	YES**	YES**	Although about 1000 dead sea otters were found, 3500 to 5500 were estimated to have been killed. Post-spill surveys showed measurable difference in populations and survival between oiled and unoiled areas. Survey data have not established a significant recovery. Prime-age animals are still being found on beaches. 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	--	--	--	--	--	--	No field studies were done.
Brown Bear	NO	NO	~~YES~~ NO	--	--	--	--	--	--	Hydrocarbon exposure documented on Alaska Peninsula in 1989.
River Otters	YES	~~NOT DETECTED~~ UNKNOWN	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Significant exposure to hydrocarbons and sub-lethal effects determined, but no effects 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	~~YES~~ NO	--	--	--	--	--	--	Elevated hydrocarbons found in tissues in some deer in 1989.
BIRDS										

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Bald Eagles	YES	NO	YES	RECOVERING	UNKNOWN	YES	YES	YES**	YES**	Productivity disrupted in 1989. Population estimates and productivity returned to normal in 1990. Significant exposure to hydrocarbons and some sub-lethal effects found in 1989 and 1990, but no continuing effects established on populations.
Black-legged Kittiwakes	YES	NO	~~YES~~ NO	NO CHANGE	NO	YES	YES**	YES**	YES**	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 the reproductive failure may be unrelated to the oil spill.
Black Oyster-catchers	YES	YES	YES	RECOVERING	YES	YES	YES**	YES**	YES**	Differences in egg size between oiled and unoiled areas persist. Significant exposure to hydrocarbons and some sub-lethal effects determined. Populations declined more in oiled areas than unoiled areas in post-spill surveys. Black oystercatchers feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Common Murres	YES (175,000 to 300,000)	YES	YES	STABLE, BUT NOT RECOVERING ~~CONTINUING DECLINE~~	YES	NO	YES	YES	YES	Measurable impacts on populations with comparisons to pre-spill conditions. Adult mortality 175,000-300,000. Breeding is still inhibited in some colonies in the Gulf of Alaska.
Glaucous-winged gulls	YES	NOT DETECTED	NO	NO CHANGE	NO	YES**	YES**	YES**	YES**	

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Harlequin Ducks	YES	YES	YES	STABLE OR CONTINUING DECLINE	YES	YES	YES**	YES**	YES**	Post-spill samples showed hydrocarbon contamination and poor body conditions. Surveys indicate population declines and near total reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Marbled Murrelets*	YES (8,000 TO 12,000)	YES	~~YES~~ NO	STABLE OR CONTINUING DECLINE	NO	YES	YES**	YES**	YES**	Measurable affect on populations with comparisons to pre-spill conditions. Estimated adult mortality 8,000 to 12,000. Marbled murrelet populations were declining prior to the spill. Hydrocarbon contamination was found in livers of adult birds.
Peale's Peregrine Falcons	YES	~~NOT DETECTED~~ UNKNOWN	~~YES~~ NO	--	--	--	--	--	--	
Pigeon Guillemots*	YES	YES	~~YES~~ NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES**	YES**	YES**	Over 500 carcasses were recovered. Between 1500 and 3000 were estimated to have been killed by the spill. Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found in birds and, externally, on eggs.
Storm Petrels	YES	NO	AWAITING RESULTS	NO CHANGE	UNKNOWN	YES**	YES**	YES**	YES**	

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality ~~(total mortality estimate)~~	~~Measured Decline in Population~~ after the spill	~~Evidence of~~ Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	~~Evidence of Continuing~~ Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Other Seabirds	YES	VARIABLE	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	~~Adult mortality of 375,000 to 435,000 birds.~~ Total seabird recovery has not been measured. Species collected dead 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	~~YES~~ NO	~~YES~~ NO	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	More than 2,000 sea duck carcasses were recovered. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil. Species collected dead 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.
Other Shorebirds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	Species collected dead include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpiper; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality ~~(total mortality estimate)~~	Measured Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Other Birds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Species collected dead 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.
FISH										
Cutthroat Trout	~~NO~~ YES, SEE COMMENTS	~~YES~~ NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead bodies were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Dolly Varden	~~NO~~ YES, SEE COMMENTS	~~YES~~ NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead fish were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Pacific Herring	YES, TO EGGS AND LARVAE	UNKNOWN	YES	UNKNOWN	~~YES~~ NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable difference in egg counts between oiled and unoiled areas. 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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Pink Salmon	YES, TO EGGS AND LARVAE	NOT DETECTED	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial mortality of eggs and larvae, but adult mortality was not detected. Significant exposure to hydrocarbons by adults, sub-adults, and eggs. Some sub-lethal effects determined on juveniles. Egg mortality continues to be high in oiled streams of PWS in 1991.
Rockfish	YES	UNKNOWN	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	~~A large number of~~ Approximately 16 dead fish were found but only a few were in condition to be analyzed. Significant exposure to hydrocarbons with some sub-lethal effects were determined in those fish, but no effects established on the population. Spill increased fishing pressures which may be impacting population.
Sockeye Salmon	~~UNKNOWN~~ YES, TO SMOLT	YES	YES	SEE COMMENTS	YES	UNKNOWN	YES	YES	NO	~~Assumed loss of juveniles in oiled areas.~~ Smolt survival continues to be poor in the Red Lake and Kenai River systems due to overescapements. As a result, future adult returns are expected to be low. Trophic structures of Kenai and Skilak Lakes altered by overescapement.
SHELLFISH										
Clam	UNKNOWN	UNKNOWN	~~YES~~ POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality ~~(total mortality estimate)~~	Measured Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Crab (Dungeness)	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	~~Subtidal sediments collected in 1989 were found to be contaminated at 5 of 8 locations hypothesized to be oiled. Crabs from these locations, however, were not found to contain hydrocarbons.~~
Oyster	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	Although studies were initiated in 1989, they were not completed because they were determined to be of limited ~~litigative~~ value.
Sea Urchin	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	~~Lab study demonstrated significant reduction in fertilization when exposed to both fresh and weathered Prudhoe Bay crude oil.~~
Shrimp	UNKNOWN	UNKNOWN	~~YES~~ NO	--	--	--	--	--	--	~~In 1990, total number of eggs per female at given size appears to be less in oiled areas. In 1990 a greater number of dead eggs occurred when compared to 1989 or unoiled areas.~~
INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	~~STABLE, BUT NOT RECOVERING (VARIES BY SPECIES)~~ VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	YES	YES	YES	Measureable impacts on populations in comparison to pre-spill conditions. The lower intertidal and, to some extent, the mid intertidal is recovering. Some species in the upper intertidal zone have not recovered. ~~Upper intertidal zone has not yet recovered.~~

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured Decline in Population after the spill	Evidence of Sublethal or Chronic Effects ~~or Exposure~~	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects ~~or Exposure~~	PWS	Kenai	Kodiak	Alaska Penin.	
Subtidal Communities	YES	YES	YES	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Recovery is not known but there were measurable differences between oiled and unoiled areas in 1990.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

H RWG

gorbics/December 17, 1992

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

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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*	YES (200)	YES*	YES	POSSIBLY STABLE, BUT NOT RECOVERING*	UNKNOWN	YES	YES**	UNKNOWN	UNKNOWN	Many seals were directly oiled and over 200 seals were estimated to have been killed. There was a measurable difference in populations between oiled and unoiled areas in PWS. 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	--	--	--	--	--	--	
Killer Whales	YES	YES	UNKNOWN	RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	13 adult whales of the 36 in AB pod are missing and presumed dead. The AB pos has grown by 2 whales since 1990. It is not certain that the disappearance of whales was due to the oil spill.
Sea Lions*	UNKNOWN	UNKNOWN	NO	CONTINUING DECLINE*	--	--	--	--	--	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.

* Population may have been declining prior to the spill;
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*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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 5,500)	YES	YES	STABLE, BUT NOT RECOVERING	YES, PROBABLY	YES	YES	YES**	YES**	Although about 1000 dead sea otters were found, 3500 to 5500 were estimated to have been killed. Post-spill surveys showed measurable difference in populations and survival between oiled and unoiled areas. Survey data have not established a significant recovery. Prime-age animals are still being found on beaches. 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	--	--	--	--	--	--	No field studies were done.
Brown Bear	NO	NO	NO	--	--	--	--	--	--	Hydrocarbon exposure documented on Alaska Peninsula in 1989.
River Otters	YES	UNKNOWN	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Significant exposure to hydrocarbons and sub-lethal effects determined, but no effects 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	--	--	--	--	--	--	Elevated hydrocarbons found in tissues in some deer in 1989.
BIRDS										

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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.	
Bald Eagles	YES	NO	YES	RECOVERING	UNKNOWN	YES	YES	YES**	YES**	Productivity disrupted in 1989. Population estimates and productivity returned to normal in 1990. Significant exposure to hydrocarbons and some sub-lethal effects found in 1989 and 1990, but no continuing effects established on populations.
Black-legged Kittiwakes	YES	NO	NO	NO CHANGE	NO	YES	YES**	YES**	YES**	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 the reproductive failure may be unrelated to the oil spill.
Black Oyster-catchers	YES	YES	YES	RECOVERING	YES	YES	YES**	YES**	YES**	Differences in egg size between oiled and unoiled areas persist. Significant exposure to hydrocarbons and some sub-lethal effects determined. Populations declined more in oiled areas than unoiled areas in post-spill surveys. Black oystercatchers feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Common Murres	YES (175,000 to 300,000)	YES	YES	STABLE, BUT NOT RECOVERING	YES	NO	YES	YES	YES	Measurable impacts on populations with comparisons to pre-spill conditions. Adult mortality 175,000-300,000. Breeding is still inhibited in some colonies in the Gulf of Alaska.
Glaucous-winged gulls	YES	NOT DETECTED	NO	NO CHANGE	NO	YES**	YES**	YES**	YES**	

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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.	
Harlequin Ducks	YES	YES	YES	STABLE OR CONTINUING DECLINE	YES	YES	YES**	YES**	YES**	Post-spill samples showed hydrocarbon contamination and poor body conditions. Surveys indicate population declines and near total reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Marbled Murrelets*	YES (8,000 TO 12,000)	YES	NO	STABLE OR CONTINUING DECLINE	NO	YES	YES**	YES**	YES**	Measurable affect on populations with comparisons to pre-spill conditions. Estimated adult mortality 8,000 to 12,000. Marbled murrelet populations were declining prior to the spill. Hydrocarbon contamination was found in livers of adult birds.
Peale's Peregrine Falcons	YES	UNKNOWN	NO	--	--	--	--	--	--	
Pigeon Guillemots*	YES	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES**	YES**	YES**	Over 500 carcasses were recovered. Between 1500 and 3000 were estimated to have been killed by the spill. Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found in birds and, externally, on eggs.
Storm Petrels	YES	NO	AWAITING RESULTS	NO CHANGE	UNKNOWN	YES**	YES**	YES**	YES**	

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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	VARIABLE	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Total seabird recovery has not been measured. Species collected dead 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	NO	NO	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	More than 2,000 sea duck carcasses were recovered. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil. Species collected dead 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.
Other Shorebirds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	Species collected dead 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	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Species collected dead 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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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	NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead bodies were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Dolly Varden	YES, SEE COMMENTS	NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead fish were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
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. 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.
Pink Salmon	YES, TO EGGS AND LARVAE	NOT DETECTED	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial mortality of eggs and larvae, but adult mortality was not detected. Significant exposure to hydrocarbons by adults, sub-adults, and eggs. Some sub-lethal effects determined on juveniles. Egg mortality continues to be high in oiled streams of PWS in 1991.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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	UNKNOWN	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	Approximately 16 dead fish were found but only a few were in condition to be analyzed. Significant exposure to hydrocarbons with some sub-lethal effects were determined in those fish, but no effects established on the population. Spill increased fishing pressures which may be impacting population.
Sockeye Salmon	YES, TO SMOLT	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. As a result, future adult returns are expected to be low. Trophic structures of Kenai and Skilak Lakes altered by overescapement.
SHELLFISH										
Clam	UNKNOWN	UNKNOWN	POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	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	--	--	--	--	--	--	
Oyster	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	Although studies were initiated in 1989, they were not completed because they were determined to be of limited value.
Sea Urchin	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	
Shrimp	UNKNOWN	UNKNOWN	NO	--	--	--	--	--	--	

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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.	
INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	YES	YES	YES	Measureable impacts on populations in comparison to pre-spill conditions. The lower intertidal and, to some extent, the mid intertidal is recovering. Some species in the upper intertidal zone have not recovered.
Subtidal Communities	YES	YES	YES	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Recovery is not known but there were measurable differences between oiled and unoiled areas in 1990.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

APPLIED Marine SCIENCES

RPW6
I

DATE: 9/29/92

PAGES: 2

TO: JOHN STRAND

FAX #: (407) ~~784-6608~~ -276-7178 CACI

FROM: BOB SPIES

FAX # (510) 373-7834

MESSAGE:

JOHN,

HERE IS A DRAFT VERSION OF THE TABLE SUMMARIZING INJURY FROM THE SPILL. PLEASE LET ME KNOW ~~HOW~~ HOW YOU THINK IT MIGHT BE IMPROVED. I'LL BE REVISING THIS FOR DISTRIBUTION TO RPW6 AGAIN.

BOB

P.S. LET ME KNOW IF YOU CAN'T READ THIS COPY.

2155 Las Positas Court, Suite S
Livermore, CA 94550
510 373-7142

Table XX. Summary of injury from Exxon Valdez oil spill.

RESOURCE	INJURY (uncertainty 1-5)*				geographic extent of injury			Degree of recovery (1991)††
	eggs/young	subadults	adults	Total Adult Mortality	PWS	Kenai Peninsula/ Kodiak Island	Alaskan Peninsula	
Harbor seals	yes (2)	yes (2)	yes (2)	approx 200	yes	unknown	unknown	Differences between oiled and unoiled areas persist in PWS, but there is an upward population trend in the oiled area.
Sea otters	yes (1)	yes (1)	yes (1)	approx 4,600	yes	yes	yes	Boat survey data have not established a significant recovery, a large proportion of prime-age animals are still being found on beaches.
River otters	unknown	unknown	yes (4)	approx. 12	yes	unknown	unknown	Some sub-lethal indicators of possible oil exposure remain in 1991.
Killer whales	no	yes (3)**	yes (3)**	13	yes	unknown	unknown	The AB pod has grown by 2 whales since 1990.
Common murres	yes (1)***	yes (1)****	yes (1)	175,000 to 300000	no	yes	yes	Breeding is still inhibited in some colonies in the Gulf of Alaska.
Marbled murrelets	no	yes (1)	yes (1)	8,000 to 12000	yes	?	?	
Black oyster catchers	yes (4)	?	yes (3)	approx. 120	yes	yes	unknown	Differences in egg sizes between oiled and unoiled areas persist.
Bald eagles	yes (4)	unknown	yes (3)	150+	yes	yes	unknown	Population estimates unaffected and productivity returned to normal in 1990.
Pigeon guillemots	no	probably	yes (1)	approx 3,000	yes	yes	unknown	Unknown.
Harlequin ducks	yes	probably	yes (2,4)	approx 1,000	yes	yes	unknown	Still very little breeding in the spill areas of PWS.
Other sea birds	yes	yes	yes	375,000 to 435000	yes	yes	yes	In general total sea bird recovery has not been measured.
Pink salmon	yes (1)	yes (4)	no (5)	not detected	yes	unknown	unknown	Egg mortality continues to be high in oiled streams of PWS in 1991.
Sockeye salmon	yes (1)	yes (1)	unknown	unknown	no	yes	no	Smolt survival continues to be poor in the Kenai River system as

Table XX. Summary of injury from Exxon Valdez oil spill.

RESOURCE	INJURY (uncertainty 1-5)* eggs/young	subadults	adults	Total Adult Mortality	geographic extent of injury PWS	Kenai Peninsula/ Kodiak Island	Alaskan Peninsula	Degree of recovery (1991)††
								a result of the overescapements in 1987, 1988, and 1989.
Pacific herring	yes (2)	unknown	unknown	unknown	yes	unknown	unknown	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.
Rockfish	no	unknown	yes (3,4)	greater than 5 individuals	yes	unknown	unknown	Unknown.
Dolly varden	no	no	yes (2)†	unkown	yes	unknown	unknown	In 1991 differences in survival between anadramous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Cutthroat trout	no	no	yes (2)	unkown	yes	unknown	unknown	In 1991 differences in survival between anadramous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Intertidal organisms / communities	yes (1)	yes (1)	yes (1)	not calculated	yes	yes	yes	Upper intertidal zone has not yet recovered.
Subtidal communities	unknown	yes (2)	yes (2)	not calculated	yes	unknown	unknown	Recovery is not known, but differences between oiled and unoilled areas established in 1990.

* 1. dead oganisms found or measurable affect on populations with comparisons to pre-spill conditions, little doubt of injury

2. Few dead organisms found after spill, or measurable difference in populations between oiled and unoiled areas

3. A small number of adults killed, no effects determined on population

4. Significant exposure to hydrocarons and some sub-lethal effects determined, but no effects established on population.

5. Significant exposure to hydrocarbons but no effects established

** The coincidence of 13 whales missing from AB at the time of the spill is very suggestive of an effect, but there is also much evidence to suggest that they could not have been killed by the spill.

*** The loss of eggs was due to poor reproductive success in affected colonies, such as those on the Barren Islands in 1989-1992.

**** The carcasses have not been aged but it is thought that at least some sub-adults were affected by the spill.

† Differences have been measured in the rate of return of tagged fish to oiled and unoiled streams in 1990 and 1991.

†† Data from the 1992 field season has not been evaluated in most cases .

RPWG
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Memorandum January 6, 1993

TO: RPWG and Chief Scientist

FROM: Carol Gorbics CGorbics

SUBJECT: Follow-up on Injury Subgroup Conclusions

The subgroup has reminded me that we developed a table of resources injured at the population level and subpopulation level based on the Injury Table. I inadvertently omitted it from the report that was previously provided, so here it is.

RESOURCES INJURED AT A POPULATION LEVEL

Harbor seals
Sea otters
Killer whales
Common murres
Marbled murrelet
Pigeon guillemots
Harlequin ducks
Black oystercatchers
Sockeye salmon smolts
Intertidal organisms
Subtidal organisms

RESOURCES INJURED AT A SUBPOPULATION LEVEL

River otters
Bald eagles
Black-legged kittiwakes
Pink salmon
* Pacific herring
* Rockfish
Dolly Varden
Cutthroat trout

*Recovery unknown

This information is taken from the summary table, so if changes to the summary table occur, changes to this list may occur, as well. Let me know if you have any comments by COB January 12. RPWG will be using this information in the alternatives development starting on January 13.

RPWG
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DEC 01 '92 12:29 OOSDAR

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

NATIONAL MARINE FISHERIES SERVICE
OFFICE OF OIL SPILL DAMAGE ASSESSMENT AND RESTORATION

P.O. 210029
11305 GLACIER HWY
AUKE BAY, ALASKA 99821

TELEPHONE: (907) 789-6600
FAX: (907) 789-6608

RAPIDFAX TRANSMISSION: 4 PAGES TO FOLLOW

DATE: 12-01

FROM: John Strand

TO: Barbara Iseah

FAX NUMBER: _____

SUBJECT: Spill comments to injury table

COMMENTS - please distribute to RPWG members

APPLIED
Submarine
SCIENCES

November 30, 1992

RECEIVED
DEC 1 1992
OIL SPILL OFFICE

Dr. John Strand
Chairman,
Restoration Work Planning Group
Oil Spill Office
NOAA/NMFS
Auke Bay Laboratory
11305 Glacier Highway
Juneau, Alaska 99801-8626

Dear John,

I had a break from reading the abstracts submitted for the spill symposium and spent some time reviewing the revisions made to the table summarizing injury. Some aspects of the table are definite improvements, however I find a number of problems with the table which in aggregate have the effect of painting a bleaker picture of injury and recovery than is actually the case. I present the major points first followed by points of lesser importance.

1. There is a basic problem with the title and content of the table. If it is a table summarizing injury then only species that were injured should be included, in which case sea lions, black bear, brown bear, falcons, petrels, kittiwakes, gulls, clams, shrimp, oysters, and sea urchins should not be included. With the species that are now included, it should be entitled "Species studied and others known to be injured". I strongly suggest that there be two or more tables (injured and non-injured) or, perhaps better, that the table be subdivided with the species listed in decreasing order of seriousness of injury, with all the species with no injuries at the end of the table. I am attaching criteria which can be used to rank resources according to the seriousness of their injuries. According to these criteria, for example, a serious injury is one in which greater than 10% to 15% of the resource within the spill zone was lost.

2. Under the columns labeled "Description of injury" there is a column labeled "Population decline after the spill". It is not clear if the means that there was a measurable decline after the spill in the population or that there was a post-spill effect that is result in a continuing population decline. If the former, it should perhaps be called "Measured change in the population" or "Population decline measured by census". In the sixth column, under "status of recovery", it is not clear if a "yes" means there has been recovery from a sublethal effect or injury (or exposure) or there has not.

3. The fourth column "Sublethal or chronic effects or exposure" lumps exposure and effect together, so that to receive a "yes" in this column a

resource need only have been exposed. This is potentially misleading for one can infer sublethal effects on a resource where there was only exposure.

4. In the column labeled "Dependency on currently degraded habitat" the meaning of degraded is subject to considerable judgment. This may be a problem with respect to sea and river otters where the linked to oiled mussel beds has moved from a hypothesis to an interpretation. These links are rather hypothetical. The meaning of degraded somehow needs refinement.

5. For Harbor seals the meaning of recovery for a species that was declining before the spill needs to be carefully considered. Perhaps stabilization of the decline is recovery. Is there evidence that there were injuries to harbor seals on the Kenai Peninsula ?

6. For sea lions there is no evidence that I know of that there were deaths attributable to the spill, although several carcasses were found on beaches after the spill. These could well have been from natural causes. There was exposure of this species, but putting a yes in the column labeled "sublethal or chronic effects.." is misleading. What evidence is there that sea lions were injured in Prince William Sound? Exposure is not injury.

7. For sea otters, the "yes" under chronic effects should probably be "yes. probably".

8. For sea otters, the following sentence should be inserted in the comments section "It is not certain that the disappearance of the whales was due to the oil spill".

9. For deer the "yes" under the fourth column is misleading.

10. For brown bear the "yes" under the fourth column is misleading.

11. For river otters, delete "detected" in the fourth column.

12. For bald eagles is the "yes" for "Kodiak" and "Alaska Penin." really true?

13. For falcons, the "yes" in the fourth column is misleading.

14. For common murres I know of no data that would indicate that there is a "continuing decline" of the population. What is the source of this information? There was a decline in the 1960's in the Bering Sea.

15. For marbled murrelets the "yes" under the fourth column is misleading.

16. For "black-legged kittiwakes" the reproductive declines noted after the spill for some colonies could well be due to natural causes. This species is

notorious for wholesale reproductive failures in colonies due to natural factors, such as food shortage. This is not an injury that can be attributed to the spill and this species in any case is well adapted to such failures.

17. For the pigeon guillemots the "yes" under the fourth column is misleading.

18. The 375,000 to 435,00 total mortality for "other birds" includes the murres, which have already been listed.

19. For other sea ducks the "yes" under the fourth column is misleading.

20. For pink salmon add "of eggs" to column two.

21. For sockeye salmon, add "of smolt" to column two. Under "comments" it cannot be assumed that juveniles were lost in oiled areas.

22. For herring add "of eggs and larvae" to column two. The status of recovery should indicate that the herring early life history stages are no longer experiencing sublethal effects. Again, the headings in the table are not clear in this respect. The "yes" for dependence on degraded habitat is probably not true for the herring, as they spawn in areas that were mainly only lightly oiled, e.g. parts of Naked Island, Rocky Bay on Montague Island (which was arguably even oiled intertidally). These areas should not be considered degraded in 1992.

23. Under rockfish it is questionable if rockfish depend on a degraded habitat. Analyses of sediment hydrocarbon data indicate that *Exxon Valdez* oil did not penetrate deeper than 20 m; the latest analyses of hydrocarbons in the bile of rockfish indicate that there is no longer significant exposure of these fish. There were 16 or so dead rockfish found after the spill; this is not a "large number of dead fish".

24. For Dolly Varden and cutthroat trout, there were apparent effects on the rate of return to freshwater streams from saltwater (therefore it appears that survival was poorer in oiled areas) but there were no direct measurements of the population.

25. For clams, the crucial analyses have not yet been done to indicate if the decreased growth of clams in oiled areas is due to natural factors or to oil, so column four should read "possibly, pending outcome of further analyses" or something to that effect. Tim Baker of ADF&G is still working on these analyses.

26. Crabs, shrimp oysters and sea urchins should all be included under a "not injured" section of the table. Delete comments section under crabs as it

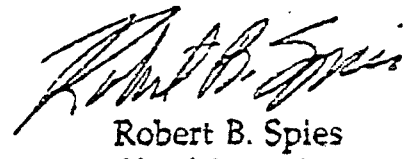
implies an effect might have been found with further study, when in fact only small amounts of *Exxon Valdez* hydrocarbons were found down to 20 m and none deeper and it is very unlikely that they were affected. For shrimp the "yes" in column four is misleading. Delete comments section, as this implies that these effects were due to oil and it is more likely that they were due to over fishing or natural variability. For sea urchins what lab study is being referred to in the comments section ? How do the hydrocarbon concentrations in the experiment compare to those measured in the field?

27. For intertidal organisms and communities, under "current population status" the lower intertidal and to some extent the mid intertidal is recovering. Some species in the upper intertidal have not recovered.

28. For subtidal, there was probably some initial mortality, so change to "unknown" or "probably". The latest information indicates that recovery of subtidal populations has started but has not been completed.

I hope this is helpful in revising the summary table. I am not particularly interested in "softening" my position with regard to changes needed in the table, so I hope you can convince the members of the RWPG to make all of the needed changes in the next revision. Please exuse my bluntness but I am weary of arguing with resource agencies over what constitutes injury.

Sincerely yours,



Robert B. Spies
Chief Scientist

RPWG
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gorbics/December 17, 1992

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

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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*	YES (200)	YES*	YES	POSSIBLY STABLE, BUT NOT RECOVERING*	UNKNOWN	YES	YES**	UNKNOWN	UNKNOWN	Many seals were directly oiled and over 200 seals were estimated to have been killed. There was a measurable difference in populations between oiled and unoiled areas in PWS. 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	--	--	--	--	--	--	
Killer Whales	YES	YES	UNKNOWN	RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	13 adult whales of the 36 in AB pod are missing and presumed dead. The AB pos has grown by 2 whales since 1990. It is not certain that the disappearance of whales was due to the oil spill.
Sea Lions*	UNKNOWN	UNKNOWN	NO	CONTINUING DECLINE*	--	--	--	--	--	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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

gorbics/December 17, 1992

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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 5,500)	YES	YES	STABLE, BUT NOT RECOVERING	YES, PROBABLY	YES	YES	YES**	YES**	Although about 1000 dead sea otters were found, 3500 to 5500 were estimated to have been killed. Post-spill surveys showed measurable difference in populations and survival between oiled and unoiled areas. Survey data have not established a significant recovery. Prime-age animals are still being found on beaches. 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	--	--	--	--	--	--	No field studies were done.
Brown Bear	NO	NO	NO	--	--	--	--	--	--	Hydrocarbon exposure documented on Alaska Peninsula in 1989.
River Otters	YES	UNKNOWN	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Significant exposure to hydrocarbons and sub-lethal effects determined, but no effects 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	--	--	--	--	--	--	Elevated hydrocarbons found in tissues in some deer in 1989.
BIRDS										

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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.	
Bald Eagles	YES	NO	YES	RECOVERING	UNKNOWN	YES	YES	YES**	YES**	Productivity disrupted in 1989. Population estimates and productivity returned to normal in 1990. Significant exposure to hydrocarbons and some sub-lethal effects found in 1989 and 1990, but no continuing effects established on populations.
Black-legged Kittiwakes	YES	NO	NO	NO CHANGE	NO	YES	YES**	YES**	YES**	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 the reproductive failure may be unrelated to the oil spill.
Black Oyster-catchers	YES	YES	YES	RECOVERING	YES	YES	YES**	YES**	YES**	Differences in egg size between oiled and unoiled areas persist. Significant exposure to hydrocarbons and some sub-lethal effects determined. Populations declined more in oiled areas than unoiled areas in post-spill surveys. Black oystercatchers feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Common Murres	YES (175,000 to 300,000)	YES	YES	STABLE, BUT NOT RECOVERING	YES	NO	YES	YES	YES	Measurable impacts on populations with comparisons to pre-spill conditions. Adult mortality 175,000-300,000. Breeding is still inhibited in some colonies in the Gulf of Alaska.
Glaucous-winged gulls	YES	NOT DETECTED	NO	NO CHANGE	NO	YES**	YES**	YES**	YES**	

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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.	
Harlequin Ducks	YES	YES	YES	STABLE OR CONTINUING DECLINE	YES	YES	YES**	YES**	YES**	Post-spill samples showed hydrocarbon contamination and poor body conditions. Surveys indicate population declines and near total reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Marbled Murrelets*	YES (8,000 TO 12,000)	YES	NO	STABLE OR CONTINUING DECLINE	NO	YES	YES**	YES**	YES**	Measurable affect on populations with comparisons to pre-spill conditions. Estimated adult mortality 8,000 to 12,000. Marbled murrelet populations were declining prior to the spill. Hydrocarbon contamination was found in livers of adult birds.
Peale's Peregrine Falcons	YES	UNKNOWN	NO	--	--	--	--	--	--	
Pigeon Guillemots*	YES	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES**	YES**	YES**	Over 500 carcasses were recovered. Between 1500 and 3000 were estimated to have been killed by the spill. Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found in birds and, externally, on eggs.
Storm Petrels	YES	NO	AWAITING RESULTS	NO CHANGE	UNKNOWN	YES**	YES**	YES**	YES**	

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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	VARIABLE	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Total seabird recovery has not been measured. Species collected dead 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	NO	NO	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	More than 2,000 sea duck carcasses were recovered. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil. Species collected dead 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.
Other Shorebirds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	Species collected dead 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	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Species collected dead 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.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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	NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead bodies were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Dolly Varden	YES, SEE COMMENTS	NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead fish were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
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. 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.
Pink Salmon	YES, TO EGGS AND LARVAE	NOT DETECTED	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial mortality of eggs and larvae, but adult mortality was not detected. Significant exposure to hydrocarbons by adults, sub-adults, and eggs. Some sub-lethal effects determined on juveniles. Egg mortality continues to be high in oiled streams of PWS in 1991.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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	UNKNOWN	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	Approximately 16 dead fish were found but only a few were in condition to be analyzed. Significant exposure to hydrocarbons with some sub-lethal effects were determined in those fish, but no effects established on the population. Spill increased fishing pressures which may be impacting population.
Sockeye Salmon	YES, TO SMOLT	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. As a result, future adult returns are expected to be low. Trophic structures of Kenai and Skilak Lakes altered by overescapement.
SHELLFISH										
Clam	UNKNOWN	UNKNOWN	POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	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	--	--	--	--	--	--	
Oyster	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	Although studies were initiated in 1989, they were not completed because they were determined to be of limited value.
Sea Urchin	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	
Shrimp	UNKNOWN	UNKNOWN	NO	--	--	--	--	--	--	

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	Measured 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.	
INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	YES	YES	YES	Measureable impacts on populations in comparison to pre-spill conditions. The lower intertidal and, to some extent, the mid intertidal is recovering. Some species in the upper intertidal zone have not recovered.
Subtidal Communities	YES	YES	YES	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Recovery is not known but there were measurable differences between oiled and unoiled areas in 1990.

* Population may have been declining prior to the spill;
** Based on recovery of dead animals from this region of the spill zone;
*** For a discussion of sediments, water column and air, see text;
**** There may have been an unequal distribution of injury within each region;
-- If no injury was detected or known, no assessment of recovery could be made.

PRWG II

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

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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*	YES (200)	YES*	YES	POSSIBLY STABLE, BUT NOT RECOVERING*	UNKNOWN	YES	YES**	UNKNOWN	UNKNOWN	Many seals were directly oiled and over 200 seals were estimated to have been killed. There was a measurable difference in populations between oiled and unoiled areas in PWS. 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	--	--	--	--	--	--	
Killer Whales	YES	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. It is not certain that the disappearance of whales was due to the oil spill.
Sea Lions*	UNKNOWN	UNKNOWN	NO	CONTINUING DECLINE*	--	--	--	--	--	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.

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-- If no injury was detected or known, no assessment of recovery could be made.

Resource	Description of Injury			Status of Recovery in 1992		Geographic Extent of Injury****				Comments/Discussion
	Initial Mortality (total mortality estimate)	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 5,500)	YES	YES	STABLE, BUT NOT RECOVERING	YES, PROBABLY	YES	YES	YES**	YES**	Although about 1000 dead sea otters were found, 3500 to 5500 were estimated to have been killed. Post-spill surveys showed measurable difference in populations and survival between oiled and unoiled areas. Survey data have not established a significant recovery. Prime-age animals are still being found on beaches. 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	--	--	--	--	--	--	No field studies were done.
Brown Bear	NO	NO	NO	--	--	--	--	--	--	Hydrocarbon exposure was documented on Alaska Peninsula in 1989 including high hydrocarbon levels in the bile of a dead cub. Brown bear feed in the intertidal zone and may still be exposed to hydrocarbons in the environment.
River Otters	YES	UNKNOWN	YES	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Significant exposure to hydrocarbons and sub-lethal effects determined, but no effects 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	--	--	--	--	--	--	Elevated hydrocarbons found in tissues in some deer in 1989.

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BIRDS										
Bald Eagles	YES	NO	YES	RECOVERING	UNKNOWN	YES	YES	YES**	YES**	Productivity disrupted in 1989. Population estimates and productivity returned to normal in 1990. Significant exposure to hydrocarbons and some sub-lethal effects found in 1989 and 1990, but no continuing effects established on populations.
Black-legged Kittiwakes	YES	NO	NO	NO CHANGE	NO	YES	YES**	YES**	YES**	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 the reproductive failure may be unrelated to the oil spill.
Black Oyster-catchers	YES	YES	YES	RECOVERING	YES	YES	YES**	YES**	YES**	Differences in egg size between oiled and unoiled areas persist. Significant exposure to hydrocarbons and some sub-lethal effects determined. Populations declined more in oiled areas than unoiled areas in post-spill surveys. Black oystercatchers feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Common Murres	YES (175,000 to 300,000)	YES	YES	STABLE, BUT NOT RECOVERING	YES	NO	YES	YES	YES	Measurable impacts on populations with comparisons to pre-spill conditions. Adult mortality 175,000-300,000. Breeding is still inhibited in some colonies in the Gulf of Alaska.

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Glaucous-winged gulls	YES	NOT DETECTED	NO	NO CHANGE	NO	YES**	YES**	YES**	YES**	
Harlequin Ducks	YES	YES	YES	STABLE OR CONTINUING DECLINE	YES	YES	YES**	YES**	YES**	Post-spill samples showed hydrocarbon contamination and poor body conditions. Surveys immediately after the spill indicated population declines and near total reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may be still be exposed to hydrocarbons in the environment.
Marbled Murrelets*	YES (8,000 TO 12,000)	YES	NO	STABLE OR CONTINUING DECLINE	NO	YES	YES**	YES**	YES**	Measurable affect on populations with comparisons to pre-spill conditions. Estimated adult mortality 8,000 to 12,000. Marbled murrelet populations were declining prior to the spill. Hydrocarbon contamination was found in livers of adult birds.
Peale's Peregrine Falcons	YES	UNKNOWN	NO	--	--	--	--	--	--	
Pigeon Guillemots*	YES (1,500 TO 3,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES**	YES**	YES**	Over 500 carcasses were recovered. Between 1500 and 3000 were estimated to have been killed by the spill. Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found in birds and, externally, on eggs.
Storm Petrels	YES	NO	AWAITING RESULTS	NO CHANGE	UNKNOWN	YES**	YES**	YES**	YES**	

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Other Seabirds	YES	VARIES BY SPECIES	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Total seabird recovery has not been measured. Species collected dead 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	NO	NO	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	More than 2,000 sea duck carcasses were recovered. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil. Species collected dead 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.
Other Shorebirds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES**	YES**	YES**	Species collected dead include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpiper; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.

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Other Birds	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES**	YES**	YES**	YES**	Species collected dead 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.
FISH										
Cutthroat Trout	YES, SEE COMMENTS	NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead bodies were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
Dolly Varden	YES, SEE COMMENTS	NO	YES	STABLE, BUT NOT RECOVERING	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Although no dead fish were found, in 1991 differences in survival between anadromous adult populations in the oiled and unoiled areas persisted despite the decrease in exposure indicators.
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. 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.

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Pink Salmon	YES, TO EGGS AND LARVAE	NOT DETECTED	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial mortality of eggs and larvae, but adult mortality was not detected. Significant exposure to hydrocarbons by adults, sub-adults, and eggs. Some sub-lethal effects determined on juveniles. Egg mortality continues to be high in oiled streams of PWS in 1991.
Rockfish	YES	UNKNOWN	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	Approximately 16 dead fish were found but only a few were in condition to be analyzed. Significant exposure to hydrocarbons with some sub-lethal effects were determined in those fish, but no effects established on the population. Spill increased fishing pressures which may be impacting population.
Sockeye Salmon	YES, TO SMOLT	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. As a result, future adult returns are expected to be low. Trophic structures of Kenai and Skilak Lakes altered by overescapement.
SHELLFISH										
Clam	UNKNOWN	UNKNOWN	POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	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	--	--	--	--	--	--	

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Oyster	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	Although studies were initiated in 1989, they were not completed because they were determined to be of limited value.
Sea Urchin	UNKNOWN	UNKNOWN	UNKNOWN	--	--	--	--	--	--	
Shrimp	UNKNOWN	UNKNOWN	NO	--	--	--	--	--	--	
INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	YES	YES	YES	Measureable impacts on populations occurred in comparison to pre-spill conditions. The lower intertidal and, to some extent, the mid intertidal is recovering. Some species in the upper intertidal zone have not recovered.
Subtidal										

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