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**SUMMARY OF EFFECTS OF THE EXXON VALDEZ OIL SPILL
ON NATURAL RESOURCES AND ARCHAEOLOGICAL RESOURCES
March 1991**

INTRODUCTION

The T/V Exxon Valdez ran aground on Bligh Reef in Prince William Sound on the night of March 23-24, 1989, spilling approximately 11 million gallons of North Slope crude oil, making this the largest oil spill in United States history. The oil spread through Prince William Sound, the Gulf of Alaska, and lower Cook Inlet. More than 1,200 miles of coastline were oiled, including portions of the Chugach National Forest, Alaska Maritime, Kodiak, and Alaska Peninsula/Becharof National Wildlife Refuges, Kenai Fjords National Park, Katmai National Park and Preserve, and Aniakchak National Monument and Preserve. Oil from the T/V Exxon Valdez impacted shorelines nearly 600 miles from Bligh Reef.

The magnitude of efforts of the state and federal governments, the public, and Exxon to contain and clean up the spill, rescue wildlife, and study the effects of the spill is unprecedented. Among those efforts are the state/federal natural resource damage assessment studies designed to measure injuries to natural resources including birds, mammals, fish and other wildlife, and marine and terrestrial habitats. These studies are intended to provide the information necessary for the Trustee agencies to manage and restore injured resources appropriately and to provide necessary documentation to enable the governments to present a claim for damages to the responsible parties. This summary briefly describes the area affected by the spill, the chronology of the spill, and the process developed to implement and manage the injury assessment studies. It focuses, however, on what has been learned over the past two years about the effects of this oil spill on natural resources.

DESCRIPTION OF THE AREA AFFECTED BY THE SPILL

Prince William Sound lies near the top of the Gulf of Alaska (see map), an 850 mile arc extending from the Aleutian Islands on the west to the islands of southeast Alaska. The gulf coast is remote, rugged, and scenic. Its maritime climate nourishes a lush, green landscape in the summer. The area is snow covered in the winter. Bears, whales, bald eagles, puffins, seals, sea lions, and sea otters are among the abundant wildlife of the area. Storms that cross the Gulf drop as much as 300 inches of rain and snow annually in the high coastal mountains. Glaciers descend from permanent ice fields capping these coastal mountain ranges, continuing to carve intricate fjords and send icebergs floating out to sea. These are the largest glaciers outside Antarctica and Greenland.

Prince William Sound is one of the largest relatively undeveloped marine ecosystems in the United States. It has one of the continent's largest tidal estuary systems. Prince William Sound has rich commercial herring and salmon fisheries. The open water of the Sound is about the size of Chesapeake Bay. Its many islands, bays, and fjords give it

more than 2,000 miles of shoreline. Prince William Sound is surrounded by land, most of which is part of Chugach National Forest.

To the southwest of Prince William Sound is the Kenai Peninsula, home of the Kenai Fjords National Park, various units of the Alaska Maritime National Wildlife Refuge, and, among others, the cities of Homer and Seward. Numerous seabird colonies are located along the coast of the Kenai Peninsula, including those most frequently visited by tourists in Alaska. Both Prince William Sound and the Kenai Peninsula are accessible by air, boat, and on a limited basis, by automobile from nearby Anchorage, Alaska's major population center. State ferries that run among the larger communities and many charter boats make it easy for people to visit the heart of the Gulf coast. In recent years, there has been a steady increase in the number of wilderness seekers, kayakers, cruise ship passengers, and other tourists visiting the area.

The Kenai Peninsula points southwest to Shelikof Strait and Kodiak Island. Shelikof Strait lies between Kodiak Island, on the south and the Alaska Peninsula on the north. Shelikof Strait is the source of a very productive commercial pollock fishery. The Kodiak National Wildlife Refuge is located on the Kodiak Archipelago and Katmai National Park and Preserve, Alaska Peninsula/Becharof National Wildlife Refuge, and Aniakchak National Monument and Preserve are located along the coast of the Alaska Peninsula. The Alaska Peninsula tapers, then scatters into the islands of the Aleutian chain.

CHRONOLOGY OF THE EXXON VALDEZ OIL SPILL

For the first three days of the spill, the weather was calm and the slick lengthened and widened amoeba-like and generally stayed in the vicinity of the grounded tanker and off the beaches. Even with these seemingly ideal circumstances for oil recovery, the amount of oil in the water completely overwhelmed efforts to contain and recover the oil. A major windstorm on March 27, 1989, pushed the oil in a southwesterly direction and oiled beaches on Little Smith, Naked, and Knight Islands. The oil continued to spread, contaminating islands, beaches, and bays in Prince William Sound. Four days into the spill, oil began to enter the Gulf of Alaska. The leading edge of the slick reached the Chiswell Islands off the coast of the Kenai Peninsula on April 2, 1989, and the major seabird nesting colonies on the Barren Islands on April 11, 1989, nineteen days into the spill. By May 18, 1989, oil had moved some 470 miles and had fouled shorelines of Prince William Sound, the Kenai Peninsula, the Kodiak Archipelago, and the Alaska Peninsula. Oil subsequently reached shorelines on the Alaska Peninsula nearly 600 miles from Bligh Reef.

During 1989, the response to contain and cleanup the spill and rescue oiled wildlife involved a massive effort. Skimmer ships were sent throughout the spill zone to vacuum oil from the water surface. Booms were positioned to keep oil from reaching important commercial salmon hatcheries in Prince William Sound. A fleet of fishing vessels, known as the "Mosquito Fleet," played an important role in protecting these hatcheries, in corralling oil to assist the skimmer ships, and in capturing oiled wildlife and

transporting these animals to rehabilitation centers. After oil contaminated shorelines, a beach cleanup program was activated. Various local committees, with community and government agency participation, provided recommendations to the U.S. Coast Guard about areas that should receive priority for cleanup. An army of workers cleaned shorelines, using techniques ranging from cleaning rocks by hand to high pressure hot water washing. Fertilizers, sometimes in a chemical base, were applied to some oiled shorelines to increase the activity of oil-metabolizing bacteria, in an experimental procedure known as bioremediation. When deteriorating weather brought an end to cleanup work in the fall of 1989, a great amount of oil remained on the shorelines. Although winter storms proved extremely effective in cleaning many beaches, spring shoreline surveys indicated that much work remained to be done in 1990. Crews operating from boats and helicopters cleaned oiled shorelines in Prince William Sound, along the Kenai and Alaska Peninsulas, and on the Kodiak Archipelago. Manual pick up of remaining oil was the principal method used during 1990, but bioremediation and relocation of oiled berms to the active surf zone were also used in some areas.¹ Another shoreline survey will be conducted during May 1991, to determine the need for additional cleanup work.

INJURY ASSESSMENT PROCESS

The Exxon Valdez oil spill occurred just prior to the most biologically active season of the year in southcentral Alaska. During the two month period after the spill, seaward migrations of salmon fry, major migrations of birds, and the primary reproductive period for most species of birds, mammals, fish, and marine invertebrate species took place. The organisms involved in these critical periods of their life cycles encountered the most concentrated, volatile, and potentially damaging forms of the spilled oil. As will be discussed in this summary, the oil affected different species differently. Whereas, for example, it directly killed large numbers of birds and sea otters that encountered oil on the water surface, it did not prohibit in and out migration and spawning of large schools of salmon and herring.

The state and federal Trustee agencies were forced to mobilize field studies rapidly with little time for planning. Through intensive efforts, studies were designed, administrative processes were accelerated, and 58 field studies were carried out. Additionally, technical services programs were organized to provide hydrocarbon analysis, histopathology, and mapping support for the field studies. Initial decisions on the types and scope of studies conducted were made by agency experts familiar with the resources and the environment. Even with the rapid deployment of studies, however, some opportunities to gather injury data were irretrievably lost during the early weeks of the spill.

A legal framework was subsequently established and studies were reviewed and modified according to their likelihood to document resource injury. Expert peer reviewers were retained and study plans used during 1989 underwent scientific review for possible

¹Exxon has represented that it has paid over \$2.0 billion to conduct cleanup activities during 1989 and 1990.

modification in 1990. Some studies were discontinued or modified if they were unable to further document resource injury, and some new studies were initiated to fill identified information needs. Status reports prepared in January 1990, were used to guide the development of plans for the second year of studies. Thirty-nine studies and three technical services programs were continued in 1990. Scientific review was again used to plan for the upcoming 1991 field season, during which 29 studies and two technical services programs will be conducted.

This summary of the effects of the Exxon Valdez oil spill on natural resources is preliminary, as studies are still underway and available data are not fully analyzed and interpreted. However, the injuries to natural resources that have been documented to date are summarized herein. This summary also addresses studies that were discontinued. It should be noted that studies were discontinued for a variety of reasons, such as the determination that field work had been completed, that there was no practicable way to measure injury, or that no injury was documented. Even though some studies failed to identify injury and were discontinued, this does not necessarily mean that the resources were not affected by the spill. Certain injuries (if present), such as possible latent or sublethal effects on reproductive or other systems in animals, might not become fully evident for a number of years after the spill. At present there is no significant indication of long-term injury to resources other than those specifically noted below. Although studies indicate that there are continuing injuries to certain resources, natural recovery may also have begun. As petroleum hydrocarbons are broken down in the ecosystem, plant and animal communities begin to reestablish themselves. This recolonization has already been observed in some of the more lightly oiled areas. In the more heavily oiled areas, this natural recovery process is expected to take longer. As this natural recovery occurs, many of the birds and mammals that feed in these areas are expected to begin recovering.

MARINE MAMMALS

Following the spill, studies of humpback whales, Stellers sea lions, sea otters, harbor seals, and killer whales were started. The humpback whale and Stellers sea lion studies were discontinued following the 1990 field season. Humpback whale investigations were limited to photo identification of whales, estimations of reproductive success, and possible relocations of whales. It was not possible to take tissue samples for petroleum hydrocarbon analysis to document exposure. The study did not show direct oil spill mortalities or reproductive failures.

The sea lion study is being completed following the 1990 pup counts. Some tissue samples were analyzed for petroleum hydrocarbon concentrations, and although there was some indication of exposure to oil, it was difficult to determine what populations were affected because of the sea lions' active seasonal movements. Because of an ongoing pre-spill population decline and premature pupping of sea lions, it was not possible to distinguish post- from pre-spill population effects clearly.

Studies of killer whales, based on observations only (because tissue sampling was not an

option), have indicated that killer whales are missing from at least one and possibly two pods in Prince William Sound. Injuries to harbor seals and sea otters have been clearly indicated and studies of these species are continuing.

Sea Otters: The population of sea otters in Prince William Sound before the spill was estimated to have been as high as 10,000. The total sea otter population of Alaska was estimated to be at least 20,000. Statewide, the sea otter population was estimated at 150,000. Sea otters were particularly vulnerable to the spill. As the spill moved through Prince William Sound and the Gulf of Alaska, it covered areas used by large numbers of otters. When sea otters become contaminated by oil, their fur loses its insulating capabilities, leading to death from hypothermia. Sea otters also died as a result of ingestion of oil and perhaps inhalation of toxic aromatic compounds that evaporated from the slick shortly after the spill. The effects of oil were documented by surveys of wild populations; analysis of tissues for petroleum hydrocarbons and indicators of reduced health; by tracking sea otters outfitted with radio transmitters (including those released from rehabilitation centers); and estimating total mortality from the number of sea otters found on beaches. These studies concentrated on developing an estimate of sea otter mortality in Prince William Sound and along the Kenai Peninsula, the population most affected by the spill. During 1989, a total of 1,011 sea otter carcasses were recovered in the spill area, cataloged, and stored in evidence trailers. Of these, 876 were recovered dead from the field and 135 died in rehabilitation centers or other facilities. The total number of sea otters estimated to have been killed directly by the spill ranges from 3,500 to 5,500 animals throughout the spill area.

Initial results indicate significant differences in hematology and blood chemistry parameters between sea otters in oiled and unoiled areas. Greater variation was observed in DNA content of blood lymphocytes of sea otters from oiled areas, but sperm and testicular cells showed no indication of DNA damage resulting from oil exposure. It cannot yet be determined whether these differences affect sea otter health or survival. There are indications that sea otters continue to be exposed to petroleum hydrocarbons in oiled areas. Analysis of blood and fat samples collected from animals during 1990 found elevated concentrations of certain aromatic compounds in sea otters from heavily oiled areas and elevated concentrations of petroleum hydrocarbons continue to be documented in food items eaten by sea otters in oiled areas. Additionally, other damage assessment studies have documented a decreased abundance of mussels in oiled areas, a key prey species for sea otters.

Studies have documented continuing injury to sea otters. Normally, very few prime age sea otters (animals between 2 and 8 years old) die each year and most mortality occurs among very young and old age classes. The high number of prime age sea otter carcasses found during 1990 indicates that the pattern of sea otter mortality in heavily oiled areas continues to be abnormal. Results of boat surveys indicated continued declines in sea otter abundance within oiled habitats in Prince William Sound. Preliminary results indicate that pupping rates in oiled and unoiled areas are not significantly different. However, the first information available for the spring of 1991 shows higher yearling mortality rates in oiled areas than in unoiled areas. Studies of the survival and reproductive success of sea otters released from rehabilitation

centers indicate a high level of mortality of adult animals and significantly lower pupping rates than the pre-spill mortality and pupping rates in Prince William Sound. Of the 193 sea otters released from rehabilitation centers, 45 were fitted with radio transmitters. Sixteen of these animals are still alive, 13 are known to be dead, and 15 are missing. One radio transmitter is known to have failed.

Harbor Seals: There has been no census of harbor seals in Prince William Sound since the mid-1970s when the population was estimated at 3,000 to 5,000 animals. Since that time, the harbor seal population in Prince William Sound and the Gulf of Alaska has declined substantially. A population census of Prince William Sound is planned for the summer of 1991.

Two hundred harbor seals are estimated to have been killed by the spill. Only 19 seal carcasses were recovered following the spill, since seals sink when they die. Population changes were documented by summer and fall aerial surveys of known haulout areas. Toxicological and histopathological analyses were conducted to assess petroleum hydrocarbon accumulation and persistence and to determine toxic injuries to tissues.

Population surveys, which are reliable indicators of population trends, conducted in 1984 and 1988 indicated that harbor seal populations in Prince William Sound had declined prior to the spill, with similar declines in what were subsequently oiled and unoiled areas. From 1988 to 1990, however, the decline at oiled sites (35 percent) was significantly greater than at unoiled sites (13 percent).

Severe debilitating lesions were found in the thalamus of the brain of a heavily oiled seal collected in Herring Bay 36 days after the spill. Similar but milder lesions were found in five other seals collected three or more months after the spill. In 1989, oiled harbor seals behaved abnormally, being lethargic or unwarmed. Hydrocarbon concentrations in bile were 5 to 6 times higher in oiled seals one year after the spill. This indicates that seals were still encountering petroleum in the environment, were metabolizing stored fat reserves that had elevated petroleum hydrocarbons, or both.²

Killer Whales: Approximately 182 killer whales forming nine distinct family units or "pods" resided in Prince William Sound before the spill. This count is based on pre-spill documentation. These whales were studied intensively before the spill and their group composition and dynamics are well known. Damage assessment studies of killer whales involved extensive boat-based surveys in Prince William Sound and adjacent waters. Whales were photographed and the photographs were compared to the Alaskan

²Harbor seals are taken in some Alaska villages for subsistence. The State of Alaska conducted a program, separate from the damage assessment program, to test subsistence foods potentially affected by the spill to insure that they were safe for human consumption. The State of Alaska determined that harbor seals in the affected area were safe for people to eat (Oil Spill Health Task Force, July-August 1990 Report and September-October 1990 Report. Alaska Department of Fish and Game, Division of Subsistence).

killer whale photographic database for the years 1977 to 1989 to determine changes in whale abundance, seasonal distribution, pod integrity, and mortality and natality rates.

The AB pod of 36 individual whales was sighted intact in September of 1988. When sighted on March 31, 1989, seven days after the spill, seven individuals were missing. These whales remain absent and six additional whales were missing from the AB pod in 1990. Several of the missing whales are females who left behind calves. It is unprecedented for females to abandon calves, therefore their prolonged absence implies that these adult females are dead. In addition, nine individuals from AT pod were missing in 1990. Explanations for the possible causes of death of these missing whales, including explanations apart from the effects of the spill, are being explored. Killer whale surveys will continue in 1991.

TERRESTRIAL MAMMALS

Studies were conducted on terrestrial mammals that may have been exposed to oil through foraging in intertidal habitats. These species included brown bear, mink, black bear, Sitka black-tailed deer, and river otters.

Brown bears are long-lived animals and forage seasonally in the intertidal and supratidal areas of the Alaska Peninsula and the Kodiak Archipelago. Preliminary analysis of brown bear fecal samples and some tissues show that some brown bears were exposed to petroleum hydrocarbons, but no conclusive injury has been documented. Radio-collared brown bears along the Katmai coast and at a control site on the Alaska Peninsula will continue to be monitored while the transmitters remain active.

Mink and other small mammals that are known to feed and spend part or all of their time in the intertidal zone are difficult to study. They are known to crawl off into burrows or the brush if sick or injured and carcasses are unlikely to be found. Also, information on pre-spill populations of these animals is minimal. Scientists developed a laboratory study to test reproductive effects of oil on ranch-bred mink, in which they were fed food mixed with small, non-lethal amounts of weathered oil. Although changes in reproductive rates or success were not documented, it was found that oil-contaminated food moved through the intestines of the animals at a more rapid rate than did clean food, possibly providing less nutrition to the animals. No field studies were carried out for black bear due to the difficulty of finding, collaring, or otherwise investigating these animals in the dense underbrush in which they reside. However, a literature search confirmed that these animals do forage in the intertidal zone in the spill area.

The deer study found no evidence of injury based on intensive searches of beaches that revealed no mortality attributable to the spill. However, deer taken for purposes of testing for safety for human consumption (not part of the damage assessment process) found slightly elevated petroleum hydrocarbons in some tissues in deer (which feed on kelp in intertidal areas) but it was determined that the deer were safe to eat.

River Otters: A few river otter carcasses were found by cleanup workers. River otters forage in streams and shallow coastal habitats that were contaminated by the spill. Analysis of river otter bile indicated that petroleum hydrocarbons are being accumulated by this species. Studies of radio tagged animals in Prince William Sound showed that home ranges are larger, movements more erratic, and body weights are lower in oiled habitat. Field work is continuing in 1991 to further assess the status of this species, including analysis of blood samples to measure the health of these animals.

BIRDS

Among the most conspicuous effects of the Exxon Valdez oil spill was the injury to birds. Seabirds are particularly vulnerable to oil as they spend much of their time on the sea surface while foraging. Oiled plumage insulates poorly and loses buoyancy and birds die from hypothermia or drowning. Birds surviving initial acute exposure may then ingest oil by preening. Approximately 36,000 dead birds were recovered after the spill; at least 31,000 of these deaths were attributed to the effects of oil. In addition to the large number of murres, sea ducks, and bald eagles, carcasses of loons, cormorants, pigeon guillemots, grebes, murrelets, and other species were also recovered (see attached comprehensive list of bird carcasses logged into evidence trailers by September 25, 1989). Only a small proportion of the total number of birds estimated to have been killed were recovered, as many undoubtedly floated out to sea, sank, were scavenged, were trapped and hidden in masses of oil and were not visible, were buried under sand and gravel by wave actions, decomposed, or simply beached in an area where they were not found. Additionally, it is known that, in a number of cases, carcasses found shortly after the spill were not turned in to receiving stations. Preliminary analyses provided by computer models that account for some of these variables estimate that the total number of birds killed by the spill ranges from 260,000 to 580,000 with the best approximation that between 350,000 and 390,000 birds died. Following peer review, the model will be run again to provide a more refined estimate of total mortality.

Common and Thick-billed Murres: Murres are the third most abundant seabird in Alaska (after tufted puffins and black-legged kittiwakes). A total of approximately 1,400,000 murres reside in the Gulf of Alaska (Unimak Pass to the Canadian border in southeastern Alaska). The total population of murres in Alaska is approximately 12,000,000. The murre colonies on the Chiswell Islands are the most visited by tourists in Alaska. In 1989 and 1990 murres were the most heavily affected bird species. Murre colonies impacted by the spill lost 60 to 70 percent of breeding birds. Oil in Prince William Sound affected major wintering areas of murres and other species. As oil moved out of Prince William Sound and along the Kenai Peninsula and the Alaska Peninsula, it hit major seabird nesting areas such as the Chiswell and Barren Islands, as well as numerous smaller colonies. The oil hit these areas outside Prince William Sound at the same time that adult murres were congregating on the water near colonies in anticipation of the nesting season. Approximately 22,000 murre carcasses were recovered following the spill. Colony surveys indicate that an estimated minimum of 120,000 to 140,000 breeding adult murres in the major colonies that were surveyed were killed by the spill. Extrapolating this information to other known murre colonies hit by

the spill (but not specifically studied), the mortality of breeding adult murres is estimated to have been 172,000 to 198,000. However, area-wide, including wintering and non-breeding birds, the total mortality of murres is estimated to be about 300,000. Murres exhibit strong fidelity to traditional breeding sites and infrequently immigrate to new colonies.

Normally, murres breed in densely packed colonies on cliff faces. Each murre colony initiates egg laying almost simultaneously. This synchronized breeding behavior helps the birds repel predators such as gulls and ravens. In oiled areas, murre colonies have exhibited a much lower populations than before the spill, breeding is later than normal, and breeding synchrony has been disrupted. These structural and behavioral changes in colonies have caused complete reproductive failure during 1989 and 1990, and thus lost production of at least 215,000 chicks. Murre colonies in unoiled areas displayed none of these injuries and had normal productivity. Monitoring of reproductive success of the colonies will continue in 1991.

Bald Eagles: Of the estimated Alaskan bald eagle population of 30,000 birds (20,000 adults and 10,000 fledglings), an estimated 2,200 reside in Prince William Sound. One hundred forty-four (144) dead bald eagles were found following the spill. Although there is considerable uncertainty regarding the total mortality of bald eagles, it is estimated that several times this amount may have been killed by the initial spill. Approximately 90 percent of radio-tagged bald eagles that died during subsequent studies were not found on the beach but in the brush back from the beachfront. This suggests that most of the eagles that died in the spill would not have been found by surveys typically restricted to beach areas. To assess injuries to bald eagles, helicopter and fixed-wing surveys were flown to estimate populations and productivity. Radio transmitters were attached to bald eagles to estimate survival, distribution, and exposure to oiled areas. Bald eagles in Prince William Sound were most intensively studied. Productivity surveys in 1989 indicate a failure rate of approximately 85 percent for nests on moderately or heavily oiled beaches compared to 55 percent on unoiled or lightly oiled beaches. Bald eagles have a delayed sexual maturity and have a relatively long life span under normal circumstances. Consequently, although reproduction apparently rebounded to more normal levels in 1990, population impacts as a result of poor productivity of nestlings and the death of hundreds of adult eagles in 1989 may not be readily apparent for several years. Fewer bald eagles were sighted in 1990 than in 1989, however this change was within the expected error of the survey method. An additional survey will be conducted in 1991 to see if there is a downward population trend.

Sea Ducks: More than 2,000 sea duck carcasses were recovered after the spill, including more than 200 harlequin ducks. Studies concentrated on harlequins, goldeneyes, and scoters, species that use the intertidal and shallow subtidal habitats most heavily affected by the spill. Harlequins were most affected, consistent with the fact that they feed in the shallow water area of the intertidal zone. This is the only species of sea duck studied that both nests in the spill area and feeds in the shallow intertidal zone. All of these species feed on invertebrates such as mussels and are likely to continue to be exposed to petroleum hydrocarbons through their food. About 33 percent of the harlequins collected in the spill area had poor body condition and about 40 percent had

tissues contaminated with petroleum hydrocarbons. Preliminary surveys also indicate harlequins may have failed to reproduce in the spill zone in Prince William Sound during 1990. These injuries will be investigated further during 1991.

Other Birds: Surveys and studies indicate reduced numbers of black oystercatchers, pigeon guillemots, and marbled murrelets in oiled areas. Black oystercatchers and pigeon guillemots use inshore and intertidal areas for feeding and nesting. Reduced breeding success of black oystercatchers was documented in oiled areas, largely as a result of loss of chicks along oiled beaches. It is estimated that between 1,500 and 3,000 pigeon guillemots were killed by the spill, representing as much as 10 percent of the catalogued population in the Gulf of Alaska. This species is susceptible to continued exposure to petroleum hydrocarbons because it uses intertidal rocks and waters within 200 meters of shore. Petroleum hydrocarbons were found in eggs and tissue in 1989.

Marbled and Kittlitz's murrelets represented a high proportion of the dead birds recovered in oiled areas of Prince William Sound. The reduction in the number of murrelets observed in oiled areas during cleanup in 1989 and the return of many of these birds in 1990 suggest disturbance associated with cleanup activities affected these birds. The extent of injury to certain species, including loons, cormorants, and gulls will probably never be known because pre-spill information on numbers of these birds in the spill area are not available. Data on bird distribution and abundance data gathered during aerial and boat surveys remain to be fully analyzed and interpreted. Boat surveys will continue during 1991. Studies did not document injury to certain bird species such as Peale's peregrine falcons or songbirds.

FISH/SHELLFISH

No massive die-offs of adult fish were found following the spill, and adult salmon, for example, were evidently able to migrate to spawning areas after the spill. However, fish are most vulnerable to oil contamination during the early stages of their life cycles. Accordingly, most fish studies initially focused on this phase of fish life history. During 1991, scientists will begin to be able to assess affects on adult fish such as salmon that would have been exposed to oil as eggs or larvae. Species most often affected by the spill were those that inhabit and spawn in the intertidal zone (salmon) or in the shallow areas next to shore (herring and Dolly Varden).³ Less than ten dead rockfish were found during the spill and their deaths were attributed to oil. Several species of coastal and offshore fish (pollock, halibut, sablefish, cod, yellowfin and flathead sole, and rockfish) show evidence over a large geographic area of continuing exposure to petroleum hydrocarbons in areas affected by the spill, but significant injury has not yet been documented. Exposure to petroleum hydrocarbons does not necessarily lead to

³The State of Alaska imposed the highest possible standards for commercial fishery openings and for processing plant inspections to insure that all commercially harvested salmon were free from contamination. Salmon subject to commercial harvest in the spill area were rigorously tested to insure that the catch was safe for human consumption.

injury, since many animals have the capability to physiologically "manage" the exposure with no resulting harm. In particular, salmon and other fish can metabolize petroleum hydrocarbons so that these contaminants are unlikely to be found in edible fish tissues. Indicators of exposure among fish include bile metabolites and mixed function oxidases. Since injuries from chronic exposure to oil may not manifest themselves for a number of years, it is premature to conclude that coastal and offshore species were not injured; therefore certain studies are continuing.

Pink Salmon: The full extent of short term injury to pink salmon cannot be assessed until after the 1991 run returns to spawn in the summer. Although the overall catch of pink salmon in Prince William Sound during 1990 was an all-time record (as predicted before the spill), this was primarily due to strong runs of hatchery-produced salmon. Salmon survival associated with the Armin F. Koerning hatchery, located in the middle of a heavily oiled area of the spill zone, was half that of Ester Hatchery, located outside the area of the spill. Wild production of pink salmon did not mirror the record production of hatchery fish.

Seventy-five percent of wild pink salmon spawn in the intertidal portion of streams in Prince William Sound. Wild stock salmon did not shift spawning habitat following the spill and deposited eggs in intertidal areas of oiled streams. Preliminary analyses indicate a 70 percent greater mortality of pink salmon eggs laid in the summer of 1989 and a 50 percent greater mortality in the summer of 1990 in oiled streams as compared to control streams. Larvae from heavily oiled streams showed gross morphological abnormalities, including club fins and curved spines. The pink salmon that returned to Prince William Sound in the summer of 1990 were exposed to oil as larvae as they swam under the slick, but not as eggs which were more directly exposed to oil than the larvae. Fish returning in 1991 will be the first that were exposed to oil as eggs. Eggs and larvae of wild populations continue to be exposed to oil in intertidal gravel in oiled areas.

Sockeye Salmon: Commercial harvest of sockeye salmon was curtailed in portions of Cook Inlet, Chignik, and Kodiak in 1989 because of the spill, resulting in an unusually high number of adults migrating to spawn in certain lake spawning systems (returning adults that arrive at the spawning areas are referred to as the "escapement"). Overly large spawning escapements may result in poor returns in future years by producing more juvenile salmon than can be supported by the nursery lake's productivity. Preliminary data indicate that overescapement degraded rearing habitat in lakes and that sockeye salmon survival and growth rates are lower than usual. Further study is needed before the extent of these injuries can be determined.

Dolly Varden and Cutthroat Trout: Prince William Sound is the northern extreme of the range of cutthroat trout. Both cutthroat trout and Dolly Varden use nearshore and estuarine habitat for feeding throughout their lives (in contrast to salmon which migrate out to sea). The highest concentrations of bile petroleum hydrocarbon metabolites in all fish sampled were found in Dolly Varden. Tagging studies have demonstrated that the annual mortality of adult Dolly Varden was 32 percent greater in oiled areas than in unoiled areas. The larger cutthroat trout showed similar levels of mortality in oiled and unoiled areas. Additionally, cutthroat trout growth rates were reduced in oiled areas.

Studies are continuing to measure impacts on populations of these popular sport fish species.

Pacific Herring: Populations of Pacific herring were spawning in shallow eelgrass and algal beds at the time of the spill. The effects of oil on egg survival, hatching success, larval development, and recruitment to the spawning population were studied. Study results show a large increase in the percentage of abnormal embryos and larvae in oiled areas of Prince William Sound during the 1989 reproductive season. Larvae in oiled areas also had a greater incidence of eye tumors. These effects continued but at somewhat lower rates in 1990. Results also showed greater egg mortality in oiled areas as compared to unoiled areas. Whether the adult population has been affected by these larval injuries will not be determined until the 1989 and 1990 cohorts return to spawn in 1992 and 1993.

COASTAL HABITAT

The coastal tidal zone, commonly known as the "intertidal zone," was the most severely contaminated habitat. Intertidal habitats are highly productive and biologically rich. They are particularly vulnerable to the grounding of oil, its persistence, and effects of associated clean-up activities. An interdisciplinary team with expertise in plant and systems ecology, marine biology, and statistical analysis, was established to conduct field studies to assess the effects of oil on intertidal ecosystems.

Supratidal: Results of studies in the Kodiak/Alaska Peninsula area suggest that oil in the supratidal habitat and beach cleanup disturbance decreased the productivity of grasses and other vegetation including beach rye grass, that help stabilize beach berms. In one instance, cleanup activities completely removed the vegetation. Increased production of supratidal vegetation was found in Prince William Sound in 1989. This finding corresponds with information from other oil spills. It is not known whether this increased production was a result of decreased browsing by terrestrial mammals or a fertilizer effect of the oil.

Intertidal: Natural populations of intertidal organisms were significantly reduced along heavily oiled shorelines such as Herring Bay. Densities of intertidal algae (*Fucus*), barnacles, limpets, amphipods, isopods, and marine worms were decreased. Although there were increased densities of mussels in oiled areas, they were significantly smaller than mussels in the unoiled areas and the total biomass of mussels was significantly lower. Intertidal organisms continue to be exposed to hydrocarbons from the more heavily oiled sediments. Petroleum hydrocarbon accumulation in filter feeding mussels experimentally placed in oiled areas indicate that oil remains available for uptake by other organisms. Initial findings also indicate that oiled surfaces retarded settlement by juvenile barnacles when compared to unoiled sites. In addition to direct mortality, the reproductive cycle of mussels at oiled sites in the lower Cook Inlet/Kenai Peninsula and Kodiak/Alaska Peninsula regions was delayed by several months.

Intertidal fishes were less abundant in oiled areas than in unoiled areas. In addition, gill

parasitism and respiration rates were significantly higher in fish from oiled sites compared to unoiled sites.

Fucus, the dominant intertidal plant, was severely affected by the oil and subsequent cleanup activities. The percentage of intertidal areas covered by Fucus was reduced following the spill and opportunistic plant species which characteristically flourish in disturbed areas were increased. The average size of Fucus was reduced, the number of reproductive sized plants greatly decreased, and the remaining plants of reproductive size decreased in reproductive potential due to fewer fertile receptacles per plant. There was also reduced recruitment of Fucus at oiled sites.

SUBTIDAL HABITATS

Spilled oil in some areas has migrated to and contaminated the seafloor at depths of up to 100 meters as contaminated sediments moved off beaches during winter storms and cleanup activities. There is evidence that petroleum hydrocarbons have been taken up by animals feeding on the ocean bottom. Petroleum hydrocarbon metabolites have been found in the bile of yellowfin sole, rock sole, rockfish, and pollock. Concentrations of petroleum hydrocarbon metabolites in the bile of yellowfin sole have not declined from 1989 to 1990. This contrasts with Dolly Varden which feed close to shore and where petroleum hydrocarbon metabolites in bile decreased in the same period. The effects of this exposure are still being studied. Many subtidal and intertidal species, particularly fish, have the capability of metabolizing and eliminating petroleum hydrocarbons from their bodies. Clams metabolize hydrocarbons very slowly and consequently accumulated them in high concentrations.

Contaminated clams and other invertebrates are a potential continuing source of petroleum hydrocarbons for sea otters and otherspecies that forage in the shallow subtidal zone. Samples from pollock, which feed in the water column, taken as far away as 500 mile from the wreck site on Bligh Reef, showed elevated petroleum hydrocarbon metabolite concentrations in their bile. This indicates that the water column or food supply was affected at great distances from the spill. Initial 1990 study results show a significant effect on benthic organisms associated with eelgrass beds. These are known to be highly productive habitats. The composition of benthic animal communities on soft-bottom habitats as deep as 40 meters were also significantly altered in oiled areas.

ARCHAEOLOGICAL AND SUBSISTENCE RESOURCES

The spill directly impacted archaeological sites and subsistence resources. Cleanup activities and the associated significant increases in human activity throughout the spill zone resulted in additional injuries to these resources.

Archaeological Resources: Archaeological sites along the shoreline were injured by the

spill. Review of spill response data revealed injuries from oil to a minimum of 26 archaeological sites. Among these are burial sites and home sites. Twenty-one (21) of these sites are on federally-owned land, with the remaining five on State of Alaska and private lands. Of the 21 sites on federal land, 10 are on national parks, six on national wildlife refuges, four within Chugach National Forest, and one on Bureau of Land Management land. While injury to these 26 sites was documented during cleanup, a spill-wide assessment of injuries to archaeological resources has yet to be completed. In addition to oil contamination, increased knowledge of the location of archaeological sites may put them at risk from looting. Loss of rye grass cover may threaten some sites. A comprehensive survey of injuries to archaeological resources on public lands throughout the spill zone will be conducted during 1991.

A study was conducted to determine impacts caused by oil contamination on radiocarbon dating of archaeological resources and to investigate the potential for cleaning artifacts and materials to allow such dating. Preliminary results indicate significant injury to the ability to contextually date artifacts and materials by Carbon 14 analysis. It also appears that these materials cannot be successfully "cleaned" to allow accurate dating.

Subsistence Resources: Surveys undertaken by state researchers before the spill and in 1990 indicated that subsistence harvesters in the area affected by the oil spill significantly reduced their use of subsistence resources after the spill, primarily because of their concerns about possible contamination of these resources. The oil spill disrupted the subsistence lifestyle of some communities that have historically relied upon these resources. Some communities virtually or entirely ceased subsistence harvests in 1989 and have only gradually begun to resume harvests, while other communities continued some reduced level of subsistence harvest in 1989 and thereafter. The attached report (Subsistence Use of Fish and Wildlife in 15 Alutiiq Villages after the Exxon Valdez Oil Spill) details these studies. Warnings were issued by the state in 1989 for people to avoid consumption of intertidal invertebrates (such as mussels and clams, which bioaccumulate petroleum hydrocarbons) found along shorelines contaminated by oil. After the spill, an oil spill health task force was formed, including the state and federal governments, subsistence users, and Exxon. This group helped oversee studies conducted by the state and others in conjunction with FDA and NOAA in 1989 and 1990, on subsistence food resources such as seals, deer, salmon, ducks, clams, and bottomfish. Based upon the test results these resources, with the exception of clams and mussels in certain oiled areas such as Windy Bay, were determined to be safe for human consumption.

CONCLUSION

The federal and state Trustee agencies have now concluded two field seasons of study and are currently preparing to begin a third year of studies to assess injuries to natural resources resulting from the Exxon Valdez oil spill. The information contained in this

summary is based upon the field work and data analysis conducted to date, and is preliminary. Many studies will likely need to continue for additional years before a full understanding of injuries is developed. For example, long-lived species such as bald eagles, murre, and sea otters, may not manifest some effects until a number of years have passed. For other species, such as herring and salmon that return to spawn years after hatching, it is necessary to wait for these key life history events to occur before one can determine the extent to which or if they have been injured. At present there is no indication of long-term injury for species other than those noted in this summary. Although two field seasons of study are complete, only a portion of the data gathered has been fully analyzed and interpreted. As studies and data analysis are completed, some of the information contained in this summary may need to be modified.

For the reasons given above, injury assessment studies will continue in 1991, and thereafter until the process is complete. The need to continue to understand the long-term effects of the spill will be accomplished through monitoring projects that will measure the natural recovery of resources injured by the spill as well as the effectiveness of restoration measures implemented by the Trustee agencies. The information gathered by the injury assessment studies, the restoration monitoring studies, and other studies will be used to develop and implement a restoration program that will accelerate the recovery of injured resources.

Restoration measures will begin in 1991 and are expected to become more comprehensive as the understanding of the effects of the spill improves and as experts and the public provide input on where restoration measures should be concentrated. Wherever possible, restoration will focus on those projects that will provide ecosystem-wide benefits, thereby benefitting a variety of species. These projects may include various initiatives to protect habitat; in other cases it may be necessary to conduct restoration programs that will primarily benefit a particular resource injured by the spill.

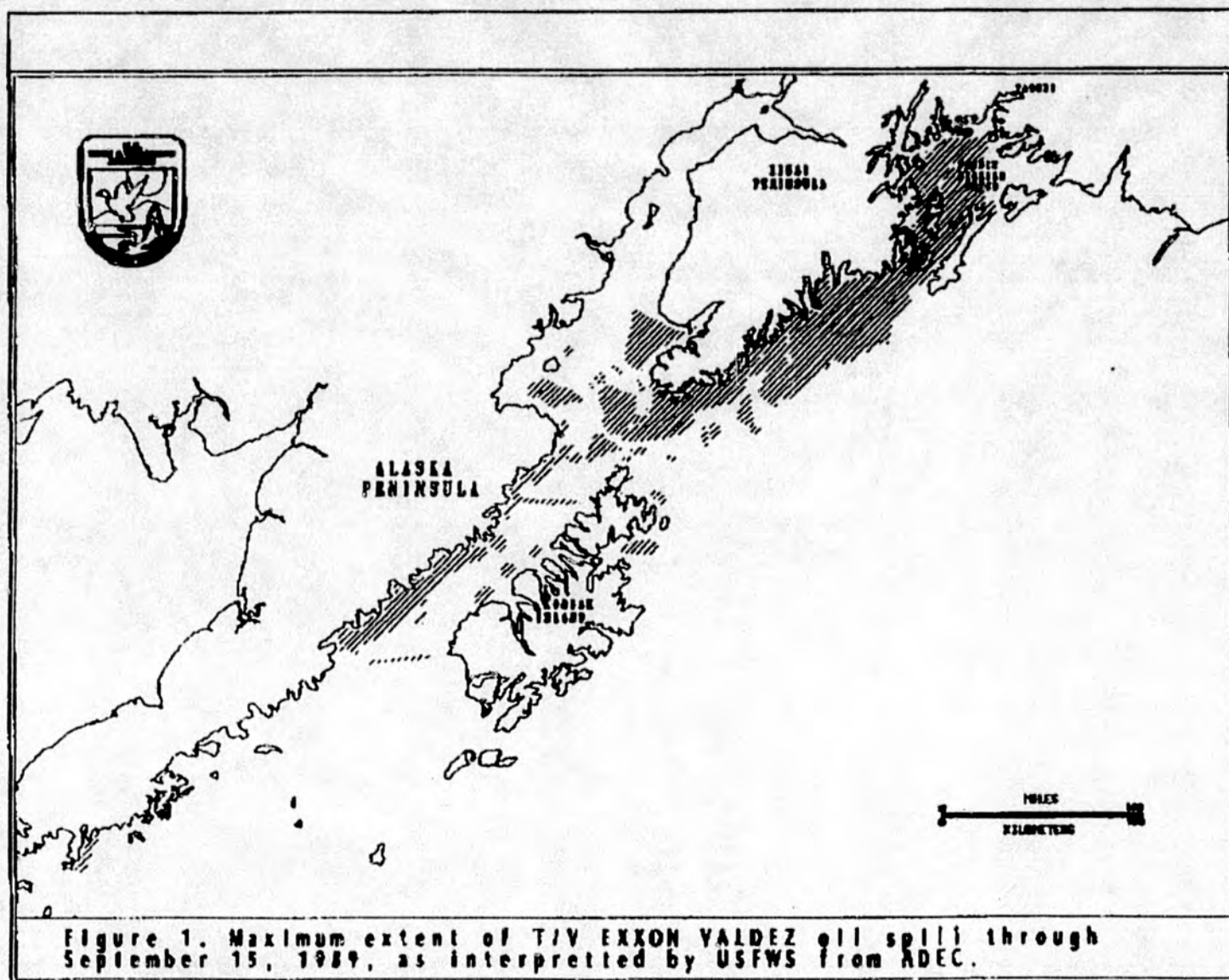


Table 1. Species composition and number of birds retrieved from oiled areas and processed at U.S. Fish and Wildlife receiving stations as of 25 September, 1989.

Species	Total	Valdez	Seward	Homer	Kodiak
Total	35,279	3,360	3,503	5,778	22,638
Unidentified bird	2,927	476	414	916	1,121
Unidentified loon	69	27	6	25	11
Common Loon	216	142	23	32	19
Yellow-billed Loon	87	72	5	3	7
Pacific Loon	18	8	5	0	5
Red-throated Loon	5	3	1	1	0
Unidentified grebe	65	27	8	11	19
Red-necked Grebe	120	79	22	12	7
Horned Grebe	277	233	15	22	7
Northern Fulmar	426	0	22	12	115
Unidentified shearwater	579	5	22	14	538
Sooty Shearwater	360	4	80	34	242
Short-tailed Shearwater	2,460	1	84	4	2,371
Unidentified petrel	69	2	24	14	29
Fork-tailed Storm-petrel	363	1	50	19	293
Leach's Storm-petrel	12	0	9	0	3
Unidentified cormorant	219	76	27	56	60
Double-crested Cormorant	38	19	10	0	9
Pelagic Cormorant	418	277	65	29	47
Red-faced Cormorant	161	90	29	9	33
Great Blue Heron	1	1	0	0	0
Unidentified swan	3	0	2	1	0
Emperor Goose	2	0	0	0	2
Canada Goose	1	0	0	1	0
Brant	3	0	1	2	0
Unidentified duck	30	4	6	20	0
Unidentified seaduck	112	63	2	11	36
Mallard	11	2	4	1	4
Northern Pintail	4	0	3	1	0
Green-winged Teal	5	0	5	0	0
Unidentified Scaup	4	1	3	0	0
Greater Scaup	27	2	21	4	0
Lesser Scaup	2	0	2	0	0
Unidentified Goldeneye	25	8	2	14	1
Common Goldeneye	6	3	0	2	1
Barrow's Goldeneye	33	19	9	4	1
Bufflehead	21	17	1	0	3
Oldsquaw	185	131	43	6	5

Table 1. Species composition and number of birds retrieved from oiled areas and processed at U.S. Fish and Wildlife receiving stations as of 25 September, 1989. (Cont'd)

Species	Total	Valdez	Seward	Homer	Kodiak
Harlequin Duck	213	148	10	35	20
Unidentified Eider	3	0	0	3	0
Stellar's Eider	4	4	0	0	0
Common Eider	17	5	0	2	10
King Eider	9	0	0	0	9
Unidentified Scoter	162	23	17	51	71
White-winged Scoter	342	164	13	137	28
Surf Scoter	175	45	28	9	6
Black Scoter	132	112	4	8	8
Ruddy Duck	1	0	1	0	0
Unidentified merganser	3	1	0	0	2
Common Merganser	2	2	0	0	0
Red-breasted Merganser	33	30	1	1	1
Sandhill Crane	2	1	1	0	0
Black Oystercatcher	9	2	2	0	5
Golden Plover	1	0	0	1	0
Unidentified sandpiper	11	1	5	1	4
Unidentified turnstone	1	0	0	0	1
Common Snipe	1	0	0	1	0
Semipalmated Sandpiper	1	0	1	0	0
Lesser Yellowlegs	2	0	0	2	0
Western Sandpiper	5	0	0	5	0
Baird's Sandpiper	1	0	0	0	1
Least Sandpiper	4	0	2	0	2
Surfbird	3	3	0	0	0
Short-billed Dowitcher	1	0	0	0	1
Red Phalarope	2	0	0	2	0
Red-necked Phalarope	7	1	3	0	3
Long-tailed Jaeger	1	0	0	0	1
Unidentified gull	99	6	34	39	20
Glaucous-winged Gull	555	33	188	28	213
Herring Gull	8	3	5	0	0
Mew Gull	33	0	3	3	27
Black-legged Kittiwake	1,225	8	214	74	929
Arctic Tern	3	1	1	0	1
Aleutian Tern	1	0	0	0	1

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Table 1. Species composition and number of birds retrieved from oiled areas and processed at U.S. Fish and Wildlife receiving stations as of 25 September, 1989. (Cont'd)

Species	Total	Valdez	Seward	Homer	Kodiak
Unidentified alcid	173	24	0	15	134
Unidentified murre	8,851	21	775	2,101	5,954
Common Murre	10,428	399	523	1,353	8,153
Thick-billed Murre	669	16	142	73	438
Pigeon Guillemot	614	136	109	155	214
Unidentified murrelet	413	21	37	121	234
Marbled Murrelet	612	289	97	82	144
Kittlitz's Murrelet	67	23	19	21	4
Ancient Murrelet	311	3	40	73	195
Cassin's Auklet	48	0	36	2	10
Least Auklet	5	0	0	1	4
Parakeet Auklet	31	1	2	1	27
Rhinoceros Auklet	141	0	31	31	79
Unidentified puffin	46	0	7	4	35
Horned Puffin	139	0	32	13	94
Tufted Puffin	361	0	29	15	317
Bald Eagle	125	31	20	15	59
Unidentified raptor	7	1	3	2	1
Peregrine Falcon	2	0	0	0	2
Willow Ptarmigan	1	0	0	0	1
Unidentified owl	1	0	0	1	0
Great-horned Owl	3	0	0	3	0
Unidentified woodpecker	1	0	0	1	0
Cliff Swallow	3	0	3	0	0
Violet-green Swallow	1	0	1	0	0
Unidentified passerine	9	1	7	1	0
Stellar's Jay	1	1	0	0	0
Magpie	7	1	0	0	6
Common Raven	18	1	4	0	13
Northwestern Crow	34	6	3	3	22
American Robin	2	0	2	0	0
Varied Thrush	1	0	0	0	1
Hermit Thrush	1	0	1	0	0
Unidentified warbler	1	0	0	0	1
Yellow Warbler	3	0	3	0	0
Pine Grosbeak	1	0	0	0	1
Unidentified sparrow	15	0	10	2	3
savannah Sparrow	1	0	1	0	0
Golden-crowned Sparrow	4	0	3	0	1
White-winged Crossbill	8	0	0	6	2

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Budget Summary for the Exxon Valdez Oil Spill Damage Assessment - 1991

Budgeted costs for projects from 3-1-91 through 2-29-92.

STUDY NO.	STUDY TITLE	LEAD AGENCY	BUDGET
Marine Mammals			
2	Killer Whale	NOAA	\$186,000
4	Sea Lion	ADF&G	24,000*
5	Harbor Seal	ADF&G	94,200
6	Sea Otter Injury	DOI	810,800
	subtotal		\$1,115,000
Terrestrial Mammals			
3	River Otter & Mink	ADF&G	\$377,300
4	Brown Bear	ADF&G	76,000
6	Mink Reproduction	ADF&G	8,500*
	subtotal		\$461,800
Birds			
1	Beached Bird Survey	DOI	\$313,000
2	Census/Seasonal Distribution	DOI	220,000
3	Seabird Colony Surveys	DOI	530,000
4	Bald Eagles	DOI	255,000
11	Sea Ducks	DOI	178,900
	subtotal		\$1,496,900

Budget Summary for the Exxon Valdez Oil Spill Damage Assessment - 1991
(continued)

Budgeted costs for projects from 3-1-91 through 2-29-92.

STUDY NO.	STUDY TITLE	LEAD AGENCY	BUDGET
Fish/Shellfish			
1	Salmon Spawning Area Injury	ADF&G	\$288,000
2	Eggs/Pre-emergent Fry Sampling	ADF&G	259,000
3	Coded-wire Tagging	ADF&G	1,075,000
4	Early Marine Salmon Injury	ADF&G NOAA	136,400 172,000
5	Dolly Varden Injury	ADF&G	325,100
7	Salmon Spawning Area Injury, Outside PWS	ADF&G	15,000*
8	Egg & Pre-emergent Fry Sampling, Outside PWS	ADF&G	15,000*
11	Herring Injury	ADF&G	558,000
13	Clam Injury	ADF&G	147,000
15	Injury to Shrimp	ADF&G	moved to Subtidal
17	Injury to Rockfish	ADF&G	moved to Subtidal
18	Trawl Assessment	NOAA	40,000*
24	Injury to Demersal Fish	NOAA	moved to Subtidal
27	Sockeye Salmon Overescapement	ADF&G	334,300
28	Run Reconstruction	ADF&G	175,100
30	Database Management	ADF&G	175,800
	subtotal		\$3,715,700

Budget Summary for the Exxon Valdez Oil Spill Damage Assessment - 1991
(continued)

Budgeted costs for projects from 3-1-91 through 2-29-92.

STUDY NO.	STUDY TITLE	LEAD AGENCY	BUDGET
Technical Services			
1	Hydrocarbon Analysis	DOI	\$550,000
		NOAA	2,000,000
3	Mapping	DOI	300,000
		ADNR	656,300
		subtotal	\$3,506,300
Archaeology			
1	Archaeological	ADNR	\$688,600
		USFS	103,000
		subtotal	\$791,600
	SUBTOTAL FOR SCIENCE PROJECTS		\$18,238,800
Peer Reviewers/Chief Scientist			
	Department of Agriculture		\$772,000
	Department of Interior		772,000
	National Oceanic and Atmospheric Administration		772,000
	SUBTOTAL FOR PEER REVIEWERS/CHIEF SCIENTIST		\$2,316,000
Economics			
1	Commercial Fisheries Losses	FEDERAL	\$265,500
5	Recreation Uses Damage	FEDERAL	390,400
6	Subsistence Losses	FEDERAL	532,100
7	Intrinsic Value Loss	FEDERAL	1,964,600
8	Research Program Damage	FEDERAL	104,900
10	Petroleum Products Price	FEDERAL	271,300
	SUBTOTAL FOR ECONOMICS		\$3,528,800
Restoration Planning			
	State of Alaska		\$2,968,000
	Environmental Protection Agency		1,267,000
	Department of Interior		300,000
	Department of Agriculture		525,000
	National Oceanic & Atmospheric Administration		425,000
	SUBTOTAL FOR RESTORATION		\$5,485,000**

Budget Summary for the Exxon Valdez Oil Spill Damage Assessment - 1991
(continued)

Budgeted costs for projects from 3-1-91 through 2-29-92.

STUDY NO.	STUDY TITLE	LEAD AGENCY	BUDGET
Coastal Habitat			
1A	Intertidal Studies	USFS	\$5,100,000
1B	Intertidal Studies	NOAA	68,000
		subtotal	\$5,168,000
Air/Water			
2a	Injury to Subtidal	DEC NOAA	moved to Subtidal moved to Subtidal
2b	Deep Water Benthos	ADF&G	moved to Subtidal
3	Hydrocarbon in Water	DEC NOAA	moved to Subtidal moved to Subtidal
6	Oil Fate and Toxicity	NOAA	moved to Subtidal
Subtidal			
1	Hydrocarbon Exposure, Microbial and Meiofaunal Community Effects (A/W 2a)	DEC NOAA	\$139,800 295,000
2	Injury to Benthic Communities:	ADF&G	592,500
3	Bio-availability and transport of hydrocarbons (A/W 3)	DEC NOAA	196,200 150,000
4	Sediment Toxicity Bioassays (A/W 6)	NOAA	125,000
5	Injury to Shrimp (F/S 15)	ADF&G	50,000
6	Injury to Rockfish (F/S 17)	ADF&G	120,000
7	Injury to Demersal Fish (F/S 24)	ADF&G NOAA	80,000 235,000
		subtotal	\$1,983,500

Summary for the Exxon Valdez Oil Spill Damage Assessment - 1991
(continued)
Budgeted costs for projects from 3-1-91 through 2-29-92.

STUDY NO.	STUDY TITLE	LEAD AGENCY	BUDGET
	Oil Spill Public Information Support		
	Department of Agriculture *		\$614,000
	Department of Interior		1,739,000
	National Oceanic and Atmospheric Administration		599,000
	SUBTOTAL FOR OIL SPILL PUBLIC INFORMATION SUPPORT		\$2,952,000
	Overhead		
	State of Alaska		\$1,037,200
	Department of Agriculture		600,000
	Department of Interior		300,000
	National Oceanic and Atmospheric Administration		900,000
	Environmental Protection Agency		200,000
	SUBTOTAL FOR OVERHEAD		\$3,037,200
	GRAND TOTAL		\$35,557,800

* These studies are being funded for the completion of data analysis and final report preparation.

** Restoration implementation projects may be conducted this summer depending on resource availability. (See FR 88, 98, March 1, 1991.)

BUDGET SUMMARY FOR THE EXXON VALDEZ OIL SPILL BY AGENCY

State of Alaska	\$10,612,300
Department of Agriculture	7,714,000
Department of Interior	6,268,700
National Oceanic and Atmospheric Administration	5,967 [*] ,000
Environmental Protection Agency	1,467,000
All Federal Agencies (Economics)	3,528,800

GRAND TOTAL

\$35,557,800

PART V: RESTORATION PLANNING

RESTORATION PLANNING

OBJECTIVES

The goal of the restoration planning effort is to identify appropriate measures that can be taken to restore natural resources injured by the EVOS. Specific objectives are:

- A. Identify or develop technically feasible restoration options for natural resources and services potentially injured by the EVOS;
- B. Determine the nature and pace of natural recovery of injured resources, and identify where direct restoration measures may be appropriate;
- C. Incorporate an approach to restoration that where appropriate, focuses on recovery of ecosystems rather than on the individual components of those systems;
- D. Identify costs associated with implementing restoration activities, in support of the overall natural resource damage assessment process; and
- E. Encourage, provide for, and be responsive to public participation and review during the restoration planning process.

DEFINITION

For any injury, there are three types of possible restoration activities:

1. direct restoration refers to measures in addition to response actions, usually taken on site, to directly rehabilitate an injured, lost, or destroyed resource;
2. replacement refers to substituting one resource for an injured, lost, or destroyed resource of the same or similar type; and
3. acquisition of equivalent resources means to compensate for an injury to a resource by substituting another resource that provides the same or substantially similar services as the resource injured, lost, or destroyed.

Determining the adequacy of natural recovery is fundamental to the choice of a restoration activity. In some cases the Trustees may determine that it is most appropriate to allow natural recovery to proceed without further intervention.

1990 RESTORATION ACTIVITIES

The Trustee agencies and EPA initiated several small-scale field studies to evaluate the feasibility of restoration techniques. Results from these studies will help to determine the costs and effectiveness of full-scale restoration projects. Several technical support studies were also initiated to provide information needed to evaluate or carry out some potential restoration activities. These studies were described in the 1990 State/Federal Natural Resources Damage Assessment and Restoration Plan for the Exxon Valdez Oil Spill, August 1990 (available at the OSPIC) and preliminary results are summarized below.

1990 RESTORATION FEASIBILITY STUDIES

1. Reestablishment of *Fucus* in Rocky Intertidal Ecosystems

Lead Agency: EPA

Early observations indicated that *Fucus*, a marine plant (rockweed) found on rocky shorelines in the intertidal zone throughout the oil spill area, was extensively damaged by both the spilled oil and cleanup efforts. If the natural recovery of *Fucus* could be significantly accelerated or enhanced, it would benefit the recovery of associated flora and fauna on intertidal rocky shores.

Specific objectives of this study were to identify the causes of variation in *Fucus* recovery at and near Herring Bay, Knight Island in PWS; to document the effects of alternative cleaning methods on *Fucus*; and to test the feasibility of enhancing the reestablishment of *Fucus*. Although results are preliminary it appears that *Fucus* recovers most slowly at intensively cleaned sites and almost no recovery occurs where tar cover persists.

2. Reestablishment of Critical Fauna in Rocky Intertidal Ecosystems

Lead Agency: USFS

This feasibility study was designed to compare the rates of faunal recovery in rocky intertidal communities, and to demonstrate the feasibility of restoration of these communities by enhancing recolonization rates for such key species as limpets and starfish. Recolonization rates for these organisms and for the rockweed, *Fucus*, may limit the natural rates of recovery for the entire community. Parameters examined included the presence or absence of common intertidal species on impacted and reference sites, population dynamics of several species of invertebrates, larval settlement on oiled versus unoled surfaces, and differences in algal grazing by limpets between oiled and reference sites. One of the preliminary results indicates that heavy predation of several

species of transplanted invertebrates was probably due to the lack of cover usually provided by *Fucus*.

3. Identification of Potential Sites for Stabilization and Restoration with Beach Wildrye

Lead Agency: DNR

This study was designed to identify sites with injury to beach wildrye grass and to recommend restoration measures. Beach wildrye grass is important in the prevention of erosion in the coastal environment and is a key component of supratidal habitats in locations throughout the oil spill area. Erosion resulting from loss of beach wildrye can lead to the destabilization and degradation of wildlife habitats and of cultural and recreational sites. Results from survey work conducted in 1990 in PWS indicate injury to several beach wildrye communities.

4. Identification of Upland Habitats Used by Wildlife Affected by the Oil Spill

Lead Agency: FWS, ADF&G

A diversity of birds, mammals, and other animals were killed by the spill or injured by contamination of prey and habitats. Many of these species are dependent on aquatic or intertidal habitats for activities such as feeding and resting, but many also use upland habitats. Protection of upland habitats from further degradation may reduce the effects of the oil on injured fish and wildlife populations, and thereby speed their recovery. This study focused specifically on marbled murrelets and harlequin ducks, two species known to have been affected by the spill and known to use upland habitats.

Based on surveys of 140 streams, preliminary results of the harlequin duck study indicate that this species nests along larger-than-average anadromous fish streams, with moderate gradients and clear waters. Preliminary results on murrelets suggest that murrelets use north facing slopes, and inland areas at the heads of bays. Open bog meadows, especially at the heads of bays, appear to be used as flight corridors to upper wooded areas.

5. Land Status, Uses, and Management Plans in Relation to Natural Resources and Services

Lead Agency: DNR

The objective of this study is to locate, categorize, evaluate, and determine the availability of maps, management plans, and other resource documents relevant to restoration planning throughout the oil spill region. Resource materials identified will assist in planning for implementing site-specific restoration activities,

including direct restoration, replacement, and the acquisition of equivalent resources.

To date, a variety of documents, maps, and management plans have been identified and are being evaluated; other resource materials are being located. This preliminary project will be completed in Spring 1991. A second phase is under consideration.

1990 Technical Support Projects

1. Peer Reviewer Process for Restoration Feasibility Studies

Lead Agencies: ADF&G, DEC, DNR, DOI, DOA, NOAA, EPA

This project provided funds to ensure that scientists with expertise on natural resource restoration were available to provide peer review of restoration feasibility projects and other restoration planning studies and activities.

2. Assessment of Beach Segment Survey Data

Lead Agency: DNR

The objective of this project is to review and summarize beach survey information (obtained through oil spill response activities) to assist in planning for and implementing site-specific restoration activities, particularly in the area of direct restoration. This study was initiated late in 1990 and continues.

A master database is being created from that portion of the beach surveys relevant to restoration. The primary sources of this information are DNR and DEC. Data from local and regional governments as well as non-governmental sources will also be reviewed and integrated into the system as appropriate. This preliminary project will be completed in Spring 1991.

3. Development of Potential Feasibility Studies for 1991

Lead Agencies: ADF&G, EPA

This project provided for the orderly development of additional feasibility studies including: a) monitoring "natural" recoveries; b) pink salmon stock identification; c) herring stock identification/spawning site inventory; d) artificial reefs for fish and shellfish; e) alternative recreation sites and facilities; f) historic sites and artifacts; and g) availability of forage fish. Feasibility study proposals are currently under consideration including the above topics.

1991 RESTORATION PLANNING ACTIVITIES

The fundamental purpose of restoration planning is to identify, evaluate, and then recommend potential restoration implementation activities, in consultation with technical experts and the public.

The NRDA studies and other sources (e.g., Shoreline Assessment Program, and other agency surveys not connected with the oil spill) provide information on species, habitats, and ecosystems in need of restoration. In 1991, as damage assessment results are synthesized, the RPWG will consult with the principal investigators, agency experts, and outside peer reviewers to review the nature and extent of oil spill injuries in relation to the biology and ecology of the injured resources. A key goal in this process will be to identify life history requirements, limiting factors, and environmental processes that are especially sensitive or that may be enhanced. In turn, this will lead to the identification of potential restoration activities.

Once potential restoration implementation activities have been identified, they must be evaluated in terms of technical feasibility, environmental benefit, cost, and other factors. In 1991, the RPWG will continue to evaluate the restoration options identified thus far (e.g., those presented in RPWG's Restoration Planning Following the Exxon Valdez Oil Spill: August 1990 Progress Report), as well as new options that are suggested through public and technical consultations.

While some potential restoration implementation activities are readily evaluated, others require more detailed review and study. In some cases, the RPWG will recommend that restoration science studies (feasibility, monitoring, or technical support) be conducted to test the efficacy of particular options or to gather basic information necessary to evaluate or implement an option (e.g., biological or resource assessment data). Several such studies were carried out in 1990. Subject to additional technical review and availability of funds, some restoration science studies and implementation projects are being considered in 1991. If these studies or projects are carried forward they will be outlined in a Federal Register notice later this spring. Additional information on the Trustees' plan to implement restoration projects in 1991 was provided in the March 1, 1991, Federal Register, (56 FR 8898).

The RPWG also expects to further evaluate restoration approaches. For example, the RPWG will review different management systems for protecting marine habitats (e.g., National Marine Sanctuary Program, Alaska Marine Parks). Another example would be to carry out economic and environmental analyses of restoration alternatives.

As information about injuries becomes available, and as potential restoration actions are evaluated, further implementation activities may be recommended.

Literature Review

The scientific literature and information from other oil spills will provide background information that is helpful in restoration planning. In 1991, the RPWG expects to synthesize previously identified literature on restoration (see Appendix B, August 1990 Progress Report). The RPWG will also complete previously initiated syntheses of literature on species and ecosystem recoveries following natural and human-induced environmental disturbances.

Monitoring

Information on the adequacy of natural recovery is central to determining whether to implement restoration activities or to allow injured resources to recover on their own. The literature reviews described above will provide background information for such considerations, while damage assessment studies will provide current data on the status of resources injured by the EVOS. In 1991 the RPWG expects to recommend several monitoring studies to be carried out in the field in 1991 and to develop protocols for evaluating the effectiveness of any restoration projects that are implemented. The RPWG also will continue efforts to develop a comprehensive plan for long-term ecological monitoring that could be implemented in the oil spill environment following resolution of damage claims.

Public Participation

In 1990, the RPWG emphasized broad scoping activities to invite suggestions from the public about potential restoration activities and priorities. Public participation will continue to be important in 1991, with increased emphasis on evaluating and determining the importance of restoration alternatives. The RPWG is interested in, and available for, meetings with individuals or constituency groups. There also will be consideration of additional activities, such as publications and workshops in 1991. Requests and suggestions from the public are invited.

Scientific Review

Technical review is essential to the scientific integrity of the restoration planning process. As needed, the RPWG draws upon experts from academic institutions, public agencies, and private organizations (e.g., consulting firms, non-profit organizations) as sources of advice and criticism in planning feasibility and technical support studies, and in evaluating and recommending

restoration activities. In 1991, the RPWG will continue to place emphasis on scientific review, including participation by peer reviewers.

BIBLIOGRAPHY

Trustee Council. 1990. 1990 State/Federal Natural Resource Damage Assessment and Restoration Plan for the Exxon Valdez Oil Spill; August, 1990. 360pp plus appendices.

Restoration Planning Work Group. 1990. Restoration Planning Following the Exxon Valdez Oil Spill; August 1990 Progress Report. 80 pp.

BUDGET

The following restoration planning budget does not include the 1991 costs of any potential restoration implementation projects.

Salaries:	\$835.0
Travel:	250.0
Supplies:	20.0
Equipment/Office:	75.0
Contractual Services:	
Literature Review	125.0
Scientific Review	100.0
Public Participation	30.0
Restoration Options Analysis	200.0
Report Publications	25.0
Restoration Science Studies:	<u>3,875.0</u>
Total Planning Activities Budget:	\$5,485.0

FILED

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UNITED STATES DISTRICT COURT
DISTRICT OF ALASKA

By _____ Deputy

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UNITED STATES DISTRICT COURT
DISTRICT OF ALASKA

UNITED STATES OF AMERICA,

Plaintiff,

v.

Exxon Corporation, Exxon Shipping
Company, Alyeska Pipeline Service
Company, Amerada Hess Pipeline
Corporation, ARCO Pipe Line Company,
Exxon Pipeline Company, Mobil Alaska
Pipeline Company, Phillips Alaska
Pipeline Corporation, BP Alaska
Pipelines, Inc., Unocal Alaska
Pipeline Company, and the T/V
EXXON VALDEZ), in rem,

Defendants.

CIVIL ACTION

NO. A91-082

NOTICE OF LODGING OF UNITED STATES' SUMMARY OF
EFFECTS OF EXXON VALDEZ OIL SPILL ON NATURAL RESOURCES

PLEASE TAKE NOTICE that the United States is lodging

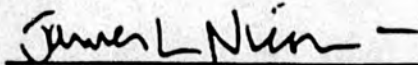
NOTICE OF LODGING OF SUMMARY OF EFFECTS - 1

with the Court the attached Summary of Effects of the EXXON VALDEZ Oil Spill on Natural Resources and Archaeological Resources (the "Summary"). The United States is lodging the Summary to assist the Court in evaluating the proposed Consent Decree lodged with the Court on March 13, 1991. The Summary is based on scientific studies conducted by the Departments of Agriculture and the Interior, the National Oceanic and Atmospheric Administration, and the Environmental Protection Agency to assess the injury to natural resources resulting from the oil spill.

The Summary is being lodged in advance of a motion to enter the proposed Consent Decree in order to give the Court additional time to consider the nature of injury to natural resources resulting from the oil spill.

Dated: April 8, 1991

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**SUMMARY OF EFFECTS OF THE EXXON VALDEZ OIL SPILL
ON NATURAL RESOURCES AND ARCHAEOLOGICAL RESOURCES
March 1991**

INTRODUCTION

The T/V Exxon Valdez ran aground on Bligh Reef in Prince William Sound on the night of March 23-24, 1989, spilling approximately 11 million gallons of North Slope crude oil, making this the largest oil spill in United States history. The oil spread through Prince William Sound, the Gulf of Alaska, and lower Cook Inlet. More than 1,200 miles of coastline were oiled, including portions of the Chugach National Forest, Alaska Maritime, Kodiak, and Alaska Peninsula/Becharof National Wildlife Refuges, Kenai Fjords National Park, Katmai National Park and Preserve, and Aniakchak National Monument and Preserve. Oil from the T/V Exxon Valdez impacted shorelines nearly 600 miles from Bligh Reef.

The magnitude of efforts of the state and federal governments, the public, and Exxon to contain and clean up the spill, rescue wildlife, and study the effects of the spill is unprecedented. Among those efforts are the state/federal natural resource damage assessment studies designed to measure injuries to natural resources including birds, mammals, fish and other wildlife, and marine and terrestrial habitats. These studies are intended to provide the information necessary for the Trustee agencies to manage and restore injured resources appropriately and to provide necessary documentation to enable the governments to present a claim for damages to the responsible parties. This summary briefly describes the area affected by the spill, the chronology of the spill, and the process developed to implement and manage the injury assessment studies. It focuses, however, on what has been learned over the past two years about the effects of this oil spill on natural resources.

DESCRIPTION OF THE AREA AFFECTED BY THE SPILL

Prince William Sound lies near the top of the Gulf of Alaska (see map), an 850 mile arc extending from the Aleutian Islands on the west to the islands of southeast Alaska. The gulf coast is remote, rugged, and scenic. Its maritime climate nourishes a lush, green landscape in the summer. The area is snow covered in the winter. Bears, whales, bald eagles, puffins, seals, sea lions, and sea otters are among the abundant wildlife of the area. Storms that cross the Gulf drop as much as 300 inches of rain and snow annually in the high coastal mountains. Glaciers descend from permanent ice fields capping these coastal mountain ranges, continuing to carve intricate fjords and send icebergs floating out to sea. These are the largest glaciers outside Antarctica and Greenland.

Prince William Sound is one of the largest relatively undeveloped marine ecosystems in the United States. It has one of the continent's largest tidal estuary systems. Prince William Sound has rich commercial herring and salmon fisheries. The open water of the Sound is about the size of Chesapeake Bay. Its many islands, bays, and fjords give it

more than 2,000 miles of shoreline. Prince William Sound is surrounded by land, most of which is part of Chugach National Forest.

To the southwest of Prince William Sound is the Kenai Peninsula, home of the Kenai Fjords National Park, various units of the Alaska Maritime National Wildlife Refuge, and, among others, the cities of Homer and Seward. Numerous seabird colonies are located along the coast of the Kenai Peninsula, including those most frequently visited by tourists in Alaska. Both Prince William Sound and the Kenai Peninsula are accessible by air, boat, and on a limited basis, by automobile from nearby Anchorage, Alaska's major population center. State ferries that run among the larger communities and many charter boats make it easy for people to visit the heart of the Gulf coast. In recent years, there has been a steady increase in the number of wilderness seekers, kayakers, cruise ship passengers, and other tourists visiting the area.

The Kenai Peninsula points southwest to Shelikof Strait and Kodiak Island. Shelikof Strait lies between Kodiak Island, on the south and the Alaska Peninsula on the north. Shelikof Strait is the source of a very productive commercial pollock fishery. The Kodiak National Wildlife Refuge is located on the Kodiak Archipelago and Katmai National Park and Preserve, Alaska Peninsula/Becharof National Wildlife Refuge, and Aniakchak National Monument and Preserve are located along the coast of the Alaska Peninsula. The Alaska Peninsula tapers, then scatters into the islands of the Aleutian chain.

CHRONOLOGY OF THE EXXON VALDEZ OIL SPILL

For the first three days of the spill, the weather was calm and the slick lengthened and widened amoeba-like and generally stayed in the vicinity of the grounded tanker and off the beaches. Even with these seemingly ideal circumstances for oil recovery, the amount of oil in the water completely overwhelmed efforts to contain and recover the oil. A major windstorm on March 27, 1989, pushed the oil in a southwesterly direction and oiled beaches on Little Smith, Naked, and Knight Islands. The oil continued to spread, contaminating islands, beaches, and bays in Prince William Sound. Four days into the spill, oil began to enter the Gulf of Alaska. The leading edge of the slick reached the Chiswell Islands off the coast of the Kenai Peninsula on April 2, 1989, and the major seabird nesting colonies on the Barren Islands on April 11, 1989, nineteen days into the spill. By May 18, 1989, oil had moved some 470 miles and had fouled shorelines of Prince William Sound, the Kenai Peninsula, the Kodiak Archipelago, and the Alaska Peninsula. Oil subsequently reached shorelines on the Alaska Peninsula nearly 600 miles from Bligh Reef.

During 1989, the response to contain and cleanup the spill and rescue oiled wildlife involved a massive effort. Skimmer ships were sent throughout the spill zone to vacuum oil from the water surface. Booms were positioned to keep oil from reaching important commercial salmon hatcheries in Prince William Sound. A fleet of fishing vessels, known as the "Mosquito Fleet," played an important role in protecting these hatcheries, in corralling oil to assist the skimmer ships, and in capturing oiled wildlife and

transporting these animals to rehabilitation centers. After oil contaminated shorelines, a beach cleanup program was activated. Various local committees, with community and government agency participation, provided recommendations to the U.S. Coast Guard about areas that should receive priority for cleanup. An army of workers cleaned shorelines, using techniques ranging from cleaning rocks by hand to high pressure hot water washing. Fertilizers, sometimes in a chemical base, were applied to some oiled shorelines to increase the activity of oil-metabolizing bacteria, in an experimental procedure known as bioremediation. When deteriorating weather brought an end to cleanup work in the fall of 1989, a great amount of oil remained on the shorelines. Although winter storms proved extremely effective in cleaning many beaches, spring shoreline surveys indicated that much work remained to be done in 1990. Crews operating from boats and helicopters cleaned oiled shorelines in Prince William Sound, along the Kenai and Alaska Peninsulas, and on the Kodiak Archipelago. Manual pick up of remaining oil was the principal method used during 1990, but bioremediation and relocation of oiled berms to the active surf zone were also used in some areas.¹ Another shoreline survey will be conducted during May 1991, to determine the need for additional cleanup work.

INJURY ASSESSMENT PROCESS

The Exxon Valdez oil spill occurred just prior to the most biologically active season of the year in southcentral Alaska. During the two month period after the spill, seaward migrations of salmon fry, major migrations of birds, and the primary reproductive period for most species of birds, mammals, fish, and marine invertebrate species took place. The organisms involved in these critical periods of their life cycles encountered the most concentrated, volatile, and potentially damaging forms of the spilled oil. As will be discussed in this summary, the oil affected different species differently. Whereas, for example, it directly killed large numbers of birds and sea otters that encountered oil on the water surface, it did not prohibit in and out migration and spawning of large schools of salmon and herring.

The state and federal Trustee agencies were forced to mobilize field studies rapidly with little time for planning. Through intensive efforts, studies were designed, administrative processes were accelerated, and 58 field studies were carried out. Additionally, technical services programs were organized to provide hydrocarbon analysis, histopathology, and mapping support for the field studies. Initial decisions on the types and scope of studies conducted were made by agency experts familiar with the resources and the environment. Even with the rapid deployment of studies, however, some opportunities to gather injury data were irretrievably lost during the early weeks of the spill.

A legal framework was subsequently established and studies were reviewed and modified according to their likelihood to document resource injury. Expert peer reviewers were retained and study plans used during 1989 underwent scientific review for possible

¹Exxon has represented that it has paid over \$2.0 billion to conduct cleanup activities during 1989 and 1990.

modification in 1990. Some studies were discontinued or modified if they were unable to further document resource injury, and some new studies were initiated to fill identified information needs. Status reports prepared in January 1990, were used to guide the development of plans for the second year of studies. Thirty-nine studies and three technical services programs were continued in 1990. Scientific review was again used to plan for the upcoming 1991 field season, during which 29 studies and two technical services programs will be conducted.

This summary of the effects of the Exxon Valdez oil spill on natural resources is preliminary, as studies are still underway and available data are not fully analyzed and interpreted. However, the injuries to natural resources that have been documented to date are summarized herein. This summary also addresses studies that were discontinued. It should be noted that studies were discontinued for a variety of reasons, such as the determination that field work had been completed, that there was no practicable way to measure injury, or that no injury was documented. Even though some studies failed to identify injury and were discontinued, this does not necessarily mean that the resources were not affected by the spill. Certain injuries (if present), such as possible latent or sublethal effects on reproductive or other systems in animals, might not become fully evident for a number of years after the spill. At present there is no significant indication of long-term injury to resources other than those specifically noted below. Although studies indicate that there are continuing injuries to certain resources, natural recovery may also have begun. As petroleum hydrocarbons are broken down in the ecosystem, plant and animal communities begin to reestablish themselves. This recolonization has already been observed in some of the more lightly oiled areas. In the more heavily oiled areas, this natural recovery process is expected to take longer. As this natural recovery occurs, many of the birds and mammals that feed in these areas are expected to begin recovering.

MARINE MAMMALS

Following the spill, studies of humpback whales, Stellers sea lions, sea otters, harbor seals, and killer whales were started. The humpback whale and Stellers sea lion studies were discontinued following the 1990 field season. Humpback whale investigations were limited to photo identification of whales, estimations of reproductive success, and possible relocations of whales. It was not possible to take tissue samples for petroleum hydrocarbon analysis to document exposure. The study did not show direct oil spill mortalities or reproductive failures.

The sea lion study is being completed following the 1990 pup counts. Some tissue samples were analyzed for petroleum hydrocarbon concentrations, and although there was some indication of exposure to oil, it was difficult to determine what populations were affected because of the sea lions' active seasonal movements. Because of an ongoing pre-spill population decline and premature pupping of sea lions, it was not possible to distinguish post- from pre-spill population effects clearly.

Studies of killer whales, based on observations only (because tissue sampling was not an

option), have indicated that killer whales are missing from at least one and possibly two pods in Prince William Sound. Injuries to harbor seals and sea otters have been clearly indicated and studies of these species are continuing.

Sea Otters: The population of sea otters in Prince William Sound before the spill was estimated to have been as high as 10,000. The total sea otter population of the Gulf of Alaska was estimated to be at least 20,000. Statewide, the sea otter population is estimated at 150,000. Sea otters were particularly vulnerable to the spill. As the oil moved through Prince William Sound and the Gulf of Alaska, it covered areas used by large numbers of otters. When sea otters become contaminated by oil, their fur loses its insulating capabilities, leading to death from hypothermia. Sea otters also died as a result of ingestion of oil and perhaps inhalation of toxic aromatic compounds that evaporated from the slick shortly after the spill. The effects of oil were documented by surveys of wild populations; analysis of tissues for petroleum hydrocarbons and indicators of reduced health; by tracking sea otters outfitted with radio transmitters (including those released from rehabilitation centers); and estimating total mortality from the number of sea otters found on beaches. These studies concentrated on developing an estimate of sea otter mortality in Prince William Sound and along the Kenai Peninsula, the population most affected by the spill. During 1989, a total of 1,011 sea otter carcasses were recovered in the spill area, cataloged, and stored in evidence trailers. Of these, 876 were recovered dead from the field and 135 died in rehabilitation centers or other facilities. The total number of sea otters estimated to have been killed directly by the spill ranges from 3,500 to 5,500 animals throughout the spill area.

Initial results indicate significant differences in hematology and blood chemistry parameters between sea otters in oiled and unoled areas. Greater variation was observed in DNA content of blood lymphocytes of sea otters from oiled areas, but sperm and testicular cells showed no indication of DNA damage resulting from oil exposure. It cannot yet be determined whether these differences affect sea otter health or survival. There are indications that sea otters continue to be exposed to petroleum hydrocarbons in oiled areas. Analysis of blood and fat samples collected from animals during 1990 found elevated concentrations of certain aromatic compounds in sea otters from heavily oiled areas and elevated concentrations of petroleum hydrocarbons continue to be documented in food items eaten by sea otters in oiled areas. Additionally, other damage assessment studies have documented a decreased abundance of mussels in oiled areas, a key prey species for sea otters.

Studies have documented continuing injury to sea otters. Normally, very few prime age sea otters (animals between 2 and 8 years old) die each year and most mortality occurs among very young and old age classes. The high number of prime age sea otter carcasses found during 1990 indicates that the pattern of sea otter mortality in heavily oiled areas continues to be abnormal. Results of boat surveys indicated continued declines in sea otter abundance within oiled habitats in Prince William Sound. Preliminary results indicate that pupping rates in oiled and unoled areas are not significantly different. However, the first information available for the spring of 1991 shows higher yearling mortality rates in oiled areas than in unoled areas. Studies of the survival and reproductive success of sea otters released from rehabilitation

centers indicate a high level of mortality of adult animals and significantly lower pupping rates than the pre-spill mortality and pupping rates in Prince William Sound. Of the 193 sea otters released from rehabilitation centers, 45 were fitted with radio transmitters. Sixteen of these animals are still alive, 13 are known to be dead, and 15 are missing. One radio transmitter is known to have failed.

Harbor Seals: There has been no census of harbor seals in Prince William Sound since the mid-1970s when the population was estimated at 3,000 to 5,000 animals. Since that time, the harbor seal population in Prince William Sound and the Gulf of Alaska has declined substantially. A population census of Prince William Sound is planned for the summer of 1991.

Two hundred harbor seals are estimated to have been killed by the spill. Only 19 seal carcasses were recovered following the spill, since seals sink when they die. Population changes were documented by summer and fall aerial surveys of known haulout areas. Toxicological and histopathological analyses were conducted to assess petroleum hydrocarbon accumulation and persistence and to determine toxic injuries to tissues.

Population surveys, which are reliable indicators of population trends, conducted in 1984 and 1988 indicated that harbor seal populations in Prince William Sound had declined prior to the spill, with similar declines in what were subsequently oiled and unoled areas. From 1988 to 1990, however, the decline at oiled sites (35 percent) was significantly greater than at unoled sites (13 percent).

Severe debilitating lesions were found in the thalamus of the brain of a heavily oiled seal collected in Herring Bay 36 days after the spill. Similar but milder lesions were found in five other seals collected three or more months after the spill. During 1989, oiled harbor seals behaved abnormally, being lethargic or unwary. Petroleum hydrocarbon concentrations in bile were 5 to 6 times higher in seals from oiled areas one year after the spill. This indicates that seals were still encountering oil in the environment, were metabolizing stored fat reserves that had elevated levels of petroleum hydrocarbons, or both.²

Killer Whales: Approximately 182 killer whales forming nine distinct family units or "pods" resided in Prince William Sound before the spill. This count is based on pre-spill documentation. These whales were studied intensively before the spill and their group composition and dynamics are well known. Damage assessment studies of killer whales involved extensive boat-based surveys in Prince William Sound and adjacent waters. Whales were photographed and the photographs were compared to the Alaskan

²Harbor seals are taken in some Alaska villages for subsistence. The State of Alaska conducted a program, separate from the damage assessment program, to test subsistence foods potentially affected by the spill to insure that they were safe for human consumption. The State of Alaska determined that harbor seals in the affected area were safe for people to eat (Oil Spill Health Task Force, July-August 1990 Report and September-October 1990 Report. Alaska Department of Fish and Game, Division of Subsistence).

killer whale photographic database for the years 1977 to 1989 to determine changes in whale abundance, seasonal distribution, pod integrity, and mortality and natality rates.

The AB pod of 36 individual whales was sighted intact in September of 1988. When sighted on March 31, 1989, seven days after the spill, seven individuals were missing. These whales remain absent and six additional whales were missing from the AB pod in 1990. Several of the missing whales are females who left behind calves. It is unprecedented for females to abandon calves, therefore their prolonged absence implies that these adult females are dead. In addition, nine individuals from AT pod were missing in 1990. Explanations for the possible causes of death of these missing whales, including explanations apart from the effects of the spill, are being explored. Killer whale surveys will continue in 1991.

TERRESTRIAL MAMMALS

Studies were conducted on terrestrial mammals that may have been exposed to oil through foraging in intertidal habitats. These species included brown bear, mink, black bear, Sitka black-tailed deer, and river otters.

Brown bears are long-lived animals and forage seasonally in the intertidal and supratidal areas of the Alaska Peninsula and the Kodiak Archipelago. Preliminary analysis of brown bear fecal samples and some tissues show that some brown bears were exposed to petroleum hydrocarbons, but no conclusive injury has been documented. Radio-collared brown bears along the Katmai coast and at a control site on the Alaska Peninsula will continue to be monitored while the transmitters remain active.

Mink and other small mammals that are known to feed and spend part or all of their time in the intertidal zone are difficult to study. They are known to crawl off into burrows or the brush if sick or injured and carcasses are unlikely to be found. Also, information on pre-spill populations of these animals is minimal. Scientists developed a laboratory study to test reproductive effects of oil on ranch-bred mink, in which they were fed food mixed with small, non-lethal amounts of weathered oil. Although changes in reproductive rates or success were not documented, it was found that oil-contaminated food moved through the intestines of the animals at a more rapid rate than did clean food, possibly providing less nutrition to the animals.

No field studies were carried out for black bear due to the difficulty of finding, collaring, or otherwise investigating these animals in the dense underbrush in which they reside. However, a literature search confirmed that these animals do forage in the intertidal zone in the spill area.

The deer study found no evidence of injury based on intensive searches of beaches that revealed no mortality attributable to the spill. However, deer taken for purposes of testing for safety for human consumption (not part of the damage assessment process) found slightly elevated petroleum hydrocarbons in some tissues in deer (which feed on kelp in intertidal areas) but it was determined that the deer were safe to eat.

River Otters: A few river otter carcasses were found by cleanup workers. River otters forage in streams and shallow coastal habitats that were contaminated by the spill. Analysis of river otter bile indicated that petroleum hydrocarbons are being accumulated by this species. Studies of radio tagged animals in Prince William Sound showed that home ranges are larger, movements more erratic, and body weights are lower in oiled habitat. Field work is continuing in 1991 to further assess the status of this species, including analysis of blood samples to measure the health of these animals.

BIRDS

Among the most conspicuous effects of the Exxon Valdez oil spill was the injury to birds. Seabirds are particularly vulnerable to oil as they spend much of their time on the sea surface while foraging. Oiled plumage insulates poorly and loses buoyancy and birds die from hypothermia or drowning. Birds surviving initial acute exposure may then ingest oil by preening. Approximately 36,000 dead birds were recovered after the spill; at least 31,000 of these deaths were attributed to the effects of oil. In addition to the large number of murres, sea ducks, and bald eagles, carcasses of loons, cormorants, pigeon guillemots, grebes, murrelets, and other species were also recovered (see attached comprehensive list of bird carcasses logged into evidence trailers by September 25, 1989). Only a small proportion of the total number of birds estimated to have been killed were recovered, as many undoubtedly floated out to sea, sank, were scavenged, were trapped and hidden in masses of oil and were not visible, were buried under sand and gravel by wave actions, decomposed, or simply beached in an area where they were not found. Additionally, it is known that, in a number of cases, carcasses found shortly after the spill were not turned in to receiving stations. Preliminary analyses provided by computer models that account for some of these variables estimate that the total number of birds killed by the spill ranges from 260,000 to 580,000 with the best approximation that between 350,000 and 390,000 birds died. Following peer review, the model will be run again to provide a more refined estimate of total mortality.

Common and Thick-billed Murres: Murres are the third most abundant seabird in Alaska (after tufted puffins and black-legged kittiwakes). A total of approximately 1,400,000 murres reside in the Gulf of Alaska (Unimak Pass to the Canadian border in southeastern Alaska). The total population of murres in Alaska is approximately 12,000,000. The murre colonies on the Chiswell Islands are the most visited by tourists in Alaska. In 1989 and 1990 murres were the most heavily affected bird species. Murre colonies impacted by the spill lost 60 to 70 percent of breeding birds. Oil in Prince William Sound affected major wintering areas of murres and other species. As oil moved out of Prince William Sound and along the Kenai Peninsula and the Alaska Peninsula, it hit major seabird nesting areas such as the Chiswell and Barren Islands, as well as numerous smaller colonies. The oil hit these areas outside Prince William Sound at the same time that adult murres were congregating on the water near colonies in anticipation of the nesting season. Approximately 22,000 murre carcasses were recovered following the spill. Colony surveys indicate that an estimated minimum of 120,000 to 140,000 breeding adult murres in the major colonies that were surveyed were killed by the spill. Extrapolating this information to other known murre colonies hit by

the spill (but not specifically studied), the mortality of breeding adult murres is estimated to have been 172,000 to 198,000. However, area-wide, including wintering and non-breeding birds, the total mortality of murres is estimated to be about 300,000. Murres exhibit strong fidelity to traditional breeding sites and infrequently immigrate to new colonies.

Normally, murres breed in densely packed colonies on cliff faces. Each murre colony initiates egg laying almost simultaneously. This synchronized breeding behavior helps the birds repel predators such as gulls and ravens. In oiled areas, murre colonies have exhibited a much lower populations than before the spill, breeding is later than normal, and breeding synchrony has been disrupted. These structural and behavioral changes in colonies have caused complete reproductive failure during 1989 and 1990, and thus lost production of at least 215,000 chicks. Murre colonies in unoiled areas displayed none of these injuries and had normal productivity. Monitoring of reproductive success of the colonies will continue in 1991.

Bald Eagles: Of the estimated Alaskan bald eagle population of 30,000 birds (20,000 adults and 10,000 fledglings), an estimated 2,200 reside in Prince William Sound. One hundred forty-four (144) dead bald eagles were found following the spill. Although there is considerable uncertainty regarding the total mortality of bald eagles, it is estimated that several times this amount may have been killed by the initial spill. Approximately 90 percent of radio-tagged bald eagles that died during subsequent studies were not found on the beach but in the brush back from the beachfront. This suggests that most of the eagles that died in the spill would not have been found by surveys typically restricted to beach areas. To assess injuries to bald eagles, helicopter and fixed-wing surveys were flown to estimate populations and productivity. Radio transmitters were attached to bald eagles to estimate survival, distribution, and exposure to oiled areas. Bald eagles in Prince William Sound were most intensively studied. Productivity surveys in 1989 indicate a failure rate of approximately 85 percent for nests on moderately or heavily oiled beaches compared to 55 percent on unoiled or lightly oiled beaches. Bald eagles have a delayed sexual maturity and have a relatively long life span under normal circumstances. Consequently, although reproduction apparently rebounded to more normal levels in 1990, population impacts as a result of poor productivity of nestlings and the death of hundreds of adult eagles in 1989 may not be readily apparent for several years. Fewer bald eagles were sighted in 1990 than in 1989, however this change was within the expected error of the survey method. An additional survey will be conducted in 1991 to see if there is a downward population trend.

Sea Ducks: More than 2,000 sea duck carcasses were recovered after the spill, including more than 200 harlequin ducks. Studies concentrated on harlequins, goldeneyes, and scoters, species that use the intertidal and shallow subtidal habitats most heavily affected by the spill. Harlequins were most affected, consistent with the fact that they feed in the shallow water area of the intertidal zone. This is the only species of sea duck studied that both nests in the spill area and feeds in the shallow intertidal zone. All of these species feed on invertebrates such as mussels and are likely to continue to be exposed to petroleum hydrocarbons through their food. About 33 percent of the harlequins collected in the spill area had poor body condition and about 40 percent had

tissues contaminated with petroleum hydrocarbons. Preliminary surveys also indicate harlequins may have failed to reproduce in the spill zone in Prince William Sound during 1990. These injuries will be investigated further during 1991.

Other Birds: Surveys and studies indicate reduced numbers of black oystercatchers, pigeon guillemots, and marbled murrelets in oiled areas. Black oystercatchers and pigeon guillemots use inshore and intertidal areas for feeding and nesting. Reduced breeding success of black oystercatchers was documented in oiled areas, largely as a result of loss of chicks along oiled beaches. It is estimated that between 1,500 and 3,000 pigeon guillemots were killed by the spill, representing as much as 10 percent of the catalogued population in the Gulf of Alaska. This species is susceptible to continued exposure to petroleum hydrocarbons because it uses intertidal rocks and waters within 200 meters of shore. Petroleum hydrocarbons were found in eggs and tissue in 1989.

Marbled and Kittlitz's murrelets represented a high proportion of the dead birds recovered in oiled areas of Prince William Sound. The reduction in the number of murrelets observed in oiled areas during cleanup in 1989 and the return of many of these birds in 1990 suggest disturbance associated with cleanup activities affected these birds. The extent of injury to certain species, including loons, cormorants, and gulls will probably never be known because pre-spill information on numbers of these birds in the spill area are not available. Data on bird distribution and abundance data gathered during aerial and boat surveys remain to be fully analyzed and interpreted. Boat surveys will continue during 1991. Studies did not document injury to certain bird species such as Peale's peregrine falcons or songbirds.

FISH/SHELLFISH

No massive die-offs of adult fish were found following the spill, and adult salmon, for example, were evidently able to migrate to spawning areas after the spill. However, fish are most vulnerable to oil contamination during the early stages of their life cycles. Accordingly, most fish studies initially focused on this phase of fish life history. During 1991, scientists will begin to be able to assess affects on adult fish such as salmon that would have been exposed to oil as eggs or larvae. Species most often affected by the spill were those that inhabit and spawn in the intertidal zone (salmon) or in the shallow areas next to shore (herring and Dolly Varden).³ Less than ten dead rockfish were found during the spill and their deaths were attributed to oil. Several species of coastal and offshore fish (pollock, halibut, sablefish, cod, yellowfin and flathead sole, and rockfish) show evidence over a large geographic area of continuing exposure to petroleum hydrocarbons in areas affected by the spill, but significant injury has not yet been documented. Exposure to petroleum hydrocarbons does not necessarily lead to

³The State of Alaska imposed the highest possible standards for commercial fishery openings and for processing plant inspections to insure that all commercially harvested salmon were free from contamination. Salmon subject to commercial harvest in the spill area were rigorously tested to insure that the catch was safe for human consumption.

injury, since many animals have the capability to physiologically "manage" the exposure with no resulting harm. In particular, salmon and other fish can metabolize petroleum hydrocarbons so that these contaminants are unlikely to be found in edible fish tissues. Indicators of exposure among fish include bile metabolites and mixed function oxidases. Since injuries from chronic exposure to oil may not manifest themselves for a number of years, it is premature to conclude that coastal and offshore species were not injured; therefore certain studies are continuing.

Pink Salmon: The full extent of short term injury to pink salmon cannot be assessed until after the 1991 run returns to spawn in the summer. Although the overall catch of pink salmon in Prince William Sound during 1990 was an all-time record (as predicted before the spill), this was primarily due to strong runs of hatchery-produced salmon. Salmon survival associated with the Armin F. Koerning hatchery, located in the middle of a heavily oiled area of the spill zone, was half that of Ester Hatchery, located outside the area of the spill. Wild production of pink salmon did not mirror the record production of hatchery fish.

Seventy-five percent of wild pink salmon spawn in the intertidal portion of streams in Prince William Sound. Wild stock salmon did not shift spawning habitat following the spill and deposited eggs in intertidal areas of oiled streams. Preliminary analyses indicate a 70 percent greater mortality of pink salmon eggs laid in the summer of 1989 and a 50 percent greater mortality in the summer of 1990 in oiled streams as compared to control streams. Larvae from heavily oiled streams showed gross morphological abnormalities, including club fins and curved spines. The pink salmon that returned to Prince William Sound in the summer of 1990 were exposed to oil as larvae as they swam under the slick, but not as eggs which were more directly exposed to oil than the larvae. Fish returning in 1991 will be the first that were exposed to oil as eggs. Eggs and larvae of wild populations continue to be exposed to oil in intertidal gravel in oiled areas.

Sockeye Salmon: Commercial harvest of sockeye salmon was curtailed in portions of Cook Inlet, Chignik, and Kodiak in 1989 because of the spill, resulting in an unusually high number of adults migrating to spawn in certain lake spawning systems (returning adults that arrive at the spawning areas are referred to as the "escapement"). Overly large spawning escapements may result in poor returns in future years by producing more juvenile salmon than can be supported by the nursery lake's productivity. Preliminary data indicate that overescapement degraded rearing habitat in lakes and that sockeye salmon survival and growth rates are lower than usual. Further study is needed before the extent of these injuries can be determined.

Dolly Varden and Cutthroat Trout: Prince William Sound is the northern extreme of the range of cutthroat trout. Both cutthroat trout and Dolly Varden use nearshore and estuarine habitat for feeding throughout their lives (in contrast to salmon which migrate out to sea). The highest concentrations of bile petroleum hydrocarbon metabolites in all fish sampled were found in Dolly Varden. Tagging studies have demonstrated that the annual mortality of adult Dolly Varden was 32 percent greater in oiled areas than in unoiled areas. The larger cutthroat trout showed similar levels of mortality in oiled and unoiled areas. Additionally, cutthroat trout growth rates were reduced in oiled areas.

Studies are continuing to measure impacts on populations of these popular sport fish species.

Pacific Herring: Populations of Pacific herring were spawning in shallow eelgrass and algal beds at the time of the spill. The effects of oil on egg survival, hatching success, larval development, and recruitment to the spawning population were studied. Study results show a large increase in the percentage of abnormal embryos and larvae in oiled areas of Prince William Sound during the 1989 reproductive season. Larvae in oiled areas also had a greater incidence of eye tumors. These effects continued but at somewhat lower rates in 1990. Results also showed greater egg mortality in oiled areas as compared to unoiled areas. Whether the adult population has been affected by these larval injuries will not be determined until the 1989 and 1990 cohorts return to spawn in 1992 and 1993.

COASTAL HABITAT

The coastal tidal zone, commonly known as the "intertidal zone," was the most severely contaminated habitat. Intertidal habitats are highly productive and biologically rich. They are particularly vulnerable to the grounding of oil, its persistence, and effects of associated clean-up activities. An interdisciplinary team with expertise in plant and systems ecology, marine biology, and statistical analysis, was established to conduct field studies to assess the effects of oil on intertidal ecosystems.

Supratidal: Results of studies in the Kodiak/Alaska Peninsula area suggest that oil in the supratidal habitat and beach cleanup disturbance decreased the productivity of grasses and other vegetation including beach rye grass, that help stabilize beach berms. In one instance, cleanup activities completely removed the vegetation. Increased production of supratidal vegetation was found in Prince William Sound in 1989. This finding corresponds with information from other oil spills. It is not known whether this increased production was a result of decreased browsing by terrestrial mammals or a fertilizer effect of the oil.

Intertidal: Natural populations of intertidal organisms were significantly reduced along heavily oiled shorelines such as Herring Bay. Densities of intertidal algae (*Fucus*), barnacles, limpets, amphipods, isopods, and marine worms were decreased. Although there were increased densities of mussels in oiled areas, they were significantly smaller than mussels in the unoiled areas and the total biomass of mussels was significantly lower. Intertidal organisms continue to be exposed to hydrocarbons from the more heavily oiled sediments. Petroleum hydrocarbon accumulation in filter feeding mussels experimentally placed in oiled areas indicate that oil remains available for uptake by other organisms. Initial findings also indicate that oiled surfaces retarded settlement by juvenile barnacles when compared to unoiled sites. In addition to direct mortality, the reproductive cycle of mussels at oiled sites in the lower Cook Inlet/Kenai Peninsula and Kodiak/Alaska Peninsula regions was delayed by several months.

Intertidal fishes were less abundant in oiled areas than in unoiled areas. In addition, gill

parasitism and respiration rates were significantly higher in fish from oiled sites compared to unoiled sites.

Fucus, the dominant intertidal plant, was severely affected by the oil and subsequent cleanup activities. The percentage of intertidal areas covered by Fucus was reduced following the spill and opportunistic plant species which characteristically flourish in disturbed areas were increased. The average size of Fucus was reduced, the number of reproductive sized plants greatly decreased, and the remaining plants of reproductive size decreased in reproductive potential due to fewer fertile receptacles per plant. There was also reduced recruitment of Fucus at oiled sites.

SUBTIDAL HABITATS

Spilled oil in some areas has migrated to and contaminated the seafloor at depths of up to 100 meters as contaminated sediments moved off beaches during winter storms and cleanup activities. There is evidence that petroleum hydrocarbons have been taken up by animals feeding on the ocean bottom. Petroleum hydrocarbon metabolites have been found in the bile of yellowfin sole, rock sole, rockfish, and pollock. Concentrations of petroleum hydrocarbon metabolites in the bile of yellowfin sole have not declined from 1989 to 1990. This contrasts with Dolly Varden which feed close to shore and where petroleum hydrocarbon metabolites in bile decreased in the same period. The effects of this exposure are still being studied. Many subtidal and intertidal species, particularly fish, have the capability of metabolizing and eliminating petroleum hydrocarbons from their bodies. Clams metabolize hydrocarbons very slowly and consequently accumulated them in high concentrations.

Contaminated clams and other invertebrates are a potential continuing source of petroleum hydrocarbons for sea otters and otherspecies that forage in the shallow subtidal zone. Samples from pollock, which feed in the water column, taken as far away as 500 mile from the wreck site on Bligh Reef, showed elevated petroleum hydrocarbon metabolite concentrations in their bile. This indicates that the water column or food supply was affected at great distances from the spill. Initial 1990 study results show a significant effect on benthic organisms associated with eelgrass beds. These are known to be highly productive habitats. The composition of benthic animal communities on soft-bottom habitats as deep as 40 meters were also significantly altered in oiled areas.

ARCHAEOLOGICAL AND SUBSISTENCE RESOURCES

The spill directly impacted archaeological sites and subsistence resources. Cleanup activities and the associated significant increases in human activity throughout the spill zone resulted in additional injuries to these resources.

Archaeological Resources: Archaeological sites along the shoreline were injured by the

spill. Review of spill response data revealed injuries from oil to a minimum of 26 archaeological sites. Among these are burial sites and home sites. Twenty-one (21) of these sites are on federally-owned land, with the remaining five on State of Alaska and private lands. Of the 21 sites on federal land, 10 are on national parks, six on national wildlife refuges, four within Chugach National Forest, and one on Bureau of Land Management land. While injury to these 26 sites was documented during cleanup, a spill-wide assessment of injuries to archaeological resources has yet to be completed. In addition to oil contamination, increased knowledge of the location of archaeological sites may put them at risk from looting. Loss of rye grass cover may threaten some sites. A comprehensive survey of injuries to archaeological resources on public lands throughout the spill zone will be conducted during 1991.

A study was conducted to determine impacts caused by oil contamination on radiocarbon dating of archaeological resources and to investigate the potential for cleaning artifacts and materials to allow such dating. Preliminary results indicate significant injury to the ability to contextually date artifacts and materials by Carbon 14 analysis. It also appears that these materials cannot be successfully "cleaned" to allow accurate dating.

Subsistence Resources: Surveys undertaken by state researchers before the spill and in 1990 indicated that subsistence harvesters in the area affected by the oil spill significantly reduced their use of subsistence resources after the spill, primarily because of their concerns about possible contamination of these resources. The oil spill disrupted the subsistence lifestyle of some communities that have historically relied upon these resources. Some communities virtually or entirely ceased subsistence harvests in 1989 and have only gradually begun to resume harvests, while other communities continued some reduced level of subsistence harvest in 1989 and thereafter. The attached report (Subsistence Use of Fish and Wildlife in 15 Alutiiq Villages after the Exxon Valdez Oil Spill) details these studies. Warnings were issued by the state in 1989 for people to avoid consumption of intertidal invertebrates (such as mussels and clams, which bioaccumulate petroleum hydrocarbons) found along shorelines contaminated by oil. After the spill, an oil spill health task force was formed, including the state and federal governments, subsistence users, and Exxon. This group helped oversee studies conducted by the state and others in conjunction with FDA and NOAA in 1989 and 1990, on subsistence food resources such as seals, deer, salmon, ducks, clams, and bottomfish. Based upon the test results these resources, with the exception of clams and mussels in certain oiled areas such as Windy Bay, were determined to be safe for human consumption.

CONCLUSION

The federal and state Trustee agencies have now concluded two field seasons of study and are currently preparing to begin a third year of studies to assess injuries to natural resources resulting from the Exxon Valdez oil spill. The information contained in this

summary is based upon the field work and data analysis conducted to date, and is preliminary. Many studies will likely need to continue for additional years before a full understanding of injuries is developed. For example, long-lived species such as bald eagles, murre, and sea otters, may not manifest some effects until a number of years have passed. For other species, such as herring and salmon that return to spawn years after hatching, it is necessary to wait for these key life history events to occur before one can determine the extent to which or if they have been injured. At present there is no indication of long-term injury for species other than those noted in this summary. Although two field seasons of study are complete, only a portion of the data gathered has been fully analyzed and interpreted. As studies and data analysis are completed, some of the information contained in this summary may need to be modified.

For the reasons given above, injury assessment studies will continue in 1991, and thereafter until the process is complete. The need to continue to understand the long-term effects of the spill will be accomplished through monitoring projects that will measure the natural recovery of resources injured by the spill as well as the effectiveness of restoration measures implemented by the Trustee agencies. The information gathered by the injury assessment studies, the restoration monitoring studies, and other studies will be used to develop and implement a restoration program that will accelerate the recovery of injured resources.

Restoration measures will begin in 1991 and are expected to become more comprehensive as the understanding of the effects of the spill improves and as experts and the public provide input on where restoration measures should be concentrated. Wherever possible, restoration will focus on those projects that will provide ecosystem-wide benefits, thereby benefitting a variety of species. These projects may include various initiatives to protect habitat; in other cases it may be necessary to conduct restoration programs that will primarily benefit a particular resource injured by the spill.

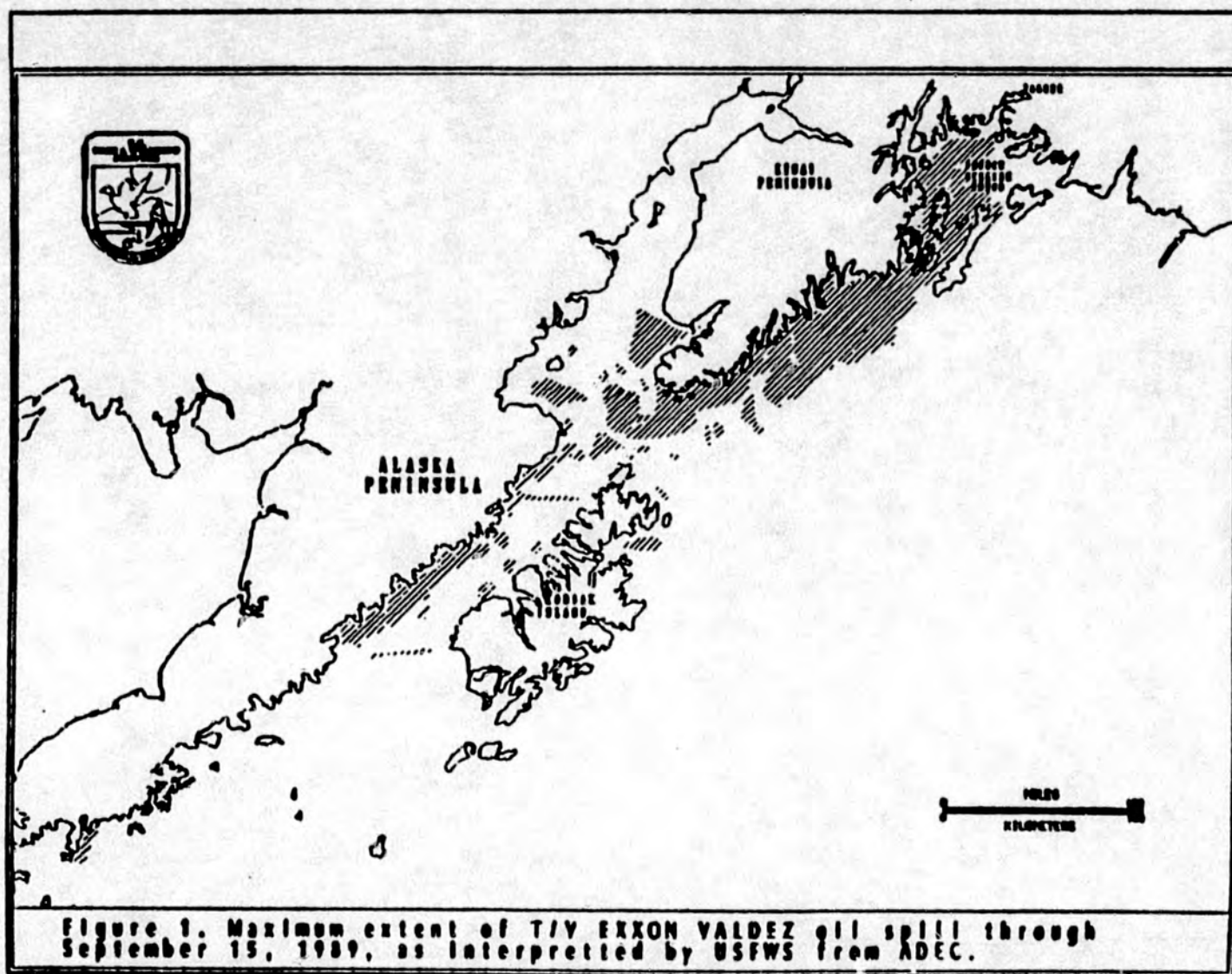


Table 1. Species composition and number of birds retrieved from oiled areas and processed at U.S. Fish and Wildlife receiving stations as of 25 September, 1989. (Cont'd)

Species	Total	Valdez	Seward	Homer	Kodiak
Harlequin Duck	213	148	10	35	20
Unidentified Eider	3	0	0	3	0
Stellar's Eider	4	4	0	0	0
Common Eider	17	5	0	2	10
King Eider	9	0	0	0	9
Unidentified Scoter	162	23	17	51	71
White-winged Scoter	342	164	13	137	23
Surf Scoter	175	45	28	9	6
Black Scoter	132	112	4	8	8
Ruddy Duck	1	0	1	0	0
Unidentified merganser	3	1	0	0	2
Common Merganser	2	2	0	0	0
Red-breasted Merganser	33	30	1	1	1
Sandhill Crane	2	1	1	0	0
Black Oystercatcher	9	2	2	0	5
Golden Plover	1	0	0	1	0
Unidentified sandpiper	11	1	5	1	4
Unidentified turnstone	1	0	0	0	1
Common Snipe	1	0	0	1	0
Semipalmated Sandpiper	1	0	1	0	0
Lesser Yellowlegs	2	0	0	2	0
Western Sandpiper	5	0	0	5	0
Baird's Sandpiper	1	0	0	0	1
Least Sandpiper	4	0	2	0	2
Surfbird	3	3	0	0	0
Short-billed Dowitcher	1	0	0	0	1
Red Phalarope	2	0	0	2	0
Red-necked Phalarope	7	1	3	0	3
Long-tailed Jaeger	1	0	0	0	1
Unidentified gull	99	6	34	39	20
Glaucous-winged Gull	555	33	188	28	213
Herring Gull	8	3	5	0	0
Mew Gull	33	0	3	3	27
Black-legged Kittiwake	1,225	8	214	74	929
Arctic Tern	3	1	1	0	1
Aleutian Tern	1	0	0	0	1

Table 1. Species composition and number of birds retrieved from oiled areas and processed at U.S. Fish and Wildlife receiving stations as of 25 September, 1989. (Cont'd)

Species	Total	Valdez	Seward	Homer	Kodiak
Unidentified alcid	173	24	0	15	134
Unidentified murre	8,851	21	775	2,101	5,954
Common Murre	10,428	399	523	1,353	8,153
Thick-billed Murre	669	16	142	73	438
Pigeon Guillemot	614	136	109	155	214
Unidentified murrelet	413	21	37	121	234
Marbled Murrelet	612	289	97	82	144
Kittlitz's Murrelet	67	23	19	21	4
Ancient Murrelet	311	3	40	73	195
Cassin's Auklet	48	0	36	2	10
Least Auklet	5	0	0	1	4
Parakeet Auklet	31	1	2	1	27
Rhinoceros Auklet	141	0	31	31	79
Unidentified puffin	46	0	7	4	35
Horned Puffin	139	0	32	13	94
Tufted Puffin	361	0	29	15	317
Bald Eagle	125	31	20	15	59
Unidentified raptor	7	1	3	2	1
Peregrine Falcon	2	0	0	0	2
Willow Ptarmigan	1	0	0	0	1
Unidentified owl	1	0	0	1	0
Great-horned Owl	3	0	0	3	0
Unidentified woodpecker	1	0	0	1	0
Cliff Swallow	3	0	3	0	0
Violet-green Swallow	1	0	1	0	0
Unidentified passerine	9	1	7	1	0
Stellar's Jay	1	1	0	0	0
Magpie	7	1	0	0	6
Common Raven	18	1	4	0	13
Northwestern Crow	34	6	3	3	22
American Robin	2	0	2	0	0
Varied Thrush	1	0	0	0	1
Hermit Thrush	1	0	1	0	0
Unidentified warbler	1	0	0	0	1
Yellow Warbler	3	0	3	0	0
Pine Grosbeak	1	0	0	0	1
Unidentified sparrow	15	0	10	2	3
Savannah Sparrow	1	0	1	0	0
Golden-crowned Sparrow	4	0	3	0	1
White-winged Crossbill	8	0	0	6	2

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Table 1. Species composition and number of birds retrieved from oiled areas and processed at U.S. Fish and Wildlife receiving stations as of 25 September, 1989.

Species	Total	Valdez	Seward	Homer	Kodiak
Total	35,279	3,360	3,503	5,778	22,638
Unidentified bird	2,927	476	414	916	1,121
Unidentified loon	69	27	6	25	11
Common Loon	216	142	23	32	19
Yellow-billed Loon	87	72	5	3	7
Pacific Loon	18	8	5	0	5
Red-throated Loon	3	3	1	1	0
Unidentified grebe	65	27	8	11	19
Red-necked Grebe	120	79	22	12	7
Horned Grebe	277	233	15	22	7
Northern Fulmar	426	0	22	12	115
Unidentified shearwater	579	5	22	14	538
Sooty Shearwater	360	4	80	34	242
Short-tailed Shearwater	2,460	1	84	4	2,371
Unidentified petrel	69	2	24	14	29
Fork-tailed Storm-petrel	363	1	50	19	293
Leach's Storm-petrel	12	0	9	0	3
Unidentified cormorant	219	76	27	56	60
Double-crested Cormorant	38	19	10	0	9
Pelagic Cormorant	418	277	65	29	47
Red-faced Cormorant	161	90	29	9	33
Great Blue Heron	1	1	0	0	0
Unidentified swan	3	0	2	1	0
Emperor Goose	2	0	0	0	2
Canada Goose	1	0	0	1	0
Brant	3	0	1	2	0
Unidentified duck	30	4	6	20	0
Unidentified seaduck	112	63	2	11	36
Mallard	11	2	4	1	4
Northern Pintail	4	0	3	1	0
Green-winged Teal	5	0	5	0	0
Unidentified Scaup	4	1	3	0	0
Greater Scaup	27	2	21	4	0
Lesser Scaup	2	0	2	0	0
Unidentified Goldeneye	25	8	2	14	1
Common Goldeneye	6	3	0	2	1
Barrow's Goldeneye	33	19	9	4	1
Bufflehead	21	17	1	0	3
Oldsquaw	185	131	43	6	5

CERTIFICATE OF SERVICE

I certify that I caused to be served by mail the attached Notice of Lodging of United States' Summary of Effects of EXXON VALDEZ Oil Spill on Natural Resources and attached Summary of Effects of EXXON VALDEZ Oil Spill on Natural Resources and Archaeological Resources on

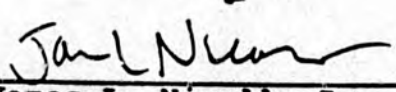
Douglas Serdahely
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1031 W. Fourth Ave.
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431 N. Franklin St.
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Randall J. Weddle
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550 West Seventh Ave.
Suite 1000
Anchorage, Alaska 99501

Charles P. Flynn
Burr, Pease & Kurtz
810 N. Street
Anchorage, Alaska 99501

on April 8, 1991.


James L. Nicoll, Jr.

DEATH TOLL ESTIMATE

From Exxon Valdez Oil Spill



BOB HALLINEN / ADN file photo
An oiled sea otter.

SEA OTTERS

■ **ESTIMATED DEATHS:** 3,500 — 5,500 in an area where the pre-spill population was 30,000.

■ **CARCASSES FOUND:** 1,011

■ **PROGNOSIS:** "Sea otters were particularly vulnerable to the spill ... Mortality in heavily oiled areas continues to be abnormal ... Studies have documented continuing injury ... (but) pupping rates in oiled and unoled areas are not significantly different."



EWIK HILL / Anchorage Daily News file photo
A bird oiled in the spill

BIRDS

■ **ESTIMATED DEATHS:** 260,000 — 580,000

■ **CARCASSES FOUND:** 36,000

■ **ESTIMATED DEATHS OF BREEDING ADULT MURRES:** 172,000 — 198,000

■ **ESTIMATED DEATHS OF PIGEON GUILLEMOTS:** 1,500 — 3,000

■ **ESTIMATED DEATHS OF BALD EAGLES:** Several hundred; 144 carcasses

■ **PROGNOSIS:** Murre breeding in oiled areas seriously disrupted leading to "complete reproductive failure during 1989 and 1990, and thus lost production of at least 215,000 chicks."

KILLER WHALES



Prince William Sound killer whales

BOB HALLINEN / Anchorage Daily News file photo

■ **ESTIMATED DEATHS:** No direct link to the spill established, but 22 of the 102 killer whales living in Prince William Sound before the spill are thought to have perished.

■ **PROGNOSIS:** Whale surveys will continue this year.

OTHER SPECIES

HARBOR SEALS Estimated 200 killed, 19 carcasses.

BEARS No documented deaths

DEER No documented deaths

MINK No documented deaths

RIVER OTTERS A few deaths; erratic behavior observed.

Study worsens spill damage estimates ^{4.9.91}

By CHARLES WOHLFORTH
and DAVID HULEN
Daily News reporters

The Exxon Valdez oil spill was far more lethal than previously thought, according to a federal report released Monday. Its effects — including mutations in fish larvae and brain damage in seals — were more pervasive and longer-lasting, and animals in the oiled environment are still suffering damage.

The report was a 18-page summary of about \$70 million worth of scientific work done for the state and federal governments to assess the damage of the nation's worst

oil spill. The information has been secret until now because government lawyers didn't want to show their hand before going into court against Exxon.

The state still didn't want to release the information Monday when the federal side filed it in Anchorage federal court at 4:29 p.m. The summary was filed three days before public comments are due on last month's \$1 billion settlement of oil spill litigation between Exxon and the state and federal governments.

Federal officials said when the settlement was announced that they would release study data, and they overrode state objec-

tions in making Monday's release. Paul Gertler of the U.S. Fish and Wildlife Service said the report contained all the findings of oil spill damage by all the studies — including those conducted by the state.

The summary reports spill damage far worse than suggested by information already in the public domain. It contradicts Exxon's rosy portrayal of Prince William Sound and Gulf of Alaska as recovering fast and in no need of further restoration.

Instead of killing 36,000 birds, which was the number found dead, or 100,000 to 300,000 birds, as earlier reports suggested, Monday's report says 260,000 to 530,000 birds died

because of the spill.

Of those, 172,000 to 192,000 were murrelets which live long and breed slowly, laying only one egg per year. Colonies off the Kenai Peninsula lost up to 70 percent of their members, then failed completely to reproduce for the last two years. About 218,000 chicks were lost, the study estimates.

How long will they take to come back?

"If you have enough predation by gulls, it's possible they might not," said David Nyswander, who headed the murre study.

Please see Back Page, Oil

Continued from Page A-1

for the U.S. Fish and Wildlife Service. "But I think most biologists think they will come back, although we don't know how long it will take, 10 or 15 years or 70 years."

Other birds were also hit hard. Harlequin ducks failed to reproduce last year, and pigeon guillemots lost 10 percent of their total Gulf of Alaska region population.

Harbor seals declined 35 percent in oiled areas in Prince William Sound. They declined only 13 percent in unoled areas. And because of the spill, some developed brain lesions that killed some and made others listless and unresponsive. Seals still had oil in their bodies last year, but their behavior appeared more normal, said Lloyd Lowry of the Alaska Department of Fish and Game, who participated in the study.

The summary estimates the spill killed 200 harbor seals from a population of 1,500 to 2,500 that was already in steep decline.

"In a situation where the animals were declining already, you can't really talk about natural recovery," Lowry said.

The spill killed 3,500 to 5,500 sea otters, according to the study. That would be roughly a fourth of the otters in the Gulf of Alaska.

And the otters are still suffering. The blood chemistry and DNA of otters in oiled areas is altered, and in 1990 they continued to pick up oil from the food they eat, which was less abundant anyway because of the spill. Adult otters were still dying at an abnormally high rate last summer, and a preliminary 1991 study found that baby otters continued to die at a higher rate in oiled areas than in areas that were not hit.

Only a third of the otters rescued from the spill in 1989 appear to have survived into the present, according to a radio tagging study.

Other otters were affected, too. Oil accu-

Twenty-six archaeological sites were also damaged, including Native burial grounds.

But the spill area is one of "abundant life," Exxon spokesman Karsten Rodvik said Monday night.

"We haven't seen the document, but everything we're seeing suggests that the biological community is healthy and thriving," he said. "Attention ought to be focused on what is out there right now, what people are seeing today. And that is a viable, thriving and diverse biological community."

Others were surprised by the severity of the bad news. When read excerpts of the summary, several people familiar with the oil spill said damage estimates appeared to be worse than anything they had previously heard, but they also added that little scientific information has been released before now.

"This is stuff I've never heard before," said Marilyn Leland, executive director of Cordova District Fishermen United. "There's been lots of talk and speculation, but since we haven't seen any of the assessments, no one's had any hard information."

Deborah Donahue, a lawyer for the National Wildlife Federation, said the mortality figures appeared higher than any estimates she had heard. She said the information could "serve as a red flag" that the proposed settlement has flaws.

State officials were unhappy about the federal release.

"I'm supposed to go before the legislature tomorrow," said Michael Dean, acting director of the oil spill program for the state Department of Fish and Game. "It's sure going to make Mr. Cole and myself and the state of Alaska look pretty silly if he has to go up there and say he can't release this information because of litigation concerns, when the federal government has gone and released this."

obviously as other animals. Seventy percent more salmon eggs died in oiled areas than in clean areas in 1989, and 50 percent more died in 1990. And some of the survivors were deformed. "Larvae from heavily oiled streams showed gross morphological abnormalities, including club fins and curved spines," the report said. Those fish will begin to return this summer.

Herring also had more dead eggs and abnormal larvae in 1989 and 1990. Dolly varden and other trout picked up oil. Dolties were 32 percent more likely to die in oiled areas than in clean areas, and cutthroat trout had reduced growth rates.

Scientists found oil 330 feet below the ocean's surface in areas near heavily oiled shores and evidence that fish and clams had been eating the oil. Bottom fish had oil in their bodies 500 miles from the site of the spill, and the amount did not go down from 1989 to 1990. Clams had also picked up a lot of oil and were holding onto it.

The beaches and tide-pool areas were hit hard by the spill and cleanup. Many varieties of organisms dropped sharply in number, and much of the kelp, which is basic food for the ecosystem, was destroyed. Mussels placed on the shoreline to check for oil are still picking it up, according to the summary.

General Charles Cole refused to go along with its release.

Cole said Monday night he didn't agree to release the information for fear of what it might do to the state in court, but he also said he saw nothing in the summary that would necessarily hurt the state. The state is being sued by people who were damaged by the spill.

John Sandor, commissioner of the department of environmental conservation and one of the resource trustees who will spend the settlement money, did not know about the release until a reporter told him Monday night.

"If indeed they did release what we asked them not to release, I would be quite disappointed," he said. "The attorney general is trying to protect the state's interests."

Gertler, the federal official, confirmed that the state had not agreed to the release. But he said the federal trustees decided the public and the courts needed the information to make an informed decision about the settlement before a public comment period ends Thursday.

"We're trying to move away from an litigation environment," Gertler said. "We're really getting to the place where we can tell the Alaska people what happened in Alaska. The right time has come."

2

Spill damage detailed

U.S. assesses toll, finds evidence 'injury continuing'

■ House says spill settlement needs legislative review B8

ASSOCIATED PRESS

For the first time since the 1989 Exxon Valdez oil spill, the federal government Monday released a report detailing the disaster's toll on wildlife and natural resources in Prince William Sound — and indicating that the damage continues.

It is the first time the government has released results of secret oil-spill damage assessments — estimates that to date have remained confidential because of the huge number of lawsuits resulting from the spill.

The 19-page report, a summary of preliminary findings of dozens of scientific studies conducted since the March 24, 1989, Valdez spill, was released by the federal oil-spill trustees and filed simultaneously in federal court in Anchorage. It painted a grim picture of

destruction, and said the true impacts of the spill won't be known for years.

Alaska's rich salmon and herring fisheries were harmed, and its abundant pollock and other offshore fish were exposed to hydrocarbons, though the effects of that exposure is yet unknown.

Pink salmon had a mortality rate 70 percent above normal in 1989 and 50 percent higher than normal last year. The 1991 summer spawning season will tell more about the long-term effects on the pinks, the report said. Sockeye salmon and trout also were affected, though more study is needed, officials said.

Among Pacific herring, the studies have documented a large increase in

abnormal embryos and larvae and in egg mortality. And sea otter mortality in particular continues to be high, the report said.

The report said years of additional study will be required to assess the complete damage from the spill.

"There are indications that injury is continuing," said Paul Gertler, chairman of the federal trustees' management team and a U.S. Fish and Wildlife Service official.

The report said several hundred bald eagles, as many as 500,000 birds of various species and several hundred thousand more chicks, at least 3,500 and up to 5,500 sea otters, and 200 harbor seals perished in the spill.

Serious harm also was done to at least 26 archaeological sites in the spill area, including damage to artifacts.

See Sp11, back page

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"In many cases, it's far too early for us to be able to say how long it's going to be before those species (most affected) can recover," Gertler said.

fects of the spill.

But Monday's report said oil from the 11 million gallon spill — the nation's worst — had contaminated sediments up to 330 feet below the surface of the sound, and that the oil continues to pollute marine mammals and other wildlife.

The federal trustees — the secretaries of Interior and Agriculture, the National Oceanic and Atmospheric Administration and the Environmental Protection Agency — filed the report with Judge H. Russel Holland four weeks after a proposed \$1 billion settlement was reached.

ration fund and a record \$100 million fine. In exchange, the state agreed to drop its civil suit against Exxon, and the U.S. Department of Justice halted prosecution of Exxon on criminal charges stemming from the spill.

Exxon was to go on trial in Anchorage on the criminal charges Wednesday.

Alaska officials have opposed release of the oil-spill impact studies, and did not participate in handing over the material Monday. They have said that making public such information would hurt the state's position in oil-spill lawsuits filed against the

worked for two years to document the impacts from the Valdez spill.

But the results have been kept secret because of the federal government's criminal prosecution of Exxon, a state civil suit against Exxon seeking unspecified damages, and hundreds of private lawsuits against Exxon and the state by fishermen, Native groups and others seeking hundreds of millions of dollars in compensation.

Gertler said the agency released the data to help the public judge the proposed Exxon set

Spill

Continued from page B1

and Native villagers' hunting and fishing lifestyle also was severely affected, the report said.

Contaminated clams and invertebrates are a continuing source of oil pollution to otters and other marine mammals, it is said.

Although the spill caused no massive die-off of fish or shellfish, its long-term impacts on some species still may be serious, researchers found.

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P. 6

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"In many cases, it's far too early for us to be able to say how long it's going to be before those species (most affected) can recover," Gertler said.

Exxon officials in Alaska had not seen the report late Monday and until doing so could not comment, Exxon spokesman Joe Tucker said.

The company spent \$2.2 billion to clean up after the spill, caused when its tanker Exxon Valdez ran aground at Bligh Reef near Valdez. In recent months Exxon has mounted a nationwide public relations campaign to portray Prince William Sound as having largely recovered from the ef-

culture, the National Oceanic and Atmospheric Administration and the Environmental Protection Agency — filed the report with Judge H. Russel Holland four weeks after a proposed \$1 billion settlement was reached between the federal government, the state of Alaska and Exxon Corp.

The out-of-court settlement was reached after weeks of negotiation, and still must be approved by the Alaska Legislature and Judge Holland.

Settlement terms include guilty pleas by Exxon and its shipping subsidiary to three misdemeanor and one felony environmental violations, the payment of \$900 million into a resto-

release of the oil-spill impact studies, and did not participate in handing over the material Monday. They have said that making public such information would hurt the state's position in oil-spill lawsuits filed against the state.

"We reviewed the summary, and for reasons predicated on the pending litigation against the state, chose not to participate in its release," Attorney General Charles Cole said Monday.

During his review of the trustees' report, however, Cole said he "found nothing in it which is prejudicial to the state's ongoing litigation." Cole is the lead trustee for the state of Alaska.

Hundreds of scientists have

and the state by fishermen Native groups and others seeking hundreds of millions of dollars in compensation.

Gertler said the agencies released the data to help the public judge the proposed Exxon settlement. The U.S. Department of Justice made the final decision on how much data could be released, he said.

"We will be extremely gratified when this litigation is settled so we can all benefit from a free flow of our information to the public and the rest of the scientific community," Gertler said.

The results of the studies will be used to formulate restoration plans for the Sound beginning later this year, he said.

2

Hot washing oily beaches was mistake

NOAA says marine life 'cooked'

BY DAVID WHITNEY 4/10/91
Day News reporter

WASHINGTON — Hot-water washing of Alaska beaches saturated with oil after the Exxon Valdez spill two years ago did more harm than good, the National Oceanic and Atmospheric Administration said Tuesday.

The agency said the high-pressure washing of hundreds of miles of beaches "cooked" creatures living in the rocks and sand and will add years to the time it takes the beaches to recover. Sylvia Earle, the agency's chief scientist, said saturated beaches that were not treated are recovering faster than those that were. "Where there was hot-water treatment, the abundance and diversity of life is significantly lower," she said.

John H. Robinson, chief of the agency's hazardous materials branch in Seattle, Wash., said "the indication is that the treatment process (caused) most of the problems."

The spill occurred after the Exxon Valdez tanker ran aground in Bligh Reef in Prince William Sound. About 11 million gallons of thick oil gushed into the waterway.

As that oily mess washed up onto beaches, Exxon Co.



governments searched for ways to quickly and the environmental damage that followed. Hundreds of thousands of birds and mammals perished in the go.

State and federal scientists agreed with Exxon Co. that hot-water washing of the beaches was a way to clean up the mess and preserve vital wildlife habitat.

As a result, Exxon equipped vessels with steam-generation plants that combed the sand, spraying hot water at high pressure to wash away the oil into the sea where it either could be picked up by skimmers or swept out to the Pacific Ocean by tidal action.

"On balance, it was a mistake," said Robinson. Nine, 100-yard-long areas in the Sound that were heavily saturated were set aside from any treatment.

Recent studies indicate that those areas are recovering more quickly than those that were treated with the pressurized hot water, he said.

Robinson said the agency has not been able to quant-

B2 Anchorage Daily News

Wednesday, April 10, 1991

CLEANUP: Hot washing beaches 'cooked' marine life

Continued from Page B-1

fy how extensive the damage is. He said, however, that it may take treated beaches three or four years longer to recover than those that weren't.

Such predictions are uncertain and depend in large measure on where the beaches are, he said. Those that are subject to heavy wave action recover more quickly than those in more protected areas where the recovery period may be 10 years or longer.

He said, however, that the untreated areas within the spill zone now more closely resemble those that escaped contamination than those saturated and cleansed by the hot-water hoses.

Exxon was not to blame in the decision to use the hot-water treatment, the NOAA officials said.

Exxon immediately assumed responsibility for the spill cleanup following the tanker grounding, but the cleanup operation was directed by the Coast Guard, which relied on NOAA for its scientific assessments.

Spill deal opinions sought

The Associated Press

JUNEAU — Alaskans have until Thursday to submit comments to a federal court in Anchorage on the proposed criminal plea bargain for Exxon Corp.

The deadline for submitting written comments to the state and federal governments on the proposed civil settlement is April 18.

The legislature is urging Alaskans to voice their opinions on the \$1 billion settlement, said a news release from the House majority coalition.

"It's unusual for the public to be given so much opportunity to comment on legal matters," said Rep. Max Gruenberg, D-Anchorage and chairman of the House special committee reviewing the settlement.

The committee will hold two statewide teleconferences to take public testimony, at 2-8 p.m. Sunday and 3-6:30 p.m. Monday. A Senate hearing will be held Saturday from 10 a.m. to 4 p.m. Testimony can be given at legislative information offices.

"In this instance, we used the best technology that was available," said NOAA general counsel Tom Campbell. "What we are doing now is going back and critically analyzing what we did so that we can do a better job the next time."

Earle said that hot-water washing of oil-polluted

beaches had been tried before but not on the massive scale employed during the \$2 billion Exxon Valdez cleanup.

"If we had predicted the negative impact, we would not have recommended it," she said.

Many of the populations

of tiny, tidal creatures that were scalded to death by the 150-degree water are the life forms that other sea birds and marine mammals depend on for their food, the NOAA scientists said.

Among the hardest hit were clams that Robinson said would take "many, many years to come back to pre-spill condition."

"Sometimes the best, and ironically the most difficult, thing to do in the face of an environmental disaster is to do nothing," Earle said.

"Certainly, as far as Alaska's shoreline is concerned, the environment would have been better off if there had been less aggressive hot-water treatment and we had let nature take its course," she said.

But Earle said the experience in Alaska has not been in vain.

She said scientists believed the hot-water treatment would speed the environmental recovery. Now that studies have proved otherwise, she said "it is probably not a system we'd recommend in the future."

Lawmaker says Alyeska betrayed plan Firm never intended to fight Sound spill, official charges

By DAVID WHITNEY
Daily News Reporter

WASHINGTON — A year before the Exxon Valdez tanker spilled 11 million gallons of oil in Prince William Sound, the owners of the company that runs the trans-Alaska pipeline agreed among themselves to renounce their commitment to respond promptly to such a disaster, a California congressman charged Tuesday.

The charge was contained in a letter from Rep. George Miller to federal judges trying that the \$1 billion settlement with Exxon Corp. criminal and civil damage claims from the March 1989 spill will be rejected because it is Alyeska Pipeline Service Co. off the hook.

■ **MORE DAMAGE:** How many washing of oil beaches more harm than good, a federal agency says. B-1

■ **MONEY QUESTIONS:** N. Miller is the acting chairman of the House Interior and Insular Affairs Committee, which has investigated the spill. Alyeska Pipeline Service Co. decided that Alyeska would provide immediate response to oil spills in Valdez Arm and Valdez Sound. B-1

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Please see Back Page, SPILL

SPILL: Alyeska didn't intend to clean up oil, congressman says

Continued from Page A-1

Narrows only," according to a July 1988 telex that Miller's committee obtained from Arco Marine Inc.

Such a decision would be a direct violation of Alyeska's approved oil-spill contingency plan, in which it had agreed to promptly respond to spills anywhere in Prince William Sound, with strategies for handling spills of up to 1.2 million gallons.

The 1989 spill occurred when the tanker ran aground on Bligh Reef in the Sound. The rocks were well outside the Valdez Narrows leading to the oil-loading docks in Valdez at the southern terminus of the 800-mile pipeline.

Exxon immediately took responsibility for the spill cleanup, but there was insufficient equipment and manpower available from Alyeska or anyone else, and the spill spread throughout the Sound and into the Gulf of Alaska, polluting a thousand miles of beaches and killing wildlife by the hundreds of thousands.

Alyeska spokeswoman Marnie Isaacs said Miller

was misinterpreting documents the pipeline company provided to his committee last year.

Isaacs said the documents refer to planning for a 1990 spill contingency plan now under review by the Alaska Department of Environmental Conservation.

She said they were not part of any plot to "walk away" from the spill cleanup plan in effect when the Exxon Valdez ran aground.

"He interprets these as a lack of commitment when the opposite is true," Isaacs said.

She cited Alyeska's pre-spill decision to build a large oil skimmer, the Valdez Star, as evidence that the pipeline company was not backing away from its commitments.

But Miller said Alyeska's decision not to respond to spills out in the Sound is reason to scuttle the Exxon settlement. Exxon owns 20 percent of the pipeline company.

A part of that settlement commits the U.S. Department of Justice not to take any legal action, including criminal prosecution,

against Alyeska.

In a letter to U.S. District Judge Russel Holland in Anchorage and Stanley Sporkin in Washington, D.C., Miller said the settlement is not in the public's best interests.

"Based on the evidence, it is inconceivable that the Department of Justice would waive its rights to pursue criminal claims, and virtually all civil claims, against Alyeska," Miller wrote. "The oil industry betrayed its own promises and deceived the Congress."

Holland is presiding over the settlement, which he will not make final until the opportunity for public comment ends. It ends Thursday for the criminal part of the settlement and April 18 for the civil part. Sporkin also has reserved the right to review the settlement because of a lawsuit filed last month by Alaska Natives.

According to Alyeska's 1987 oil-spill contingency plan, in effect at the time of the Exxon Valdez grounding, the company promised to have well-tested, state-of-the-art equipment available to "insure overall readiness

for response to large-scale oil spills."

But Alyeska knew in 1988 that it could not meet that commitment, according to the documents offered by Miller. The issue was raised at a meeting of an Alyeska operations subcommittee in Bellingham, Wash., in May 1988.

Theo L. Polasek, Alyeska's vice president of operations, told the subcommittee that "immediate, fast response to mid-point of Prince William Sound (is) not possible with present equipment complement," according to documents obtained by Miller's staff.

Roger A. Gale, manager of marine operations for Sohio Oil, now British Petroleum, said in a June 1988 telex that an Alyeska marine services subcommittee was urging the owners' committee to go along with an "acceptable compromise" calling for more equipment to protect the Sound, including a large barge equipped with booming and skimmers and a "study of the best and quickest methods of moving the barge around."

Gale invited other sub-

committee members to comment on the proposal.

Stanley Factor, an Arco Marine vice president for chartering and evaluations, said in a July 6, 1988, response that "Arco Marine Inc. does not agree with (Gale's) telex nor do we concur that this represents the thoughts of the subcommittee."

"At the owners' committee meeting in Phoenix, it was decided that Alyeska would provide immediate response to oil spills in Valdez Arm and Valdez Narrows only," he said.

"Further efforts in the Prince William Sound would be limited to the use of dispersants and any additional effort would be the responsibility of the spiller," Factor said.

Steve Provant, the Alaska Department of Environmental Conservation manager for Prince William Sound, said it's possible the documents refer to a spill plan envisioned for 1990 but that it seemed unlikely such attention was being paid to a contingency plan so far from submission to the state.

"A contingency plan is

good for three years," he said. "They may have been looking ahead."

But Provant said the final 1990 plan does not end Alyeska's responsibility for spills at the Valdez Narrows.

"They will respond to spills within Prince William Sound," he said.

The lead federal agency negotiating the oil-spill settlement with Exxon was the National Oceanic and Atmospheric Administration.

NOAA general counsel Tom Campbell said Tuesday that the settlement bans any federal action against Alyeska because Exxon wanted it that way.

"Exxon wanted to pay only once," Campbell said. He said the company worried that any related action against Alyeska would subject Exxon to further payments because it owns 20 percent of the pipeline company.

"We said, fine, as long as you pay adequate compensation for restoration."

Campbell said the federal government thinks it is getting enough money from Exxon to restore the way.

A10 Wednesday, April 10, 1991, The Anchorage Times

Report: Spill cleanup method was harmful

ASSOCIATED PRESS

WASHINGTON — The use of millions of gallons of hot, pressurized water on oil-soiled Alaska beaches after the 1989 Exxon Valdez tanker spill probably did more environmental harm than good, a government report concluded Tuesday.

The report by the National Oceanic and Atmospheric Administration urged that the hot-water cleanup technique be avoided in future oil spills.

"Certainly, as far as Alaska's shoreline is concerned, the environment would have been better off if there had been less aggressive hot-water treatment and we had let nature take its course," said Dr. Sylvia Earle, the agency's chief scientist.

Some environmentalists, however, were not as quick to rule out such water treatment in future spills.

To eliminate any plausible cleanup technique would allow oil companies to rely extensively on natural remedies

Hot, pressurized water hurt more than helped

after a spill and avoid costly cleanup efforts, argued Douglas Wolf of the National Wildlife Federation.

"There probably are circumstances where it doesn't make sense to use hot water treatment, but it's premature to say there would be no circumstances where it would be appropriate," said Wolf.

The Exxon Valdez spilled nearly 11 million gallons of oil into Prince William Sound in March 1989. Exxon spent an estimated \$2 billion in cleanup efforts and has promised to pay an additional \$1 billion in fines and penalties for restoration and environmental recovery efforts.

After the oil spread across more than 400 miles of Alaska shoreline, Exxon cleanup crews pumped massive amounts of hot water through high-pressure hoses in an attempt to wash the

sticky oil off rocks and beaches.

The effort required millions of dollars worth of equipment. Photographs of workers dousing beaches with water from high-pressure hoses symbolized the cleanup effort.

Karsten Rodvik, a spokesman for Exxon USA in Anchorage, said the hot water treatment was used on about one-fourth of the more than 350 miles of coastline contaminated by the spill. He said the decision to use hot water was reached "by consensus," with state and federal agencies as well as Exxon agreeing it was the best approach.

"The fundamental objective first was to remove the gross contamination and hasten the recovery process," Rodvik said in a telephone interview.

Dr. Earle agreed that federal agencies, including NOAA, went along with using the technique.

"Everybody did it with best of intent. It seemed like the right thing to do," she said. But she said NOAA scientists would have opposed using hot, pressurized water as a cleanup technique "had they known then what we know now."

But the NOAA study concluded that the hot-water treatment — using water heated to as much as 150 degrees and pressurized to 100 pounds per square inch of pressure — likely caused more harm to Alaska shoreline and marine life than if the contaminated areas had been left alone.

The NOAA scientists said that they found that some contaminated sections of sand and gravel that had not been hosed down "had richer and more varied marine life similar in most instances to sites where no oil had come ashore."

The report said that the high-pres-

sure flow of water "in effect sterilized many parts of the beaches" and killed marine life including barnacles, mussels, clams, eelgrass and rockweed.

It said that the water pressure "greatly altered the physical aspect of the beaches," flushing finer contaminated sands and gravel away from shore and covering lower levels of the beach with oily sediment.

VECO International was the company hired to clean up oiled beaches of Prince William Sound.

Tom Maloney, corporate business manager for VECO International, said under the circumstances VECO did what it thought was necessary to save the beaches and surrounding waters.

"During a catastrophe you do the best you can. If we didn't do anything the oil was not going to go away," Maloney said. "The Coast Guard thought it (steam washing the beaches) was the best thing to do at the time."

Lawmakers argue for spill data's release

By DAVID WHITNEY

Daily News reporter

WASHINGTON — House Democrats pounded on Bush administration officials at a hearing Wednesday, saying their refusal to release damage studies on the 1989 Exxon Valdez oil spill makes it impossible to determine whether the \$1 billion settlement reached last week is in the public interest.

"I came here with a lot of doubts and I leave here with a lot of doubts," said Rep. Gerry Studds, D-Mass., who presided over the House Merchant Marine and Fisheries Committee hearing on the settlement.

During the 90-minute session, Studds and other Democrats berated officials from the Justice Department, the National Oceanic and Atmospheric Administration, the Interior Department and three other federal agencies for refusing to disclose the basis for the settlement.

They wondered whether the settlement figure is too low and whether Exxon is getting off too easily. Rep. Dennis Hertel, D-Mich., charged the deal was

hatched to speed congressional action for oil drilling in the Arctic National Wildlife Refuge and offshore waters.

Under the settlement, Exxon Corp. and Exxon Shipping Co. would plead guilty to two misdemeanors and pay \$100 million in fines and restitution. They also would pay \$900 million to resolve natural-resource damage claims of Alaska and the federal government.

According to a Congressional Research Service report released at the hearing, the present value for Exxon of the settlement — which is stretched out over 10 years and is mostly tax-deductible — is between \$421 million and \$524 million.

"What is clear is that what its authors have called a billion-dollar deal for restoring Prince William Sound is actually a \$500 million deal — or even less," Studds said in opening the hearing.

The federal witnesses, however, staunchly defended the settlement. Assistant Attorney General Richard Stewart said the recovery "should provide sufficient funds to undertake and com-

plete the needed restoration program for the Sound."

Stewart said the government will release a summary of damage-assessment studies next week that will help explain how and why the \$1 billion settlement figure was reached.

He said the studies will remain secret until the settlement is final because, if the deal falls apart, their disclosure would reveal the information the government would use in resuming prosecution of both the criminal and civil cases.

Rep. William Hughes, D-N.J., called the Justice Department's refusal to release the studies now "untenable" because it prohibits an informed appraisal of the settlement terms.

"The comment period I presume was provided so that the public can comment intelligently," Hughes said. "I suspect that the court will not look kindly on this stonewalling."

Hughes, the most impassioned of the Democratic critics, also questioned

Stewart on why no corporate officers of Exxon were personally accused of crimes in connection with the spill.

Stewart said there was no basis for charging any of them personally.

"I continue to have problems with any analysis that finds that a corporation can be criminally liable and yet the officers are not at fault," Hughes said.

Alaska Rep. Don Young was one of the few Republicans who attended the hearing — but he stayed for only about 30 minutes, long enough to get assurances from Stewart that the rights of Alaska Natives and others with damage suits against Exxon will not be impaired.

Asked later why he didn't stay for the entire hearing, Young said "I had other things to do."

Young was holding a fund-raising party Wednesday evening.

"If I thought there would be much achieved at the hearing I would have stayed longer," he said.

POLICE REPORT

Fire forces emergency

A Reeve Aleutian Airport passengers had to make Salmon Wednesday afternoon. The plane landed a.m., shortly after the 1. The airport's runway was while firefighters the p.

Credit union robbery

The Frontier Alaska State Wednesday morning by cap, according to the FBI after the bank at 3500 E. robber headed west from some cash, the FBI said. white man, about 6 feet dark, collar-length hair. navy blue or black nylon winter boots. The credit robbed in Anchorage so authorities.

Senate approves emergency

The Associated Press

JUNEAU — The Senate first piece of legislation chambers this session — a use of an emergency vehicle. House Bill 21 would make taking a marked emergency up to five years in prison.



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SEARS

— correction notice —

On Page 3 of the March 21 preprint, the Kenmore #73401/73311 gas range is incorrectly described as having an electronic clock. It has a dial clock. On Page 4 of the March 21 preprint the #60051 refrigerator is

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