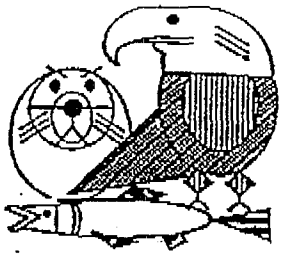
Exxon Valdez Oil Spill Trustee Council
Restoration Office
645 "G" Street, Anchorage, AK 99501
Phone: (907) 278-8012 Fax: (907) 276-7178



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FAX COVER SHEET

To: Cab Walcoff / Ken Rice

Number: 703-548-0426

From: Karen Klinge

Date: 4-27-93

Comments:

Total Pages:

State of Alaska: Departments of Fish & Game, Law, Natural Resources, and Environmental Conservation
United States: National Oceanic and Atmospheric Administration, Departments of Agriculture, and Interior

RESTORATION PLANNING WORK GROUP
OIL SPILL RESTORATION OFFICE
645 G STREET
ANCHORAGE, ALASKA 99501

Ken, 26 April 1993

This is the first installment on the "effectiveness" chapter. I will keep sending them as they are completed. We have not decided the exact location for this section. It will probably be at the end of Chapter 5 or a new Chapter 6. I think we may end up using the "short" format that is shown for the harbor seals. It requires less reading. However, it is easier for me to write the long version and then shorten it, so that is what you will be seeing this week.

I hope all is going well for you this week,

Karen

WHAT CAN WE DO TO HELP INJURED RESOURCES AND SERVICES RECOVER?

As described earlier, part of the evaluation process used to determine which restoration options belonged in each alternative differed between resources and services. For options directed at resources, the evaluation was based on their predicted effectiveness for improving the estimated recovery time, or in preventing additional stress on the recovering populations. For restoration options for services (human uses) that were not focused on the recovery of a key injured resource, the options were evaluated based on the opportunities for human uses that could be created or protected.

This chapter describes how the options are expected to influence the recovery of the injured resources and services. These results are based largely on best professional judgement and are therefore subject to change as new information becomes available. New options that could be included are continually being suggested and may be added as the final restoration plan is developed.

RESOURCES

Some important points to look for in this section are the number of options that actually are thought to have the ability to affect the recovery of the injured resources. Unfortunately, there is very little that can be done directly for some species. Some options that have the potential to affect the recovery of a resource are experimental and have to be tested before they can be considered for broad-scale application. These are clearly identified by **(Special Study)** printed after the option name. Other options may be effective only in localized areas. These options are identified as providing "localized benefits only".

Options that are thought to be able to provide "substantial" improvement in recovery or prevention on either a localized or broad scale are in Group 1 and appear as General Restoration Options in Alternatives 3-5. Options that are thought to provide "some" improvement are in Group 2 and appear only in Alternative 5. Cumulative effects of any combination of these options may provide more benefit than is recognized in this evaluation.

Options for Habitat protection and acquisition are described in this section for only a few resources. For these resources, protecting (or acquiring) habitat from realistic (forseeable?) changes was thought to prevent a notable additional decline in the injured population. Many other resources benefit by habitat acquisition - even when an area may have been identified for a different resource or service. These important secondary benefits are not discussed here, but are included in the process for identifying habitats. (right?)

MAMMALS

HARBOR SEALS: There are few methods of actively aiding harbor seal recovery. The causes of the long term population decline in harbor seals since the 1970s are unknown, therefore it is difficult to develop restoration options that will enable the population to increase. The restoration options presented here are protective: protecting harbor seal haul outs from disturbance, cooperative programs with commercial fishing groups to protect harbor seals, and cooperative programs with subsistence users.

Disturbance at haul-out sites within the oil spill area is not considered a significant problem at this time. However, other studies have shown that disturbance can cause additional pup mortality and increase the stress on adults. Therefore, preventing unnecessary disturbance at haul-out sites was thought to provide some improvement in preventing additional stress or mortality (Group 2).

The two options that would develop cooperative programs between subsistence users or commercial fishermen and the harbor seal managers and researchers (Options XX and XX, respectively) are believed to have the most potential for improving harbor seal recovery. Both options are in Group 1. Creating greater communication and cooperation between the groups of people who interact most with harbor seals in the affected area would improve our understandings of the injured population and may help to identify ways to prevent or slow any additional decline.

KILLER WHALES: Three options were considered to help the one injured whale pod increase its numbers to pre-spill levels. The experts interviewed did not believe that two of these, reducing disturbance at rubbing beaches, and special designations (**what is the new name for this again?**), would have any effect on recovery. The third option, facilitating gear changes in the black cod fishery (Group 1), was thought to have the greatest potential to allow the pod to recover without additional stresses.

RIVER OTTERS: There is very little that has been identified that can be done to address the injuries to river otters. This is partially due to the difficulties in assessing the actual injuries, but it is also due to the life history patterns of the otters. Several options (List option #"s) should provide secondary benefits to river otters in the area, but none of these are expected to benefit more than a few individuals at a time.

Currently, the only option that could provide some benefits (Group 2), is to coordinate with the Board of Game to adjust trapping guidelines for otters within the oiled areas.

SEA OTTERS: In addition to the individuals killed directly by the oil in 1989, researchers believe that there has been poor weanling pup survival and higher than normal mortality in prime-age adults (based on post-spill studies in Prince William Sound). The causes

or extent of these additional problems are not known, but researchers speculate that the otters may still be exposed to oil by eating food from subtidal and intertidal areas.

There are three options that appear to have potential to help the sea otter populations recover. Two require preliminary research (**special studies**) before their effectiveness can be accurately evaluated. A **special study** option to determine the effects of removing oil from mussel beds may show that it substantially improves survival (Group 1); unfortunately, implementing this option is only expected to provide localized benefits. The other **special study** would determine the effects of upland disturbances on nearby concentrations of sea otters. If these studies indicate that upland disturbances negatively effect sea otter productivity then options that protect private or public lands from such disturbances could be considered (i.e. Habitat protection and acquisition or altering management pratices on public lands). Overall, experts felt that the benefits from these protective measures would have some improvement over current recovery conditions; therefore, this option is in Group 2.

The third option would develop a cooperative program between subsistence users and the managers and researchers of the sea otter populations. This type of cooperative program could have substantial benefits by improving the overall understanding of sea otter population and its recovery status (Group 1).

BIRDS

BALD EAGLES: No continuing effects of the sublethal injuries have been documented since 1990, and the population of bald eagles monitored in Prince William Sound is expected to reach its pre-spill numbers by 1996. Because The Bald Eagle Protection Act of 19.. provides considerable protection of eagles and their nest trees, no restoration options other than habitat protection have been identified.

BLACK OYSTERCATCHERS: There are two options that have been identified for black oystercatchers. Accelerating the recovery of the upper intertidal zone where black oystercatchers feed (option XX) could provide some benefit in localized areas (Group 2). Because black oystercatchers do not breed close to other pairs, this option would have to be implemented over a huge area in order to have a substantial impact on the population.

The second option would focus mostly on oystercatchers **outside** of the oil spill area. Removing introduced predators (rats and foxes) from islands (probably in the Aleutian Islands) that once had breeding black oystercatchers could increase the state-wide population of the birds. Fox removal projects have shown substantial increases in black oystercatcher populations on the treated islands. **(i think i have some real numbers to put in here**

HARBOR SEALS: Only a few methods have been identified for actively aiding harbor seal recovery. The causes of the long term population decline in harbor seals since the 1970s are unknown, therefore it is difficult to develop restoration options that will enable the population to increase. The restoration options presented here are protective.

Disturbance at haul-out sites within the oil spill area is not considered a significant problem at this time, but reducing disturbance has been shown to decrease pup mortality and stress on adults in other areas. Creating greater communication and cooperation between the groups of people who interact most with harbor seals (subsistence users, commercial fishermen, researchers and managers) in the affected area would improve our understandings of the injured population and may help to identify ways to prevent or slow any additional decline.

"Substantial"- Implement cooperative programs between subsistence users and agencies.

Implement cooperative programs between commercial fishermen and agencies.

"Some" - Reduce disturbance of harbor seals at haul-out sites.

Exxon Valdez Oil Spill Trustee Council

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

April 19, 1993

Dear Concerned Citizen:

The Trustee Council is in the process of developing the 1994 program of work to help restore the resources and services injured by the Exxon Valdez Oil Spill. "Restoration includes....injury assessment, restoration, replacement and enhancement of natural resources, and acquisition of equivalent resources or services," (Memorandum of Agreement and Consent Decree for Civil Action A91-081CV in U.S. District Court, District of Alaska, filed August 29, 1991). Attached is a list of titles for potential restoration projects for 1994 which are being considered for this program. These potential projects have been derived from the following sources:

(1) Public comments on the Restoration Framework (an April 1992 restoration discussion document),
(2) Public comment on the 1992 and 1993 work plans,
(3) Federal and state trustee agency recommendations,
(4) Other solicited and unsolicited public comments,
(5) Projects identified by the Exxon Valdez Oil Spill Public Advisory Group,
(6) Projects suggested by individuals testifying at Trustee Council meetings.
(7) Projects identified by the Chief Scientist and peer reviewers.

Please review and comment on this list of potential projects. It may be difficult for you to comment on many of the projects because of the limited information available. However, you are being asked to comment now so that you have an opportunity to influence the projects that will be selected for inclusion in the draft 1994 Work Plan. Project descriptions of these titles will be developed for the draft 1994 Work Plan to be released for public comment this summer. After reviewing those public comments, the Trustee Council will select the projects to be conducted in 1994.

Please check the columns on the right hand side of the attached table to indicate whether a project should be conducted and when. Additional space has been provided under each resource name in the table for new project titles. Be sure to note in the appropriate column the injured resource or service and the restoration option/suboption your project title addresses. Titles should be as complete and meaningful as possible. Please indicate the geographic area in which the project would be conducted. If the project is outside of the spill area please write "out" in the region columns. Your cost estimates and duration may be preliminary estimates and subject to change as are ours. A paragraph explaining your new proposed project would be useful to make sure we understand what you are proposing. At the end of the project title listing, two blank sheets are included for your new project ideas. Summary of injury tables are attached as background information to assist your deliberations on restoration projects.

The $900 million civil recovery from the *Exxon Valdez* Oil Spill is to be paid over a 10 year period. In September 1993, a $100 million payment will occur, and, from 1994 through 2001, yearly payments of $70 million will be made. Since the money is being paid over a multi-year period, not all potential projects can be funded in 1994. No decision has been made on the total amount that will be spent for the 1994 program of work (October 1, 1993 through September 30, 1994). Please note that in addition to project costs, any program of work will require funding for the administration of restoration activities.

A Restoration Plan is being developed as a long-term guide to the restoration of the resources and services injured by the *Exxon Valdez* oil spill. The Restoration Plan will be used to guide the selection of specific projects to be included in each annual work plan. A draft Restoration Plan is expected to be available in June 1993; the final version will be published by the end of 1993.

There is a 30-day period to review and comment on the enclosed potential project titles. To make sure your comments are considered, they must be postmarked by May 20, 1993. Please return your comments to:

Exxon Valdez Trustee Council
1994 Work Plan Work Group
645 "G" Street
Anchorage, Alaska 99501

Thank you.

Michael A. Barton
Regional Forester
Alaska Region
Forest Service
U.S. Department of Agriculture

Charles E. Cole
Attorney General
State of Alaska

Paul D. Gates
Regional Environmental Officer
Office of the Secretary
U.S. Department of Interior

Steve Pennoyer
Director
Alaska Region
National Marine Fisheries Service

Carl L. Rosier
Commissioner
Alaska Department of Fish and Game

John A. Sandor
Commissioner
Alaska Department of Environmental Conservation

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

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

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

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

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	Oil Spill Mortality (total mortality estimate) (b)	Decline in Population after the spill	Evidence of Sublethal or Chronic Effects	Current Population Status	Evidence of Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
BIRDS										
Bald Eagles	YES (614-902)	YES	YES	RECOVERING	UNKNOWN	YES	YES	YES (d)	YES(d)	Productivity in PWS was disrupted in 1989, but returned to normal in 1990. Exposure to hydrocarbons and some sub-lethal effects were found in 1989 and 1990, but no continuing effects were observed on populations.
Black-legged Kittiwakes	YES (NUMBER UNKNOWN)	NO	NO	NO CHANGE	NO	YES	YES (d)	YES (d)	YES (d)	Total reproductive success in oiled and unoiled areas of PWS has declined since 1989. Hydrocarbon contaminated tissues were detected in 1989. Hydrocarbon contaminated stomach contents were detected in 1989 and 1990. This species is known for great natural variation and reproductive failure may be unrelated to the oil spill.
Black Oyster-catchers	YES (129 ADULTS; UNKNOWN FOR CHICKS (f)	YES	YES	RECOVERING	YES	YES	YES (d)	YES (d)	YES (d)	Differences in egg size between oiled and unoiled areas were found in 1989. Exposure to hydrocarbons and some sublethal effects were determined. Populations declined more in oiled areas than unoiled areas in post-spill surveys in 1989, 1990 and 1991. Black oystercatchers feed in the intertidal areas and may be still be exposed to hydrocarbons in the environment.
Common Murres	YES (175,000 to 300,000)	YES	YES	DEGREE OF RECOVERY VARIES IN COLONY	YES	NO	YES	YES	YES	Measurable impacts on populations were recorded in 1989, 1990 and 1991. Breeding is still inhibited in some colonies in the Gulf of Alaska.
Glaucous-winged gulls	YES (NUMBER UNKNOWN)	NOT DETECTED	NO	NO CHANGE	NO	YES (d)	YES (d)	YES (d)	YES (d)	While dead birds were recovered in 1989, there is no evidence of a population level impact when compared to historic (1972, 1973) population levels.

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Harlequin Ducks	YES (423)	YES	YES	STABLE OR CONTINUING DECLINE	YES	YES	YES (d)	YES (d)	YES (d)	Post-spill samples showed hydrocarbon contamination and poor body conditions. Surveys in 1990-1992 indicated population declines and near total reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may still be exposed to hydrocarbons in the environment.
Marbled Murrelets (c)	YES (8,000 TO 12,000)	YES	UNKNOWN	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (d)	YES (d)	YES (d)	Measurable population effects on were recorded in 1989, 1990 and 1991. Marbled murrelet populations were declining prior to the spill. Hydrocarbon contamination was found in livers of adult birds.
Peale's Peregrine Falcons	UNKNOWN	UNKNOWN	NO	(e)	(e)	(e)	(e)	(e)	(e)	When compared to 1985 surveys a reduction in population and lower than expected productivity was measured in 1989 in the PWS. Cause of these changes are unknown.
Pigeon Guillemots (c)	YES (1,500 TO 3,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (d)	YES (d)	YES (d)	Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found in birds and, externally, on eggs.
Storm Petrels	YES (NUMBER UNKNOWN)	NO	AWAITING RESULTS	NO CHANGE	UNKNOWN	YES (d)	YES (d)	YES (d)	YES (d)	Few carcasses were recovered in 1989 although petrels ingested oil and transferred oil to their eggs. Reproduction was normal in 1989.
Other Seabirds	YES (375,000-435,000)	VARIES BY SPECIES	UNKNOWN	VARIES BY SPECIES	UNKNOWN	YES (d)	YES (d)	YES (d)	YES (d)	Seabird recovery has not been studied. Species collected dead in 1989 include common, yellow-billed, pacific, red-throated loon; red-necked and horned grebe; northern fulmar; sooty and short-tailed shearwater; double-crested, pelagic, and red-faced cormorant; herring and mew gull; arctic and Aleutian tern; Kittlitz's and ancient murrelet, Cassin's, least, parakeet, and rhinoceros auklet; and horned and tufted puffin.

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Other Sea Ducks	YES (875) (b)	NO	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (d)	YES (d)	YES (d)	Species collected dead in 1989 include Stellar's, king and common eider; white-winged, surf and black scoter; oldsquaw; bufflehead; common and Barrow's goldeneye; and common and red-breasted merganser. Sea ducks tend to feed in the intertidal and shallow subtidal areas which were most heavily impacted by oil.
Other Shorebirds	YES (NUMBER UNKNOWN)	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (d)	YES (d)	YES (d)	Species collected dead in 1989 include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpiper; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.
Other Birds	YES (NUMBER UNKNOWN)	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	YES (d)	YES (d)	YES (d)	YES (d)	Species collected dead in 1989 include emperor and Canada goose; brant; mallard; northern pintail; green-winged teal; greater and lesser scaup; ruddy duck; great blue heron; long-tailed jaeger; willow ptarmigan; great-horned owl; Stellar's jay; magpie; common raven; northwestern crow; robin; varied and hermit thrush; yellow warbler; pine grosbeak; savannah and golden-crowned sparrow; white-winged crossbill.
FISH										
Cutthroat Trout	YES, SEE COMMENTS	POSSIBLY	YES	STABLE, BUT NOT RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Differences in survival and growth between anadromous adult populations in the oiled and unoiled areas persisted in 1991 despite the decrease in exposure indicators. This could be due to continuing injury to the food base.
Dolly Varden	YES, SEE COMMENTS	POSSIBLY	YES	STABLE, BUT NOT RECOVERING	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Differences in survival between anadromous adult populations in the oiled and unoiled areas persisted in 1991 despite the decrease in exposure indicators. This could be due to continuing injury to the food base.

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Pacific Herring	YES, TO EGGS AND LARVAE	UNKNOWN	YES	UNKNOWN	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable difference in egg counts between oiled and unoiled areas were found in 1989 and 1990. Lethal and sublethal effects on eggs and larvae were evident in 1989 and to a lesser extent in 1990; in 1991 there were no differences between oiled and unoiled areas. It is possible that the 1989 year class was injured and could result in reduced recruitment to the fishery.
Pink Salmon (Wild) (c)	YES, TO EGGS	POSSIBLY	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial egg mortalituy in 1989. Egg mortality continued to be high in 1991, possibly due to genetic damage to spawners. Abnormal fry were observed in 1989. Reduced growth of juveniles was found in the marine environment, which can be correlated with reduced survival.
Rockfish	YES (20) (f)	UNKNOWN	YES	UNKNOWN	UNKNOWN	YES	YES	UNKNOWN	UNKNOWN	Few dead fish were found in 1989 in condition to be analyzed. Exposure to hydrocarbons with some sub-lethal effects were determined in those fish, but no effects established on the population. Closures to salmon fisheries increased fishing pressures on rockfish which may be impacting population.
Sockeye Salmon	UNKNOWN	YES	YES	SEE COMMENTS	YES	UNKNOWN	YES	YES	NO	Smolt survival continues to be poor in the Red Lake and Kenai River systems due to overescapements in Red Lake in 1989, and in the Kenai River in 1987, 1988, 1989. As a result, future adult returns are expected to be low in 1994 and successive years. Trophic structures of Kenai and Skilak Lakes have been altered by overescapement.
SHELLFISH										
Clam	YES (NUMBER UNKNOWN)	UNKNOWN	POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	Native littleneck and butter clams were impacted by both oiling and clean-up, particularly high pressure, hot water washing. Littleneck clams transplanted to oiled areas in 1990 grew significantly less than those transplanted to unoiled sites. Reduced growth recorded at oiled sites in 1989 but not 1991.

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Crab (Dungeness)	UNKNOWN	UNKNOWN	UNKNOWN	(e)	(e)	(e)	(e)	(e)	(e)	Crabs collected from oil areas were not found to have accumulated petroleum hydrocarbons.
Oyster	UNKNOWN	UNKNOWN	UNKNOWN	(e)	(e)	(e)	(e)	(e)	(e)	Although studies were initiated in 1989, they were not completed because they were determined to be of limited value.
Sea Urchin	UNKNOWN	UNKNOWN	UNKNOWN	(e)	(e)	(e)	(e)	(e)	(e)	Studies limited to laboratory toxicity studies.
Shrimp	UNKNOWN	UNKNOWN	NO	(e)	(e)	(e)	(e)	(e)	(e)	No conclusive evidence presented for injury linked to oil spill.
INTERTIDAL/SUBTIDAL COMMUNITIES										
Intertidal Organisms/ Communities	YES	YES	YES	VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	YES	YES	YES	Measurable impacts on populations of plants and animals were determined. The lower intertidal and, to some extent, the mid intertidal is recovering. Some species (Fucus) in the upper intertidal zone have not recovered, and oil may persist in and mussel beds.
Subtidal Communities	YES	YES	YES	VARIABLE BY SPECIES, SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	Measurable impacts on population of plants and animals were determined in 1989. Eel grass and some species of algae appear to be recovering. Amphipods in eel grass beds recovered to pre-spill densities in 1991. Leather stars and helmet crabs show little sign of recovery through 1991.

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

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

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

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

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

(a) There may have been an unequal distribution of injury within each region.

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

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

(a) There may have been an unequal distribution of injury within each region.

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

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

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

(a) There may have been an unequal distribution of injury within each region.
(b) This page has not yet been reviewed by the Chief Scientist.

(a) There may have been an unequal distribution of injury within each region.

Name:_____

Phone:_____

1994 POTENTIAL PROJECT TITLES

	RESOURCE or SERVICE	RESTORATION OPTION SUBOPTION	POTENTIAL PROJECTS	REGION PWS	KEN	KOD	EST. COST/YR $K	EST. DURATION (YEARS)	1994	1995	1996	1997	1998	1999	2000	2001	DO Not Fund
1	Archaeology	Acquire Archaeological Artifacts	Archaeological Specimens Collection, University of Alaska Museum	X	X	X	$41	M									
2		Acquire Archaeological Artifacts	Nuchek Heritage Interpretive Center, Design	X			$300	1									
3		Habitat Protection and Acquisition	Archaeological Site Acquisition	X	X	X	$200	M									
4		Intensified Management	Coastal Archaeological Inventory and Evaluation of Archaeological Sites-Interagency	X	X	X	$525	M									
5		Intensified Management	Vandalized Cultural Resources--Inventory, Evaluation, Interpretation	X	X	X	$400	M									
6		Option Not Identified	Restoration of Chenega Village Site	X			$75	1									
7		Option Not Identified	Site-specific Archaeological Restoration - Interagency	X	X	X	$300	93 - M									
8		Public Information	Passports in Time-Cultural Resource Patterns in PWS	X			$230	M									
9		Public Information	Heritage Information Replacement	X	X	X	$200	M									
10		Public Information	PWS Landmarks-Evaluation and Interpretation	X			$400	M									
11		Public Information	Public Education and Interpretation of Archaeological Resource	X	X	X	$400	M									
12		Restoration Monitoring	Study of Petroleum Hydrocarbon Spectra at Selected Sites	X	X	X	$225	M									
13		Site Patrol and Monitoring	Archaeological Site Protection-Public Education-Interagency	X	X	X	$150	M									
14		Site Patrol and Monitoring	Archaeological Site Protection-Site Patrol Monitoring-Interagency	X	X	X	$210	M									
15		Site Stewardship Program	Archaeological Site Stewardship Program	X	X	X	$114	M									
16		Visitor Center	Chugach National Forest Heritage Interpretive Center, Design	X			$1,200	1									
17	Bald Eagle	Habitat Protection	Identification and Protection of Important Bald Eagle Habitats	X	X	X	$262	M									
18		Recovery Monitoring	Bald Eagle Productivity Survey and Catalog	X	X	X	$10	M									
19		Recovery Monitoring	Long-Term Population Monitoring for Bald Eagles	X	X	X	$200	M									
20	Black Oystercatcher	Recovery Monitoring	Black Oystercatcher Interaction with Intertidal Communities	X	X	X	$108	93 - M									
21		Recovery Monitoring	Feeding Ecology and Reproductive Success of Black Oystercatchers in PWS	X			$125	M									

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1994 POTENTIAL PROJECT TITLES

	RESOURCE or SERVICE	RESTORATION OPTION or SUBOPTION	POTENTIAL PROJECTS	REGION PWS	REGION KEN	REGION KOD	EST. COST/YR $K	EST. DURATION (YEARS)	1994	1995	1996	1997	1998	1999	2000	2001	Do Not Fund
22	**Black Oystercatcher**	Restoration Monitoring															
23	**Commercial Fishing**	Habitat Protection and Acquisition	Weir And Conservation Land Acquisition	X	X	X	$1,100	M									
24		Intensify Management	Establish an Ecological Basis for Restoring and Enhancing Mixed-stock Salmon Resources	X	X	X	$385	M									
25		Intensify Management	Fishery Industrial Technology Center	X	X	X	$3,500	1									
26		Intensify Management	Model for Capacity of Salmon Production for the Susitna Drainage		X		$150	M									
27		Intensify Management	Susitna River Sockeye Salmon Production Evaluation		X		$300	M									
28		Monitoring	Thirteen Commercial Species Hydrocarbon Contamination and Injury Assessment	X	X	X	$200	M									
29		Option Not Identified	Payoff Debt of Valdez Fisheries Development Association	X			$5,000	1									
30		Recovery Monitoring	Recovery of Coded-Wire Tags from Pink Salmon in Commercial Catches, Hatchery Cost Recovery	X			$868	M									
31		Recovery Monitoring	Wild Fish Stock Information Assessment	X	X	X	$50	M									
32		Replace Harvest Opportunities	Mitigation Fishery at Kitoi Bay Hatchery on Afognak Island			X	$45	M									
33		Replace Harvest Opportunities	Montague Island Chum Salmon Restoration	X			$80	M									
34		Replace Harvest Opportunities	Paint River Fish Ladder Salmon Stocking Program		X		$50	M									
35		Replace Harvest Opportunities	Red Lake Mitigation			X	$191	M									
36	**Common Murre**	Feasibility Study: Improve Nest Sites	Testing of the Feasibility of Enhancing Productivity	X	X	X	$280	M									
37		Feasibility Study: Social Stimuli	Restoration of Murres by Way of Behavioral Attraction and Habitat Enhancement	X	X	X	$51	93 - M									
38		Feasibility Study: Social Stimuli	Restoration of Murres by Way of Transplantation of Chicks-Feasibility Study	X	X	X	$73	M									
39		Recovery Monitoring	Common Murre Population Monitoring OUT	X	X	X	$191	M									
40		Reduce Disturbance	Reduce Disturbance Near Murre Colonies Injured by the Oil Spill	X	X	X	$40	M									
41		Remove Introduced Species	Removal of Introduced Predators from Bird Colonies OUT				$460	M									

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#	RESOURCE or SERVICE	RESTORATION OPTION or SUBOPTION	POTENTIAL PROJECTS	REGION PWS	REGION KEN	REGION KOD	EST. COST/YR $K	EST. DURATION (YEARS)	1994	1995	1996	1997	1998	1999	2000	2001	Do Not Fund
42	Common Murre	Restoration Monitoring						M									
43	Cutthroat/Dolly	Intensify Management	Cutthroat Trout and Dolly Varden Habitat Restoration	X			$200	M									
44		Intensify Management	Enhanced Management of Cutthroat Trout and Dolly Varden	X			$285	M									
45		Option Not Identified	Anadromous Cutthroat and Dolly Varden Char Habitat Inventory, Evaluation, and Restoration	X			$35	M									
46		Option Not Identified	Cutthroat Trout and Dolly Varden Hatchery	X			$950	M									
47		Restoration Monitoring						M									
48	General	Administration	Oil Spill Restoration Support Service and Facilities	X	X	X	$600	1									
49		Monitoring	Monitoring of Small Cetaceans (Dall Porpoises) in PWS	X			$200	M									
50		Option Not Identified	Hazardous Material Collection Facility	X	X	X	$100	1									
51		Option Not Identified	Testing of Patch-Response Patch Dependence Hypothesis-Testing of an Ecosystem Model	X	X	X	$488	M									
52		Public Information	Public Broadcasting System Program on Oil Spill	X	X	X	$70	M									
53		Public Information	Publish and Distribute Brochures on Injured Species	X	X	X	$90	M									
54		Public Information	PWS Brochures	X			$65	M									
55		Public Information	PWS Implementation of Interpretive Plan	X			$150	M									
56		Public Information	PWS Large Format Photographic Book	X			$100	M									
57		Public Information	PWS Scenic Byway-- Nomination and Interpretive Plan	X			$70	M									
58		Public Information	PWS Video Programs	X			$100	M									
59		Public Information	Science of the Sound- Education Program	X			$53	M									

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1994 POTENTIAL PROJECT TITLES

	RESOURCE SERVICE	RESTORATION OPTION SUBOPTION	POTENTIAL PROJECTS	REGION PWS	REGION KEN	REGION KOD	EST COST/YR $K	EST DURATION (YEARS)	1994	1995	1996	1997	1998	1999	2000	2001	Do Not Fund
60	**Harbor Seal**	Cooperative Program-Fishermen															
61		Monitoring	Monitoring Trends in Abundance of Harbor Seals in PWS	X			$39	M									
62		Option Not Identified	Subsistence Harvest Assistance	X			$23	M									
63		Option Not Identified	Habitat Use and Behavior of Harbor Seals in PWS	X			$165	93 - M									
64		Recovery Monitoring	Habitat Use, Monitoring, Population Modelling, and Information Synthesis	X	X	X	$230	M									
65	**Harlequin Duck**	Eliminate Oil from Mussel Beds															
66		Monitoring	Harlequin Duck Recovery Monitoring, Population Modelling and Habitat Information Synthesis	X	X	X	$700	93 - M									
67		Option Not Identified	Quantification of Stream Habitat for Harlequin Ducks from Remotely Sensed Data	X	X	X	$53	M									
68	**Intertidal**	Accelerate Recovery of Intertidal	Deposit Sand on Cleaned Beaches, to Promote Clam Recruitment-Feasibility Study	X	X	X	$20	M									
69		Accelerate Recovery of Intertidal	Fucus Restoration Feasibility Study	X	X	X	$70	M									
70		Accelerate Recovery of Intertidal	Restoration of High-Intertidal Fucus	X	X	X	$300	M									
71		Accelerate Recovery of Intertidal	Beach Subsurface Oil Recovery	X	X	X	$50	M									
72		Accelerate Recovery of Intertidal	Hydrodynamic Purging of Oil from Contaminated Beaches, PWS	X			$500	M									
73		Accelerate Recovery of Intertidal	Rapid Restoration of Weathered Crude Contaminated Beach Subsurface Material	X	X	X	$800	M									
74		Accelerate Recovery of Intertidal	Restore Shorelines Injured by Beach Berm Relocation	X	X	X		M									
75		Monitoring	Coastal Habitat Injury Assessment - Intertidal Algae	X	X	X	$620	M									
76		Monitoring	Fate and Transport of Subsurface Hydrocarbons in Beach Deposits in PWS	X			$600	M									
77		Monitoring	Coastal Habitat Comprehensive Intertidal Monitoring Program	X	X	X	$500	M									
78		Monitoring	Hydrocarbons in Mussels from Coastal Gulf of Alaska, Cook Inlet and Shelikof Strait		X	X	$200	M									
79		Monitoring	Intertidal/Shallow Subtidal Crustacean (Decapod) Composition	X	X	X	$275	M									
80		Monitoring	Long-Term Monitoring -Acute and Chronic Toxicity of Residual Hydrocarbons to Littleneck Clams	X	X	X	$50	M									
81		Monitoring	Monitoring for Recruitment of Littleneck Clams	X	X	X	$186	M									

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	RESOURCE or SERVICE	RESTORATION OPTION or SUBOPTION	POTENTIAL PROJECTS	REGION PWS	REGION KEN	REGION KOD	EST. COST/YR $K	EST. DURATION (YEARS)	1994	1995	1996	1997	1998	1999	2000	2001	Do Not Fund
82	Intertidal	Monitoring	Monitoring Sites - Collector Beaches and Lagoons	X	X	X	$500	M									
83		Monitoring	Natural Recovery of Oiled and Treated Shorelines and Monitoring	X	X	X	$600	M									
84		Monitoring	Quantification of Intertidal Algal Recovery Using Multispectral Digital Remote Sensing	X	X	X	$195	M									
85		Monitoring	Recovery Monitoring of Intertidal Oiled Mussel Beds	X	X	X	$500	93 - M									
86		Monitoring	Herring Bay Experimental and Monitoring Studies	X			$495	93 - M									
87		Option Not Identified	Bivalve Shellfish Rehabilitation Project	X	X	X	$860	M									
88		Option Not Identified	Clam Enhancement	X	X	X	$120	M									
89		Option Not Identified	Replacement of Oiled Mussels with Commercially Produced Mussels	X	X	X	$500	M									
90		Option Not Identified	Restoration of Mussel Beds	X	X	X	$500	M									
91		Option Not Identified	Characterization of Near-Shore Bottom Habitat	X	X	X	$237	M									
92	Killer Whale	Monitoring	Photo-Identification Studies of PWS Killer Whales	X			$120	93 - M									
93		Monitoring	Recovery Monitoring	X			$125	M									
94		Monitoring	Use of Satellite Transmitters to Investigate Killer Whale Ecology in PWS	X			$180	M									
95		Reduce Fishery Interactions	Change Black Cod Fishery Gear	X				M									
96	Marbled Murrelet	Habitat Protection	Identification of Nesting Habitat Criteria and Reproductive Success for Marbled Murrelet	X	X	X	$240	93 - M									
97		Habitat Protection	Survey to Identify Upland Use by Murrelets	X	X	X	$180	93 - M									
98		Habitat Protection	Assessment of Marbled Murrelet Foraging Habitat Requirements During Breeding Season	X	X	X	$250	M									
99		Habitat Protection	Marbled Murrelet Nesting and Feeding Site Characterization and Assessment	X	X	X	$509	M									
100		Minimize Incidental Take															
101		Recovery Monitoring	Determine Status of Marbled Murrelet Populations In Kenai Fjords and Katmai National Parks		X	X	$200	M									

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	RESOURCE or SERVICE	RESTORATION OPTION / SUBOPTION	POTENTIAL PROJECTS	REGION PWS	REGION KEN	REGION KOD	EST. COST/$K	EST. DURATION (YEARS)	1994	1995	1996	1997	1998	1999	2000	2001	Do Not Fund
102	**Marbled Murrelet**	Restoration Monitoring	Survey to Monitor Recovery of Marbled Murrelets	X	X	X	$250	M									
103	**Multiple Resources**	Habitat Protection	Habitat Modelling	X	X	X	$150	M									
104		Habitat Protection	Riparian Habitat Assessment	X	X	X	$110	M									
105		Habitat Protection	Stream Channel Capability Modeling	X	X	X	$110	M									
106		Habitat Protection	Stream Habitat Assessment	X	X	X	$361	93 - M									
107		Habitat Protection	Valdez Hazardous Waste Collection	X			$200	1									
108		Habitat Protection	Vegetation and Stream Classification and Mapping	X	X	X	$276	93 - M									
109		Habitat Protection	Wetland Habitat Classification, Mapping and Assessment	X	X	X	$100	M									
110		Habitat Protection	Characterization and Identification of Habitat Important to Upland Species	X	X	X	$750	M									
111		Habitat Protection and Acquisition	Inholdings in Alaska Maritime National Wildlife Refuge		X	X	$111	1									
112		Habitat Protection and Acquisition	Inholdings in Alaska Peninsula National Wildlife Refuge			X		1									
113		Habitat Protection and Acquisition	Inholdings in Becharof National Wildlife Refuge			X		1									
114		Habitat Protection and Acquisition	Valdez Duck Flats	X				1									
115		Habitat Protection and Acquisition	Inholdings in Kenai Fjords National Wildlife Refuge		X		$20	1									
116		Habitat Protection and Acquisition	Inholdings in Aniakchak National Monument and Preserve			X		1									
117		Habitat Protection and Acquisition	Kitoi Bay Hatchery Watershed Habitat Acquisition			X	$250	1									
118		Habitat Protection and Acquisition	Acquire Olsen Bay Watershed	X			$3,500	1									
119		Habitat Protection and Acquisition	Acquisition of Inholdings in Shuyak Island State Park			X	$200	1									
120		Habitat Protection and Acquisition	Acquisition of Koniag Corporation Inholdings within the Kodiak National Wildlife Refuge			X	$77,000	1									
121		Habitat Protection and Acquisition	Conservation Easement-Aialik Bay		X		$90	1									
122		Habitat Protection and Acquisition	Conservation Easement-Chugach Bay		X		$60	1									
123		Habitat Protection and Acquisition	Conservation Easement-Dogfish Bay		X		$400	1									
124		Habitat Protection and Acquisition	Conservation Easement-Port Chatham		X		$80	1									
125		Habitat Protection and Acquisition	Conservation Easement-Rock Bay		X		$740	1									
126		Habitat Protection and Acquisition	Habitat Acquisition	X	X	X	$25,000	93 - 1									
127		Habitat Protection and Acquisition	Habitat Acquisition, Afognak			X	$112,500	1									

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1994 POTENTIAL PROJECT TITLES

	RESOURCE or SERVICE	RESTORATION OPTION or SUBOPTION	POTENTIAL PROJECTS	REGION PWS	REGION KEN	REGION KOD	EST. COST/YR $K	EST. DURATION (YEARS)	1994	1995	1996	1997	1998	1999	2000	2001	Do Not Fund
128	**Multiple Resources**	Habitat Protection and Acquisition	Habitat Acquisition, Kodiak Island			X	$20,000	1									
129		Habitat Protection and Acquisition	Habitat Acquisition, North Afognak Island			X	$4,000	1									
130		Habitat Protection and Acquisition	Kodiak Bear Refuge Stream Mouth Inholdings Acquisition			X	$1,000	1									
131		Increase Natural Food Supply															
132		Intensify Management	Develop Management Strategy for Enhancing Recovery Rate of Bird and Sea Otter Populations	X	X	X	$50	M									
133		Intensify Management	Genetic Risk Assessment of Injured Salmonids	X	X	X	$408	M									
134		Intensify Management	Restoration and Mitigation of Essential Wetland Habitats for PWS Fish and Wildlife	X			$200	M									
135		Intensify Management	Restoration of Second Growth Habitat for Wildlife in PWS	X			$40	M									
136		Intensify Management	Seabird Colony Restoration	X	X	X	$250	M									
137		Intensify Management	Stock Identification of Chum, Sockeye and Chinook Salmon in PWS	X			$250	M									
138		Monitoring	Shoreline Worm Life Monitoring	X	X	X	$388	M									
139		Option Not Identified	Instream Habitat and Stock Restoration Techniques for Anadromous Fish	X	X	X	$416	M									
140		Option Not Identified	Alaska Land and Wildlife Conservation Fund	X	X	X	one billion	M									
141		Option Not Identified	Field Study of Bioremediation Enhancement Treatment Methods	X	X	X	$280	M									
142		Option Not Identified	Oil Spill Injured Resources Literature Research and Review	X	X	X	$7	M									
143		Option Not Identified	Analyze Natural Resource Damage Assessment Samples Left Un-Analyzed	X	X	X	$650	1									
144		Option Not Identified	Identification of Seabird Feeding Areas from Remotely Sensed Data and Impact on Restoration	X	X	X	$48	M									
145		Option Not Identified	Shoreline Assessment	X	X	X	$250	93 - M									
146		Option Not Identified	Uganik River Fish Counting Weir - Brown Bear and Other Wildlife Food Study			X	$28	M									
147		Recovery Monitoring	Comprehensive Monitoring Program, Plan and Administer	X	X	X	$500	93 - M									
148		Recovery Monitoring	Cook Inlet Comprehensive Monitoring Program		X		$800	M									
149		Recovery Monitoring	Full Funding for Oil Spill Recovery Institute	X	X	X	$2,300	1									
150		Recovery Monitoring	Injured Resource Food Supply	X	X	X	$850	M									
151		Recovery Monitoring	Inventory, Monitor, Protect Permanent Study Sites	X	X	X	$500	M									
152		Recovery Monitoring	Long-Term Monitoring of Marine Environment of Resurrection Bay		X		$600	M									
153		Recovery Monitoring	Migratory Shore Birds Staging in Rocky Intertidal Habitats of PWS	X			$80	M									
154		Recovery Monitoring	Migratory Waterfowl and Shorebird Monitoring	X	X	X	$150	M									
155		Recovery Monitoring	Monitor Population Status of Seabird Nesting Colonies in the Spill Zone	X	X	X	$100	M									
156		Recovery Monitoring	Restoration Recovery Monitoring of Stream-Rearing Anadromous Salmonids	X	X	X	$200	M									
157		Recovery Monitoring	Survey to Determine Abundance Distribution, Habitat, and Food Habits of Staging Shore Birds	X			$35	M									

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1994 POTENTIAL PROJECT TITLES

	RESOURCE or SERVICE	RESTORATION OPTION or SUBOPTION	POTENTIAL PROJECTS	REGION PWS	REGION KEN	REGION KOD	EST. COST/YR $K	EST. DURATION (YEARS)	1994	1995	1996	1997	1998	1999	2000	2001	Do Not Fund
158	**Multiple Resources**	Recovery Monitoring	Survey to Determine Distribution, Abundance, and Food Habits of Staging Migratory Waterfowl	X			$91	M									
159		Recovery Monitoring	Surveys to Monitor Marine Bird and Sea-Otter Populations	X	X	X	$275	93 - M									
160		Reduce Disturbance by Field Presence															
161		Reduce Disturbance Through Public Info	Public Information and Education	X	X	X	$316	M									
162		Reduce Disturbance Through Public Info	Publish and Distribute Brochures on Injured Species	X	X	X	$50	M									
163		Restoration Monitoring	Abundance and Distribution of Forage Fish and Their Influence on Recovery of Injured Species	X	X	X	$500	M									
164		Restoration Monitoring	Ecosystem Study	X	X	X	$6,000	M									
165	**Pacific Herring**	Intensify Management	Genetic Stock Identification for Herring in PWS	X			$205	M									
166		Intensify Management	Herring Spawn Deposition, Egg Loss, and Reproductive Impairment	X			$400	M									
167		Intensify Management	PWS Herring Tagging Feasibility Study	X			$112	M									
168		Monitoring	Herring Embryo Viability Evaluation - Natural and Catastrophic Effects	X			$189	M									
169		Monitoring	Larval Herring Age and Growth in PWS Using Otoliths	X			$60	M									
170		Option Not Identified	Enhancement of Pacific Herring	X	X	X	$120	M									
171		Restoration Monitoring															
172	**Pigeon Guillemot**	Monitoring	Pigeon Guillemot Colony Survey	X	X	X	$40	93 - M									
173		Monitoring	Pigeon Guillemot Recovery Enhancement and Monitoring	X	X	X	$180	M									
174		Restoration Monitoring															
175		Temporary Predator Control															

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	RESOURCE or SERVICE	RESTORATION OPTION or SUBOPTION	POTENTIAL PROJECTS	REGION PWS	REGION KEN	REGION KOD	EST. COST/YR $K	EST. DURATION (YEARS)	1994	1995	1996	1997	1998	1999	2000	2001	Do Not Fund
176	Pink Salmon	Fish Passes and Access	Feasibility of Fish Passes as Oil Spill Restoration	X	X	X	$25	M									
177		Fish Passes and Access	Horse Marine Creek Pink Salmon Restoration			X	$28	1									
178		Fish Passes and Access	Otter Creek Fish Pass	X			$130	1									
179		Fish Passes and Access	Pink Creek Pink Salmon Restoration			X	$11	1									
180		Fish Passes and Access	Sockeye Creek Fish Pass	X			$60	1									
181		Fish Passes and Access	Waterfall Creek Pink Salmon Restoration-Fish Improvement			X	$55	1									
182		Improve Survival Rates	Fry Rearing to Improve Survival and Restore Wild Pink and Chum Salmon Stocks	X	X	X	$727	M									
183		Intensify Management	Adult Tagging to Determine Distribution, Migratory Timing and Rate of Movement of Pink Salmon	X			$495	M									
184		Intensify Management	Coded Wire Tag Recoveries from Commercial Catches in PWS Salmon Fisheries	X			$855	M									
185		Intensify Management	Coded Wire Tagging of Wild Stock Pink Salmon for Stock Identification	X			$500	M									
186		Intensify Management	Inventory and Effect of Straying Hatchery Pink Salmon on Wild Pink Salmon Population	X			$253	M									
187		Intensify Management	Otolith Marking - Inseason Stock Separation Tool to Reduce Wild Stock Salmon Exploitation	X	X	X	$152	M									
188		Intensify Management	Pink Salmon Escapement Enumeration	X	X	X	$705	M									
189		Intensify Management	PWS Salmon Stock Genetics	X			$150	M									
190		Intensify Management	Quality Assurance for PWS Coded Wire Tagging and Fish Production Records	X			$66	M									
191		Monitoring	Investigating and Monitoring Oil Related Egg and Alevin Mortalities	X	X		$686	M									
192		Monitoring	Restoration Monitoring and Preservation of Wild Populations of Pink Salmon	X	X		$899	M									
193		Monitoring	Injury to Salmon Eggs and Pre-emergent Fry in PWS, Laboratory Verification	X			$141	M									
194		Monitoring	Pink Salmon Egg to Pre-Emergent Fry Survival in PWS	X			$385	93 - M									
195		Monitoring	Monitoring Early Marine Growth of Juvenile Salmon in Prince William Sound	X			$50	M									
196		Option Not Identified	Pink Salmon Stream Enhancement in Prince William Sound, Lower Cook Inlet and Kodiak	X	X	X	$300	M									
197	Recreation	Establish Marine Environmental Institute	Build Research and Monitoring Facilities and Program/Cook Inlet, Kodiak		X	X	$1,250	M									
198		Establish Marine Environmental Institute	Oiled Wildlife Rehabilitation Center	X	X	X	$6,000	1									
199		Establish Marine Environmental Institute	Seward Sea Life Center	X	X	X	$40,000	1									
200		Habitat Protection and Acquisition	17(b) Easement Identification-Public Access	X	X	X	$500	M									
201		Habitat Protection and Acquisition	Acquisition of Important Recreation Lands	X	X	X	$500	M									

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202	Recreation	Habitat Protection and Acquisition	Acquisition of Recreational Sites on Kodiak Road System			X	$500	1									
203		Habitat Protection and Acquisition	Land Exchange Shuyak for Kodiak Land on Road System			X	$70	1									
204		Habitat Protection and Acquisition	Shelter Cove, Cordova Restoration Project	X			$50	M									
205		Monitoring	Assessment of Economic Injuries to Wilderness-Based Tourism	X	X	X	$100	M									
206		Monitoring	Post-Oil Spill Recreation-Based User Survey for PWS	X			$58	M									
207		Monitoring	Recreation Field Management and Monitoring	X	X	X	$700	M									
208		New Backcountry Recreation Facilities	Enhanced Trail Opportunities, Including Columbia and Blackstone Glacier Trails	X			$150	1									
209		New Backcountry Recreation Facilities	Green Island Cabin Replacement	X			$20	1									
210		New Backcountry Recreation Facilities	Improve Marine Parks	X	X	X	$100	M									
211		New Backcountry Recreation Facilities	Low Impact Recreation Development Nellie Juan, College Fiord Wilderness Study Area	X			$100	1									
212		New Backcountry Recreation Facilities	Prince William Sound Campground	X			$70	1									
213		New Backcountry Recreation Facilities	Public Use Cabins in State Marine Parks	X	X	X	$150	M									
214		New Backcountry Recreation Facilities	PWS Kayak Trail	X			$100	1									
215		New Backcountry Recreation Facilities	PWS Recreation Facilities	X			$250	1									
216		Option Not Identified	Development of Gulf of Alaska Recreation Plan		X	X	$140	1									
217		Option Not Identified	Implement Prince William Sound Area Recreation Plan	X			$400	M									
218		Option Not Identified	Sustainable Tourism in PWS	X			$240	M									
219		Option Not Identified	Watchable Wildlife	X	X	X	$65	M									
220		Option Not Identified	Increased Access PWS	X			$100	M									
221		Plan Commercial Recreation Facilities	Recreation Development	X	X	X	$200	M									
222		Restoration Monitoring															
223		Visitor Center	Bird and Mammal Specimens, University of Alaska Museum	X	X	X	$77	M									
224		Visitor Center	Center for PWS Oil Spill and Natural Resource Education	X				1									
225		Visitor Center	Coastal Habitat Specimens, University of Alaska Museum	X	X	X	$310	M									
226		Visitor Center	Cordova Environmental Education Center	X			$15	1									
227		Visitor Center	Cordova Mini-Imaginarium	X			$63	1									
228		Visitor Center	Develop Video Library of Intertidal Habitat and Biota to Assess Impacts	X	X	X	$155	M									
229		Visitor Center	Environmental Education Center in PWS	X			$90	1									
230		Visitor Center	Environmental Learning Resource Center	X	X	X	$90	1									
231		Visitor Center	Establish Natural Resource Library and Computer Support Technical Service in Cordova	X			$450	1									

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1994 POTENTIAL PROJECT TITLES

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232	**Recreation**	Visitor Center	Information Center	X	X	X	$600	1									
233		Visitor Center	Interpretation of PWS	X			$10	M									
234		Visitor Center	Maritime Wing Valdez Museum	X			$150	1									
235		Visitor Center	Multi-agency Library on PWS and Copper River Delta	X			$150	1									
236		Visitor Center	Valdez Visitor Center	X			$850	1									
237	**River Otter**	Monitoring	River Otter Recovery Monitoring	X			$180	M									
238		Monitoring	Synthesis of Information on Ecology and Injury to River Otters in PWS	X			$40	M									
239		Restoration Monitoring															
240		Sport/trap Harvest Guidelines	Develop Harvest Guidelines to Aid Restoration of Injured Terrestrial Mammals and Seaducks	X	X	X	$99	1									
241	**Rockfish**	Intensify Management	Develop a Rockfish Management Plan	X	X		$175	M									
242		Monitoring	Monitoring Injury to Rockfish in PWS	X			$117	M									
243		Monitoring															
244	**Sea Otter**	Cooporative Prgm-Subsistence Users															
245		Habitat Protection (Public Land)	Habitat Utilization by Sea Otters and Designation of Protected Areas	X	X	X	$83	M									
246		Monitoring	Monitoring of Sea Otter Population Abundance, Distribution, Reproduction, and Mortality	X	X	X	$337	M									
247		Monitoring	Radio-Telemetry Project to Monitor Recovery of Sea Otters	X	X	X	$450	M									
248		Monitoring	Sea Otter Population Dynamics	X	X	X	$291	93 - M									
249		Restoration Monitoring															

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250	**Sea Otter**	Study: Eliminate Oil from Mussel Beds															
251	**Sockeye Salmon**	Fish Passes and Access	Solf Lake Fish Pass	X			$120	M									
252		Intensify Management	Develop and Deploy In-River Hydroacoustic Counters for Sockeye Salmon in the Kenai River		X		$333	M									
253		Intensify Management	Genetic Monitoring of Kodiak Island Sockeye Salmon			X	$275	M									
254		Intensify Management	Genetic Stock Identification of Kenai River Sockeye		X		$500	93 - M									
255		Intensify Management	Kenai River Sockeye Salmon Restoration		X		$1,000	93 - M									
256		Intensify Management	Lower Cook Inlet Sockeye Salmon Restoration and Enhancement		X		$143	M									
257		Monitoring	Ayakulik River Sockeye Salmon Escapement Evaluation			X	$6	M									
258		Monitoring	Sockeye Salmon Overescapement		X	X	$641	93 - M									
259		Option Not Identified	Restoration of the Coghill Lake Sockeye Salmon Stock	X			$165	93 - M									
260		Option Not Identified	Red Lake Salmon Restoration			X	$72	M									
261	**Sport Fishing**	Recovery Monitoring															
262		Replace Harvest Opportunities	Fort Richardson Hatchery Improvement		X		$4,200	1									
263		Restoration Monitoring															
264	**Subsistence**	Access to Traditional Foods															
265		Bivalve Shellfish Hatchery															
266		Option Not Identified	Chenega Bay Subsistence Restoration Project (Remove Oil)	X			$200	M									
267		Option Not Identified	Mariculture Hatchery and Research Center Feasibility Study and Design	X	X	X	$300	1									

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268	Subsistence	Option Not Identified	Mariculture Technical Center	X	X	X	$2,200	1									
269		Option Not Identified	Seward Shellfish Hatchery	X	X	X	$1,300	1									
270		Recovery Monitoring	Survey of Impacted Native Communities-Subsistence	X	X	X	$700	M									
271		Replace Harvest Opportunities	Chenega Bay Replacement Subsistence Resource Project	X			$50	M									
272		Replace Harvest Opportunities	Chenega Chinook and Coho Release Program	X			$55	M									
273		Replace Harvest Opportunities	Port Graham Salmon Hatchery		X		$2,500	1									
274		Replace Harvest Opportunities	Silver Lake Fish Hatchery	X			$1,000	1									
275		Replace Harvest Opportunities	Subsistence Harvest Replacement-Transport Subsistence Users to Unoiled Areas	X	X	X	$55	M									
276		Restoration Monitoring															
277		Subsistence Mariculture Sites	Village Mariculture Project - Oyster Farming	X	X	X	$589	M									
278		Test Subsistence Foods	Assessment and Quality Assurance of Shellfish Resources	X	X	X	$300	M									
279		Test Subsistence Foods	Subsistence Food Safety Testing	X	X	X	$308	93 - M									
280	Subtidal	Habitat Protection	Juvenile Spot Shrimp Habitat Identification	X	X		$110	M									
281		Intensify Management	PWS Spot Shrimp Recovery Management Plan	X			$715	M									
282		Monitoring	PWS Spot Shrimp Survey	X			$90	M									
283		Monitoring	Injury and Recovery of Deep-Benthic Macrofaunal Communities	X	X	X	$275	M									
284		Monitoring	Natural Recovery Monitoring of Subtidal Eelgrass Communities in PWS	X			$265	93 - M									
285		Monitoring	Recovery Monitoring of Hydrocarbon-Contaminated Subtidal Marine Sediment Resources	X	X	X	$390	M									
286		Monitoring	Subtidal Recovery Monitoring	X	X	X	$400	M									
287		Restoration Monitoring	Experimental Studies of Interaction Between Subtidal Epifaunal Invertebrates	X	X	X	$90	M									
288	Technical Services	Administration	Electronic Archiving of Exxon Valdez Records	X	X	X	$450	M									
289		Administration	Geographic Information System Mapping of Natural Resources in Western PWS	X			$75	M									

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290	Technical Services	Administration	Hydrocarbon Data Analysis and Interpretation	X	X	X	$105	93 - M									
291		Administration	Toxicological Profile of PWS	X			$150	M									
292		Public Information	CD-ROM Publication of Digital Spatial Data from Exxon Valdez Oil Spill Mapping Activities	X	X	X	$8	M									
293		Public Information	Database Integration	X	X	X	$148	M									
294		Public Information	Develop User Friendly Synopsis of Oil Spill Information	X	X	X		M									
295		Public Information	Providing Public Access to Oilspill GIS Databases Using Arcview in PC Windows Environment	X	X	X	$120	M									
296		Public Information	Public Access Repository for Oil Spill Geographic Information System (GIS)	X	X	X	$100	M									
297		Public Information	User-Friendly GIS and Remote-Sensing Demonstration Center for Public-5 Communities	X	X	X	$72	M									

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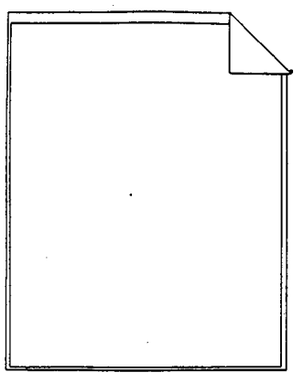
EXXON VALDEZ TRUSTEE COUNCIL
1994 Work Plan Work Group
645 "G" Street
Anchorage, Alaska 99501



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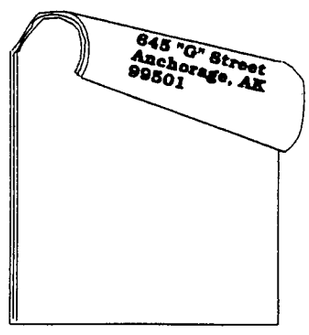

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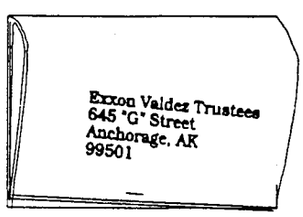

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Attach Correct Postage

Ken:

The following text provides an example of a re-write of the information presented in Chapter 3 on sea otters. The re-write does not include all of the information identified in the above list of key data.

The sea otter is a protected species under the Marine Mammal Protection Act of 1972, which placed a moratorium on the taking of sea otters except for subsistence use by Native Alaskans. The sea otter is under the management of the Fish and Wildlife Service (FWS). Pre-spill and post-spill management of sea otters by FWS has focused on population monitoring through surveys and monitoring of Native harvest.

Sea otter pre-spill populations in 1989 were estimated at over 100,000 animals along the coast of Alaska. The populations in Prince William Sound prior to EVOS was estimated at 10,000 animals. The sea otter population within the oil spill zone was likely at or near an equilibrium density and was limited by prey availability when affected by EVOS. The sea otter population in portions of its geographic ranges was and is now in direct competition with human subsistence, recreational and commercial resource users for crabs, clams and other benthic organisms. Natural predation of the species is limited.

Approximately 4,000 animals were killed directly by the oil spill. Following the spill, near-shore densities of sea otters declined by 35 percent. Nearshore densities appeared to have stabilized in 1991 in the oil spill area, but still remained below pre-spill levels.

There are limited management opportunities to increase sea otter populations. Population management is restricted to protecting habitat and monitoring Native harvest.

Life cycle requirements of the sea otter appear to be intertidal and subtidal food sources and protected areas for pup rearing and weaning. Factors influencing the population recovery for sea otters are: (1) age to reproductive maturity (3-5 years), (2) annual reproductive rate (1 pup), and (3) a low post-weaning survivorship of age class 0-1 years of age. Adult animal survivorship is generally high in absence of outside mortality events; e.g., oil spills, disease, and harvest.

EIS
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(4)

WALCOFF & ASSOCIATES

MEMORANDUM

TO: Ken Rice

FROM: Jacquie Glover-Brown

DATE: April 13, 1993

SUBJECT: Draft EIS Chapter 3 (Last Section)

Ken, as promised on Friday, April 9, enclosed is a draft copy of the last portion of Chapter 3. Please call if you have any questions.

We are looking forward to your visit.

C. Socioeconomic Description

1. Overview

This section describes the social, cultural, and economic conditions of the PWS region and its people. Included are descriptions of the communities affected by the spill; a discussion of the impact of the spill on traditional Native and non-Native subsistence hunting and fishing; information about spill-related injury to cultural and anthropological resources; and a description of the economic base of the area.

2. Relevant State History [PLACEMENT?]

The Alaska Statehood Act (48 U.S.C. [CITE?]) admitted Alaska to the Union in January 1959. The act allowed the State to select 400,000 acres (161,880 ha) of National Forest and unreserved land for community use. In addition, the State was also empowered to choose 102.55 million acres (41.5 million ha) of public lands from other unreserved U.S. lands.

reverse emphasis

The Alaska Native Claims Settlement Act (33 U.S.C. § 1601-1624) settled the aboriginal rights and established the legal claims for Alaska Natives. It also authorized formation of the Regional Native Corporations. This act also addressed the public land withdrawals and established a Joint Federal/State Land Use Planning Commission, which began the land selection procedures that resulted in the existing pattern of Federal, State, Native, and private ownership of lands in Alaska.

After Alaska became a State, oil exploration and development continued to grow. In 1968, a discovery well at Prudhoe Bay on the North Slope uncovered the largest known oil field in the United States. The North Slope oil lease, completed in 1969, granted oil rights to an oil consortium and brought more than $900 million in bonuses to Alaskans. To provide for transporting the oil from the North Slope to a shipping point, Congress passed the Trans-Alaska Pipeline Authorization Act in 1973. Construction of the pipeline was completed in 1977. Today, the pipeline moves almost 2 million barrels (84,000,000 gallons, ~~or 317,940,000 liters~~) from Prudhoe Bay to Valdez every day. Since 1977, the Port of Valdez has shipped the bulk of crude oil taken from Prudhoe Bay.

In 1976, the first of DOI's Minerals Management Service lease sales for outer continental shelf (OCS) oil and gas were completed in the eastern Gulf of Alaska. Sales followed in Lower Cook Inlet (1977 and 1981), in the northeastern Gulf of Alaska (1980), and east of Kodiak Island (1980). Although Valdez and PWS have little or no known oil or gas potential, the area is part of Lease Sale 88.

[NATIVE CORPS GO HERE. KATHY, ARE YOU GETTING THIS INFORMATION?]

The Alaska National Interest Lands and Conservation Act of 1980 (ANILCA, 16 U.S.C. 3111 *et seq.*) implemented the Alaska Native Claims Settlement Act and the Statehood Act. ANILCA allowed the Alaska Native allotments, State land selections, and

established the Alaska Land Bank. It also provided for the designation and conservation of Federal public lands, including the National Parks, National Wildlife Refuges, National Forests, Wild and Scenic Rivers, and the National Wilderness Preservation System. ANILCA also authorized the subsistence management system and allowed for the use of public resources, including the continued use of those resources in the National Parks and Forests.

3. Affected Communities

The communities affected by the *Exxon Valdez* spill are grouped into four regions: the Kenai Peninsula Borough (KPB), the Kodiak Island Borough (KIB), the Lake and Peninsula Borough, and the Valdez–Cordova Census Area. The effects of the spill differ for each region and its communities. In general, the communities that experienced the most disruption were the Native villages, which are mixed cash-subsistence hunting and fishing based economies.

a. Kenai Peninsula Borough

The Kenai Peninsula Borough, which is located south of Anchorage, includes both sides of Cook Inlet from the southern tip of the Kenai Peninsula north to the Knik Arm–Turnagain Arm split. The Kenai Peninsula holds 99 percent of the borough's population and most of the area's development because it is linked by roads to Anchorage. Sixty-three percent of the borough's population (27,338 people) lives in Kenai and Soldotna. The area is economically dependent on the oil and gas industry, as well as fishing and tourism. Communities within the central Kenai Peninsula region are the cities of Kenai, Soldotna, and Seward. ?

More about Seward needed.

The southern Kenai Peninsula contains the cities of Homer and Seldovia and the Native villages of Port Graham and English Bay. Homer is the economic and population hub of the region, with revenues from commercial fishing, tourism, government and commercial offices, and agriculture. In contrast, the Native villages are largely dependent upon subsistence hunting and fishing. Within this region, Homer was least affected by the spill, both because it was least severely oiled and because its residents were relatively less dependent upon subsistence. Port Graham and English Bay were heavily oiled, yet these communities were farthest removed from the cleanup efforts. Residents of these communities who relied upon subsistence were adversely affected by actual contamination or perceived contamination of subsistence foods.

b. Kodiak Island Borough

The Kodiak Island region includes the city of Kodiak and the six Native villages of Port Lions, Ouzinkie, Larsen Bay, Karluk, Old Harbor, and Akhiok. These communities are part of the Kodiak Island Borough (KIB). The KIB population is between 13,000 and 15,000 and includes Natives of Alutic [ALEUTIC?] background and immigrants from the Philippines and from Central and Meso-America. As in other parts of Alaska, Kodiak

What?

Island's population grows significantly in the summer. The KIB provides some social services to villages, and the Kodiak Area Native Association (KANA) provides medical and social services through the tribal governments in each village.

what? check this out

Nearly two-thirds of the Kodiak Island shoreline was oiled. Oil in varying forms spread from the northern end of the island along the west coast and through the many passages, coves, and small islands that make up the Kodiak Island group. In addition to the physical effects of the oil on these communities' land, social effects were associated with the cleanup activities that followed the spill. Daily life in many Native villages was disrupted by the presence of outsiders and by changes in the local economy caused by the influx of visitors and cash. Local governments and relations with service providers were strained in many villages, and the introduction of provisional regulations added to the tension. The communities of Akhiok, Karluk, Kodiak, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions are located in the Kodiak Island Borough.

this seems exaggerated

c. Lake and Peninsula Borough

The Lake and Peninsula Borough contains three communities Chignik Bay, Chignik Lagoon, Chignik Lake, which were exposed to oil in the form of tar balls and oil sheen. Some remote beaches were also oiled. Residents of all three communities are ethnically mixed, Aleut, Russian and Scandinavian. The economy of the communities is mixed cash-subsistence.

d. Valdez-Cordova Census Area

The Prince William Sound region covers an area of about 20,000 square miles (EQUIV) of water, ice, and land. For the purpose of this study, the region includes five communities: Valdez, Cordova, Whittier, Chenega Bay and Tatitlek. Each is accessible by air or water, and all have dock or harbor facilities. Only Valdez is accessible by road.

The region has an abundant supply of fish, shellfish, and marine mammals. These and the other natural resources of PWS play a part in the lives of area residents. In addition, the area is considered by many to be a unique, pristine wilderness, offering unparalleled opportunities for outdoor recreation, adventure, and travel.

Communities in the PWS region depend on a variety of economic activities, as shown in Table IIIX.

Table IIIa Valdez-Cordova Employment by Industry

Occupational Classification	Number employed
Agriculture, Forestry, Fisheries	574
Mining	115
Construction	421

Occupational Classification	Number employed
Manufacturing (nondurable goods)	146
Manufacturing (durable goods)	110
Transportation	618
Communication and public utilities	149
Wholesale trade	84
Retail trade	612
Finance, insurance, and real estate	102
Business and repair service	87
Personal services	154
Entertainment and recreation	60
Health services	316
Education services	523
Other professional and related services	447

Source: [KATHY—CAN WE GET SOURCE HERE.]

The economic bases of the five communities is diverse. Cordova's economy is based on commercial fishing, primarily for red salmon. As the terminus of the Trans-Alaska Pipeline, Valdez is dependent on the oil industry; but commercial fishing and fish processing are also important to the local economy. Whittier residents work as government employees, longshoremen, commercial fishermen, and service providers to tourists. The Alaska Native people of Chenega Bay and Tatitlek, by contrast, rely on subsistence fishing, hunting, and gathering for their livelihood.

not sure of this

(Comm. fishing too)

Table III# Cordova Wage and Salary Employment, 1989 - 1990

Font size

Occupational Classification	1989	1990
Nonagricultural wage and salary	1,301	1,321
Construction	29	51
Transportation, Communications, and Utilities	197	96
Trade	178	190
Finance, Insurance, and Real Estate	24	24
Services	120	127

— where is fishing?

Occupational Classification	1989	1990
Miscellaneous	92	101
Government	335	372
Federal	40	49
State	112	121
Local	184	202

Source: [KATHY, I NEED SOURCE FOR THIS!]

Table III# Valdez Wage and Salary Employment, 1989 - 1990

Occupational Category	1988	1989	1990
Nonagricultural wage and salary	1,789	2,887	2,200
Mining	0	0	0
Constuction	38	23	26
Manufacturing	206	261	247
Transportation, Communication, and Utilities	388	1,129	563
Trade	175	237	265
Finance, Insurance, Real Estate	15	24	30
Services, Miscellaneous	294	462	346
Government	673	751	749
Federal	17	18	17
State	377	448	422
Local	280	285	310

← where is fishing?

Source: Alaska Department of Labor, Research and Analysis Section

4. Subsistence [THIS SECTION TO BE REORGANIZED, CUT CONSIDERABLY.]

a. Overview

The term "subsistence" refers to a particular pattern of harvesting and using naturally occurring renewable resources. In a subsistence system, land and labor are allocated in accordance with kinship, political, or tribal rights and obligations. Subsistence systems define a relationship with the earth and its resources, shape the economy, provide material sustenance, and form the basis of community life. Subsistence systems depend on natural resources in a way that Western industrialized societies do not.

Alaska is the only State in which a significant proportion of the population lives off the

land. The Alaska Lands Act defines subsistence as follows:

> . . . customary and traditional uses by Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for making and selling of handicraft articles out of non-edible by-products of fish and wildlife resources taken for personal or family consumption; for bartering or sharing for personal or family consumption; and for customary trade. (Alaska Lands Act, § 803)

Residents of communities legally defined as "rural" under State regulations may hunt and fish under subsistence regulations. Since there are only a few urban areas in Alaska, the majority of the State's 300 inhabited areas fall into the rural category.

Subsistence systems are characterized by four important attributes.

- Subsistence activities are seasonal. Fishing, hunting, and gathering follow the natural rhythm of the tides, wildlife and fish migration, and plant life cycles. The form of settlement and the pace of life in PWS villages depend upon the season.

- Subsistence activities are localized. Productive, accessible sites are established for various subsistence activities.

- Subsistence is regulated by a system of traditional, locally recognized rights, obligations, and appropriate behaviors. The use of sites, the division of the catch or harvest, and the assignment of responsibilities are determined by tradition. Villages that share overlapping territories for hunting and fishing occupy their individual niche and adhere to the rights and responsibilities traditionally assigned to them.

- Subsistence is opportunity-based. [WE NEED MORE HERE] (MMS, [NEED YEAR])

b. Connection to Environment

Subsistence implies a certain connection to the environment. Prior to the *Exxon Valdez* oil spill, PWS was considered a "pristine" wilderness with bountiful environmental riches. The abundant wildlife, scenic mountains, old-growth forests, clear waters, and other natural riches of PWS have made the area particularly valuable to Alaskans, both Native and non-Native. The unpolluted environment attributed to PWS was experienced as an enrichment of individual lives, a perspective somewhat less common in the lower

48 States. For many Alaskans, the spill spoiled a pure and irreplaceable resource, a place that was fundamental to their identities and values. One resident explained it this way:

> . . . [H]ere in Homer most people don't really care all that much about money or material things. They care about a quality of life that in some cases they have traveled across the entire country to find. Some things are sacred. This country is sacred. The connection of these people to the country is sacred. And no amount of money can magically undo the damage, the sacrilege. (Oil Spill Commission, 1990)

Both Alaska Natives and non-Natives in PWS experience a relationship with the environment that is unique in the United States. Many of those who choose to live there, foregoing the steady income a city job could provide, assign great value to the rural, subsistence-based way of life. When the environment is harmed, the basis of subsistence—the harmonious relationship of humans to their environment—is threatened.

c. Economic Implications

The economic aspects of the subsistence system also are dependent upon the availability of untainted natural resources. In the PWS subsistence system, food and other material resources are bartered, shared, and used to supplement supplies from other sources. Subsistence resources are the foundation of the PWS area's mixed subsistence-cash economy.

It should be noted that none of the rural communities in PWS is so isolated or so traditional as to be totally uninvolved in the modern market economy. Most PWS communities are characterized by a mixed subsistence-market economy. This label recognizes that a subsistence sector exists alongside a cash system, and that the socioeconomic system is viable because the sectors are complementary and mutually supportive. Even the most traditional subsistence hunter uses the most modern rifles, snow machines, boats, boat motors, nets, and traps he can afford. These goods cannot be acquired without cash.

Subsistence pursuits supply important material goods, however. Although some food is imported into PWS, a vast subsistence harvest is hunted, fished, and gathered locally. For some residents, subsistence is the primary source of food and supplies. For others, subsistence supplements resources available from other sources.

> Our beaches and waters provide us with deer and fish and game which helps

offset the high cost of food here (Kodiak Island). This is not simply a recreational question, it is everyone's livelihood and food resource that is affected. (The Day the Water Died, [YEAR])

Within Alaska Native communities, not all households participate in every subsistence harvest, but food is often shared among households. Sharing subsistence resources occurs both within and among PWS villages.

Estimates vary widely on the percentage of subsistence foods in the diet [DO WE MEAN JUST NATIVES? OR EVERYBODY IN PWS?], but studies indicate that subsistence may provide 70 to 80 percent of the total protein consumed within the households of PWS villages. [CITE?] Estimates place the share of subsistence meats and fish at 200 to 600 pounds [KG] per person per year. Among Alaska Natives, reliance on subsistence foods is greater still, with subsistence resources providing 80 to 100 percent of Natives' total protein intake, at an average of 500 pounds [KG] per person per year. Subsistence foods provide a large portion of the diet—a portion that families can ill afford to replace with imported substitutes. Fewer than 500 permits are given to subsistence fishermen each year, mostly residing in the Upper Copper River area and the southwestern area of PWS.

Besides making up part of the local diet, subsistence provides food for dog teams and is the only source for other material needs such as ivory for carving [CARVING WHAT?], furs for clothing, and seal hides for mukluk soles and uppers. not in PWS/GoA

The PWS communities affected by the oil spill are small, relatively isolated, and economically dependent on local fish and wildlife. The noncommercial transfer and exchange of wildlife products are important institutions in PWS and in Alaska. The prevalence of direct consumption and nonmonetary transfer and exchange of fish, wildlife, and other natural resources and services makes it difficult to determine their economic value in terms of the value system of the cash economy.

d. Sociocultural Implications

Subsistence pursuits are tied to all aspects of life in the villages affected by the oil spill and are key to the Alaska Native sociocultural system. For at least 11,000 years, Alaska Native people have depended on the lands and water of PWS for their survival. Their traditional way of life is intimately tied to the harvesting, gathering, and use of subsistence foods.

The Alaska Native culture cannot easily be separated from the subsistence way of life and each person's relationship to the land, sea, and resources. In the words of [WHO?]—

> Our area is not an economically developed area. We depend on the sea for our food and clothing. There is much sharing in the catches, as we realize the needs of our brothers and they realize our needs. It is not joyful to see our children and grandchildren hungry. . . Every one of us is Eskimo around here. We all have to eat our own native food, and there is no question about it. We cannot possibly go without it. . . Please try and fathom our great desire to survive in a way somewhat different from yours, and thus see why the hunters will continue to go out. . . Over long stretches of unrecorded time, Native Americans established balances with other life on the earth. They survived over the centuries by living in balance with the fish and birds and animals . . . in balance with the subsistence resources of the natural world . . .
> When the balance, or circle of life, as it has been called, is broken, birds and fish and animals begin disappearing from the land. When they are gone, so are the people who depended upon them (Davidson, 1974).

PWS?

The rules governing the harvesting and use of subsistence resources are derived from a combination of culture, tradition, and religious beliefs. Subsistence involves many social activities such as cooperative labor-sharing, the exchange of resources and information, transmission of knowledge and skills, and formation of values. The means of establishing prestige and maintaining peace traditionally involve the consumption, transfer, and exchange of fish, game, and their byproducts. These activities are necessary for the preservation of traditional family and community relationships that are essential to the physical and psychological well-being of Alaska Native communities. Continuous access to uncontaminated resources in a natural setting is also fundamental to the physical, spiritual, and psychological well-being of Alaska Native communities.

In Native villages, the hunt, the sharing of products of the hunt, and the beliefs surrounding the hunt tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Generous hunters are considered good men. Good hunters are often leaders. These are but some of the ways in which subsistence and beliefs about subsistence join with sociocultural values. The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and subsistence activities that occur in Native society. Subsistence also shapes the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations, employment, sports activities, and membership in voluntary organizations. Language, culture, spiritual beliefs, customs, self-esteem, and

respect for others are tied into a view of the world that is centered on the traditional hunting, fishing, and gathering way of life.

e. Effects of the Spill on Subsistence

Subsistence is the basis of a whole way of life in PWS. Recognition of this perspective is essential to understanding the significance of subsistence activities, as well as the far-reaching impacts of the *Exxon Valdez* oil spill on subsistence for Natives and non-Natives alike.

The spill fouled waters and beaches used for subsistence hunting, fishing, and gathering by 18 rural communities, including 15 Native villages, with about 15,600 inhabitants. Destruction and contamination of subsistence resources exacerbated [STRONG] the cultural disintegration and dislocation experienced by Alaska Natives in PWS.

> Livelihoods destroyed, emotional stability of people destroyed, tremendous stress—these things will be etched on my mind for the rest of my lifetime, and I think that I will be grieving for many, many years to come over what I saw in the summer of 1989. (The Day the Water Died [CITE])

Subsistence harvesting was disrupted, which in turn disrupted the traditional cultural patterns of social interaction surrounding the harvesting of local natural resources. In 1989, subsistence fishery was banned as a precaution against possible health-threatening effects of the oil spill on fish and wildlife in the Sound.

Resource and habitat contamination and destruction resulted in a 77-percent decline in subsistence resource harvesting. PWS residents had to seek food from outside the local environment. In Native villages, shortages of traditional foods resulted.

not subsistence table, why here?

Table III# Permits Issued and Estimated Harvest Values, 1989 - 1990

City/village	Permits (1988)	Harvest Earnings (1988)	Permits (1989)	Harvest Earnings (1989)	Permits (1990)	Harvest Earnings (1990)
Cordova	411	$41,500,000	309	$29,949,000	412	$31,637,000
Valdez	55	$2,710,000	30	$1,436,000	54	$1,959,000
Chenega Bay	1	not applicable	1	not applicable	3	not applicable
Tatitlek	11	$514,000	8	$196,000	6	$304,000
Whittier	16	$222,000	9	$42,000	14	$126,000

City/village	Permits (1988)	Harvest Earnings (1988)	Permits (1989)	Harvest Earnings (1989)	Permits (1990)	Harvest Earnings (1990)
Total	494	$44,946,000	357	$31,623,000	489	$34,027,000

Source: Alaska Commercial Fisheries Entry Commission

Moreover, the sociocultural system on which the traditional Alaska Native lifestyle is based was threatened by the influx of cleanup crews and the unfamiliar demands of a cash economy. Contamination of traditional foods, and fear of contamination, led potential users to stop harvesting these resources. One Alaska Native had this to say:

> We depend on ourselves. . . And we depend on the seals, sea lions, butter clams, ducks, and sea life. Now they are disappearing. The sea life is disappearing. Even if they come around, we are staying away from them. (Alaska Oil Spill Commission, 1990)

Although a number of fisheries were closed immediately following the spill and reopened once it had been determined that local fish were safe to eat, some Alaska Natives are unwilling to eat them for fear of contamination. Spot shrimp fisheries were closed in 1989 and 1990. Clams, an important part of the native diet, were shown to be contaminated after the spill. Fish, bear, moose, deer, and other Native meats were deemed safe to eat by Federal and State health officials, but not all PWS subsistence users were willing to go back to harvesting them. Restoration proposals will address the contamination that continues to affect PWS species and people who harvest them.

4. Cultural and anthropological resources

Sites important to the Alaskan culture were injured by the oil spill and by the cleanup response, mainly by increasing human activity in and around PWS. At least 26 archaeological sites, including burial grounds and home sites, were injured to various degrees. Five of these sites were on private or State lands and 21 were located on Federal land—10 on national parks, six on national refuges, four within the Chugach National Forest, and one on Bureau of Land Management (BLM) land. Injuries included vandalism, erosion of beachfront sites, removal of artifacts, and oiled sites. With regard to the oil spill, the three major sources of potential impact were direct impacts resulting from oil in direct contact with artifacts or features; treatment methods employed to remove oil; and human activities incidental to the response actions.

Some Alaska Native sites in the PWS area are more than 11,000 years old (Clark 1984a.

1984b; Crowell 1988b). The sites affected by the oil spill fall within the larger ethnographic Pacific Eskimo region, which extends from the Copper River to the middle of the Alaska Peninsula and includes the outer reaches of Cook Inlet. Cook Inlet was originally occupied by the Tanaina Athapaskans. Trade, warfare, ceremonial exchange, and occasional intermarriage led to a sharing of many cultural traits among the Pacific Eskimo, Tanaina, Aleut, ~~Eskimo,~~ Athapaskan, Eyak, and Tlingit Indian tribes.

The types and locations of PWS archaeological and architectural sites made them particularly vulnerable to disturbances related to the oil spill. Sites found in the intertidal zone include stone and wooden fish weirs, petroglyphs, shipwrecks, piers and pilings associated with historical domestic and commercial facilities, and potentially the full range of features found in the uplands. Cultural resources were known to occur in adjacent uplands, where modified deposits, villages, rock shelters, culturally modified trees, historical domestic and commercial facilities, and other features are present. The range of physical materials incorporated into these sites includes stone, bone, shell, various metals, wood, textiles, leather, and other organic items.

The major potential physical impact of oiling is the obscuring of intertidal artifacts from observation, with the secondary possibility that solidification of oil could immobilize artifacts in the intertidal zone. Both of these effects would be temporary, as wave and tidal action would remove the oil over a period of months or years. The chemical impacts of oiling are not known. Some scientists have raised questions about whether contaminated organic items can still be dated using radiocarbon techniques, but others believe that the oil can be removed from crucial samples so that they may be successfully dated. [KATHY: I DON'T THINK THIS IS IN BIBLIO. PLEASE SUPPLY FULL CITE! (CRS 1989:103)].

Several of the cleaning methods used on the beaches were particularly damaging to archaeological resources. [KATHY: WHICH ONES WERE WORST AND WHY?] Archaeological and architectural sites located in the uplands adjacent to treated shorelines were at risk only when people visited those uplands. Although a blanket restriction on upland access by cleanup crews was in effect throughout the shoreline treatment phase, some degree of access was required to efficiently undertake treatment activities. In addition, a variety of pedestrian upland crossings resulted in damage to cultural resources, especially surface features. Vandalism and looting of cultural sites occurred as a result of uncontrolled or unsupervised access to the immediate uplands, particularly where rock shelters, historic cabins, mine sites, and other surface features or subsurface deposits were exposed.

5. Economic base of the region

This needs to be checked by ADF&G fish management. Data seem old.

COMMERCIAL FISHING

Introduction

Alaska is considered the most important fishing state in the United States. In 1989 Alaska accounted for almost half the nation's catch in pounds, and 38% in value. No other state comes close to Alaska in either total harvest weight or value, according to statistics compiled by the U.S. Department of Commerce. Consequently, Alaska is a major exporter of fishery products. In 1987, seafood valued at $561 million was shipped overseas, 95% of which went to Japan. That represented approximately one-third of the U.S. seafood exports (Royce, 1991).

The major species groups contributing to Alaska's commercial fisheries are salmon, shellfish (primarily crabs and shrimps), groundfish (mostly pollock, flatfishes and cods), halibut and herring. Since 1976, salmon have accounted for roughly 50% of the ex-vessel value (gross receipts). Shellfish accounted for 40-45% until the early 1980's, when declines in several major shellfish fisheries occurred. Since the early 1980's Alaskan groundfish landings have increased, accounting for nearly one-quarter of the 1986 ex-vessel value of commercial fishery harvests. In 1986, which can be considered a representative year, salmon accounted for 46% of the total gross receipts to fishermen, groundfish amounted to 22%, shellfish were 21%, halibut were 7%, and herring were 4% (Kruse, 1988). In 1988, the value of the harvest for salmon fisheries in Prince William Sound (PWS) alone totalled $76 million, herring, $12.2 million, and shellfish, $2.4 million (ADF&G, 1989).

The ex-vessel value of Alaska's commercial fishing industry ranks first among all U.S. states. The ex-vessel value of fishery landings in Alaska is more than twice the landed values of Washington, Oregon and California combined. In 1985, Alaska's salmon catch (in numbers) exceeded the other Pacific states by more than 14 times, and landings (in weight) of shellfish into Alaskan ports was greater than three times the total amount of landings into the other west coast states. Between 1976 and 1985, 74-81 % of all annual west coast shellfish were landed in Alaska.

Since 1978, the number of fishing vessels participating in commercial fishing has increased slightly (9% increase between 1978 and 1986). Excluding vessels in the Arctic-Yukon-Kuskokwim region, there were 15,839 vessels licensed to fish commercially in

Alaska in 1986. Of these, 11,062 (70%) were registered to residents of Alaska, 2,674 were registered to non-residents, and 2,103 to individuals of unknown residency (Kruse, 1988).

In 1986, there were 28,663 commercial fishing permits purchased. Of these, 84% (24,059) were purchased by Alaskan residents; the remainder (4,604) were purchased by non-residents. These permits were purchased by 17,340 individuals, 81% (14,024) of whom were Alaska residents and the remainder (3,316) were non-residents. Between 1974 and 1986, the number of permits purchased for commercial fishing and the number of individuals purchasing permits has increased 53% and 45%, respectively. Also, in 1986, there were 29,904 licenses sold to crew members for participation in commercial fisheries in Alaska; 67% of these were purchased by Alaska residents.

Legal gear for the commercial harvest of salmon include purse seines, ~~and~~ both drift and set gill nets, and trolling gear. Drift gill net fishermen are the most numerous in PWS, and are permitted to fish in the Bering River, Copper River, Coghill, Unakwik, and Eshamy districts. During the 1989 season, 408 drift gill net permit holders participated in PWS salmon fisheries. Set gill net gear is legal only in the Eshamy district. There are 30 total permits for this gear type. Purse seine gear is legal in the Eastern, Northern, Unakwik, Coghill, Northwestern, Southwestern, Montague and Southeastern Districts. An estimated 243 purse seine permits were active during the 1989 season (ADF&G, 1991).

Purse seiners, which catch most of the fish in the sound, fish all PWS districts, except Eshamy, usually beginning in early or mid-July, depending upon the strength of early pink salmon runs. Purse seine fishing continues usually into the first or second week of August (Alaska Geographic, 1983).

Fishing Industry Employment

In 1983, the average annual employment in fish harvesting was roughly 8,000, with peak monthly employment in fish harvesting at 26,000. Of the average annual employment in the harvesting industry, approximately 6,300 (79%) were Alaska residents and 1,600 were nonresidents. The 1983 annual average employment in salmon fisheries was 5,000, shellfish fisheries employed 1,400, and 1,000 were employed in fisheries for halibut (Kruse, 1988).

Between 1976 and 1985, the number of fish processing facilities more than tripled to 629. The large increase in the number of floating processing vessels accounted for a major portion of this growth. In 1986 these processing plants were owned by 442 companies,

which reflects a nearly three-fold increase over 1976.

The estimated number of employees in food processing (primarily seafood processing) equalled 18,683 in 1984 and 19,943 in 1985 (Jensvold et al. 1987). Of these totals, 12,068 (65%) and 13,512 (68%) were nonresidents in 1984 and 1985, respectively. These estimates considered employees to be the number of individual people who worked in seafood processing and received most of their annual wages in this industry. Those who worked in seafood processing, but earned more wages in another sector of the economy, were not included in the estimate. Thus, for 1984 there were an estimated 48,287 employees in fish harvesting and processing combined. Approximately 28,738 of these employees were Alaska residents (Kruse, 1988).

The seafood industry is the largest non-governmental employer in Alaska, providing approximately 16.4% of the state's jobs. It has been estimated that the Alaskan seafood industry provides nearly 70,000 seasonal jobs, and as many as 33,000 direct, indirect and induced year-round jobs. Based on these figures, the 1987 estimated total seafood industry payroll was $596 million (Royce, 1991).

Salmon Hatcheries and Management

Article VIII, Section 5 of the Alaska Constitution authorizes the state legislature to "provide for facilities improvements and services to assure further utilization and development of the fisheries". In 1974, the Private Nonprofit Hatcheries Act (Chapter III, SLA 1974) was enacted which "authorized private ownership of salmon hatcheries by qualified nonprofit corporations for the purpose of contributing by artificial means to the rehabilitation of the state's depleted and depressed salmon fishery."

Salmon hatcheries in the PWS area include the Solomon Gulch Hatchery at Valdez operated by the nonprofit corporation, Valdez Fisheries Development Association (VFDA). Two ADF&G Fisheries Rehabilitation, Enhancement and Development (FRED) facilities are state managed (Main Bay and Gulkana Hatcheries); Prince William Sound Aquaculture Corporation (PWSAC) operates three hatcheries: Armin F. Koering or AFK Hatchery; Esther Hatchery, now the Wally Hagen Nuerenberg Hatchery; and Cannery Creek, which is a FRED facility under a 20 year management lease to PWSAC **(Figure I)**. Today, seven regional associations from Southeast Alaska to Kodiak produce salmon for common property fisheries (PWSAC, 1990).

= Port San Juan on map.

+ Perry Island?

The AFK and Cannery Creek Hatcheries produce primarily pink salmon; Nuerenberg

Hatchery produces all five species of Pacific salmon, the majority of which are pink, chum and coho. Main Bay Hatchery produces sockeye salmon smolt in the western part of the Sound. The VFDA's Solomon Gulch hatchery in Valdez Arm produces pink, chum and coho salmon (PWSAC, 1990).

From the inception of the hatchery system the intent has been to protect the fisheries from cyclical weaknesses. During the 1970's, salmon runs declined throughout the state. In PWS, seining did not open at all in 1972 and 1974 because the returning wild runs were below fisheries management escapement levels for reproduction and commercial harvest needs (PWSAC, 1990).

The importance of hatchery reared salmon was made apparent during the 1986 season, when approximately 11.5 million pink salmon were caught in PWS. Approximately 10.5 millon fish were harvested in common property fisheries, and 909,219 fish were harvested in the special harvest area sales harvests of the two major (PNP) hatcheries in the area. Approximately 5.8 million fish in the common property harvest were of hatchery origin. The combined common property and sales harvests of hatchery produced fish was 6.8 million fish. This marked the first time in the history of the fishery that hatchery fish constituted more than half of the pink salmon harvest (Sharr et al, 1988).

Because egg-to-fry survival is 80 percent or higher in hatcheries as opposed to 20 percent or less in natural spawning beds, hatcheries allow at least a 4-fold increase in production from a given number of spawners (PWSAC, 19??).

In an average year, the Prince William Sound hatcheries provide up to 40 percent of the salmon harvest in the Sound. In 1988, because of low natural runs of pink salmon, it is estimated that they contributed almost 90 percent of the Sound's total pink salmon harvest (AF&G, 1989).

Benefits from the introduction of the hatchery system have been achieved at some cost, not only financially, but in terms of fishery conditions, both perceived and real. Hatchery salmon production, intended to both increase catches and reduce harvest variability, has resulted in changes in the distribution of catches by species, the gear types used, seasonal opportunity to fish in historic and traditional areas, and fishing patterns.

Hatcheries in PWS have added new complexities to management of PWS salmon returns.

All major salmon returns to PWS hatcheries overlap with the timing of adjacent wild stock systems. In the general fishing districts of the Sound, hatchery fish are randomly mixed with wild stock fish, following the same migration routes to their respective points of origin. However, unlike the wild stock pink and chum systems distributed uniformly throughout the Sound, hatchery stocks return in mass to a limited number of release sites. In these areas termed terminal areas, hatchery fish are isolated from wild stocks. This provides the only management opportunity to specifically target the commercial harvest on the surplus production without risking a large incidental take of wild stock fish.

A shift in the composition of salmon in the harvest by the common property fishery (CPF) can be attributed to the hatchery system. Since the inception of the hatchery program in 1978, the wild stock contribution has declined. In the 1988-89 harvest seasons only 10-15% of the catch was from wild stocks (PWSAC, 1990). This is in contrast to early in the development of the hatchery program when wild stock returns were greater than hatchery returns. Wild stock returns could seemingly withstand greater exploitation rates, and returns to hatcheries fell short of brood stock and cost recovery needs. In an effort to insure that brood stock needs could be met, regulatory management plans were developed to implement closures around the hatcheries to reduce CPF interception rates. This was intended to assist hatchery operators in achieving cost recovery and brood stock goals. Because recent wild stock returns have been quite small relative to the hatchery returns, in order to achieve minimum escapement goals for wild stocks, it has been necessary to close the mixed stock areas of the general districts, and harvest a majority of the surplus hatchery returns in the hatchery terminal harvest areas (PWSAC, 1990).

Four Alaskan agencies are involved in managing Alaska's salmon fisheries. The Alaska Board of Fisheries sets policy and promulgates the regulations, the Alaska Department of Fish and Game (ADF&G) manages the fisheries according to the policies and regulations of the Board and State law, the Alaska Commercial Fisheries Entry Commission controls the amount of fishing effort, and the Alaska Department of Public Safety enforces the regulations (NPFMC, 1990).

In-season fisheries management is the responsibility of the Alaska Department of Fish and Game.

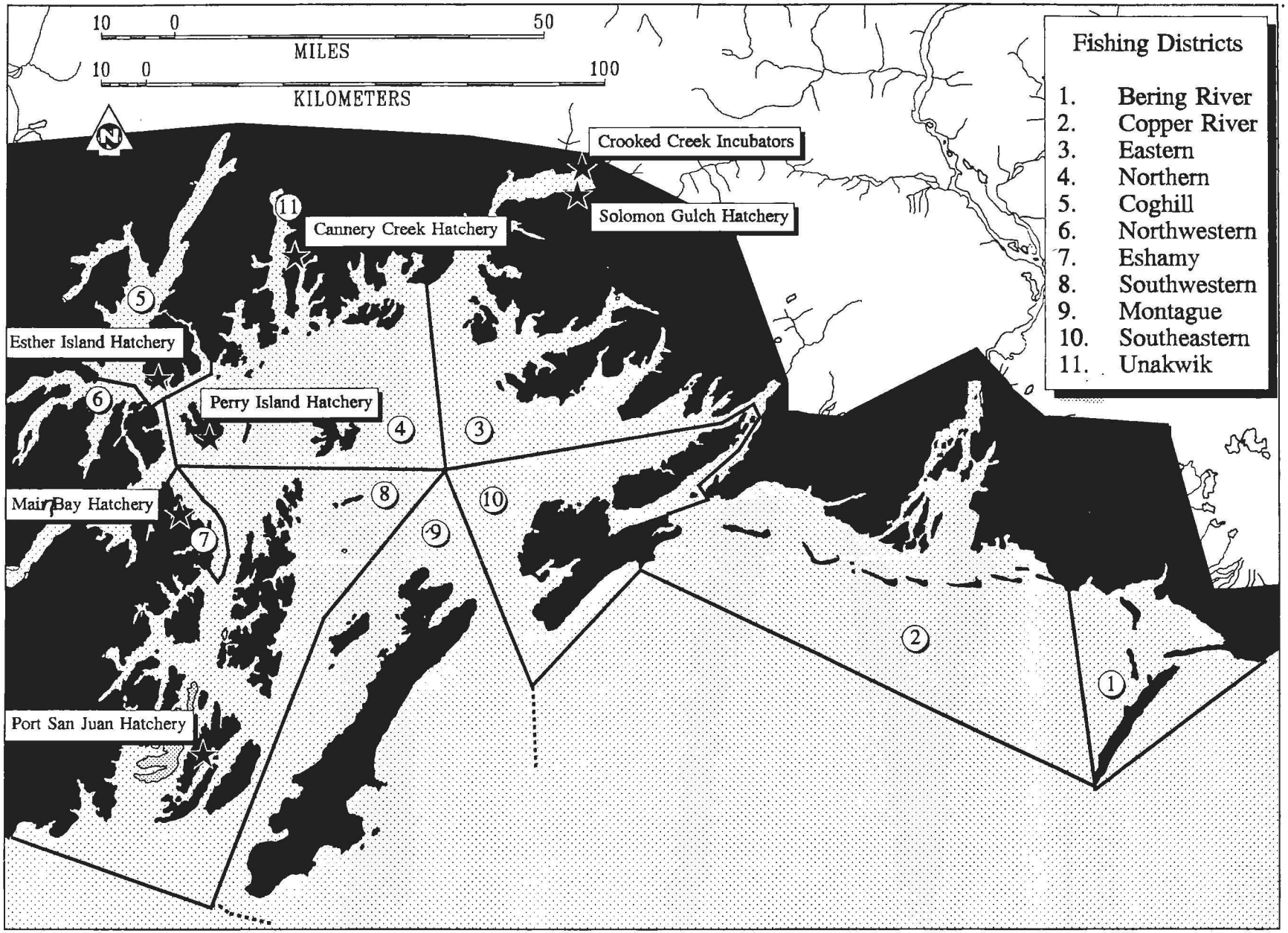
The primary management tool used by ADF&G for regulating salmon returns is emergency order authority to open and close fishing areas. The base management units in PWS for wild stock salmon are the 11 commercial fishing districts **(Figure I)**. Pink

and chum escapement performance for the aggregate index streams within a district determine the length of the weekly fishing periods that can be permitted. During years when the wild stock returns are strong, a liberal weekly fishing schedule may be permitted. However, when the wild stock pink and chum returns are weak, fishing must be restricted within the district to meet minimum spawning requirements.

Pink and chum stocks in PWS are so numerous and widely distributed that managing returns at each individual spawning stream is not feasible. Consequently, escapement performance is evaluated for an aggregate of streams sharing a common geographical area such as a district or a large bay. A subset of 200 representative streams have been identified as "index streams". These index streams are surveyed aerially on a weekly basis through the course of the season to evaluate escapement performance. Harvesting periods and closures are determined by comparing the observations at index streams with a computer data base containing historical aerial survey data dating back to the early 1960's. This comparison forms the basis for the development of timing curves with weekly anticipated escapement performance (PWSAC, 1990).

The ADF&G has not been given the authority to allocate the opportunity to utilize the salmon resources of the Sound between the various user groups. This authority is given to the Alaska Board of Fisheries, which establishes the regulations that govern PWS fisheries. Each year the Board of Fisheries solicits proposals to change regulations governing Alaska's fisheries. Usually, it is the Alaska Department of Fish and Game that responds to the Board's solicitation. The Board distributes these proposals to the public for review and comment and then conducts open public meetings to evaluate and take action on the proposals. This regularly scheduled participatory process is relied upon by the fishing community as the basis for changing Alaska's fishing regulations. Actions considered by the Board include changes in areas for the salmon fisheries, and the allocation of harvests among the various groups of fishermen. Thus while ADF&G determines when and where fishery openings can occur, the Board of Fisheries regulations determine who can fish in the designated areas.

The Alaska Commercial Fisheries Entry Commission is an independent, quasi-judicial state agency responsible for promoting the conservation and sustained yield of Alaska's fishery resources. By regulating entry into the fisheries, they ensure the economic health and stability of commercial fishing. The Commission's activities fall into three categories: licensing, research, and adjudication. As an example of their activities, in 1974, the Commission began establishing the maximum number of power trollers that may participate in the commercial salmon fisheries in Southeast Alaska; in 1982, it began


10 0 50
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Crooked Creek Incubators
Solomon Gulch Hatchery
Cannery Creek Hatchery
Esther Island Hatchery
Perry Island Hatchery
Main Bay Hatchery
Port San Juan Hatchery
Fishing Districts
1. Bering River
2. Copper River
3. Eastern
4. Northern
5. Coghill
6. Northwestern
7. Eshamy
8. Southwestern
9. Montague
10. Southeastern
11. Unakwik

limiting hand trollers.

The Fish and Wildlife Protection Division of the Alaska Department of Public Safety enforces the state regulations that are promulgated by the Board of Fisheries (NPFMC, 1990).

The ADF&G FRED is responsible for the development of the state's fisheries. The Division encourages the investment of private non-profit (PNP) organizations in the fisheries to ensure continuing and increasing production and use of the food resources of Alaska's waters.

Along with FRED, the U.S. Forest Service and PNPs are largely responsible for the rehabilitation and enhancement of salmon populations in the PWS area. Rehabilitation efforts are aimed at restoring wild stocks to former levels of abundance through stream improvements, fish ladders, and other activities that improve natural spawning conditions. Stream rehabilitation projects are carried out by the U.S. Forest Service in cooperation with the ADF&G. The Forest Service has this responsibility since many of the spawning streams are located in the Chugach National Forest which surrounds PWS and the headwaters of the Copper River. Between 1963 and 1982 there were 78 fish habitat improvement projects, 66 of which were completed by the Forest Service in PWS and Copper River areas.

In 1987, the largest state general fund expenditures on fisheries management were associated with ADF&G ($34.2 million), followed by the Department of Public Safety ($7.5 million). The estimated total expenditures for all state departments involved in fisheries management in FY-87 was $45.2 million from state general funds or $64.3 million from all funding sources combined. When expenditures on Sea Grant and the Marine Advisory Program of the University of Alaska are added, the totals come to $46.3 million (general funds) and $67.0 million (all funds). As a basis for comparison, approximately 1.6% of the total $2.145 billion in general fund expenditures by the state of Alaska for FY-87 went toward fisheries management activities by ADF&G. The estimated general fund expenditures on fisheries management of all departments in FY-87 was 2.1% of the state total or 2.2%, when Sea Grant and Marine Advisory Programs expenditures are included.

In contrast, for all west coast states, the largest 1987 annual budget for a state fish and game agency belongs to California ($106.6 million), followed by Alaska ($75.6 million), then Washington ($59.8 million) and Oregon($50.0 million). California spent the greatest

amount annually on fisheries management ($68.5 million), followed by Alaska ($54.2 million for the average of FY-86 and FY-87), Washington ($47.7 million), and Oregon ($38.3 million). The FY-87 funding level form all funding sources for fisheries management by ADF&G was $50.9 million.

Commercial Herring Harvest

The pacific herring is also an important species to the Alaskan fishing industry because it eggs or roe are sold in large quantities, primarily to the Japanese market. Also, the herring is a vital part of the food chain, and it is consumed by larger commercial species of fish such as salmon and halibut (Royce, 1991).

In Alaska, there are four commercial herring fisheries. First, a small number of fish are caught for food and bait. Second, divers gather herring eggs or roe on kelp in shallow, open waters. Third, roe is gathered on kelp in man-made enclosures (this is known as the pound-kelp fishery). The fourth and most important commercial harvest is the "sac-roe" fishery, in which herring are netted to collect the mature female's egg filled membrane or sac. Each year the state limits the sac-roe harvest to 20% of the estimated herring stocks. (Herring) continue to reproduce until they are nine years old or older. The bulk of the herring harvested in PWS are three to seven years old (Royce, 1991).

There are five different herring fisheries in the PWS management area, that all target on what is treated as a single major stock of herring in the Sound. Management of the PWS herring fishery involves a maximum exploitation rate of 20% for the PWS herring biomass for all fisheries combined. The food and bait fishery is the only one that occurs in the fall and winter, generally in the Knowles Head area. This fishery is not limited, but generally has fewer than 10 boats participating annually. The four spring fisheries usually occur in the month of April, coinciding with the spawn timing of the PWS herring stock. The spring fisheries include: 1) a purse seine sac row fishery, that accounts for a large portion of the harvest and limited to approximately 100 permit holders, 2) a gill net sac row fishery with 25 limited entry permit holders, 3) a roe on kelp produced in pounds fishery with approximately 125 limited entry permit holders, and 4) a wild harvest fishery of natural roe on kelp, that is open to entry and has annual participation between 100 to 200 (ADF&G, 1991).

Herring are mass spawners and congregate in shallow areas (depths less than 35 feet) where eelgrass, kelp and other seaweeds can be found. From April to June, females deposit their eggs. These eggs, which are sticky, adhere to underwater plants, rocks and

other surfaces where they are fertilized by the males (Hart, 1973).

The annual harvest draws from herring within approximately a five-year age span. Thus, each year's catch is not dependent on a single year's successful survival, as with pink salmon.

Commercial Harvest Value

In 1984 there were approximately 30,000 harvesters and 19,000 others earned most of their personal income from in-state seafood processing. Approximately 22,100 (74%) of the harvesters and 6,600 (35%) of the processing employees were Alaskan residents. In 1984, approximately $597 million was paid to fishermen for commercial fishery harvests from waters off Alaska. Approximately $509 million was paid to fishermen for landings (1.0 billion lbs) into Alaskan ports, and gross receipts paid to Alaskan seafood processors totalled $1.044 billion. The harvest and processing of these seafood products resulted in personal income of $583 million to all workers in the state. Alaskan residents earned approximately $431 million of that total. This included $239 million to harvesters (57% or $136 million to Alaskan residents), $104 million to processing employees (53% or $55 million to residents), $210 million to Alaska residents employed in indirect and induced activities (e.g., service industries, transportation, etc.), and approximately $30 million in taxes related to the commercial fishing industry. Excluded from these figures are $5-7 million in licenses and permits bought by fishermen, and an unknown portion of the revenues to the state's general fund that were generated directly or indirectly by commercial fishing from other assessments (e.g., corporate income taxes, business licenses, etc.). In 1984, the total direct, indirect and induced earnings from the commercial fishing industry totalled approximately 7% of the total personal income in Alaska or 27% of the total personal income generated by the private sector. Commercial fishing was most important to the southwest region of the state where it generated 47% of the total regional income or 98% of the total personal income by private basic sector activity (Kruse, 1988).

The total ex-vessel value (gross receipts) of fish and shellfish landed into Alaskan ports nearly tripled from $227 million corresponding to 616 million lbs in 1976, to $591 million representing more than 1.2 billion lbs in 1985. The ex-vessel value of all commercial fisheries harvests taken from Alaskan waters (those landed in and out of state) increased from $241 million in 1976 to $890 million in 1986. Gross receipts paid to fishermen increased 50% from 1984 to 1986 alone. Gross receipts to Alaskan processors similarly increased 50% from $1.044 billion in 1984 to approximately $1.6 billion in 1986. Even

when these figures are adjusted for inflation using the Anchorage Consumer Price Index (CPI), the ex-vessel value (measured in 1986 dollars) of Alaska's commercial fisheries doubled between 1976 and 1986 (Kruse, 1988). These ex-vessel values probably underestimate the total gross benefits transferred to fishermen. Other economic values not accountable by gross receipts may include boat storage, financing, food, fuel and other benefits that may be provided by processors (Crutchfield et al. 1982).

Aside from the ex-vessel values of Alaska's fisheries and the economic activity (in terms of employment and personal income) generated from them, fishing generates revenues directly to the State of Alaska from taxes and licenses. State revenues generated in FY-86 from fisheries equalled $47.3 million, of which $43.4 million went to the general fund and $3.9 million went to the fish and game fund. Fishery revenues included fish taxes, marine fuel taxes, fishing permits, fishing licenses and other similar items.

The PWS Area combined commercial salmon harvest for 1989 was approximately 24.4 million fish. This catch exceeds the average harvest over the past 10 years. However, an exceptionally large portion of this catch (33%) was composed of hatchery sales fish from the PNP hatcheries, leaving a common property portion of the catch below the 10 year average (ADF&G, 1991).

The value of the combined 1989 commercial salmon harvest was estimated at $41.3 million, excluding hatchery sales. The drift gill net catch was valued at $23.8 million, setting the average earnings for the estimated 480 permit holders that fished in 1989 at $49,470. Seiners harvested $18.9 million worth of fish setting the average earnings for the estimated 235 permit fleet at $80,610. Because the Eshamy district was closed for the season, set net fishermen had no opportunity to fish in the PWS area in 1989 (ADF&G, 1991).

In 1985, the 147 million salmon landed in Alaska by commercial fishermen weighed approximately 647 million lbs (ADF&G 1986b). Pink salmon accounted for 304 million lbs (45% by round weight), sockeye salmon equalled 225 million lbs (33%), and chum salmon weighed a total of 83 million lbs (12%). Coho and chinook salmon accounted for 47 (12%) and 13 (2%) million lbs, respectively. In terms of numbers (or round weight) of salmon, the largest salmon fishery in the state was the pink salmon fishery in Southeast Alaska. A total of 52 million pink salmon (166 million lbs) were caught in Southeast Alaska, compared to a total of 24 million sockeye salmon (140 million lbs) in Bristol Bay. However, in terms of ex-vessel value, the Bristol Bay fishery was the most valuable salmon fishery ($122 million for all salmon species) in the State of Alaska in

1985 (Kruse, 1988).

Shellfish landings accounted for 21% of the total ex-vessel value of commercial fisheries harvests in Alaska for 1986. The $182 million in gross receipts paid to fishermen for shellfish in 1986 was the highest amount since 1982. The increase is primarily attributable to the steady growth of fisheries for brown king and Dungeness crabs, and 1986 openings for Bristol Bay king and Tanner crabs. Because many shellfish fisheries remain closed due to low stock sizes, significant potential for growth exists (Kruse, 1988).

Transportation

The prime mode of transportation in Alaska is by aircraft. Approximately three-quarters of the state can not be reached overland. Small aircraft fly to towns and attractions throughout the state. The planes are usually 9 - 16 seaters, but in remote areas smaller planes, usually 2 - 4 seaters, fly (Castleman and Pitcher 1992).
Another major mode of transportation in Alaska is the ferry service known as the Alaska Marine Highway. There are two major routes for the Alaska Marine Highway system: the Southeast system serving almost every town in Southeast Alaska, and the Southwest system serving most of the coastal towns in Southcentral, Kodiak Island, the Kenai and Alaska peninsulas, and the Aleutian Chain as far west as Dutch Harbor/Unalaska (ADT 1990 Alaska Marine Highway System, 1989 Traffic Volume). However, the two systems do not interconnect. The Alaska Airlines flight from Juneau to Cordova provides connection (Castleman and Pitcher 1992).

Public transportation systems by land in Alaska consist of train, bus, and van services. Alaska has over 12,200 miles of public roads. Of these land miles, over 5,500 miles are under state jurisdiction, over 4,200 miles are under local government jurisdiction, and the remainder are under the jurisdiction of various federal agencies. Approximately one half of the public roads are paved. The major highway systems consist of Alaska Highway and George Parks Highway. The Alaska Highway is mostly paved, two-lane highway running in north-southeast direction, connecting Fairbanks ~~to Prudhoe Bay~~ in north and Dawson Creek, British Columbia in east. The George Parks Highway traverses in northsouth direction between Fairbanks and Anchorage. Anchorage and Seward are also connected by a highway, which is the most travelled highway in the state. Another highway (Richardson Highway) runs in northsouth direction connecting ~~Fairbanks~~ and Valdez. Getting around in private cars is a popular mode of transportation. Public bus service is highly primitive in Alaska. However, major destinations are served by bus or minibus, and some of the smaller towns are served by

vans (Castleman and Pitcher 1992).

The only train in Alaska is the Alaska Railroad which runs 470 miles between Seward and Fairbanks passing through Portage and Anchorage. A seven- mile stretch of the railroad connects Portage to Whittier, where travelers transfer from cruise ships, ferries, and tour boats to Alaska Railroad. Two expresses, one northbound and one southbound, run between Seward and Fairbanks daily. A shuttle train transports passengers between Portage and Whittier several times a day (Castleman and Pitcher 1992).

6. Recreation and Commercial Tourism

a. Overview

Alaska has the largest assemblage of park, refuge and forest lands in the United States, and much of this land is still natural. The nation's two largest national forests are located in Alaska: Tongass in Southeast (16 million acres) and Chugach in Southcentral (4.8 million acres). The Alaska State Park System, with more than 3.2 million acres of land and water, and 100 park units, is the largest state park system in the United States. This vast expanse of undeveloped land together with freshwater and marine systems has created a wide range of outdoor recreational opportunities in Alaska including hunting, fishing, hiking, camping, skiing, sightseeing, backpacking, climbing, dogsledding, snowmobiling, snowshoeing, kayaking, canoeing, power boating, flightseeing, photographing, and filming. In recent years, mountain biking, wind-surfing, river rafting, paragliding, paraskiing, winter camping, ice fishing, and scuba diving have also increased in popularity (Castleman and Pitcher 1992). These limitless recreational opportunities has helped create a growing tourism industry which offers a variety of professional services enabling visitors to use and enjoy the wilderness.

Hiking and camping, being relatively inexpensive and easily available, are by far the most preferred outdoor recreation for the majority of Alaska's residents and visitors. Although, there are very few trails in Alaska, the vast taiga and tundra terrain along with the perpetual daylight during hiking season allow freedom to deviate from normal hiking/camping cycles (Castleman and Pitcher 1992). In addition, while hiking there is a possibility of encountering the abundant wildlife. Photography of the scenery and the fauna and flora go hand in hand with hiking and camping.

The Exxon Valdez oil spill has impacted some of the recreational activities in Southcentral and Southwest Alaska. More than ----% (this figure would be provided later on) of the land in the oil spill area is designated as national and state parks, forests, and wildlife refuges and is managed by various Federal and State government agencies. A full range of private and commercial recreation activity occurs in these areas supported by facilities like mooring buoys, boat ramps, recreational-user cabins, camping sites and trails. The national parks and forests include the Chugach National Forest, Kenai Fjords National Park, Katmai National Park and Preserve, Lake Clark National Park and Preserve, and Aniakchak National Monument and Preserve; the national wildlife refuges include Alaska Maritime National Wildlife Refuge, Kenai National Wildlife Refuge, Kodiak National Wildlife Refuge, Alaska Peninsula National Wildlife Refuge, and Becharof National Wildlife Refuge; and the state parks include the Chugach State Park and Kachemak Bay State Wilderness Park (Gousha 1991). Several other areas under the state management designated for various purposes such as, State Historic Sites, Marine Parks, Recreation Areas, and Recreation Parks attrast recreationists. Large portions of land within Katmai National Park and the Becharof National Wildlife Refuge have been designated wilderness areas by the Congress. Both of these areas and the Kachemak Bay State Wilderness Park were oiled by the Exxon Valdez spill. The following sections describe the recreation and tourism in the spill-affected area.

b. Recreation

For the purposes of this section, the oil spill area is divided into two regions: Southcentral region which includes Anchorage, Kenai Peninsula, and Prince William Sound; and Southwest region which includes Kodiak Island, Katmai, and other southwest locations. A brief description of recreational opportunities provided by each region follows.

Southcentral Alaska

Southcentral Alaska is a land of short rivers, long mountain ranges, and wide valleys, which extends north from the Gulf of Alaska to the crest of the Alaska range. Southcentral is the rich heartland of Alaska, with one big metropolis, many small towns, some of the State's finest scenery, and best hiking/camping opportunities (Castleman and Pitcher 1992). Chugach National Forest, the second largest national forest, encompasses much of this region. The Chugach National Forest provides a highly visible and popular recreation program in the Kenai mountain range. The Forest Service operates and maintains 37 public recreation cabins and 16 campgrounds. There are over

200 miles of trail, including two National Recreation trails. In addition, there are 149 recreation special use permit facilities, including one major ski resort and six other resort facilities. The Portage visitor center and the Russian River, located within the Forest are among the three most heavily visited area in the state. Approximately 90% of the Forest's recorded recreational activities occurs on the Kenai Peninsula. The most popular activities are auto driving, camping, hiking, skiing, and fishing (USDA 1984). Alaska's second-largest state facility, Chugach State Park, located within this region, encompasses nearly half a million acres. Hiking is the main recreational activity in this park with about a dozen well-maintained, well-used, moderate-to-difficult trails. Along with hiking, photography and wildlife-watching are popular recreational activities.

Southcentral Alaska includes some of the premier kayaking areas in the world. Kayaking trips are taken from Valdez, Kodiak, Homer, Whittier, and Seward to the western portion of PWS and the bays along the Kenai Peninsula and Kodiak Island. A typical trip involves charter boat transportation to a site some distance from port. Most trips last more than one day and thus include both kayaking and wilderness camping.

The Kenai Peninsula is like a mini-Alaska, compressing all of the country's features. The Kenai is the most popular all around destination for all Alaskans and visitors (Kenai 1993). It is the most often viewed landscape in Alaska with the Seward/Anchorage highway being the most heavily used travel route in the state (USDA 1984). Captain Cook State Recreation Area, Kenai National Wildlife Refuge, Kenai Fjords National Park, Alaska Maritime National Wildlife Refuge, Kachemak Bay State Park, and Chugach National Forest are some of the areas affording a wide variety of recreational opportunities in the Kenai Peninsula and making it best in the state for wildlife viewing. The Kenai Fjords National Park, under the management of National Park Service, is an area with ice fields and a deep-water fjord coastline providing opportunities to see whales, tortoise, sea otters, and birds of all kinds. At locations in the western and southern parts of the peninsula, the Alaska Department of Natural Resources maintains public access and recreation sites (including the Kachemak Bay State Park) totaling several thousand acres (Kenai 1993).

Few refuges contain as diverse landscape, abundant fish and wildlife populations, and varied recreational opportunities as the Kenai Refuge. Although not large compared to other refuges in Alaska, the Kenai Refuge supports more recreational use than any other refuge in the world. The Kenai refuge has natural and man-made features necessary to support a wide variety of outdoor activities. The wide array of facilities that support and encourage public use and protect refuge resources include a headquarter, visitor

centers, and 47 recreational sites including campgrounds, access areas, wayside, and trailheads. These facilities vary from small undeveloped sites to large campgrounds with tables, fire grates, parking-spurs, boat ramps, water wells, and sanitary facilities. Recreational opportunities in the Kenai Refuge include salmon fishing, camping in developed campgrounds along roads and trails to isolated and primitive areas, hunting, wildlife observation, sightseeing, canoeing, boating, horseback riding, crosscountry skiing, snowmobiling, and berry picking. Most visitors participate in several activities while on the refuge (U.S. FWS 1983).

Besides the public lands, various small communities offer recreational opportunities on the Kenai Peninsula and their economy, to some extent, is based on recreation and tourism. The city of Seward, located at the head of deep-water inlet known as Resurrection Bay, is popular for fishing and sightseeing. The city of Soldotna, located in the Central Peninsula region, is famous for salmon fishing in Kenai River along with scenic views across Cook Inlet. The city of Kenai sits on a bluff where the Kenai River meets Cook Inlet and where some of the greatest tidal ranges occur, is famous for whale watching. Incoming tides actually reverse the flow of the river, influencing the movement of fish and the white beluga whales that follow them. Homer, located on the southern tip of the Kenai Peninsula provides charter boat tours to Gull Island for viewing thousands of birds. Homer is also visited for salmon, and halibut fishing (Kenai 1993).

Prince William Sound (PWS), located within the Southcentral region at the northern-most point of the Gulf of Alaska, is considered by many to be a unique, pristine, wilderness abundant with land and marine wildlife. The Sound is filled with deep fjords, snow ~~ice~~-covered mountain ranges, tidewater glaciers, and hundreds of islands with innumerous sea birds. Murre colonies on Chiswell Islands, located in this region, are colonies most visited by tourists in Alaska. PWS is primarily used by boat with some areas accessed by float-equipped or wheel aircraft (USDA 1984). PWS covers over 2,700 miles of coastline, 4.4 million acres of National Forest and three of North America's major icefields. Prince William Sound offers tremendous opportunities for hiking, sightseeing, wildlife viewing, glaciers viewing, and fishing (PWS 1993).

Several communities located within the Prince William Sound area offer recreational opportunities and services expected from large cities. The city of Cardova, a modern thriving community, offers a wide variety of lodging options and recreational services including flightseeing, several boat charter services, and recreation centers. The city of Valdez, surrounded by towering mountains, provides a wide variety of local tours and sightseeing opportunities. Numerous scheduled cruises to Columbia and Shoup Glaciers

start here. In addition, several guided walking and bus tours showing historic Valdez and the Alyeska Pipeline Terminal are also available (PWS 1993).

Outdoor recreation plays an important role in the lifestyles of many Alaskan residents. A public survey conducted on the lifestyles of Southcentral Alaskans yielded information on the recreational activities that these residents engage in (Table I) (USDA 1984). The results of the survey indicated that driving, walking, and fishing were the most popular activities among the Southcentral Alaskans. Respondents also indicated that the important attributes of their favorite activities include getting away from usual demands, being close to nature, doing something exciting, experiencing new and different things, and being with family and friends. Attributes of favorite recreational places considered important by the respondents included fishing opportunities, scenery, and remoteness.

Table I

Participation of Southcentral Residents in Various Activities

Activity	% of Respondents Who Engaged in Activity
Driving for pleasure	59
Walking or running for pleasure	53
Freshwater fishing	42
Attending outdoor sport	37
Tent camping	31
Motor boating	30
Bicycling	29
Cross Country skiing	26
Target shooting	25
RV camping	24
Hiking with pack	22
Baseball, softball	19
Flying for pleasure	19
Sledding, toboggan	17
Kayaking, canoeing	17
ORV winter	17
ORV summer	14
Outdoor tennis	17

Swimming, scuba diving	16
Alpine skiing	14

Southwest Alaska

Southwest region includes the Kodiak Island group, the Alaska Peninsula, the Aleutian Islands, and Katmai. In this region Katmai National Park and Preserve, Alaska Peninsula National Wildlife Refuge, Becharof National Wildlife Refuge, Kodiak National Wildlife Refuge, and Aniakchak National Monument and Preserve are located.

what's largest?

Kodiak Island is the largest island in Alaska and the second largest in the U.S. Kodiak has Alaska's longest history, largest fishing fleet, and biggest brown bear population. Kodiak Refuge, established in 1941 to protect the habitat of brown bear and other wildlife, occupies about two-thirds of the island. Five species of Pacific salmon rearing and spawning habitat is provided within the refuge. Over 200 species of birds, large brown bear and bald eagle populations make the refuge an exciting place for wildlife viewing. Other recreational activities include photography, rafting, canoeing, camping, backpacking, hiking, hunting, and fishing. A visitors center and a limited number of recreational cabins are also located within the refuge. The town of Kodiak, where the majority of the Kodiak Island population live, is accessible by air and is a tourist attraction for viewing commercial fishing operations. The communities of Larsen Bay and Ports Lion on the Kodiak Island are visited for hiking, fishing, and hunting opportunities and their economy to a large extent is dependent on tourism (U.S. FWS 1987).

c. Tourism

Tourism is Alaska's third-largest industry behind petroleum production and commercial fishing. Tourism was, and is, an industry of growing economic importance to the state. Once regarded as a stepchild of the major traditional resource industries, tourism's obvious growth in the 1980s gave it legitimacy as a major industry. A visitor survey conducted by the Alaska Division of Tourism under the Alaska Visitors Statistics Program II (AVSP) revealed important statistics on the tourism industry. The survey results indicated that more than 750,000 people visited Alaska in 1989 from all around the world and of this 521,000 people visited in summer generating $304 million in revenue in summer alone. The Southcentral region was the major beneficiary of visitor spending, capturing 44% of the $304 million (ADT 1989a). Sixty-nine percent of the total

summer visitors were vacation/pleasure (VP) visitors. Southcentral Alaska accommodated more visitors per year than any other region but among VP visitors, Southeast was the most visited region, with nearly three out of every four VPs visiting the region. Southcentral was second with two-thirds of the VP visiting market (ADT 1989b). Southwest was visited by only 6% of the total VP visitors (ADT 1989a) and thus captured 5% of the $304 million (ADT 1989b).

Information on vacation planning for tourists is available through various sources such as, Alaska Division of Tourism, travel agents, and newspaper travel sections. The State Vacation Planner is widely used by the visitors in planning their Alaska trip. Once in Alaska, the majority of the visitors used visitor information centers (VICs), and reported that the VICs were doing a good job. Past studies have shown that the use of VICs enhanced visitor satisfaction and the likelihood of returning to Alaska in the future. A visitor using a VIC is more likely to see the best attractions in the local area, have contact with friendly locals, and be more active as a result. However, with the exception of one visitor information center at Tok, the state of Alaska relies on local communities and government agencies (usually Federal) to provide information to visitors. While many communities and agencies do a good job, brochure distribution practices are inconsistent, as are training, hours and seasons of operations, signage, and facility size and quality. Additionally, most agency information centers are oriented towards single attractions and some communities limit the types of information and brochures which they offer (ADT 1989b).

Survey results also revealed that Anchorage, Seward, Kenai/Soldotna, Homer, Valdez/PWS, and Whittier were among the most visited communities in the Southcentral region and King Salmon, Kodiak, Bethel were among the most visited communities in the Southwest region. The most visited attractions on the Kenai Peninsula were Kenai River, Kenai National Wildlife Refuge, Resurrection Bay, Kachemak Bay, and Kenai Fjords National monument. In the Prince William Sound area the most visited attractions were Columbia Glacier, Prince William Sound, Valdez Pipeline Terminal, and College Fjord. In the Southwest region the most visited attractions were Kodiak Russian Orthodox Church, Katmai National Park, and Kodiak National Wildlife Refuge. In addition, cultural attractions and museums were popular among Southcentral visitors (ADT 1989b).

Among the wide variety of recreational opportunities offered in Alaska, wildlife viewing was the most common activity in every region among the VP visitors and was the main activity in the Denali region. Bird watching was also common in all regions. Rafting

was most popular in Southeast and Denali. Hiking was universal but Southwest and Denali visitors did it most. Southwest was fishing country, with twice the participation of the next leading fishing region, Southcentral (ADT 1989b).

The visitors of Southcentral rated flightseeing and day cruises highly in the tour list while rafting, hiking, and canoeing/kayaking lead the activities list in satisfaction. Southwest VP visitors give that region's activities the highest marks in the state. Fishing (fresh water more than salt water), hunting, rafting, and canoeing/kayaking all score very well, and the state's highest flightseeing score was in Southwest (ADT 1989b).

7. Sport Fishing and Hunting

a. Sport Fishing

Sport fishing is one of the most popular recreational activity for both residents and visitors of Alaska. A wide variety of sport fishing opportunities exist in the oil-affected region. Marine recreational fishing originates in all major towns on the PWS as well as Cook Inlet, Kodiak Island, the Kenai Peninsula, and the Alaska Peninsula. Fishing trips are taken in several ways - from shore, from private boats, and from charter vessels. Several species of Pacific salmon, rockfish and halibut are available in both fresh and salt water and Dolly Varden, rainbow and cutthroat trout are found in several freshwater streams and lakes. Although sport fishing is popular throughout the state, seventy percent of Alaska's sport fishing occur in the Southcentral region and majority of which occur in the Kenai Peninsula because access by car from Anchorage to Kenai Peninsula is relatively easy (Castleman and Pitcher 1992). The Kenai River is well known for king salmon fishing. Sport fishing throughout the state is conducted according to the Alaska Sport Fishing Regulations, formulated by the Alaska Department of Fish and Game. The fishing regulations specify bag, possession, and size limits for the fishes to be taken from different streams/rivers/lakes etc. (ADF&G 1992a). In addition, there are management plans for king salmon on the Kenai River.

Historically (between 1984 and 1988), the number of anglers, fishing days, and fish harvest in the oil-affected area had been increasing at a rate of 10 - 16% per year. However, following the oil spill, there have been decline in the number of anglers, fishing days, and fish harvest, whereas, the area outside the oil spill continued to experience increase. The estimated number of anglers in the oil-affected region decreased 13% from 120,160 in 1988 to 104,739 in 1989, the number of days fished decreased 6% from 312,521 to 294,598, and the number of fish harvested decreased 10%

from 352,630 to 318,981 (ADF&G 1992b). Since 1977, there has been a 4.5% average annual increase in the number of residents who sport fish, while the number of non-residents sport fishing has increased 16% annually.

b. Sport Hunting

Alaska has 12 species of big game, including several not found (muskox, Dall sheep), or very rare (wolf, wolverine, brown bear, caribou), in the other 49 states. Approximately 144,000 - 166,000 moose; 835,000 caribou; 60,000 - 80,000 Dall sheep; 32,000 - 43,000 brown bears; over 100,000 black bears; 5,900-7,900 wolves; 2,100 muskoxen; 13,000 - 15,000 mountain goats; 350,000 - 400,000 black-tailed deer; 1,400 - 1,600 elk and 850 bison inhabit the state. Also abundant are 19 species of furbearers, three species of ptarmigan, four species of grouse, two species of hares and many species of waterfowl, migratory birds, raptors and marine mammals (Castleman and Pitcher 1992). Hunting is conducted according to the Alaska State Hunting and Trapping Regulations formulated by Alaska Department of Fish and Game (ADF&G 1992c, 1992d). These regulations specify bag limits and season area-wise for hunting. The many wildlife refuges, parks, and national forests located within the oil-affected region provide tremendous opportunities for hunting.

or Board

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WALCOFF

April 9, 1993

Ken Rice
Restoration Planning Work Group
645 G Street
Anchorage, AK 99501

Subject: Progress to Date on the *Exxon Valdez* Restoration Plan EIS

Dear Ken:

Carol Paquette asked that I forward the enclosed documents to you. I have also enclosed several pieces of information from Jacquie Glover-Brown at her request. Please note that all of the enclosed materials are in draft form and need work—which is progressing even as I write this. We are currently reorganizing our materials to match the outline and are ensuring that our writeups match yours.

I hope this meets with your approval. We look forward to receiving your comments.

Sincerely,

Susan E. Brown
Editor

Enclosures

Ken - Missing beginning of Ch III - was still printing when last fed-ex run was made. Will get to you Mon/Tu.

INFORMATION ♦ MANAGEMENT ♦ COMMUNICATIONS

635 Slaters Lane, Suite 400, Alexandria, Virginia 22314 Phone (703) 684-5588 / Fax (703) 548-0426 / TDD (703) 684-8226

Chapter III. Affected Environment

This chapter describes the areas within Prince William Sound (PWS) and the Gulf of Alaska directly affected by the *Exxon Valdez* oil spill. Part A covers the physical setting, including climate, oceanography, habitat types, geology, and mineral resources. Part B describes the fish and wildlife of PWS and summarizes the results of the NRDA studies on the biological impacts of the spill, including injury to biota in affected aquatic, intertidal, and terrestrial habitats. Part C provides an overview of the socioeconomic environment and conditions in the affected area before and after the spill. This section gives the historical background of the affected regions, as well as information about the socioeconomic and cultural impacts of the spill on affected communities.

A. Physical Description

1. Setting

Map IIIA shows the location of the area oiled by the *Exxon Valdez* spill in relation to the rest of the State of Alaska. Within this area, PWS was the most severely affected.

[MAP HERE.]

PWS is located in southcentral Alaska, north of the Gulf of Alaska, encompassing a surface area of approximately 15,000 square miles (38,850 sq km). PWS contains an open water area of approximately 100 miles (161 km) in diameter and up to 2,850 feet (869 m) deep (Mickelson, 1988). It is an estuary about the size of Maryland's Chesapeake Bay or Washington State's Puget Sound, with a mainland shoreline of more than 1,500 miles (2,413 km). It is approximately 15 times the size of San Francisco Bay. ~~The total mainland shoreline of PWS is approximately 1,500 miles (2,413 km).~~ PWS contains 15 major islands, including Montague, Kodiak, and Afognak; 19 minor islands; and 150 lesser islands. The combined island shorelines measure approximately 1,500 miles (2,413 km). PWS is one of the largest and least developed marine ecosystems in the United States.

Southwest of PWS are the Kenai Peninsula and Kodiak Island. ~~South of the Kenai Peninsula~~ is the Shelikof Strait, which lies between Kodiak Island and the Alaska Peninsula. The Alaska Peninsula narrows into the Aleutian chain of islands. In this diverse system of land, marine, and freshwater habitats are located the following public (State- or Federal-owned) lands: Chugach National Forest, Kenai Fjords National Park, the Alaska Maritime National

Wildlife Refuge, Kodiak National Wildlife Refuge, Katmai National Park and Preserve, the Alaska Peninsula/Becharof National Wildlife Refuge, Aniakchak National Monument and Preserve, and Kachemak Bay State Park.

The geology of the PWS region is young and relatively unstable. Glaciers, earthquakes, and active volcanoes are common. Two major rock formations prevail, the Valdez group and the Orca group. It is estimated that the Valdez group, which is composed of marine sandstone and slate, is 180 million years old. The younger Orca group contains both sedimentary and volcanic rock. The Chugach Mountains, part of the Orca group, rise to heights of 13,000 feet (3,965 m) and surround much of PWS (Mickelson, 1988).

In March 1964, an earthquake with an epicenter west of Columbia Glacier shook PWS for approximately 5 minutes. The towns of Valdez, Whittier, and Chenega were destroyed by waves, and people in several small villages were killed. Damaging effects of the earthquake ~~were felt~~ as far away as Anchorage. As a result of the quake, the south end of Montague Island rose 38 feet (11.58 m), shorelines and river mouths were ~~forever~~ changed, and much of PWS ~~to the southeast~~ rose an average of 6 feet (1.83 m).[1]

2. Air and Water Quality

PWS has a maritime climate with heavy precipitation, averaging 150 inches (381 cm) annually with a range of 64 to 179 inches (163 to 455 cm). The area is snow covered in the winter, with up to 21 feet (6.4 m) of snowfall per year in Valdez; 15 percent of the total area, mostly in the mountains, is covered with permanent ice and snow. Snow falls in the high country of the Chugach Range from September through April. Temperatures in the region range from approximately 20° F (-4° C) in January to a high of approximately 50° F (13° C) in the summer. The ports of Homer and Seward usually remain ice-free (Mickelson, 1988).

Winter winds in the Gulf of Alaska are generally easterly or southeasterly and interact with currents to push waters into PWS. This produces complex flow patterns resulting in strong downwelling and an outflow of surface waters to the southwest. Various distinct local wind patterns exist; however, PWS winds are predominantly from the north. In central and southern PWS, dominant winds are from the east (Michel et al., 1991 Oil Spill Conference). The southerly wind pattern pushes surface waters out of PWS and into the Gulf of Alaska.

[1]Ownership of evulsive (i.e., lands brought above sea level by the earthquake) is one issue the public wishes the Restoration Plan and the EIS to address.

Data from water samples in the spill area indicate that concentrations of VOA, PAH, PHC, and TPH in PWS and the Gulf of Alaska peaked immediately after the spill and decreased shortly thereafter. Peak concentrations for all subject compounds were well below State and Federal standards. Isolated samples that showed elevated concentrations were observed to contain mousse. Analysts concluded that no long-term contamination of the water column resulted from the spill. [NEED GRAPH HERE THAT SHOWS MEASURED CONCENTRATIONS OVER TIME, PLUS ANALYTICAL LIMITS AND FED/STATE STDS.]

define

Ken: THE species will go @ end of this section. 4/9

B. Biological Description

The Prince William Sound region supports a diverse ~~collection of~~ wildlife. The Exxon Valdez oil spill occurred in March, just before the most biologically active season of the year. It affected the migration of birds, and occurred just prior to the primary breeding season for most species of birds, mammals, fish and marine invertebrates in the spill's path. The spill affected each species differently. For some species, the population measurably declined. For example, an estimated 3,500 to 5,000 sea otters were killed by the spill, and the population ~~will~~ may not recover for many generations. References Other species were killed or otherwise injured by the spill, but the injury did not measurably lower the overall population. Some species, such as marbled murrelets, pigeon guillemots, and harbor seals were declining before the spill. Their rate of decline was accelerated by the spill, but other factors such as variations in climatic conditions, habitat loss, or increased competition for food may also have influenced long-term trends in the health and populations of these other species. Still other species may have been indirectly affected by changes in food supplies or disruption of their habitats.

The availability of population and habitat data varies from species to species. Some PWS species (e.g., invertebrates such as clams and barnacles) have never been inventoried. Others, such as the brown bear and the bald eagle, are counted annually for management purposes. And much is known about species that have played a significant historic or economic role in the region, such as sea otters and salmon. Federal and State environmental agencies had conducted baseline surveys of some native species prior to the oil spill; these surveys documented selected species' populations and critical habitats.

This section provides a summary of the baseline conditions for species and resources found the oil spill area. It will be used in evaluating potential impacts, either direct or indirect, of the various restoration options.

1. Marine Mammals

Harbor Seals

Harbor seals (*Phoca vitulina richardsi*) are found only in the North Pacific Ocean from northern Mexico to Alaska and the Bering Sea, and in the western Pacific from Japan to Siberia. They are found in Prince William Sound year round (Frost et al., 1993). Harbor seals prefer coastal waters less than 60 meters deep. They live close to shore, and often enter estuaries and rivers to hunt for fish (Van Gelder, 1982). Rocky areas, isolated

beaches, ice flows, sand bars, and mud bars are used by the seals as haulout areas. Haulout areas are important to seals for pupping, nursing young, resting, and molting (Ronald et al., 1982). Harbor seals feed on abundant area fishes and often interfere with commercial fishing activities by damaging nets. Harbor seals also feed on benthic invertebrates ~~such as~~ crabs, crayfish, shrimp, and starfish, ~~as well as~~ squid, herring, ~~sardine, salmon, rockfish, and other fish.~~ Larger food is taken to the surface and eaten in pieces; smaller food is swallowed whole. Seals require only one large meal a day (Ronald et al., 1982).

Harbor seals become sexually mature between 2-5 years for females and 3-6 years for males. Mating occurs in late June through July with a single pup born between May and July at a ~~haulout~~ pupping area or rookery. The pup usually stays with its mother for 3 to 6 weeks (Van Gelder, 1982). Much of this time is spent at the ~~haulout~~ pupping area. Molting in the late summer months also occurs on the haulout areas, and disturbances during molting can threaten the survival of the seals.

Harbor seals have a life span of approximately 18 years, though they have been known to live as long as 40 years (Ronald et al., 1982). The population in Alaska has been declining at about 11-14% per year since the mid-1970s for unknown reasons (Frost and Lowry, 1993). After the Exxon Valdez oil spill, seal populations at oiled areas were declining at 44%, while nearby unoiled populations were declining at 8% (Frost and Lowry, 1993). In August 1991, the population of harbor seals was estimated at 2,875 in the Prince William Sound (Exxon Valdez Oil Spill Trustees, 1992).

Steller's Sea Lions

Steller's sea lions (*Eumetopias jubatus*) range along the Pacific coast of North America from southern California through Alaska (Ronald et al., 1982). The north Gulf of Alaska contains a major portion of the worldwide habitat (NRDA, 1990). During the spring, several thousand sea lions move through the Gulf of Alaska returning to rookeries (sometimes called haulouts) to mate and give birth. Sexual maturity is reached in 4-5 years for females, and 5-7 years for males. Mating and pupping occur from mid-May to late June, with gestation lasting for approximately 12 months (Ronald et al., 1982). Major breeding rookeries along the Alaskan coast include the entrance to Prince William Sound, along the eastern Kenai Peninsula coastline, Barren Islands, northern Kodiak area, Chirikof Island to the south of Kodiak, and the Semidi Islands to the south of Shelikof Strait (NRDA, 1990).

Marmot Island is the

Prior to 1982, the population of sea lions in the Alaska area was 200,000 (Ronald et al., 1982), however, the population has been declining substantially since the 1970s (NRDA, 1990). The reasons for the population decline are unknown.

The sea lion prefers shallow waters near the coast, with access to gravel beaches ~~and ice flows~~. The sea lion diet consists of coelenterates, sand dollars, worms, and mollusks, as wells as cod, herring, halibut, and salmon (Ronald et al., 1982).

Sea Otters

Sea otters (*Enhydra lutris*) are found only in the North Pacific Ocean. Historically, sea otters ranged from Baja California, up the coast of the United States and Canada, along Alaska and the Aleutian Islands, to the northern islands of Japan (Kenyon, 1982). Due to extensive fur hunting of sea otters through the eighteenth and nineteenth centuries, the present population is thinly distributed, with the bulk of the population located near the Aleutian Islands. The Marine Mammal Protection Act of 1972 placed a moratorium on harvesting many marine mammals, including sea otters. Native Alaskans are exempt, and continue to hunt sea otters for subsistence. Range areas along the state of Alaska include Prince William Sound, Kenai Peninsula, Kodiak Islands, and the Alaska Peninsula (Gibbons, 1993).

Prior to 1989, the population of sea otters was estimated at over 100,000 along the coast of Alaska (Van Gelder, 1982). The population may have been as high as 10,000 in Prince William Sound and 20,000 in the Gulf of Alaska prior to the oil spill (Exxon Valdez Oil Spill Trustees, 1992). When the Exxon Valdez oil spill occurred, the sea otter populations along Prince William Sound and the Kenai Peninsula were particularly affected (Exxon Valdez Oil Spill Trustees, 1992). Frost et al. (1993) reports that more than 4,000 sea otters died from the oil spill, with over 2,000 deaths specifically in Prince William Sound. Up to 1,011 sea otter carcasses have been reported due to the spill (Exxon Valdez Oil Spill Trustees, 1992). In the year after the spill, the sea otter population in the oiled areas declined by 35% while nearby unoiled populations increased by 13% (Frost et al., 1993). In 1991 estimates, the sea otter population in the oiled areas appeared to have stabilized, but remains below the pre-spill levels (Frost et al., 1993).

The habitat of sea otters is restricted to shallow coastal waters. They do not inhabit inland waterways (Kenyon, 1982). Sea otters are known to rest in kelp beds and use intertidal rocks and exposed beaches as haulouts. The importance of haulouts for sea otters is not fully understood. Haulouts appear to be necessary for the sea otter to clean

and dry its fur (Van Gelder, 1982). Maintaining their fur is an important activity because sea otters do not have a blubber layer like many marine mammals. They are dependent on the ability of their fur to trap air to insulate against the cold (Kenyon, 1982).

Sea otters feed in intertidal and subtidal areas on mussels, clams, crabs, and other benthic invertebrates, as well as slow moving benthic fish (Van Gelder, 1982). To feed, sea otters dive into the water, catch their food with their paws, and return to the surface to eat while floating on their backs, often using their chest as a table (Van Gelder, 1982). Mother-pup pairs tend to hunt in shallower areas, preferring shorter dives (Exxon Valdez Oil Spill Trustees, 1992). Sea otters are prey for eagles, sharks, and killer whales (Kenyon, 1982).

Sea otters reach sexual maturity between the ages of 4 and 7 years. They can breed throughout the year, but they usually mate between September and October. Males and females do not remain paired after mating. A single pup is born between May and June, and is dependent on its mother for 6 to 8 months after birth (Van Gelder, 1982).

According to Monson and Ballachey (1993), the natural mortality pattern for sea otters is for 45% of deaths to be juveniles (0 to 1 year olds), 15% prime age (2 to 8 year olds), and 40% old individuals (greater than 9 year olds). Monson and Ballachey (1993) report that the mortality patterns of the sea otters have changed since the oil spill. Instead of the mortality proportions of 45%, 15%, and 40% for juvenile, prime age, and old otters, respectively; the pattern in the spill year (1989) was 32%, 44%, and 24%, respectively. The altered pattern was still present in 1990 and 1991, and indicates that the sea otter population has yet to enter a recovery phase (Rotterman and Monnett, 1993).

Killer Whales

Killer whales (*Orcinus orca*), the largest member of the Dolphin family, live and migrate in groups of up to 50 individuals called pods. A typical pod will contain 5 to 20 individuals composed of 23% mature males, 34% mature females, 39% juveniles and 4% calves or young of the year (Grzimek, 1990). There are two types of pods, resident and transient. Transient pods travel great distances throughout the year. Individuals from transient pods may leave their pods for a period of several months to several years and swim with other transient pods. Resident pods have a more defined social structure, including a home range that may cover an area up to several hundred square miles. Maternal groups of the resident pod remain together throughout their entire life span. Offspring will remain with the pod, and when they mature their offspring also remain

with the pod (Matkin, Dahlheim, Ellis and Saulitis, 1993).

Killer whales, although observed in oceans throughout the world, prefer cooler coastal waters and sometimes enter shallow bays, estuaries and mouths of rivers. Salmon, cod, Pacific herring, flatfish, blackcod, squid, pinnipeds and other cetaceans are documented food sources of the killer whale. Resident pods primarily eat fish, although sometimes they will eat small mammals and birds. Transient pods also eat fish and birds, but prey on small marine mammals more than resident pods.

Killer whales reach lengths of 21 to 26 feet for males and 16 to 21 feet for females, and weigh between 5,500 and 15,400 pounds (Grzimek, 1990). Killer whales have a life span of approximately 25 years and reach sexual maturity at an age of approximately 7 years. Breeding may occur at any time of year, but in the Northern Hemisphere mating peaks from May to July with births occurring in the fall (Walker, 1983). The gestation period is about 16 to 17 months and the cows give birth to a single calf. The females will nurse their calves for about 12 months and care for them for up to 2 years (Trustees, 1992). The birthing rate of killer whales varies, with 5 years being an average time between calves.

Humpback Whales

Humpback whales, (*Megaptera novaengliae*), are currently listed under the U.S. Endangered Species Act of 1973. The estimated worldwide population of humpback whales is 10,000, with approximately 1,500 occurring in the North Pacific (von Ziegesar and Dahlheim, 1993). The humpback whale grows to a length of 36 to 47 feet for males and 38 to 48 feet for females, and weighs 33 to 50 tons (Grzimek, 1990). Their preferred habitat is along shallow shelves and bank areas, instead of deeper ocean waters. ~~During spring migration, the humpback whale travels well defined~~ routes ~~along the continental coastline to higher latitude waters for feeding~~. In the Northern Hemisphere the mating and calving season is October to March (Walker, 1983). During the breeding season, the humpback whales migrate to tropical waters, usually in groups of only two or three individuals. Humpback whales give birth to 1 calf every 1 to 3 years. After birth, calves nurse for approximately 11 months. The life span of the humpback whale is unclear but is estimated to be up to 77 years. The humpback whale reaches sexual maturity in 7 to 10 years.

Humpback whales primarily feed on krill and schooling fishes such as herring, anchovies, and sardines.

2. Terrestrial Mammals

Sitka Black-tailed Deer

The range of the Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) lies along the Pacific Coast of Canada, Prince William Sound, and the Kodiak Islands (Wallmo, 1978). The black-tailed deer is the most abundant large mammal in its range area in Alaska. In Prince William Sound, the deer population is estimated at 15,000 to 20,000, and up to 100,000 in the Kodiak Islands. Most of the deer habitat at Prince William Sound is on the Hinchinbrook, Montague, and Hawkins Islands (NRDA, 1990).

Sitka black-tailed deer live in coniferous forested areas for most of the year. Studies have indicated that old-growth forest habitat is essential for maintenance of a healthy deer population (Smith and Trent, 1991). In winter/early spring, the deer forage on beaches in intertidal areas due to snow accumulation in higher altitudes. When the uplands begin to melt in the spring, the deer move further inland.

Deer eat intertidal ~~marine vegetation,~~ kelp, coastal sedges, grasses, shrubs, and herbaceous vegetation in the forest understory (NRDA, 1990). They have a seasonal eating cycle, eating more in summer and fall when food is more abundant, and relying more on fat stores in the lean winter months. Body weight generally peaks in October and reaches a low point in March (Mackie et al., 1982). They are a subsistence source used by Native Alaskans and hunted for sport. Brown bears occasionally kill young deer for food.

The Sitka black-tailed deer reaches sexual maturity at approximately one and a half years of age (Mackie et al., 1982). Mating occurs between September and November. One to two fawns are born the following summer (Wallmo, 1978).

Black Bear

Black bears (*Ursus americanus*) live in less settled, forested areas in the major mountain ranges of the U.S. and in all of the Canadian provinces. Black bears are found throughout the state of Alaska with dense populations in Prince William Sound (Jonkel, 1978; NRDA, 1990). Black bears prefer inaccessible terrain with thick understory vegetation, but also range over early successional areas ~~including~~ as well as high tidelands, riparian areas, and wet and dry meadows (Pelton, 1982).

Black bears are omnivorous. They eat grasses, berries, tree borne fruit, and colonial insects and beetles (Pelton, 1982). Prior to hibernation, foraging activities become more intense and black bears will travel over large distances searching for food, often leaving the forested areas. Foraging may take them to beaches where black bears eat intertidal organisms and scavenge carcasses of marine mammals and birds (NRDA, 1990).

Black bears become sexually mature at 3 to 5 years old. They reproduce every other year. Breeding occurs in the summer, peaking in late June and July. Two to three cubs are born in winter during hibernation. Bears emerge from their dens in late March to early May. Cubs stay with their mother until spring or summer of the following year (Pelton, 1982).

Brown Bear

Historically, brown bears (*Ursus arctos*) ranged from the North American Great Plains to northern Alaska. Presently, they are abundant only in remote areas of western Canada, and coastal southcentral and southwest Alaska (Craighead and Mitchell, 1982). Besides the Alaskan Peninsula, brown bears live on the islands of Kodiak, Afognak, and Shuyak. Brown bears have seasonal movement patterns. They emerge from their dens in early April and May, forage along the coastline during the spring, move to anadromous streams in the summer, and travel upland when berries ripen in the fall. Between October and November, brown bears enter dens in the mountains for hibernation (Craighead and Mitchell, 1982).

Brown bears are omnivorous and eat a wide variety of foods. Favored plant food includes roots, acorns, berries, sedges, and grasses. Brown bears forage in intertidal areas for clams and mussels. They scavenge beaches for dead marine mammals. They are capable of killing ~~small~~ ungulates, and in spring they will feed on young moose, deer, and caribou. During the spawning season, bears will fish at areas of salmon runs. ~~They are also attracted to garbage dumps for foraging (Craighead and Mitchell, 1982).~~

Brown bears reach sexual maturity between 3.5 and 9.5 years. Mating occurs between mid-May and mid-July, with a peak in early June. The following February, 2 to 3 cubs are born. Cubs stay with their mother until they are weaned as two-year olds (Craighead and Mitchell, 1982; Jonkel, 1978). Only 45 to 69% of cubs survive to be yearlings (1.5 years old).

Thousands of visitors come to Katmai National Park and McNeil River State Game Sanctuary annually to observe and photograph brown bears. Approximately 250 brown bears are harvested annually by residents and non-residents (NRDA, 1990).

River Otters

The River Otter (*Lutra canadensis*), has been found throughout North America except for the extreme Southwest (Trustee, 1992). The river otter is one of the largest members of the Weasel family. Found in marshes, wooded stream banks, and all types of inland waterways, the river otter is almost completely aquatic, although it will travel great distances across land, moving from one stream to another (Forsyth, 1985). River otters do not excavate their own dens, but instead use natural cavities in shores or use dens

3. Birds

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) occurs only in North America, ranging from south of the arctic tundra in Alaska and Canada to the southern United States and Baja California in Mexico. Breeding and nesting habitats are primarily along the coast and inland lakes and rivers (Brown and Amadon, 1968). Of the estimated Alaska bald eagle population of 39,000 birds (27,000 adults and 12,000 fledglings), an estimated 4,000 reside in Prince William Sound, and an estimated 8,000 to 10,000 reside along the northern Gulf of Alaska coast (Exxon Valez Oil Spill Trustees, 1992). Breeding density may be as high as one nesting pair per mile (1.6 km) of shoreline (Mickelson, 1988).

Water is the feature common to bald eagle nesting habitat throughout the continent. Nearly 100 percent of all bald eagle nests are within two miles, and the vast majority are within a half mile, of a coastal area, bay, river, lake, or other body of water (Grubb, 1976; Lehman ,1979). Proximity to water reflects the dependence of bald eagles on fish, waterfowl, and seabirds as primary food sources.

Nesting usually occurs in trees with two characteristics, a clear flight path to at least one side of the nest and excellent visibility (often with an unobstructed view of water) common to nearly all bald eagle nests. These characteristics usually are provided by dominant or co-dominant trees within wooded areas, trees at the edge of wooded areas, and trees in open areas. Most nest trees also have a stout limb structure or a branching pattern that is suitable for supporting a large nest near the treetop. Nests typically are used for a number of years and become immense in size because the birds add to them each year. Occupied nests on cliffs and rock pinnacles are known to occur in Alaska (Sherrod *et al*, 1977).

Abundant, readily available food resources are a primary characteristic of bald eagle wintering habitat. Most wintering areas are associated with open water where eagles feed on fish or waterfowl, often taking dead or injured animals that are obtained easily. Wintering bald eagles also use habitats with little or no open water if other food resources, such as carrion, are regularly present (Spencer, 1976). Night roost sites are the other major characteristic of winter habitat. Roost trees usually are the oldest and largest trees within a stand and most have stout horizontal limbs and an open branching pattern. Visibility of the surrounding area is unobstructed, and little or no human activity occurs in the immediate vicinity.

Bald Eagles are monogamous and are believed to mate with the same individual for several years, possibly for life. A breeding female lays a single clutch of one to three eggs. Although bald eagles have been known to lay a second clutch if the first is destroyed (Hoxie, 1910), this apparently is rare. Mated pairs do not necessarily produce eggs each year. Nesting usually starts in March with incubation beginning when the first egg is laid. Incubation usually last 34 to 36 days. The young fledge from 70 to 98 days after hatching. Sometimes the smaller and weaker sibling is killed during this pre-

left behind by other animals. On occasion they will build nest like structures in aquatic vegetation.

The primary diet of the river otter is nongame fish. They also eat frog, crayfish, crabs, mussels, clams, snails and other aquatic invertebrates (Walker, 1983). Additionally, they have been known to eat birds and small land mammals such as rodents and rabbits.

Male river otters reach maturity at 2 years but do not become successful breeders until 5 years. Females mature in 2 years and may breed in as little as 1 year. Breeding occurs in late winter to early spring. The river otter has a delayed implantation process and actual gestation is 60 to 63 days (Toweill and Tabor, 1982). Births normally occur in the spring and the female will breed again shortly after giving birth. The litter size of the river otter varies from 1 to 6 kits, with 2 or 3 kits being common. River otter kits are born blind and helpless. They are blind until the age of 3 weeks and do not swim until the age of 6-9 weeks. The river otter has a life span of 13 years. Predators include bobcat, lynx, coyote, wolves, bald eagle, great horned owl and large game fish when they are young.

fledgling period. Young eagles usually remain dependent on the adults for another 60 to 80 days while they learn to hunt (Bent, 1937; Maestrellin and Wiemeyer, 1975; Fraser, 1981).

Bald eagles in captivity have been recorded as living up to 36 years, but it is unlikely that many individuals reach that age in the wild (Newton, 1979). Of the young birds that fledge, probably at least 50 to 70 percent die within a year, and it has been estimated that more than 90 percent may die prior to attaining adult plumage. Mortality is believed to be low for adults and is estimated to range from five to 10 percent per year (Sherrod *et al*, 1977). It was estimated that in 1989, 85 percent of the nests located in the oil spill areas failed to produce young. Reports indicate that the eagle population recovered during the following year, and in 1990 reproduction rates returned to normal.

Peale's Peregrine Falcon

The Peale's peregrine falcon (*Falco peregrinus pealei*) is a very large, dark western form, or subspecies, of the peregrine falcon. In North America it nests from the Aleutians, occasionally the Pribilofs, south to Queen Charlotte Island. In winter it migrates to California (Brown and Amadon, 1968).

During the breeding season peregrines frequently inhabit offshore islands where bluffs provide suitable undisturbed nest sites and an abundance of food from nearby colonies of nesting seabirds. At all seasons more open country is preferred, particularly shores and marshes frequented by shorebirds and waterfowl. In Alaska, nesting usually occurs around July with three to four eggs laid (Terres, 1980). Incubation is by both sexes, but is mainly done by the female, beginning with the second to third egg. Incubation lasts 28 to 29 days with the young flying 35 to 42 days after hatching (Brown and Amadon, 1980). The young birds are dependent on the adults for a further two months. Peregrines usually do not breed until three years old (Nelson, 1972). Peregrines will lay a second set of eggs if the first set is destroyed early in incubation (Beebe, 1967).

Common Murre

The subspecies of common murre found in Alaska (*Uria aalge inornata* Salomonsen) breeds from the Commander Islands, Saint Matthew Island, and northwestern Alaska to Kamchatka, the Kurile Islands, southern Sakhalin, eastern Korea, and Hokkaido, and through the Aleutian and Pribilof Islands to southern British Columbia (Johnsgard, 1987). The strongly black-and-white plumage and moderately large body (wingspread of about 30 inches) separate this species from all other alcids except the thick-billed murre and the razorbill. Before the spill, approximately 1.4 million murres, both common and thick billed (*Uria lomvia*), occupied the region between Unimak Pass and the Canadian border in southeast Alaska. The total murre population in Alaska was estimated to be approximately 12 million.

Breeding colonies of common murres are largely restricted to subarctic and temperate coastlines having surface water temperatures in August ranging from 4°C in the north

to 19°C in the south, with the northern limit corresponding fairly well to the southern edge of the pack ice in March (Voous, 1960). Within these limits, murres of both species breed mostly on rocky coasts that usually have steep seaward cliffs, though low-lying coasts may also be used if they are remote and predator-free. Stratified rock layers providing nesting ledges, or weathered pinnacles and similar promontories , are important habitat components (Tuck, 1961). Where both species of murres occur, the thick-billed murre is more likely to occur on narrower cliff ledges and smaller promontories than the common murre (Voous, 1960).

Non-breeding habitats are coastal and pelagic areas extending as far south as the 15°C February isotherm, and probably north to the limits of pack ice. Typically, they are found in the offshore zone (at least 8 kilometers out to sea), and no more than a few hundred kilometers offshore at their southernmost breeding limits (Tuck, 1961).

The common murre feeds predominantly on schools of fish throughout the year. Prey are captured by extended dives, mostly at depths of 4-5 meters, but sometimes by bottom feeding at 8 meters (Madsen, 1957). Under pelagic conditions the birds may dive even deeper, rarely as much as 30 meters, at which depths it has been captured in crab pots off coastal Alaska (Forsell and Gould, 1981). Foraging tends to occur in flocks early in the breeding season, but as the year progresses murres increasingly forage individually.

Murres normally nest in dense colonies on cliff faces, and breeding is synchronized so that all young hatch at the same time. Synchronized breeding helps repel predators such as gulls and ravens. Murres are highly social birds on the breeding areas, with maximum densities of 28 to 34 birds per square meter reported by Tuck (1960), with some birds occupying no more than 500 cm^2 (about 0.5 square feet) of ledge. No nest is built, though a few pebbles or other materials may be dropped at the nest site, perhaps to reduce rolling of eggs early in incubation before the egg has become cemented to the substrate by excrement and sediment (Johnsgard, 1987). Only one large ~~pyriform (pear-shaped)~~ egg is laid. If disturbed, the egg will roll in a small circle ~~around its pointed end~~. Both sexes incubate with an average incubation period of 28 to 34 days (Tuck, 1961). Both adults feed the chick, which is rarely left unattended. Nonetheless, there is often a fairly high loss of chicks to exposure or falls during the first six days after hatching, after which clinging, hiding, and thermoregulation abilities have become better developed (Johnsgard, 1987). Chicks leave the nest 18 to 25 days after hatching by scrambling, flying, or gliding down to the sea in company with one of the adults, nearly always after dusk (Greenwood, 1964). The young birds immediately leave the vicinity of the colony, and for the first few weeks chicks are cared for communally by adults until able to fly, about 39 to 46 days after hatching (Tuck, 1961).

Breeding success has been reported to be between 70 to 80 percent of young fledged per breeding pair (Birkhead, 1977; Hedgren, 1980). Birkhead (1974) estimated a six percent annual adult mortality rate and stated that most birds probably do not begin breeding until their fifth year. A six percent mortality rate results in an average life expectancy for adults of 16 years; though banded birds have been known to survive as long as 32

years.

Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratum marmoratum*) ~~apparently~~ breeds on islands and in coastal areas from southeastern Alaska to northwestern California. In Alaska, it is probably a common to abundant breeder in southeastern and south-coastal areas, a resident and probable local breeder in the Alaska Peninsula and also the Aleutians, and a casual summer visitor in western areas (Kessel and Gibson, 1976). Islieb and Kessel (1973) estimated a total marbled murrelet population of several hundred thousands, possibly in the millions, in the North gulf Coast and Prince William Sound region of Alaska.

In both plumages the marbled murrelet closely resembles the Kittlitz murrelet (*Brachyramphus brevirostris*), and in southern Alaska waters these two species can perhaps be separated by the shorter exposed bill of the Kittlitz, its more uniformly brownish color in the breeding season, and by its greater amount of white on the face in winter (Johnsgard, 1987).

The total breeding distribution of this species is poorly understood, but it apparently is limited to fairly warm waters of the west coast of North America and the east coast of Asia, approximately between the August surface water isotherms of 9°C and 15°C. It is most closely associated with the humid coastal areas supporting wet-temperate coniferous forests with redwood, Douglas fir, and other ecologically similar species, but it also inhabits coastlines along tundra-covered uplands along the Alaska Peninsula and in the Aleutian Islands. In winter the birds move farther south, sometimes as far as southern California, but some wintering occurs on protected waters as far north as the Kodiak area of Alaska and as far west as the Aleutians (Forsell and Gould, 1981). For most of the year the birds seem to prefer semiprotected waters of bays and inlets, making only limited use of rock coastlines (Hatler, Campbell, and Dorst, 1978).

The murrelet eats small fishes which it gets by diving in tide rips and other places where small fishes swim in schools. The major fish prey, sand lance (*Ammodytes*), belongs to a group of fish in which the young of the previous fall and winter tend to migrate to surface waters and move inshore in late spring, when they would become available to the murrelets. The fall and winter diet of the species is essentially unknown, but samples from a few birds suggest that sea perch (*Cymatogaster*) may be an important food item, and possibly also mysid and schizopod crustaceans (Sealy, 1975). Foraging in spring is done mainly by pairs or by single subadults, and later in early July mixed flocks of adults and subadults being to form. Nearly all foraging is done in fairly shallow water, close to shorelines.

Day, Oakley, and Barnard (1983) summarized data on 8 known and 1 probable marbled murrelet nests; all but one contained unhatched eggs, and the remaining one a hatched chick. Dates of the nests with eggs ranged from June 3 (Kodiak Island) to August 1 (East Amatuli Island, Alaska). They ranged in elevation from 68 to 690 meters above sea

breeding until they are three to five years of age.

Glaucous-winged Gull

The glaucous-winged gull (*Larus glaucescens*) occurs primarily along the Pacific coast of North America. The summer range extends from Alaska and the islands of St. Lawrence, Pribilofs, and Aleutians south to northwestern Washington. The winter range extends from southeastern Alaska along the Pacific coast to Baja California (Terres, 1980).

The glaucous-winged gull is oceanic in its habits, and is most often found in the vicinity of salt and brackish water along the northern Pacific coast. This species is omnivorous, scavenging for garbage on docks, dumps, and shores near coastal cities, and will feed on the carcasses of animals or birds killed by hunters. Glaucous-winged gulls follow boats and ships in search of garbage, and will eat carrion and fishes at sea. Although this gull often follows sea-going vessels, it rarely forages more than a few miles off shore. From the near-shore areas, this species will gather barnacles, mollusks, and sea urchins for food (Terres, 1980, Godfrey, 1979).

Glaucous-winged gulls breed on steep coastal cliffs and rocky islands offshore. They often nest colonially, usually on flat, low islands, rock ledges of higher islands, or rock outcroppings. Nests are well-made bulky cups of grasses, seaweeds, feathers, fish-bones, and other debris built among tufts of plant life or left in the open on rocky ledges. The breeding season begins in late May. The female produces a single clutch of two to three eggs, that are incubated for 26 to 28 days. The young are tended by both adults and leave the nest between 35 and 54 days. Glaucous-winged gulls are single-brooded, but usually replace lost clutches (Harrison, 1978; Terres, 1980).

Harlequin Duck

The harlequin duck (*Histrionicus histrionicus*) is a diving duck common to the northern coastal areas of North America, and is a very familiar species along the coasts of the Aleutian Islands and Alaska. The harlequin duck occupies both an eastern and western range in the Northern Hemisphere. The eastern range includes Iceland, parts of Greenland, and Labrador, and may extend as far south as New Jersey in the winter. The western range includes northeastern Siberia north to the Arctic Circle, across the Bering Sea to the Aleutian Islands, much of the Alaskan interior, and south to northwest Wyoming and central California. The western population is much more abundant than the eastern population, with the main western stronghold being Alaska. The greatest abundance of harlequin ducks is in the Alexander Archipelago, the Alaska Peninsula, and the Aleutian Islands (Bellrose, 1980; Johnsgard, 1978; Terres, 1980).

Fall and spring migration patterns consist of lateral movements from interior breeding grounds to coastal habitat. A number of ducks migrate from the Alaskan interior to the Aleutians each fall. In the late 1960's, the May to August population estimates for the Aleutian Islands National Wildlife Refuge ranged from 100,000 to 150,000. Population estimates for this wildlife refuge peaked, however, during the winter season (September

to April) with ranges from 600,000 to 1 million individuals (Bellrose, 1980).

During the summer breeding season, the preferred habitat of the harlequin duck is a cold, turbulent mountain stream, or ponds or lakes along rocky arctic shores. The species will favor a forested mountain stream over a non-forested stream. In winter, the preferred habitat is heavy surf adjacent to a rocky coastline with shelves, reefs, and sunken rocks (Terres, 1980). This habitat of rocky shores and rushing mountain streams is not conducive to other duck species, making the harlequin duck a distinctive species in this habitat (Johnsgard, 1978). The breeding and wintering ranges of the harlequin duck lie within relatively remote areas. Therefore, this species has not historically been affected by habitat destruction or hunting (Bellrose, 1980). It should be noted, however, that harlequin ducks can be legally harvested in Alaska in the fall.

Harlequin ducks are not known to breed until their second year. Their breeding season begins in mid-May of each year. Adults congregate at the mouths of anadromous fish streams in spring, and most are paired by the time they leave the coastal wintering area for their interior breeding grounds. The females may use the same nest site each year. Harlequin ducks are primarily surface nesters. The male follows the female as she searches for an appropriate nesting site, inspecting crevices in rocks and densely vegetated shorelines. The nests are always well concealed by dense vegetation and are located along the rocky shores of turbulent mountain streams, often adjacent to rapids, in mature forests. Nests are composed of thin layers of grass, twigs, and leaves, and lined with white down (Bellrose, 1980).

The female produces one clutch consisting of three to seven eggs, laid at a rate of one every two days. The male leaves the female shortly after incubation begins, and leaves the breeding ground in preparation for the molt. The incubation period lasts from 27 to 33 days, although the time period has not been firmly established. The female incubates intently, taking feeding breaks every 48 hours. The ducklings are tended by the female only, and are capable of flying in about 40 days (Johnsgard, 1978; Harrison, 1978; Terres, 1980). The female remains with the brood in the freshwater stream until late summer when they migrate to the coastal habitat. Adults breed annually after reaching maturity.

Harlequin ducks feed by day, usually by themselves, and roost on rocks at night. They prefer water rich in aquatic life. This duck is a diving duck, feeding much like a torrent duck, and is well adapted to swimming in torrential currents. Harlequins have been observed diving to depths of three to five feet in swift currents in search of food. They often emerge at their points of entry, indicating an ability to walk along the bottom of the stream against the current. At times they feed by immersing their heads or upending like dabbling ducks. Harlequin ducks have been observed feeding in the late afternoon and early morning hours (Terres, 1980; Bellrose, 1980).

The harlequin duck feeds primarily on animal life. Crustaceans, mollusks, insects, echinoderms, and fishes have all been taken as prey. In the mountain streams during summer, the harlequin will prey on mayfly nymphs, stone flies, caddis fly larvae, and

black flies. During the winter months, the duck will feed about sunken wrecks and rock breakwaters, and rocky underwater places. The primary prey in the coastal habitat are crustaceans (crabs, amphipods, isopods) and mollusks (barnacles, limpets, snails, chitons, blue mussels) that are dislodged from rocks. In addition to crustaceans and mollusks, the harlequin also preys on small fishes and echinoderms (Bellrose, 1980; Johnsgard, 1978; Terres, 1980).

Black Oystercatcher

Oystercatchers are large shorebirds distinguished by their long red bill. The bill is laterally compressed and used to open bivalves. The black oystercatcher (*Haemotapus bachmani*) is a resident along the Pacific coast of North America, and is often seen on rocky ledges along outer beaches where it preys on attached shellfish exposed by retreating tides. The black oystercatcher's range extends along the coast from Kiska Island, the Aleutians, Alaska, and south to Baja, California. The species is causal in winter on Pribilof Island and Yukon. The black oystercatcher does not migrate, and winter flocks seldom wander more than 30 miles from their nesting places (Terres, 1980). Observations from Alaska, however, indicate that some birds may disperse in the winter. The black oystercatcher prefers a rocky habitat. Outer saltwater shores and islands are most suitable (Godfrey, 1979).

The black oystercatcher breeds on coastal sites, preferring rocky shores, promontories and islands. The highest breeding densities occur on low elevation, gravel shorelines, with little wave action. Nests consist of a hollow on gravel beaches above the tide line, or a hollow of a rocky islet or reef. Nests are often unlined, or lined with a variable amount of small pebbles or bits of stone and shell chips. Nesting begins in late May to early June. This species ~~are~~ is single-brooded, but will renest to replace lost clutches. The female produces a single clutch of two to three eggs. Both sexes incubate the eggs for a period of 26 to 27 days. The young are attended by both adults. The chicks can run well at three days, catch insects at five days, and fly and remove limpets and mussels with their bill at 30 days. The young are very active, drawing attention to their location, and vulnerable to predation. Known predators include the river otter, mink, and gulls. The chicks are usually fledged after 30 days, but may continue to be fed by the adults (Terres, 1980; Harrison 1978; Godfrey, 1979). Black oystercatchers may take up to three years to reach sexual maturity.

This species feeds in the intertidal zone, primarily on limpets, mussels, clams, and chitons (Terres, 1980).

4. Fish

Pink Salmon

Pink salmon (*Oncorhynchus gorbuscha*) are anadromous in rivers and streams from northern California to Canada, Alaska, and the Soviet Union. Washington is considered the southern end of the range of exploitable spawning migration stocks of pink salmon. They also occur in Asia as far south as Japan (Bonar *et al*, 1989). Pink salmon are the most abundant salmon in Cook Inlet, as well as Prince William Sound. For the years 1973 to 1982, this species made up 39.6% of the total catch (numbers of fish) in Cook Inlet, with an annual averge catch of 1.8 million. This was about 4.4% of the statewide catch of this species during those years.

Major pink salmon producing streams that feed into Cook Inlet include the Kenai and Susitna Rivers located at the head of the inlet. The Talachulitna River, a tributary of the Susitna, is probably the most important pink producer, with as many as 1 million pink salmon spawners in some years (Alaska Geographic, 1983).

On Kodiak Island, at the mouth of Cook Inlet, during the time period of 1973 to 1982 salmon fishermen caught an annual average of 10 million salmon of all five species, or about 15% of the total statewide catch of salmon. Most of these fish were pink salmon (85%), for the many short streams of Kodiak are ideal for this species. Chum salmon are the second most abundant salmon of the Kodiak area, and in recent years about 7.2% of the catch has been of chums (Alaska Geographic, 1983).

In general, major glacial watersheds, except where buffered by lake systems, contain only a small proportion of the spawning and rearing salmon. This is primarily because of stream instability; flow volume and shifting sediment loads. Consequently, small steep streams lying in the lateral zones of the fjords or in small bays contain most of the salmon stocks. There are 500 or more of these streams utilized by salmon, and the dominant pink and chum species have adapted to heavy use of intertidal zones for deposition of eggs. The 35 to 77 percent range of intertidal use by pink and chum salmon exceeds all other Pacific coast salmon areas in this regard. In contrast, red and coho salmon are in low abundance in the Prince William Sound/Cook Inlet area, owing to the blockage by barrier falls of most lake systems required by these species for early life rearing (PWSAC, 19??).

Because of their spawning patterns, oil from the spill of the Exxon Valdez did not threaten the spawning and rearing areas of the sockeye, chinook and coho salmon, which are located in freshwater lakes and streams far from the spill area. Unlike pinks, these species ~~mature~~ rear for one, two and sometimes three years in ~~these areas~~ freshwater before heading for the ocean. For example, the commercially important sockeye or red salmon is four or five inches long when it heads to sea as a one- or two-year old. It is a much larger, older and stronger fish than the tiny pinks that head for salt water. If the spill did not harm the pink salmon fry of 1989, the larger sockeye juveniles were even more likely to survive. King and coho juveniles are even larger when they head to sea, averaging

between five and seven inches in length (Hart, 1973).

Pink salmon have the simplest and least variable life cycle of all salmon. Adults mature after 2 years and die after their first spawning. Because of this simple life cycle, populations spawning on odd number calendar years are effectively isolated from populations spawning on even number years, therefore, no gene flow occurs between the populations (Bonar *et al*, 1989). As adults, pink salmon return to their natal spawning grounds in the fall to reproduce, traveling several miles up their natal streams (Scott and Crossman, 1973). However, as much as 75% of Prince William Sound populations spawn in the intertidal zone (ADFG, 1985a). Spawning generally occurs between June and mid-September and hatching occurs between October and January.

The female builds a nest, called a redd, in the gravel in water depths of 0.15 to 0.53 meters and water velocities of 21 to 100 cubic meters per second (cm/s). Upon completion of the redd, the female will move to the deepest part of the redd and spawn with a dominant male and, in some instances, the female may spawn with as many as six males. The female will then protect the redd from other nesting females (Bonar *et al*, 1989). When spawning densities are high, redds may be superimposed, thus reducing egg survival. Fecundity is dependent on the size of female, but in general the female produces between 15,000 and 19,000 eggs. Length of the incubation period is dependent on water temperature. Egg survival is dependent on chemical and physical characteristics of the gravel in which they are layed. Egg mortality usually results from oxygen deprivation, freezing, flow fluctuations, dewatering, predation, and microbial infestation (Bonar *et al*, 1989). The hatched alevins remain in the gravel until the yoke-sac is absorbed (several weeks), leave the redd as fry and move downstream to saltwater. They remain in low salinity waters for the first summer. The majority of all pink salmon fry in Prince William Sound migrate along the western shore of the sound. The juveniles move out to sea and mature in approximately 18 months, whereupon they return to their natal spawning grounds (ADFG, 1985a). Egg to fry survival is from 5 to 10 percent, and fry to adult survival is from 2 to 5 percent.

The diet of pink salmon fry consists primarily of invertebrate eggs, amphipods and copepods. Juveniles feed primarily on larger invertebrates and small fishes, and adults feed mostly on euphausiids, squid, and other invertebrates and small fishes (Bonar *et al*, 1989 and ADFG, 1985a). Eggs, alevins, and fry are preyed upon by Dolly Varden, cutthroat trout, coho salmon and other fishes and aquatic birds. During spawning migrations, juveniles and adults are consumed by terrestrial mammals such as bears and otters and by marine mammals, predatory birds, and other fishes while at sea (ADGF, 1985a).

The most critical life stages of pink salmon are the egg to juvenile stages. Certain environmental requirements must be met for successful reproduction. Optimum water temperature for spawning is between 7.2 and 12.8 °C. They can withstand prolonged low temperatures if the initial temperature was greater than 6°C. Optimum incubation temperatures range from 4.4 to 13.3°C. Pink salmon eggs and alevins exposed to high salinities exhibit increased mortality (Bonar *et al*, 1989).

Eggs and alevins in the intergravel redd require a minimum of 6.0 mg/l of dissolved oxygen (DO) for successful incubation. They can tolerate temporary decrease in DO, but will not withstand oxygen concentrations below 5.0 mg/l for any length of time. Low DO can cause premature hatching, fry abnormalities, and swimming performance impairment in adults. The preferred water velocity for successful spawning is 21 to 100 cm/s. Developing eggs and alevin are affected by water velocity through either temperature changes, mechanical damage, or reduced intergravel DO concentrations.

Although adults can tolerate high turbidities during migration, the eggs can be suffocated from increased silt loads and osmoregulation in young fish can be disrupted. Streams with low turbidities are preferred.

Sockeye Salmon

Sockeye salmon (*Oncorhynchus nerka*) are found from northern California to the Yukon River in Alaska and from Siberia to Japan. Their primary spawning grounds in Alaska are the Kenai, Chignik, Naknek, Kuichak, Woos, and Kodiak Island river systems (Pauley *et al*, 1989; ADGF, 1985b). The sockeye salmon are anadromous fish and spend 1 to 4 years in the ocean and 2 years in freshwater. After reaching maturity they return to their natal streams, which are usually associated with a lake, and spend 1 to 8 months in that lake before ascending their natal streams to spawn. They die after spawning is completed.

Spawning usually occurs between July and October. The female builds several redds in sand or graveled areas that will provide sufficient oxygenation for the eggs and alevins. The female places herself over the redd followed by a male and the milt and eggs are deposited. After spawning is completed the fertile eggs are buried by the female. Fecundity is dependent on the size of the female, but in general the female lays an average of 3,500 eggs during the spawn. The incubation period of the eggs varies with temperature (4.4 to 13.3 °C) and lasts between 50 and 140 days (Scott and Crossman, 1973). After hatching the alevins remain in the gravel for 3 to 5 weeks allowing the yoke sac to be absorbed. The alevins leave the gravel as fry in April or May (Pauley *et al*, 1989).

The fry move into their nursery lakes and remain for 1 to 2 years, 3 years in some Alaskan lakes, as smolts. This is a very critical stage in their life cycle. Mortality is generally high from predation. During this time they are pelagic schooling fish that feed primarily on zooplankton during the afternoon and avoid predators at other times. Migration as smolts from the nursery lakes to the sea is usually temperature dependent. They migrate to the ocean and remain in the inshore areas for the first few months before moving out to the Gulf of Alaska. Adults will remain in the marine environment for 2 to 4 years before returning to freshwater to spawn (ADFG, 1985b, Pauley *et al*, 1989).

Adults feed primarily on Euphausiids, amphipods, copepods, and young fishes. When returning to freshwater the adults generally do not feed. Juveniles in streams feed

primarily on small insects, insect larvae in streams, and feed on zooplankton in lakes. In the marine environment they feed on small crustaceans, plankton, and fish larvae. Juveniles are important prey species for birds and other anadromous fish species such as Dolly Vardens, coho salmon, cutthroat trout, arctic char, and sculpins. Adults are preyed on by marine mammals and predatory fishes (Pauley *et al*, 1989; ADFG 1985b).

The most critical life stages of Sockeye salmon are the egg to juvenile stages. Certain environmental requirements must be met for successful reproduction. The optimum temperature range for spawning is 10.6 to 12.2°C. Lower mortality and faster growth rates during incubation occurs when water temperatures are between 8.9 and 10.0°C. Water temperatures greater than 23.0°C and lower than 7.2°C have increased mortality and poor growth. Sockeye salmon require a minimum of 5.0 mg/l of DO for successful spawning. Low DO can disrupt swimming efficiency during migration and stunted growth in alevins and juveniles (Pauley *et al*, 1989; ADFG 1985b).

The preferred water velocity for successful spawning is 21 to 101 cm/s. Changes in velocity can effect developing eggs and alevin through either mechanical damage, temperatures changes, or reduced DO concentrations (Pauley *et al*, 1989; ADFG 1985b).

Pacific Herring

Pacific herring (*Clupea harengus pallasi*) are found on the continental shelf from northern Baja California to arctic Alaska and Japan (Pauley *et al*, 1988). This species is important to the Alaskan fishing industry, and is a vital part of the food chain. Pacific herring are consumed by larger commercial species of fish such as salmon and halibut (Royce, 1991).

Pacific herring mature between 3 and 4 years, and spawn annually. They live offshore, but spawn in nearshore coastal waters. Their greatest mortality occurs during the egg to juvenile stages where mortality is 99%. Adults have life span of approximately 19 years (Pauley *et al*, 1988).

Adults return to natal nearshore intertidal and subtidal areas between March and June to spawn in Prince William Sound. The eggs are highly adhesive and are laid on a variety of substrates including kelp, eelgrass, prominent rocks and even artificial substrates. Fecundity is positively correlated with size of female and is usually measured as number of eggs per 1 gram of body weight. Number of eggs is dependent on the geographic area. There is no specific data available for the Gulf of Alaska populations at this time. Egg incubation is dependent on water temperatures, but hatching usually occurs between 14 and 25 days. After hatching, herring larvae retain their yolk sac for approximately 2 weeks, depending on water temperature. Following absorption of the yolk sac the herring enter a critical period of feeding. The highest mortality normally occurs during this time due to the narrow margin between starvation and nutrition. They feed primarily on invertebrate eggs, nauplii, and diatoms. As they increase in size their diet extends to include barnacle larvae, mollusks, bryzoans and

rotifers. Juvenile herring congregate nearshore in shallow waters during the summer and move offshore in the fall. In general, larval survival of herring depends greatly on timing in relation to predation and food supply (Pauley *et al*, 1988). Juvenile herring feed on crustaceans, mollusks and fish larvae, and adults feed on euphausiids, planktonic crustaceans and fish larvae (Pauley *et al*, 1988). Herring eggs are preyed on by shore birds, diving birds, gulls, invertebrates and fish. Larvae are preyed by jellyfish, amphipods, and fish. Adults are a prey base for large finfish, sharks, and marine mammals and birds (Pauley *et al*, 1988).

In general, the herring lives in water temperatures between 0 and 10°C throughout its life cycle, from egg to adult. Salinity for successful spawning occurs between 3 and 29 parts per ~~million~~ thousand (ppt), and larvae generally prefer salinities between 13 and 21 ppt. Excessive turbidity may hinder spawning and egg incubation, but higher turbidities associated with estuary nursery areas may enhance larval survival. Feeding intensities were shown to be greater in turbidities between 500 and 1000 mg/l than the control of 0 mg/l (Pauley *et al*, 1988).

Rock Fish

There are over 50 species of rockfish (*Sebastes* spp. and *Sebastolobes* spp.), including yellow rockfish (*Sebastes ruberrimus*), quillback (*S. maliger*), and copper rockfish (*S. caurinus*), that are found in Prince William Sound, Cook Inlet, and the Gulf of Alaska. Their life histories are variable and not well understood. The following life history information is for the yellow rockfish (*S. ruberrimus*).

The yellow rockfish range extends from Cook inlet in Alaska south to Baja California (Hart, 1973). This species first reproduces between 14 and 19 years of age, and breeds annually thereafter. They can live up to 114 years. Very little is known about their migration patterns, and they may not migrate at all. It is known that older fish tend to move to deeper water (Carlson and Straty, 1981).

Yellow rockfish are considered live bearers and release live planktonic larvae into the water column between April and June in southeastern Alaska (Carlson and Straty, 1981). Very little is known on the early life history of larvae and juveniles.

Yellow rockfish are considered to be opportunistic feeders, and feed primarily on a variety of crabs, shrimp, snails, and fish. Small yellow rockfish are preyed upon by large rockfish and other fishes (Carlson and Straty, 1981).

Dolly Varden

Dolly Varden (*Salvelinus malma*) are found in fresh and saltwater in western North America and eastern Asia. It ranges from northern California to the arctic coast of Alaska (Scott and Crossman, 1973).

Dolly Varden mature between 4 and 7 years of age. As adults they live near there natal

streams in nearshore areas of marine environments during the summer and migrate to freshwater lakes to overwinter. They are fall spawners ~~which occurs between September and December.~~ They return to their natal streams to spawn and spawn annually from age 6 to 10 years. The young remain in their natal streams for 3 to 4 years. The average life span is 12 years (Scott and Crossman, 1973; ADFG, 1985c).

Spawning occurs in the fall between September and December. The female builds the redd and is usually attended by 4 to 5 males during spawning. Fecundity is a positive correlation with female size, but females generally produce between 1,300 and 3,400 eggs. The eggs hatch in approximately 4 to 5 months. The alevin remain in the redd for approximately 18 days and then emerge as fry. The fry remain close to the bottom for the first few days but commence active feeding soon after and begin growing rapidly. The young remain in freshwater for 3 to 4 years before moving seaward. They are found near logs and undercut banks where they seek protection from predation. Post spawning mortality is usually high in adults (Scott and Crossman, 1973; ADFG, 1985c).

The primary diet for marine adult Dolly Varden consists of smelt, herring, juvenile salmonids and other small fishes. In their freshwater habitat juvenile salmonids, invertebrates and other small fishes are the main diet. Juvenile Dolly Varden feed near the bottom and prey primarily aquatic insects, insect larvae, and fish eggs (Scott and Crossman 1973, ADFG 1985c).

Cutthroat Trout

Cutthroat trout (*Salmo clarki*) range from northern California, Oregon, British Columbia to Prince William Sound Alaska (Pauley *et al*, 1989).

Male cutthroat trout mature at 2 to 3 years and females mature at 3 to 6 years. They return to their natal streams to spawn in the spring between February and May depending on geographic area. After spawning, adults and smolts return to the sea between March and July where they remain in the vicinity of the natal stream and feed along the shores. They return to freshwater lakes to overwinter. Cutthroat trout can live up to 10 years, although collected individuals range from 3 to 6 years of age (Pauley *et al*, 1989). Cutthroat trout are considered to have a high survival rate between spawnings.

~~Spawning occurs in the spring between February and May, depending~~ on geographic area. The female builds a redd in sand or graveled areas that will provide sufficient flow and oxygenation for the eggs and larvae. The female places herself over the redd followed by a male where milt and eggs are deposited. After spawning is completed the eggs are buried by the female. Fecundity is a positive correlation with size of female. The female generally lays an average of 1,100 to 1,700 eggs during the spawn (Scott and Crossman, 1973). The incubation of eggs ranges from 28 to 40 days depending on water temperature. The newly hatched alevins remain in the redd for 1 to 2 weeks until the yolk sac is absorbed. The emerging fry generally live in the shallow, low velocity stream

margins close to where they were spawned, but their range increases with age. The time of smolting is variable and is size dependent (Pauley *et al*, 1989).

Adult cutthroat trout feed primarily on small fish and shrimp and become more piscivorous as they increase in size. Fry and juveniles feed primarily on insects and crustacean, but will feed on smaller fish such as sticklebacks and other salmonids as they increase in size. In the marine environment, they feed on ~~gammarid~~ amphipods, ~~sphaeromid~~ isopods, ~~callianassid~~ shrimp, immature crabs and other salmonid fishes (Pauley *et al*, 1989). Fry and juveniles are preyed on by rainbow trout, brook trout, Dolly Varden, short head sculpins and adult cutthroat trout as well as a various bird species such as great blue herons and kingfishers. In the marine environment cutthroat are preyed on by Pacific hake, sharks, marine mammals, and adult salmon (Pauley *et al*, 1989).

The most critical life stages of cutthroat trout are the egg to juvenile stages. Certain environmental requirements must be maintained for successful reproduction. The preferred water temperature for spawning ranges from 6 to 17°C. The optimum water temperature for egg incubation is 10° to 11°C. The optimal temperature for juveniles is 15°C, and water temperatures greater than 28°C can be detrimental. Low DO causes premature hatching, fry abnormalities, and swimming performance impairment in adults. Cutthroat trout generally avoid water with DO less than 5.0 mg/l, but can tolerate temporary low DO conditions (Pauley *et al*, 1989).

Cutthroat trout are sensitive to high turbidity and its associated problems. They will stop migration in streams with turbidity greater than 4,000 mg/l and may stop feeding and move to cover when turbidities exceed 35 mg/l. Excessive silt loads can effect DO concentrations causing increased egg mortality in the redds and disrupt the emerging fry. The preferred water velocity for successful spawning is 11 to 90 cm/s. Fry are generally found in lower water velocities of less than 30 cm/s, with an optimum velocity of 8 cm/s. Changes in flow can effect developing eggs and alevin in several ways including mechanical damage, temperatures changes, or reduced DO (Pauley *et al*, 1989).

5. Coastal Habitat

Intertidal Zone

The intertidal zone is the environment located between the extent of high and low tides. Because of the rise and fall of the tides, the area is not always inundated. The size of the intertidal area is dependent upon the slope of the shore and the extent of the rise and fall of the tides (Newell, 1979). Inhabitants of the intertidal zone consist of algae (e.g., *Fucus*), mussels, clams, barnacles, limpets, amphipods, isopods, marine worms, and certain species of fish. The intertidal zone is used as a spawning area by many species of fish (Exxon Valdez Oil Spill Trustees, 1992). The intertidal zone serves as a feeding grounds for marine consumers (e.g., sea otters, Dungeness crabs, juvenile shrimps, rockfish, cod, and juvenile fishes), terrestrial consumers (e.g., bears, river otters, and humans), and birds (e.g., black oystercatchers, harlequin ducks, numerous other species of ducks, and shorebirds) (Peterson, 1993). Because of the nature of the intertidal environment, the intertidal zone is especially vulnerable to initial and continued contamination in the event of an oil spill, as well as to the effects of clean-up operations (Exxon Valdez Oil Spill Trustees, 1992).

The intertidal and subtidal zones were most affected by the spill and were therefore the focus of many of the Natural Resources Damage Assessment (NRDA) studies. More than 1,000 miles (1,609 km) of coastal shoreline was oiled. Zones exposed to wave and tidal action were most affected by the oil spill, and were in many cases re-oiled after the initial cleanup response. Surface oil contamination was greatest in the upper one-third to upper one-half of the intertidal zone, which resembled an oiled "bathtub ring." By fall 1989, the average depth of oil penetration in sediment[1] was approximately 20 inches (50 cm), and the persistence of subsurface oil became the major treatment issue during 1990 (Michel et al. 1991). Over time and through frequent winter storms in 1991 and 1992, oil has moved deeper into the sediments of PWS and has contaminated the seafloor to ~~depths of 328 feet (100 m)~~ over 200 m (660 feet). Measurements taken in the summer of 1992 indicate that the upper intertidal zones still have not recovered due to the continued presence of oil (Restoration Team, 1992 ii).

Following the oil spill, decreases in the populations of many intertidal organisms were observed along the oil-contaminated shorelines of Prince William Sound, Kodiak Island, and Cook Inlet. The intertidal habitat suffered from the effects of the spill and pressurized hot water treatments. Elevated concentrations of petroleum hydrocarbons were detected in intertidal and subtidal sediment samples in Western Prince William Sound, as well as in intertidal mussels and other benthic marine invertebrates. Subsurface oil in the beaches presents an ongoing potential for petroleum hydrocarbon contamination of intertidal organisms, and contamination continues to be evident in the intertidal mussels. Although increased densities of mussels in oil-contaminated areas have been documented, the mussels in the oil-contaminated areas were smaller than

[1]Oil mixes with sediment particles and "sinks."

those found in uncontaminated areas (Exxon Valdez Oil Spill Trustees, 1992). Some degree of recovery has been observed in the lower intertidal and the mid intertidal zones. Recovery of the upper intertidal zone, where the mussel beds are located, has not occurred (Restoration Planning Working Group, 1993).

In 1991, high concentrations of oil remained in mussels and the underlying mats of the mussel beds. Because the mussel beds were not cleaned or removed following the spill, they present sources of fresh oil for the organisms that feed upon mussels. The extent of the oil-contaminated mussel beds have not been determined; however, investigative studies are ongoing (Exxon Valdez Oil Spill Trustees, 1992). Studies have identified 31 mussel beds within Prince William Sound and 9 along the Kenai Peninsula and Alaska Peninsula that have sediment petroleum hydrocarbon levels greater than 1,700 µg/g wet weight oil equivalents. The contamination of mussels presents a potential for continued food chain contamination (Babcock, et.al., 1993).

Populations of *Fucus*, the primary intertidal plant, were reduced following the oil spill and clean-up operations. The reduction in intertidal area covered by *Fucus* was accompanied by an increase in coverage of opportunistic plant species that thrive in disturbed habitats. In addition to the decrease in *Fucus* coverage, the size of the *Fucus* plants decreased, the number of reproductive-sized plants decreased, and the number of fertile receptacles per reproductive-sized plants were reduced. Therefore, not only was the actual coverage of *Fucus* reduced, its ability to replenish itself was decreased (Exxon Valdez Oil Spill Trustees, 1992). *Fucus* is the primary structural habitat in the Alaskan intertidal zone, and its reduction effects other intertidal zone inhabitants (Peterson, 1993).

Characterizations of the following intertidal inhabitants are presented in subsequent paragraphs: ~~bay~~ (blue) mussel (*Mytilus ~~edulis~~ trossulus*), common littleneck clam (*Protothaca staminea*), and Pacific razor clam (*Siliqua patula*). Profiles of these selected organisms are being presented because of their important function within Alaska and the surrounding area (i.e., mussels provide a source of food for many other organisms, and clams are harvested both recreationally and commercially).

These are the names we have been using - NRDA

Blue

~~Bay~~ Mussel. The ~~bay~~ (blue) mussel is distributed from the Arctic Ocean to ~~Cape San Lucas, Baja~~ central California. It is found along rocky coastlines, in bays, and in estuaries. ~~Bay~~ blue mussels are harvested commercially for bait and for food. ~~Bay~~ blue mussels are suspension feeders and feed on dinoflagellates, organic particles, small diatoms, zoospores, ova and spermatozoa, flagellates, unicellular algae, and detritus. There is limited culture of these mussels for food. These mussels are preyed upon by sea stars, gastropods, crabs, sea otters, black oystercatchers, and ducks (Shaw *et. al.*, 1988).

The spawning period for ~~bay~~ blue mussels occurs in July through November in northern California. Spawning is not initiated by temperature changes, rather it may be stimulated by other factors such as a pulling on the byssal threads or a chain reaction caused by the spawning of one organism. Larvae are subject to movement by water currents, which may effect the ability of the mussel to set by carrying it away from

appropriate setting areas. Adult ~~bay~~ mussels set on the byssal threads by attaching to algae or recently exposed hard surfaces. Spawning occurs at approximately one year. ~~Bay~~ blue mussels are sensitive to wave action and tidal action (Shaw *et. al.*, 1988).

~~Bay~~ blue mussels are subject to pollution and paralytic shellfish poisoning. Commercial harvest of these mussels in California has decreased immensely over the years, primarily due to the repercussions of paralytic shellfish poisoning. These mussels can also accumulate hydrocarbons in their tissues by taking hydrocarbons up through the gill tissues. It has been indicated that oil is slightly toxic to mussels; however, it may prevent them from being marketed as food, as well as being toxic to other predators of the mussel (Shaw *et. al.*, 1988).

Common Littleneck Clam. The common littleneck clam is widely distributed along the coast of the Northwest region, but can be found from Mexico to the Aleutian Islands, Alaska. It serves as an important commercial and recreational species. This species is found in both intertidal and subtidal zones. Common littleneck clams are farmed in the intertidal zone in Puget Sound. It is a filter-feeder, feeding primarily on diatoms. Predators of the common littleneck clam in Prince William Sound include the sea star and the sea otter (Chew and Ma, 1987).

Spawning is dependent upon water temperature. The spawning period is shortened at the northern end of the geographic distribution range. Water temperatures of approximately 8°C trigger spawning in late May in Southcentral Alaska. The spawning period in Prince William Sound consists of a single annual spawning period that can extend up to four months, usually beginning in late-May to mid-June and lasting until September. The eggs develop into larvae within 12 hours, and the clams go through a 3 week larval stage in which they feed upon plankton. Throughout this period the larvae are subject to movement by the currents. Once the clam ~~surveys~~ larvae the larval stage, it attaches itself to the substrate by secreting byssal threads. The juvenile common littleneck clam can crawl about by using its foot. Optimum habitat for growth consists of beaches subject to strong tidal currents, with substrates consisting of coarse sand, or fine gravel interspersed with mud, stones, or shells. Adults burrow to approximately 15 cm of the surface (Chew and Ma, 1987).

The common littleneck clam suffers from overfishing, water pollution, and loss of habitat due to development of coastal land. Studies show that the quantity of common littleneck clams landed in the U.S. Pacific Northwest have been decreasing yearly (these statistics did not include Alaska). Little recruitment of common littleneck clams occurred in Prince William Sound in 1967 to 1971 due to poor spawning and recruitment conditions. Harvest of abundant clams along the coast of Alaska is limited because of paralytic shellfish poisoning (i.e., toxic phytoplankton is filtered in and accumulated by shellfish and is fatal to humans, but not to the shellfish). It has been shown that common littleneck clams grow at a slower rate in oil-treated sediments, and they tend to burrow to a shallower depth, making them more accessible to predators (Chew and Ma, 1987).

Pacific Razor Clam. The Pacific razor clam is found on open sandy beaches from Pismo Beach, California to the Aleutian Islands, Alaska. Large razor clams tend to inhabit the lower intertidal zone, and razor clams found in the subtidal zone tend to be juveniles. The razor clam filters its food from the water it inhabits, and serves as prey for seagulls, sea ducks, and Dungeness crabs. The razor clam is an economically important recreational and commercial fisheries, although this species of clam has more recently been sought after for recreational purposes rather than commercial purposes. It has been suggested in the past that artificial propagation of razor clams is not feasible; however, the State of Washington has maintained a razor clam hatchery since 1980 (Lassuy and Simons, 1989).

In the Pacific Northwest, this species spawns in late spring or early summer. Spawning occurs progressively later in the season in the more northern locations, with razor clams in Alaska undergoing peak spawning in late August. Spawning is triggered by an abrupt rise in ambient water temperature. Razor clams go through a 5 to 16 week larval life span in which dispersal is limited. Following the larval period, the juvenile razor clams dig into the sand ("set") and may undergo limited lateral movement, although juveniles larger than 1 inch usually remain stationary in the top few inches of sand. Adult clams are positioned about 1 foot below the surface of the sand and remain laterally in place; however, rapid vertical movement through a digging mechanism, is characteristic of the razor clams. Maturation is reached at a size of approximately 10 cm, and the age of the clam at maturation varies with geographic location. The growth rate is slowest during late fall and winter and fastest in spring, when the water temperature increases (Lassuy and Simons, 1989).

The razor clam has been subject to disease in the past. In 1984 and 1985, a prokaryotic pathogen was responsible for the closure of the entire razor clam fishery in the State of Washington. Additionally, paralytic shellfish poisoning in razor clams was found in Alaskan razor clam populations between 1985 and 1987 (Lassuy and Simons, 1989).

Subtidal Zone

The subtidal zone is the environment encompassed ~~by~~ below the low tide. Because this covers a very vast area, the depth of the subtidal zone extends over a wide range. Inhabitants of the shallow subtidal zone consist of amphipods, clams, eelgrass, crabs, juvenile cod, *Laminaria* plants, spot shrimp, and many other organisms. As with the intertidal zone, oil-contaminated areas in the subtidal zone suffered declines in the populations of many of the organisms that inhabited them.

Evidence of ongoing subtidal oil contamination was documented in the winter of 1990-1991 through the use of sediment traps. The sediment traps collected elevated concentrations of petroleum hydrocarbons, indicating that, through beach cleaning and natural processes, oil was being withdrawn from the beaches and transported to subtidal areas (Sale *et. al*, 1992). Between 1989 and 1991, oil concentrations remained the same and occasionally increased in shallow subtidal sediments at depths of 3-20 meters. Further studies have indicated that petroleum hydrocarbons continue to present potential

for contamination of organisms that exist on or near the sea floor (Exxon Valdez Oil Spill Trustees, 1992).

Because of their ability to quickly take up petroleum hydrocarbons, and their inability to quickly metabolize the hydrocarbons, clams accumulate high concentrations of hydrocarbons. Therefore, clams inhabiting the shallow subtidal zone present an ongoing source of contamination to the many organisms that feed upon them (Exxon Valdez Oil Spill Trustees, 1992).

level and from less than 1 to 24 kilometers from the coastline. The nest sites varied considerably in slope and directional aspect, though a possible preference for shady north-facing slopes has been suggested. All the evidence available suggests that the clutch consists of a single egg with an incubation period of approximately 30 days and that young birds assume independent lives once they reach the sea (Sealy, 1974).

Storm Petrel

Storm petrels are among the smallest of the seabirds, measuring between 7½ and 9 inches in length and having a wingspan of 18 to 19 inches. These birds prefer the open ocean habitat and are reluctant to come ashore due to their reduced mobility on land. With the exception of the breeding and nesting period, these birds spend their entire lives on the ocean. Two species of storm petrels are known to occur in Alaska. Those species are the fork-tailed storm petrel (*Oceanodroma furcata*), and Leach's storm petrel (*Oceanodroma leucorhoa*). The fork-tailed storm petrel occurs in the Northern Pacific, from the Bering Sea to southern California (Terres, 1980). The breeding range includes the Kurile, Komandorskie, and Aleutian Islands southward along the North American Pacific coast to northern California. Leach's storm petrel occurs throughout the oceanic portion of the northern hemisphere. This species' breeding and nesting range includes coastal islands in the northern Pacific and northern Atlantic. In the Pacific, breeding occurs on the Kurile and Aleutian Islands, Alaska, southeast along the Pacific Coast to Baja California (Godfrey, 1979; Terres, 1980). The primary food sources are small fishes, crustaceans, mollusks, small squids, and oily materials gleaned from the ocean (Terres, 1980). Leach's storm petrel has been known to take refuse matter left by whales, and can be attracted to a boat by throwing bits of fish liver overboard (Godfrey, 1979).

Habitat requirements for storm petrels include the open ocean, and coastal islands for nesting purposes. For breeding purposes, storm petrels prefer offshore islands. The preferred breeding and nesting habitats are burrows or rock crevices on marine islands and islets, although they have been known to nest up to one mile inland (Terres, 1980). The forked-tail storm petrel will breed on turf, in the open or among trees, but rarely among rocks. Leach's storm petrel will breed on turf or rocky slopes, and also makes no preference to wooded or treeless sites (Harrison, 1978). As these species are dense colonial nesters, the ground at the nesting site may be honeycombed with their burrows. The burrow entrances are often camouflaged by growing vegetation (Godfrey, 1979). The burrow is usually three feet long, somewhat angled, and is excavated by the petrel. Both the male and female fork-tailed storm petrel participate in excavating their burrow, while the male Leach's petrel excavates the burrow for that species. Some plant debris may accumulate at the nest site. Banding has shown that older breeding birds are the first to return to the nesting site in spring, and that pairs often return to the same nest burrow each year. It is thought that the species mates for life (Terres, 1980).

The breeding season begins in late May for Leach's storm petrel and in June for the forked-tailed storm petrel. The female produces a single clutch consisting of one egg. If that clutch is destroyed, storm petrels will not produce a second clutch (Harrison, 1978). Incubation begins when the first egg is laid, usually in late May or early June for

Leach's storm petrel and June to July for the forked-tailed storm petrel. Both male and female participate in the incubation which usually lasts from 5½ to 7 weeks (Terres, 1980). During the day, incubating birds do not stir, and their mates remain far out at sea. At night, however, the colony becomes active as the birds return from the sea to relieve their mates (Godfrey, 1979). The young are downy, with usually two successive down coats followed by the first feathers. Although there may be long intervals between feedings for the young, they become much larger and heavier than the adults. Leach's storm petrels are brooded by one parent for the first five days, then tended at irregular intervals thereafter. The fledglings are usually deserted by the parents after 40 days. The young remain in the nest, living on fat reserves, and emerge at night to exercise as their feathers grow. The fledglings leave the nest for the sea at 63 to 70 days (Harrison, 1978).

Black-legged Kittiwake

The black-legged kittiwake (*Rissa tridactyla*) is a marine bird occurring throughout the northern part of the northern hemisphere. With the exception of the breeding season, this species occurs almost exclusively in offshore waters. The nesting range includes islands and shores of the Arctic Ocean south to the Aleutian Islands and southern Alaska, southern Newfoundland, France, the Kurile Islands, and Sakhalin. The winter habitat range extends south to Baja California, southern New Jersey, northwestern Africa, and Japan (Godfrey, 1979).

Black-legged kittiwakes spend the majority of their life at sea. It is known that they drink only salt water, and have rejected fresh water in captivity. This species assembles in enormous flocks to gather scraps thrown into the water from ships. However, the primary food sources are small fishes and small mollusks, crustaceans, and other plankton (Terres, 1980).

Black-legged kittiwakes often nest in dense colonies, usually on high cliffs overlooking the sea and in sea caves. Their nest sites may be associated with murres and other seabirds. The breeding season begins in May. Nests are deeply cupped, and constructed of grass, mud, moss, and seaweed (Terres, 1980). Nests are often built on small projections or irregularities in the rock face. The female produces, on the average, a single clutch consisting of two eggs. Both male and female participate in incubation, which lasts from 25 to 30 days (Harrison, 1978). Although black-legged kittiwakes are a single-brooded species, lost clutches are often replaced. The nestlings are tended by both adults, and are fledged between 38 and 48 days of hatching (Terres, 1980).

Pigeon Guillemot

Along the Pacific coast, the pigeon guillemot (*Cepphus columba*) is one of the most widespread members of the Auk family (Family Alcidae). These birds frequent saltwater, are skillful divers and swimmers, and prefer open seas (Terres, 1980). Pigeon guillemots have been documented as year-round residents of the Gulf of Alaska and the Aleutians. They are generally dispersed as single birds or small colonies of well under

1,000 individuals. In the winter, they move from exposed coastlines to sheltered bays and inlets. The winter range encompasses the Pribilof and Aleutian islands to Kamchatka and the Kurile Islands, and south to California. During the nonbreeding season, the birds are nonpelagic and fairly sedentary. They rarely move into water more than 50 meters deep, and tend to spread out thinly along coastlines in winter. Their breeding range extends from Chukotski Peninsula and Diomede Islands to southern Kamchatka, and from Saint Lawrence and Saint Matthew islands and the Aleutians west to Attu, Bogoslof, and Shumagin Islands, Kodiak, and southeastern Alaska south to Santa Barbara Island, California. Population estimates of the pigeon guillemot have suggested approximately 200,000 birds in Alaskan waters in the late 1970's (Johnsgard, 1987).

The pigeon guillemot is a diving bird, and feeds on bottom dwelling small fishes, mollusks, crustaceans, and marine worms (Terres, 1980). Most of the prey are to be found on or over rocky bottoms within the subtidal zone (Johnsgard, 1987). Dietary preference may vary between individuals of this species.

The pigeon guillemot breeding season begins in mid-May to mid-June, depending on latitude. The pigeon guillemot nests either solitarily or in small colonies of up to 50 pair (Terres, 1980). Nesting distribution may be dictated by the availability of nesting sites rather than by any colonial tendency. Breeding densities have been documented to range from 5 to 110 pair per colony (Johnsgard, 1987). Nest are often located in crevices or cavities under rocks, in a crevice, or a similar cavity site (Harrison, 1978). This species is also known to nest under railroad ties, use abandoned puffin and rabbit burrows, and nest on bridges and beneath wooden piers (Terres, 1980). In rocky habitats, the nests are usually close to water, often near the high-tide line. Throughout the breeding season, pigeon guillemots use the supratidal and intertidal areas in front of the nest sites for feeding and social activities (Johnsgard, 1987). Eggs are typically deposited on the bare cavity floor of the nest site, as no nest-lining materials are ever brought into the cavity. The female produces one clutch consisting of two eggs. This species is single-brooded, and the incidence of renesting after the loss of the initial clutch is still undetermined (Johnsgard, 1987). Both sexes incubate, with incubation lasting from 30 to 32 days (Terres, 1980). Losses of eggs before hatching are sometimes fairly high. Causes of egg failure are diverse, and include human disturbance, heavy rainfall causing nest desertion or chilling, or predation (Johnsgard, 1987). Egg survival may be affected by the usual crow and gull predators. The northwestern crow (*Corvus caurinus*) has been mentioned as a serious egg predator (Bent, 1919).

The young are tended by both parents and may leave the nest after the first few days, but do not leave the nesting cavity until fledging (Harrison, 1978). The young are able to fly 29 to 39 days after hatching (Terres, 1980). At fledging time, the chicks are led from the nest, after which they waddle down to the water or, if necessary, fly or glide down from higher sites. The adults then cease to tend the chicks, leaving them to feed in nearby kelp beds (Thoreson and Booth, 1958). Alternatively, the chicks may be convoyed to deeper water where they are tended by adults for about a month after leaving the nest (Johnsgard, 1987). It is thought that pigeon guillemots do not begin

Is this referenced in text?

GLOSSARY

abundance The condition of a species being observed repeatedly in normal habitats; A normal quantity of a given species within an area; *relative abundance*

acquisition of equivalent resources Protection (through purchase or other means of acquisition) of resources that are the same or substantially similar to those that were injured

ADF&G Alaska Department of Fish and Game

anadromous Of fish, such as salmon, which ascend freshwater streams from saltwater to spawn; fish that swim up river to spawn

aquaculture Production of food from managed aquatic systems

aquatic Growing, living in, frequenting or pertaining to marine or fresh water

baseline A reference point or set of data used for measuring subsequent or related changes

benthic On the bottom of lakes, rivers or oceans; of organisms which live on the bottom of water bodies

benthos Those organisms that inhabit the bottom of a body of water

berm A narrow ledge or path as along a beach; a wall or mound of earth

biological indicator species — ?

biologist A person that studies or deals with the origin, history, physical characteristics, life processes, habits, etc. of plants and animals, including botany and zoology

biota All living organisms that exist in an area

bog A quagmire or wet, spongy land usually poorly drained, highly acid and rich in plant residue

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act, 40 C.F.R. § 306.12; *Superfund Reauthorization Act*

clear cut A forest management technique that involves harvesting all the trees in one area at one time

CEQ Council on Environmental Quality

colony A group of similar plants or animals living or growing together

contiguous In physical contact; touching along all or most of one side

cooperating agencies Agencies of the *Trustee Council* that participate in reviewing drafts and decision-making

dbh diameter at breast height

DEC Alaska Department of Environmental Conservation

DEIS Draft Environmental Impact Statement

deleterious Harmful to health or well-being; injurious

density Quantity or number per unit, as of area

detection limit —?

die-off Phenomenon whereby populations or species die one-by-one until they are all gone

direct restoration On-site action to rehabilitate injured resources

diversity The richness of species in a given area; the number of kinds of organisms per unit area or volume; *biological diversity, species diversity*

DNR Alaska Department of Natural Resources

DOI U.S. Department of the Interior

ecosystem The interacting system of a biological community and its nonliving surroundings; a community and its living and nonliving environment considered collectively

EIS Environmental Impact Statement. Under the National Environmental Policy Act, any major federal action, including a "no action" alternative, must be evaluated to assess its potential impact on natural resources and the environment

endangered species Species that are in danger of becoming extinct

epicenter The area of the earth's surface directly above the place of origin, or focus, of an earthquake

escapement ~ ?

estuarine Of the mouth region of a river that is affected by tides; formed or deposited in an estuary

estuary Area where fresh water meets salt water (bays, mouths of rivers, salt marshes, lagoons) in an unimpaired connection with the open sea, and where the sea water is measurably diluted with fresh water

evaporate To change a liquid or solid into vapor or to make gaseous; to remove moisture from

Federal Register Government publication that prints presidential proclamations, reorganization plans, executive orders, notices of proposed and final rules and regulations, and administrative orders.

fishery A place where fish are bred, caught or packed and sold

flood plain That portion of a river valley which is covered in period of high (flood) water; ordinarily populated by organisms not greatly harmed by short immersions; any land area susceptible to being inundated by water from any source; also *flood-prone area*

forage The search for, pursuit, capture, and ingestion of food

fry Young fish, or small adult fish, especially when in large groups

fuelwood Wood used to provide heat/power by combustion

glacier A large mass of ice and snow that forms in areas where the rate of snowfall constantly exceeds the rate at which the snow melts

graywackes A nonporous, dark-colored sandstone containing angular particles of other rocks

habitat The natural environment in which a population of plants or animals occurs

harvest To catch, shoot, trap, etc. (fish or game), often for commercial purposes

hatchery A place for hatching eggs, especially for fish or poultry

herbivore An organism that eats living plants or plant parts, e.g., seeds

ice calving The release of a mass of ice from a glacier

injury Physical harm or damage to, or loss in value of, as a result of some act

intertidal zone The region of marine shoreline between high-tide mark and low-tide mark

invertebrate Any animal lacking a backbone, *i.e.*, insects, spiders, crustaceans, worms, mollusks, etc.

larvae Animals in an early developmental stage which will change structurally to become an adult

leaching The removal of various soluble materials from surface soil layers by the passage of water through or around the layers

mammal Any of a large class of warmblooded, usually hairy vertebrates whose offspring are fed with milk secreted by the female mammary glands

marine Of the sea or ocean

maritime On, near, or living near the sea; of or relating to sea navigation, shipping; nautical

MBF thousand board feet

metabolize To undergo chemical and/or physical processes

migration A regular, usually seasonal, movement from one region to another

migratory Characterized by migration

MMBF Million board feet

mortality rate The rate of deaths within a given population

mousse — ?

muskeg Moss-covered countryside, or continuous boggy ground

natality rate The rate of live births within a given population

NEPA National Environmental Policy Act, 42 U.S.C. § 4321 *et seq.*

nesting synchronization — ?

NMFS National Marine Fisheries Service

NOAA National Oceanic and Atmospheric Administration

NPS National Park Service

NRDA Natural Resource Damage Assessment [CITE?]

observation studies The noting and recording of facts and events for examination and investigation of a theory, behavior, cause and effect, etc.

OCS Outer continental shelf. The submerged and relatively accessible land adjacent to the coastline. The federal government claims jurisdiction from the three-mile state territorial limit to an outer ten-mile limit.

oil slick A layer of oil, especially one floating on water and forming a smooth area

organism Any living thing

overescapement — ?

overharvest — ?

PAH polycyclic aromatic hydrocarbon

parasitism A symbiotic association of two kinds of organisms in which the organism that feeds on or lives in another is benefitted and the host is usually harmed

permafrost Permanently frozen subsoil thawing at the surface in summer (characteristic of Arctic tundra)

petroleum hydrocarbons The compounds found in crude oil that contain carbon and hydrogen, and may be carcinogenic

PHC petroleum hydrocarbons

phenanthrene A colorless, crystalline hydrocarbon, present in coal tar (used in making dyes, explosives, etc.)

phytane — ?

pod A small group (herd) of animals, especially seals or whales

population A group of organisms of the same species

ppb part per billion

predator An organism, usually an animal, which kills and consumes another organism in whole or part

prokaryote —

propagation Reproduction or multiplication as of a plant or animal

pulp The pith inside the stem of a plant

PWS Prince William Sound. Located in southcentral Alaska, it is one of the largest and least developed marine ecosystems in the United States

radiocarbon techniques

radio-collared

radio-tagged

recreation Refreshment in body or mind by some form of play, amusement or relaxation, as in sports or hobbies

rehabilitate To restore conditions, property, organisms back to optimal, or at least normal, states by positive remedial actions

rehabilitation The act of rehabilitating

replacement Substituting an unaffected/uninjured resource for an injured resource of the same type

respiration The oxidative breakdown of food molecules by cells with the release of energy; a process in anaerobic organisms involving some substance other than free oxygen

restoration The rehabilitation, replacement or acquiring the equivalent of any natural resources injured, destroyed, or lost as a result of the oil spill to return such resource to its *baseline* condition

Restoration Planning Work Group

Restoration Plan Implemented through an Annual Work Plan, it provides long-term guidance for restoring injured resources and human uses

Restoration Team — ?

riparian Of, adjacent to, or living on the bank of a body of water

roe Fish eggs, especially when still massed in the ovarian membrane

? **romatics** —? ¿aromatics?

round log —?

salinity The concentration of any salt; the degree of salt in water; sodium chlorinity

seabird A bird living on or near the sea

sediment Any usually finely divided organic and/or mineral matter deposited by air or water in nonturbulent areas; the unconsolidated inorganic and organic material that is suspended in and being transported by surface water, or has settled out and has deposited into beds

sedimentary Containing usually finely divided organic and/or mineral matter deposited by air or water in nonturbulent areas

shorebird Any of an order (*Charadriiformes*) of birds that feed or nest on the shores of the oceans, rivers, *etc.* (sandpipers, puffins, gulls)

soluble Capable of being dissolved

spawn The mass of eggs or young produced or deposited by fish, mollusks, crustaceans, amphibians, etc.

species The smallest natural population regarded as sufficiently different from all other populations to deserve a name, and assumed or proved to remain different despite interbreeding with related species; any subspecies of fish or wildlife or plants, and any distinct pollution segment of any species of vertebrate fish or wildlife which interbreeds when mature

sublethal Insufficient to cause death; not quite lethal

subsistence Means of support to provide food, clothing, and shelter as needed to sustain life

substrate The layer on which organisms grow, often used synonymously with surface of ground; also, the substance, usually a protein, attached by an enzyme

subsurface oil Oil found below the surface of the water, ocean? (part of spill, already present?)

subtidal zone The region of marine shoreline before the low-tide mark?????????

Superfund Reauthorization Act Same as Comprehensive Environmental Response, Compensation, and Liability Act (*CERCLA*)

survival rate The rate at which a species continues to live (usually in spite of injury or damage caused by some event)

tar ball — ?

terrestrial Of land, the continents, and/or dry ground

threatened species Any species which is likely to become an *endangered species* within the foreseeable future throughout all or a significant portion of its range

toxin Poisonous compounds produced by some microorganism, or certain plants or animals, and causing certain diseases

TPH analysis Total [PETRO?] hydrocarbon analysis

Trustee Agencies
Alaska Department of Environmental Conservation,
Alaska Department of Fish and Game,
Alaska Attorney General's Office
U.S. Department of the Interior
U.S. Department of Agriculture
National Oceanic and Atmospheric Administration
U.S. Department of Commerce; see also *Trustee Council*

Trustee Council Council of six federal and state agency representatives established to administer the civil settlement funds to restore resources/services injured by the oil spill

State of Alaska: Commissioner of the Department of Environmental Conservation; Commissioner of the Department of Fish and Game; Alaska Attorney General;
Federal Government: Secretary, U.S. Department of the Interior; Secretary, U.S. Department of Agriculture; Administrator, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

tundra Arctic, subartic or high alpine land, devoid of trees, with mosses and sedges dominant and (in the Artic) underlain by permafrost, *i.e.*, permanently frozen subsoil thawing at the surface in summer

U.S.C. United States Code

USFS U.S. Forest Service, selected by the *Trustee Council* as the lead agency in developing the DEIS

USFWS U.S. Fish and Wildlife Service

vegetation Plants in general, or the total assemblage of plants, and their gross appearance as determined by the largest and most common *flora*

viable Able to live

VOC volatile organic compound

volatile In geochemistry, substances that readily move or have moved through the earth's
atmosphere; any substance that evaporates at a low temperature

water column — ?

waterfowl A water bird, especially any of an order (*Anseriformes*) of birds consisting of ducks, geese, and swans

What is this for? What kind of order is this in?

Common name	Scientific name	Habitats
Blue mussel	*Mytilus ~~edulis~~ trossulus*	UL
Kelp	*Pugettia producta*	LKS
Alaria kelp	*Alaria pylaii*	
Wrack kelp	*Laminaria spp.*	R, E
Bull kelp	*Nereocystis leutkeana*	N, R, E
Rockweed	*Fucus distichus*	R, E
Barnacle (great)	*Balanus nubilis*	K
Periwinkle	*Littorina spp*	ULK
Black lichen	*Verrucaria spp.*	intertidal
Sitka spruce	*P. sitchensis* (Picea)	F
Western hemlock	*Tsuga herterophylla*	F
Red cedar	*Thuja plicata*	F
Black cottonwood	*Populus balsamifera*	P, F
Rusty menziesia	*Menziesia ferruginea*	F
Alpine blueberry	*V. uliginosum* (accinium)	B, T
Stink currant	*Ribes spp.*	F
Salmonberry	*R. spectabilis* (Rubus)	S, F
Elderberrry	*Sambucus racemosa*	S
Black bear	*Ursus americanus*	pmSFBT
Moose	*Alces ~~Alces~~*	PmSF

Plant & Bird HABITAT KEY: N=nearshore, R=rocky intertidal, E=estuary, P=pond, lake, stream, river; M=meadow, marsh; S=shrubland, F=forest, B=bog, T=tundra

Inverterbrate HABITAT KEY: B=black zone (lichen), U=mid-high tide, L=low tide, K=minus tide–kelp zone, M=minus tide mud flats, S=sea floor, O=open water (floating)

Common name	Scientific name	Habitats
Porcupine	*Erethizon dorsatum*	SFbt
Blacktail deer	*Odocoileus hemionus*	sFBT
Alkaligrass	*Puccinellia spp.*	E
Seaside arrowgrass	*T. palustris*	M
Tall arrowgrass	*Triglochin maritimum*	E, M
Goose-tongue	*Plantago spp.*	E, M, P
Scurvy grass	*Cochlearia officinalis*	E
Canada sand spurry	*Spergularia spp.*	E
Lyngbye's sedge	*Carex spp.*	M, P, S
Spikerush	*Eleocharis spp.*	M, P
Pendant grass	*Arctagrostis spp.*	moist tundra
Marsh marigold	*Caltha palustris*	M
Starwort (water)	*Callitriche verna*	P
Marsh crowfoot	*Ranunculus spp.*	M, P
Willow	*Salix spp.*	S, P
Cottonwood	*Populus balsamifera*	river edge, deciduous forest
Sitka spruce	*P. sitchensis*	F
Huckleberry	*Vaccinium ovalifolium*	S, F
Alder (Sitka)	*Alnus sinuata*	S, F, P

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Common name	Scientific name	Habitats
Bering hairgrass	*Deschampsia spp.*	M, P, S, B
Bluegrass	*Poa spp.*	M, P, B
Sedge	*Carex spp.*	M, P, S
Salmonberry	*Rubus spectabilis*	S, F
Devil's club	*Echinopanax horridum*	S, F
Fireweed	*Epilobium angustifolium*	forest, follows fire
River beauty	*Epilobium latifolium*	S, P
Vetch	*Astragulus umbellatus*	alpine, river or tundra
Crowberry	*Empetrum nigrum*	B, T
Moss (spike)	*Selaginella selaginiodes*	F, B
Moss (club)	*Lycopodium spp.*	F, B
Heather (mountain)	*Phyllodoce aleutica*	T
Heather (bell)	*Cassiope spp.*	B, T
Rhododendron	*Rhododendrum camtschaticum*	T
Bearberry	*Arctostaphylos spp.*	B, T
Brown bear	*Ursus arctos*	PmSFBT
Mountain goat	*Oreamnos americanus*	FT
Ptarmigan, willow	*Lagopus lagopus*	willow scrub, upland, tundra
Sea otter	*Enhydra lutra*	NER

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Common name	Scientific name	Habitats
Salmon (chum)	*Oncorhynchus keta*	anadromous
Herring (Pacific)	*Clupea harengus*	marine
Halibut (Pacific)	*Hippoglossus stenolepis*	marine
Crabs (blue king)	*Paralithodus platypus*	S
Clams (razor)	*Siliqua patula*	M
Shrimp (pink)	*P. borealis*	KS
Red snapper (yelloweye rockfish)	*Sebastes ruberrimus*	marine
Rock greenling	*Hexagrammus lagocephalus*	marine
Lingcod	*Ophiodon elongatus*	marine
Pacific (gray) cod	*Gadus macrocephalus*	marine
Pollock (walleye)	*Theragra chalcogramma*	marine
Starry flounder	*Platichthys stellatus*	marine
Staghorn sculpin	*Leptocottus armatus*	marine
Dolly Varden	*Salvelinus malma*	anadromous
Cutthroat trout	*Salmo clarki*	anadromous
Sole	*Soleidae*	marine
Sablefish (Black cod)	*Anoplopoma fimbria*	marine
Pink (humpback) salmon	*Oncorhynchus gorbuscha*	anadromous
Sockeye (red) salmon	*Oncorhynchus nerka*	anadromous

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Common name	Scientific name	Habitats
King (chinook) salmon	*Oncorhynchus tshawytscha*	anadromous
Silver (coho) salmon	*Oncorhynchus kisutch*	anadromous
Humpback whale	*Megaptera novaeangliae*	marine
Killer whale (orca)	*Orcinus orca*	marine
Steller sea lion	*Eumetopias jubata*	marine
Harbor seal	*Phoca vitulina*	marine
Goosebeak whale	*Ziphius cavirostis*	marine
Gray whale	*Eschrichtius ~~glaecius~~ robustus*	marine
Sei whale	*Balaenoptera borealis*	marine
Fin whale	*Balaenoptera physalus*	marine
Minke whale	*B. acutorostrata* (laenoptera)	marine
Harbor porpoise	*Phocoena phocoena*	marine
Bald eagle	*Haliaeetus leucocephalus*	coastal
Loon, common	*Gavia immer*	freshwater or marine
Cormorant, double crested	*Phalacrocorax auritus*	marine
Pigeon guillemot	*Cepphus columba*	marine
Grebe	*Podiceps spp.*	marine
Murrelet, marbled	*Brachyramphus marmoratum*	marine

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Common name	Scientific name	Habitats
Horned puffin	*Fratercula corniculata*	marine
Tufted puffin	*Lunda cirrhata*	marine
Black-legged kittiwake	*Rissa tridactyla*	marine
Common murre	*Uria aalge*	marine
Thick-billed murre	*Uria lomvia*	marine
Fork-tailed storm petrel	*Oceanodroma furcata*	marine
Glaucous-winged gull	*Larus glaucescens*	marine
Parakeet auklet	*Cyclorrhynchus psittacula*	marine
Western sandpiper	*Ereunetes mauri*	coastal
Dunlin	*Erolia alpina*	coastal
Red knot	*Calidris canutus*	coastal
Dowitcher	*Limnodromus spp.*	coastal or freshwater
Sanderling	*Crocethia alba*	coastal
Surfbird	*Aphriza virgata*	coastal
Ruddy turnstone	*Arenaria interpres*	coastal
Rainbow trout	*Salmo gairdneri*	freshwater
Harlequin duck	*Histrionicus histrionicus*	coastal/riparian
Mink	*Mustela vison*	freshwater
River otter	*Lutra canadensis*	freshwater
Surf scoter	*Melanitta perspicillata*	coastal

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Common name	Scientific name	Habitats
Goldeneye duck	*Bucephala spp.*	coastal/freshwater
Limpet—keyhole	*Diadora aspera*	intertidal
Limpet—white cap	*Acmea mitra*	intertidal
Whelk (Wrinkled dog)	*Nucella lamellosa*	intertidal
Red algae	*Rhodophyceae*	subtidal
Brown algae	*Phaeophyceae*	subtidal
Beach ryegrass	*Leymus mollis*	dunes, beaches
Amphipod (Burrowing)	*Corophium spp.*	subtidal
Amphipod (Gammarid)	*Gammaris spp.*	subtidal
Isopod	*Isopoda*	subtidal
Eelgrass	*Zostera marina*	subtidal
Black oystercatcher	*Haematopus bachmani*	coastal
Hoary marmot	*Marmota caligata*	terrestrial
Marten	*Martes americana*	terrestrial
Coyote	*Canis latrans*	terrestrial
Wolf	*Canis lupus*	terrestrial
Lynx	*Lynx canadensis*	terrestrial/forest
Beaver	*Castor canadensis*	terrestrial/forest
Wolverine	*Gulo gulo*	terrestrial/forest
Vole (Alaska)	*Microtus miurus*	terrestrial

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Common name	Scientific name	Habitats
Lemming (Northern bog)	*Synaptomys borealis*	bog
Gray falcon	*Falco rusticolus*	coastal
Peregrine falcon	*Falco peregrinus*	open terrestrial
Merlin	*Falco columbarius*	open terrestrial
Golden eagle	*Aquila chrysaetos*	terrestrial
Kestrel (Sparrow hawk)	*Falco sparverius*	terrestrial
Spruce grouse	*Canachites canadensis*	forest
Owl	*Strigidae*	forest

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Dave's Comments

WALCOFF

Comments to Ken R. by noon 4/21

April 9, 1993

Ken Rice
Restoration Planning Work Group
645 G Street
Anchorage, AK 99501

Subject: Progress to Date on the *Exxon Valdez* Restoration Plan EIS

Dear Ken:

Carol Paquette asked that I forward the enclosed documents to you. I have also enclosed several pieces of information from Jacquie Glover-Brown at her request. Please note that all of the enclosed materials are in draft form and need work—which is progressing even as I write this. We are currently reorganizing our materials to match the outline and are ensuring that our writeups match yours.

I hope this meets with your approval. We look forward to receiving your comments.

Sincerely,

Susan E. Brown
Editor

Enclosures

* Too much concentration on pics in early pages

Ken - Missing beginning of Ch III - was still printing when last fed-ex run was made. Will get to you Mon/Tu.

INFORMATION ♦ MANAGEMENT ♦ COMMUNICATIONS

635 Slaters Lane, Suite 400, Alexandria, Virginia 22314 Phone (703) 684-5588 / Fax (703) 548-0426 / TDD (703) 684-8226

Chapter III. Affected Environment

This chapter describes the areas within ~~Prince William Sound (PWS) and the Gulf of Alaska~~ Oilspill Area directly affected by the *Exxon Valdez* oil spill. Part A covers the physical setting, including climate, oceanography, habitat types, geology, and mineral resources. Part B describes the ~~fish and wildlife of PWS~~ Resource and summarizes the results of the NRDA studies on the biological impacts of the spill, including injury to biota in affected aquatic, intertidal, and terrestrial habitats. Part C provides an overview of the socioeconomic environment and conditions in the affected area before and after the spill. This section gives the historical background of the affected regions, as well as information about the socioeconomic and cultural impacts of the spill on affected communities.

A. Physical Description

1. Setting

Map IIIA shows the location of the area oiled by the *Exxon Valdez* spill. ~~in relation to the rest of the State of Alaska.~~ Within this area, PWS was the most severely affected.

[MAP HERE.]

PWS is located in southcentral Alaska, north of the Gulf of Alaska, encompassing a surface area of approximately 15,000 square miles (38,850 sq km). PWS contains an open water area of approximately 100 miles (161 km) in diameter and up to 2,850 feet (869 m) deep (Mickelson, 1988). It is an estuary about the size of Maryland's Chesapeake Bay or Washington State's Puget Sound, with a mainland shoreline of more than 1,500 miles (2,413 km). ~~It is approximately 15 times the size of San Francisco Bay.~~ The total mainland shoreline of PWS is approximately 1,500 miles (2,413 km). PWS contains 15 major islands, including Montague, Kodiak, and Afognak; 19 minor islands; and 150 lesser islands. The combined island shorelines measure approximately 1,500 miles (2,413 km). PWS is one of the largest and least developed marine ecosystems in the United States.

Southwest of PWS are the Kenai Peninsula and Kodiak Island. South of the Kenai Peninsula is the Shelikof Strait, which lies between Kodiak Island and the Alaska Peninsula. The Alaska Peninsula narrows into the Aleutian ~~chain of~~ islands. In this diverse system of land, marine, and freshwater habitats are located the following public (State- or Federal-owned) lands: Chugach National Forest, Kenai Fjords National Park, the Alaska Maritime National

Wildlife Refuge, Kodiak National Wildlife Refuge, Katmai National Park and Preserve, the Alaska Peninsula/Becharof National Wildlife Refuge, Aniakchak National Monument and Preserve, and Kachemak Bay State Park.

The geology of the PWS region is young and relatively unstable. Glaciers, earthquakes, and active volcanoes are common. Two major rock formations prevail, the Valdez group and the Orca group. It is estimated that the Valdez group, which is composed of marine sandstone and slate, is 180 million years old. The younger Orca group contains both sedimentary and volcanic rock. The Chugach Mountains, part of the Orca group, rise to heights of 13,000 feet (3,965 m) and surround much of PWS (Mickelson, 1988).

In March 1964, an earthquake with an epicenter west of Columbia Glacier shook PWS for approximately 5 minutes. The towns of Valdez, Whittier, and Chenega were destroyed ~~by waves,~~ and people in several ~~small villages~~ towns were killed. ~~Damaging effects of the earthquake were felt as far away as Anchorage.~~ As a result of the quake, the south end of Montague Island rose 38 feet (11.58 m), shorelines and river mouths were forever changed, and much of PWS to the southeast rose an average of 6 feet (1.83 m).[1]

2. Air and Water Quality

PWS has a maritime climate with heavy precipitation, averaging 150 inches (381 cm) annually with a range of 64 to 179 inches (163 to 455 cm). The area is snow covered in the winter, with up to 21 feet (6.4 m) of snowfall per year in Valdez; 15 percent of the total area, mostly in the mountains, is covered with permanent ice and snow. Snow falls in the high country of the Chugach Range from September through April. Temperatures in the region range from approximately 20° F (-4° C) in January to a high of approximately 50° F (13° C) in the summer. The ports of Homer and Seward usually remain ice-free (Mickelson, 1988).

Winter winds in the Gulf of Alaska are generally easterly or southeasterly and interact with currents to push waters into PWS. This produces complex flow patterns resulting in strong downwelling and an outflow of surface waters to the southwest. Various distinct local wind patterns exist; however, PWS winds are predominantly from the north. In central and southern PWS, dominant winds are from the east (Michel et al., 1991 Oil Spill Conference). The southerly wind pattern pushes surface waters out of PWS and into the Gulf of Alaska.

[1]Ownership of evulsive (i.e., lands brought above sea level by the earthquake) is one issue the public wishes the Restoration Plan and the EIS to address.

Data from water samples in the spill area indicate that concentrations of VOA, PAH, PHC, and TPH in PWS and the Gulf of Alaska peaked immediately after the spill and decreased shortly thereafter. Peak concentrations for all subject compounds were well below State and Federal standards. Isolated samples that showed elevated concentrations were observed to contain ~~mousse~~. Analysts concluded that no long-term contamination of the water column resulted from the spill. [NEED GRAPH HERE THAT SHOWS MEASURED CONCENTRATIONS OVER TIME, PLUS ANALYTICAL LIMITS AND FED/STATE STDS.]

Ken: THE species will go @ end of this section. 4/9

B. Biological Description

The Prince William Sound region supports a diverse collection of wildlife. The Exxon Valdez oil spill occurred in March, just before the most biologically active season of the year. It affected the migration of birds, and the primary breeding season for most species of birds, mammals, fish and marine invertebrates in the spill's path. The spill affected each species differently. For some the population measurably declined. For example, an estimated 3,500 to 5,000 sea otters were killed by the spill, and the population will not recover for many generations. Other species were killed or otherwise injured by the spill, but the injury did not measurably lower the overall population. Some species, such as marbled murrelets, pigeon guillemots, and harbor seals were declining before the spill. Their rate of decline was accelerated by the spill, but other factors such as variations in climatic conditions, habitat loss, or increased competition for food may also have influenced long-term trends in the health and populations of these other species. Still other species may have been indirectly affected by changes in food supplies or disruption of their habitats.

IT IS ~~estimated~~ that

IT

The availability of population and habitat data varies from species to species. Some PWS species (e.g., invertebrates such as clams and barnacles) have never been inventoried. Others, such as the ~~brown bear and~~ the Killer whales and bald eagle, are counted ~~annually~~ for management purposes. And much is known about species that have played a significant historic or economic role in the region, such as sea otters and salmon. Federal and State ~~environmental~~ agencies had conducted baseline surveys of some native species prior to the oil spill; these surveys documented selected species' populations and critical habitats.

This section provides a summary of the baseline conditions for species and resources found the oil spill area. It will be used in evaluating potential impacts, either direct or indirect, of the various restoration options.

1. Marine Mammals

Harbor Seals

Harbor seals (*Phoca vitulina richardsi*) are found only in the North Pacific Ocean from northern Mexico to Alaska and the Bering Sea, and in the western Pacific from Japan to Siberia. They are found in ~~Prince William Sound~~ oil spill area year round (Frost et al., 1993). Harbor seals prefer coastal waters less than 60 meters deep. They live close to shore, and often enter estuaries and rivers to hunt for fish (Van Gelder, 1982). Rocky areas, isolated

beaches, ice flows, sand bars, and mud ~~bars~~ flats are used by the seals as haulout areas. Haulout areas are important to seals for pupping, nursing young, resting, and molting (Ronald et al., 1982). ~~Harbor seals feed on abundant area fish and often interfere with commercial fishing activities by damaging nets.~~ Harbor seals ~~also~~ feed on benthic invertebrates such as crabs, ~~crayfish~~, shrimp, and starfish, as well as squid, herring, sardine, salmon, rockfish, and other fish. Larger food is taken to the surface and eaten in pieces; smaller food is swallowed whole. Seals require only one large meal a day (Ronald et al., 1982).

Harbor seals become sexually mature between 2-5 years for females and 3-6 years for males. Mating occurs in late June through July with a single pup born between May and July, ~~at a haulout.~~ The pup usually stays with its mother for 3 to 6 weeks (Van Gelder, 1982). ~~Much of this time is spent at the haulout area~~. Molting in the late summer months ~~also~~ occurs on the haulout areas, and disturbances during molting can threaten the survival of the seals.

Harbor seals have a life span of approximately 18 years, though they have been known to live as long as 40 years (Ronald et al., 1982). The population in Alaska has been declining at about 11-14% per year since the mid 1970s for unknown reasons (Frost and Lowry, 1993). After the Exxon Valdez oil spill, seal populations at oiled areas were declining at 44%, while nearby unoiled populations were declining at 8% (Frost and Lowry, 1993). In August 1991, the population of harbor seals was estimated at 2,875 in the Prince William Sound (Exxon Valdez Oil Spill Trustees, 1992).

Steller's Sea Lions

Steller's sea lions (*Eumetopias jubatus*) range along the Pacific coast of North America from southern California through Alaska (Ronald et al., 1982). The north Gulf of Alaska contains a major portion of the worldwide habitat (NRDA, 1990). During the spring, several thousand sea lions move through the Gulf of Alaska returning to rookeries (sometimes called haulouts) to mate and give birth. Sexual maturity is reached in 4-5 years for females, and 5-7 years for males. Mating and pupping occur from mid-May to late June, with gestation lasting for approximately 12 months (Ronald et al., 1982). Major breeding rookeries along the Alaskan coast include the entrance to Prince William Sound, along the eastern Kenai Peninsula coastline, Barren Islands, northern Kodiak area, Chirikof Island to the south of Kodiak, and the Semidi Islands to the south of Shelikof Strait (NRDA, 1990).

Prior to 1982, the population of sea lions in the Alaska area was 200,000 (Ronald et al., 1982), however, the population has been declining substantially since the 1970s (NRDA, 1990). The reasons for the population decline are unknown.

The sea lion prefers shallow waters near the coast, with access to gravel beaches, and ice flows. The sea lion diet consists of coelenterates, sand dollars, worms, and mollusks, as wells as cod, herring, halibut, and salmon (Ronald et al., 1982).

Sea Otters

Sea otters (*Enhydra lutris*) are found only in the North Pacific Ocean. Historically, sea otters ranged from Baja California, up the coast of the United States and Canada, along Alaska and the Aleutian Islands, to the northern islands of Japan (Kenyon, 1982). Due to extensive fur hunting of sea otters through the eighteenth and nineteenth centuries, the present population is thinly distributed, with the bulk of the population located near the Aleutian Islands. The Marine Mammal Protection Act of 1972 placed a moratorium on harvesting many marine mammals, including sea otters. Native Alaskans are exempt, and continue to hunt sea otters for subsistence. Range areas along the state of Alaska include Prince William Sound, Kenai Peninsula, Kodiak Islands, and the Alaska Peninsula (Gibbons, 1993).

Prior to 1989, the population of sea otters was estimated at over 100,000 along the coast of Alaska (Van Gelder, 1982). The population may have been as high as 10,000 in Prince William Sound and 20,000 in the Gulf of Alaska prior to the oil spill (Exxon Valdez Oil Spill Trustees, 1992). When the Exxon Valdez oil spill occurred, the sea otter populations along Prince William Sound and the Kenai Peninsula were particularly affected (Exxon Valdez Oil Spill Trustees, 1992). ~~Frost et al. (1993) reports that more than 4,000 sea otters died from the oil spill, with over 2,000 deaths specifically in Prince William Sound. Up to 1,011 sea otter carcasses have been reported due to the spill (Exxon Valdez Oil Spill Trustees, 1992). In the year after the spill, the sea otter population in the oiled areas declined by 35% while nearby unoiled populations increased by 13% (Frost et al., 1993). In 1991 estimates, the sea otter population in the oiled areas appeared to have stabilized, but remains below the pre-spill levels (Frost et al., 1993).~~

No other monitoring data included in other species write-up

The habitat of sea otters is restricted to shallow coastal waters. They do not inhabit inland waterways (Kenyon, 1982). Sea otters are known to rest in kelp beds and use intertidal rocks and exposed beaches as haulouts. The importance of haulouts for sea otters is not fully understood. Haulouts appear to be necessary for the sea otter to clean

and dry its fur (Van Gelder, 1982). Maintaining their fur is an important activity because sea otters do not have a blubber layer like many marine mammals. They are dependent on the ability of their fur to trap air to insulate against the cold (Kenyon, 1982).

Sea otters feed in intertidal and subtidal areas on mussels, clams, crabs, and other benthic invertebrates, as well as slow moving benthic fish (Van Gelder, 1982). To feed, sea otters ~~dive into the water~~ submerge, catch their food with their paws, and return to the surface to eat while floating on their backs, often using their chest as a table (Van Gelder, 1982). Mother-pup pairs tend to hunt in shallower areas, preferring shorter dives (Exxon Valdez Oil Spill Trustees, 1992). Sea otters are prey for eagles, sharks, and killer whales (Kenyon, 1982).

Sea otters reach sexual maturity between the ages of 4 and 7 years. They can breed throughout the year, but they usually mate between September and October. Males and females do not remain paired after mating. A single pup is born between May and June, and is dependent on its mother for 6 to 8 months after birth (Van Gelder, 1982).

According to Monson and Ballachey (1993), the natural mortality pattern for sea otters is for 45% of deaths to be juveniles (0 to 1 year olds), 15% prime age (2 to 8 year olds), and 40% old individuals (greater than 9 year olds). Monson and Ballachey (1993) report that the mortality patterns of the sea otters have changed since the oil spill. Instead of the mortality proportions of 45%, 15%, and 40% for juvenile, prime age, and old otters, respectively; the pattern in the spill year (1989) was 32%, 44%, and 24%, respectively. The altered pattern was still present in 1990 and 1991, and indicates that the sea otter population has yet to enter a recovery phase (Rotterman and Monnett, 1993).

Killer Whales

Killer whales (*Orcinus orca*), the largest member of the Dolphin family, live and migrate in groups of up to 50 individuals called pods. A typical pod will contain 5 to 20 individuals composed of 23% mature males, 34% mature females, 39% juveniles and 4% calves or young of the year (Grzimek, 1990). There are two types of pods, resident and transient. Transient pods travel great distances throughout the year. Individuals from transient pods may leave their pods for a period of several months to several years and swim with other transient pods. Resident pods have a more defined social structure, including a home range that may cover an area up to several hundred square miles. Maternal groups of the resident pod remain together throughout their entire life span. Offspring will remain with the pod, and when they mature their offspring also remain

with the pod (Matkin, Dahlheim, Ellis and Saulitis, 1993).

Killer whales, although observed in oceans throughout the world, prefer cooler coastal waters and sometimes enter shallow bays, estuaries and mouths of rivers. Salmon, cod, Pacific herring, flatfish, blackcod, squid, pinnipeds and other cetaceans are documented food sources of the killer whale. Resident pods primarily eat fish, although sometimes they will eat small mammals and birds. Transient pods also eat fish and birds, but prey on small marine mammals more than resident pods.

Killer whales reach lengths of 21 to 26 feet for males and 16 to 21 feet for females, and weigh between 5,500 and 15,400 pounds (Grzimek, 1990). Killer whales have a life span of approximately 25 years and reach sexual maturity at an age of approximately 7 years. Breeding may occur at any time of year, but in the Northern Hemisphere mating peaks from May to July with births occurring in the fall (Walker, 1983). The gestation period is about 16 to 17 months and the cows give birth to a single calf. The females will nurse their calves for about 12 months and care for them for up to 2 years (Trustees, 1992). The birthing rate of killer whales varies, with 5 years being an average time between calves.

Humpback Whales

Humpback whales, (*Megaptera novaengliae*), are currently listed under the U.S. Endangered Species Act of 1973. The estimated worldwide population of humpback whales is 10,000, with approximately 1,500 occurring in the North Pacific (von Ziegesar and Dahlheim, 1993). The humpback whale grows to a length of ~~36 to 47 feet for males and 38 to 48 feet for females~~ 36' to 48, and weighs 33 to 50 tons (Grzimek, 1990). Their preferred habitat is along shallow shelves and bank areas, instead of deeper ocean waters. During spring migration, the humpback whale travels well defined routes along the continental coastline to higher latitude waters for feeding. In the Northern Hemisphere the mating and calving season is October to March (Walker, 1983). During the breeding season, the humpback whales migrate to tropical waters, usually in groups of only two or three individuals. Humpback whales give birth to 1 calf every 1 to 3 years. After birth, calves nurse for approximately 11 months. The life span of the humpback whale is unclear but is estimated to be up to 77 years. The humpback whale reaches sexual maturity in 7 to 10 years.

Humpback whales primarily feed on krill and schooling fishes such as herring, anchovies, and sardines.

2. Terrestrial Mammals

Sitka Black-tailed Deer

The range of the Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) lies along the Pacific Coast of Canada, Prince William Sound, and the Kodiak Islands (Wallmo, 1978). The black-tailed deer is the most abundant large mammal in its range area in Alaska. In Prince William Sound, the deer population is estimated at 15,000 to 20,000, and up to 100,000 in the Kodiak ~~Islands~~ Archepelago. Most of the deer habitat at Prince William Sound is on the Hinchinbrook, Montague, and Hawkins Islands (NRDA, 1990).

Sitka black-tailed deer live in coniferous forested areas for most of the year. Studies have indicated that old-growth forest habitat is essential for maintenance of a healthy deer population (Smith and Trent, 1991). In winter/early spring, the deer forage on beaches in intertidal areas due to snow accumulation in higher altitudes. When the uplands begin to melt in the spring, the deer move further inland.

Deer eat intertidal marine vegetation, kelp, coastal sedges, grasses, shrubs, and herbaceous vegetation in the forest understory (NRDA, 1990). They have a seasonal eating cycle, eating more in summer and fall when food is more abundant, and relying more on fat stores in the lean winter months. Body weight generally peaks in October and reaches a low point in March (Mackie et al., 1982). They are a subsistence source used by Native Alaskans and hunted for sport. ~~Brown bears occasionally kill young deer for food.~~

The Sitka black-tailed deer reaches sexual maturity at approximately one and a half years of age (Mackie et al., 1982). Mating occurs between September and November. One to two fawns are born the following summer (Wallmo, 1978).

Black Bear

Black bears (*Ursus americanus*) live in less settled, forested areas in the major mountain ranges of the U.S. and in all of the Canadian provinces. Black bears are found throughout the state of Alaska with dense populations in Prince William Sound (Jonkel, 1978; NRDA, 1990). Black bears prefer ~~inaccessible~~ terrain with thick understory vegetation, but also range over early successional areas including high tidelands, riparian areas, and wet and dry meadows (Pelton, 1982).

Black bears are omnivorous. They eat grasses, berries, tree borne fruit, and colonial insects and beetles (Pelton, 1982). Prior to hibernation, foraging activities become more intense and black bears will travel over large distances searching for food, often leaving the forested areas. Foraging may take them to beaches where black bears eat intertidal organisms and scavenge carcasses of marine mammals and birds (NRDA, 1990).

Black bears become sexually mature at 3 to 5 years old. They reproduce every other year. Breeding occurs in the summer, peaking in late June and July. Two to three cubs are born in winter during hibernation. Bears emerge from their dens in late March to early May. Cubs stay with their mother until spring or summer of the following year (Pelton, 1982).

Brown Bear

Historically, brown bears (*Ursus arctos*) ranged from the North American Great Plains to northern Alaska. Presently, they are abundant only in remote areas of western Canada, and coastal southcentral and southwest Alaska (Craighead and Mitchell, 1982). Besides the Alaskan Peninsula, brown bears live on the islands of Kodiak, Afognak, and Shuyak. Brown bears have seasonal movement patterns. They emerge from their dens in ~~early~~ April and May, forage along the coastline during the spring, move to anadromous streams in the summer, and travel upland when berries ripen in the fall. Between October and November, brown bears enter dens in the mountains for hibernation (Craighead and Mitchell, 1982).

Brown bears are omnivorous and eat a wide variety of foods. Favored plant food includes roots, acorns, berries, sedges, and grasses. Brown bears forage in intertidal areas for clams and mussels. They scavenge beaches for dead marine mammals. They are capable of killing ~~small ungulates, and in spring they will feed on~~ young moose, deer, and caribou. During the spawning season, bears will fish at areas of salmon runs. ← Awkward They are also attracted to garbage dumps for foraging (Craighead and Mitchell, 1982).

Brown bears reach sexual maturity between 3.5 and 9.5 years. Mating occurs between mid-May and mid-July, with a peak in early June. The following February, 2 to 3 cubs are born. Cubs stay with their mother until they are weaned as two-year olds (Craighead and Mitchell, 1982; Jonkel, 1978). Only 45 to 69% of cubs survive to be yearlings (1.5 years old).

Thousands of visitors come to Katmai National Park and McNeil River State Game Sanctuary annually to observe and photograph brown bears. Approximately 250 brown bears are harvested annually by residents and non-residents (NRDA, 1990).

River Otters

The River Otter (*Lutra canadensis*), has been found throughout North America except for the extreme Southwest (Trustee, 1992). The river otter is one of the largest members of the Weasel family. Found in marshes, wooded stream banks, and all types of inland waterways, the river otter is almost completely aquatic, although it will travel great distances across land, moving from one stream to another (Forsyth, 1985). River otters do not excavate their own dens, but instead use natural cavities in shores or use dens

left behind by other animals. On occasion they will build nest like structures in aquatic vegetation.

The primary diet of the river otter is ~~nongame~~ fish. They also eat ~~frog, crayfish~~, crabs, mussels, clams, snails and other aquatic invertebrates (Walker, 1983). Additionally, they have been known to eat birds and small land mammals such as rodents and rabbits.

Male river otters reach maturity at 2 years but do not become successful breeders until 5 years. Females mature in 2 years and may breed in as little as 1 year. Breeding occurs in late winter to early spring. ~~The river otter has a delayed implantation process and~~ with a ~~actual~~ gestation period of 60 to 63 days (Toweill and Tabor, 1982). Births normally occur in the spring and the female will breed again shortly after giving birth. The litter size of the river otter varies from 1 to 6 kits, with 2 or 3 kits being common. River otter kits are born blind and helpless. They are blind until the age of 3 weeks and do not swim until the age of 6-9 weeks. The river otter has a life span of 13 years. Predators include bobcat, lynx, coyote, wolves, bald eagle, great horned owl and large game fish when they are young.

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pike etc.)

3. Birds

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) occurs only in North America, ranging from south of the arctic tundra in Alaska and Canada to the southern United States and Baja California in Mexico. Breeding and nesting habitats are primarily along the coast and inland lakes and rivers (Brown and Amadon, 1968). Of the estimated Alaska bald eagle population of 39,000 birds (27,000 adults and 12,000 fledglings), an estimated 4,000 reside in Prince William Sound, and an estimated 8,000 to 10,000 reside along the northern Gulf of Alaska coast (Exxon Valez Oil Spill Trustees, 1992). Breeding density may be as high as one nesting pair per mile (1.6 km) of shoreline (Mickelson, 1988).

Water is the feature common to bald eagle nesting habitat throughout the continent. Nearly 100 percent of all bald eagle nests are within two miles, and the vast majority are within a half mile, of a coastal area, bay, river, lake, or other body of water (Grubb, 1976; Lehman ,1979). Proximity to water reflects the dependence of bald eagles on fish, waterfowl, and seabirds as primary food sources.

Nesting usually occurs in trees with two characteristics, a clear flight path to at least one side of the nest and excellent visibility (often with an unobstructed view of water) common to nearly all bald eagle nests. These characteristics usually are provided by dominant or co-dominant trees within wooded areas, trees at the edge of wooded areas, and trees in open areas. Most nest trees also have a stout limb structure or a branching pattern that is suitable for supporting a large nest near the treetop. Nests typically are used for a number of years and become immense in size because the birds add to them each year. Occupied nests on cliffs and rock pinnacles are known to occur in Alaska (Sherrod *et al*, 1977). Ground nest on Kodiak Is.

Abundant, readily available food resources are a primary characteristic of bald eagle wintering habitat. Most wintering areas are associated with open water where eagles feed on fish or waterfowl, often taking dead or injured animals that are obtained easily. Wintering bald eagles also use habitats with little or no open water if other food resources, such as carrion, are regularly present (Spencer, 1976). Night roost sites are the other major characteristic of winter habitat. Roost trees usually are the oldest and largest trees within a stand and most have stout horizontal limbs and an open branching pattern. Visibility of the surrounding area is unobstructed, and little or no human activity occurs in the immediate vicinity.

Bald Eagles are monogamous and are believed to mate with the same individual for several years, possibly for life. A breeding female lays a single clutch of one to three eggs. Although bald eagles have been known to lay a second clutch if the first is destroyed (Hoxie, 1910), ~~this apparently is rare.~~ Mated pairs do not necessarily produce eggs each year. Nesting usually starts in March with incubation beginning when the first egg is laid. Incubation usually last 34 to 36 days. The young fledge from 70 to 98 days after hatching. Sometimes the smaller and weaker sibling is killed during this pre-

fledgling period. Young eagles usually remain dependent on the adults for another 60 to 80 days while they learn to hunt (Bent, 1937; Maestrellin and Wiemeyer, 1975; Fraser, 1981).

Bald eagles in captivity have been recorded as living up to 36 years, but it is unlikely that many individuals reach that age in the wild (Newton, 1979). Of the young birds that fledge, probably at least 50 to 70 percent die within a year, and it has been estimated that more than 90 percent may die prior to attaining adult plumage. Mortality is believed to be low for adults and is estimated to range from five to 10 percent per year (Sherrod *et al*, 1977). It was estimated that in 1989, 85 percent of the nests located in the oil spill areas failed to produce young. Reports indicate that the eagle population recovered during the following year, and in 1990 reproduction rates returned to normal. oil PWS

Peale's Peregrine Falcon

The Peale's peregrine falcon (*Falco peregrinus pealei*) is a very large, dark western form, or subspecies, of the peregrine falcon. In North America it nests from the Aleutians, occasionally the Pribilofs, south to Queen Charlotte Island. In winter it migrates to California (Brown and Amadon, 1968).

During the breeding season peregrines frequently inhabit offshore islands where bluffs provide suitable undisturbed nest sites and an abundance of food from nearby colonies of nesting seabirds. At all seasons more open country is preferred, particularly shores and marshes frequented by shorebirds and waterfowl. In Alaska, nesting usually occurs around July with three to four eggs laid (Terres, 1980). Incubation is by both sexes, but is mainly done by the female ~~beginning with the second to third egg~~. Incubation lasts 28 to 29 days with the young flying 35 to 42 days after hatching (Brown and Amadon, 1980). The young birds are dependent on the adults for a ~~further~~ Age Fledge two months. Peregrines usually do not breed until three years old (Nelson, 1972). Peregrines will lay a second set of eggs if the first set is destroyed early in incubation (Beebe, 1967).

Common Murre

The subspecies of common murre found in Alaska (*Uria aalge inornata* Salomonsen) breeds from the Commander Islands, Saint Matthew Island, and northwestern Alaska to Kamchatka, the Kurile Islands, southern Sakhalin, eastern Korea, and Hokkaido, and through the Aleutian and Pribilof Islands to southern British Columbia (Johnsgard, 1987). The strongly black-and-white plumage and moderately large body (wingspread of about 30 inches) separate this species from all other alcids except the thick-billed murre and the razorbill. Before the spill, approximately 1.4 million murres, both common and thick billed (*Uria lomvia*), occupied the region between Unimak Pass and the Canadian border in southeast Alaska. The total murre population in Alaska was estimated to be approximately 12 million.

Breeding colonies of common murres are largely restricted to subartic and temperate coastlines having surface water temperatures in August ranging from 4°C in the north

to 19°C in the south, with the northern limit corresponding fairly well to the southern edge of the pack ice in March (Voous, 1960). Within these limits, murres of both species breed mostly on rocky coasts that usually have steep seaward cliffs, though low-lying coasts may also be used if they are remote and predator-free. Stratified rock layers providing nesting ledges, or weathered pinnacles and similar promontories , are important habitat components (Tuck, 1961). Where both species of murres occur, the thick-billed murre is likely to occur on narrower cliff ledges and smaller promontories than the common murre (Voous, 1960).

Non-breeding habitats are coastal and pelagic areas extending as far south as the 15°C February isotherm, and probably north to the limits of pack ice. Typically, they are found in the offshore zone (at least 8 kilometers out to sea), and no more than a few hundred kilometers offshore at their southernmost breeding limits (Tuck, 1961).

The common murre feeds predominantly on ~~schools of~~ fish throughout the year. Prey are captured by extended dives, mostly at depths of 4-5 meters, but sometimes by bottom feeding at 8 meters (Madsen, 1957). Under pelagic conditions the birds may dive up to ~~even deeper, rarely as much as~~ 30 meters, at which depths it has been captured in crab pots off coastal Alaska (Forsell and Gould, 1981). Foraging tends to occur in flocks early in the breeding season, but as the year progresses murres increasingly forage individually.

Murres normally nest in dense colonies on cliff faces, and breeding is synchronized so that all young hatch at the same time. Synchronized breeding helps repel predators such as gulls and ravens. Murres are highly social birds on the breeding areas, with maximum densities of 28 to 34 birds per square meter reported by Tuck (1960), with some birds occupying no more than 500 cm^2 (about 0.5 square feet) of ledge. No nest is built, though a few pebbles or other materials may be dropped at the nest site, perhaps to reduce rolling of eggs early in incubation before the egg has become cemented to the substrate by excrement and sediment (Johnsgard, 1987). Only one large pyriform (pear-shaped) egg is laid. If disturbed, the egg will roll in a small circle around its pointed end. Both sexes incubate with an average incubation period of 28 to 34 days (Tuck, 1961). Both adults feed the chick, which is rarely left unattended. Nonetheless, there is often a fairly high loss of chicks to exposure or falls during the first six days after hatching, after which clinging, hiding, and thermoregulation abilities have become better developed (Johnsgard, 1987). Chicks leave the nest 18 to 25 days after hatching by scrambling, flying, or gliding down to the sea in company with one of the adults, nearly always after dusk (Greenwood, 1964). The young birds immediately leave the vicinity of the colony, and for the first few weeks chicks are cared for communally by adults until able to fly, about 39 to 46 days after hatching (Tuck, 1961).

Breeding success has been reported to be between 70 to 80 percent of young fledged per breeding pair (Birkhead, 1977; Hedgren, 1980). Birkhead (1974) estimated a six percent annual adult mortality rate and stated that most birds probably do not begin breeding until their fifth year. A six percent mortality rate results in an average life expectancy for adults of 16 years; though banded birds have been known to survive as long as 32

years.

Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratum marmoratum*) ~~apparently~~ breeds on islands and in coastal areas from southeastern Alaska to northwestern California. In Alaska, it is probably a common to abundant breeder in southeastern and south-coastal areas, a resident and probable local breeder in the Alaska Peninsula and also the Aleutians, and a casual summer visitor in western areas (Kessel and Gibson, 1976). Islieb and Kessel (1973) estimated a total marbled murrelet population of several hundred thousands, possibly in the millions, in the North gulf Coast and Prince William Sound region of Alaska.

In both plumages the marbled murrelet closely resembles the Kittlitz murrelet (*Brachyramphus brevirostris*), and in southern Alaska waters these two species can perhaps be separated by the shorter exposed bill of the Kittlitz, its more uniformly brownish color in the breeding season, and by its greater amount of white on the face in winter (Johnsgard, 1987).

The total breeding distribution of this species is poorly understood, but it apparently is limited to fairly warm waters of the west coast of North America and the east coast of Asia, ~~approximately between the August surface water isotherms of 9°C and 15°C~~. It is most closely associated with the humid coastal areas supporting wet-temperate coniferous forests with redwood, Douglas fir, and other ecologically similar species, but it also inhabits coastlines along tundra-covered uplands along the Alaska Peninsula and in the Aleutian Islands. In winter the birds move farther south, sometimes as far as southern California, but some wintering occurs on protected waters as far north as the Kodiak area of Alaska and as far west as the Aleutians (Forsell and Gould, 1981). For most of the year the birds seem to prefer semiprotected waters of bays and inlets, making only limited use of rock coastlines (Hatler, Campbell, and Dorst, 1978).

The murrelet eats small fishes which it gets by diving in tide rips and other places where small fishes swim in schools. The major fish prey, sand launce (*Ammodytes*), belongs to a group of fish in which the young of the previous fall and winter tend to migrate to surface waters and move inshore in late spring, when they would become available to the murrelets. The fall and winter diet of the species is essentially unknown, but samples from a few birds suggest that sea perch (*Cymatogaster*) may be an important food item, and possibly also mysid and schizopod crustaceans (Sealy, 1975). Foraging in spring is done mainly by pairs or by single subadults, and later in early July mixed flocks of adults and subadults being to form. Nearly all foraging is done in fairly shallow water, close to shorelines.

Day, Oakley, and Barnard (1983) summarized data on 8 known and 1 probable marbled murrelet nests; all but one contained unhatched eggs, and the remaining one a hatched chick. Dates of the nests with eggs ranged from June 3 (Kodiak Island) to August 1 (East Amatuli Island, Alaska). They ranged in elevation from 68 to 690 meters above sea

level and from less than 1 to 24 kilometers from the coastline. The nest sites varied considerably inslope and directional aspect, though a possible preference for shady north-facing slopes has been suggested. All the evidence available suggests that the clutch consists of a single egg with an incubation period of approximately 30 days and that young birds assume independent lives once they reach the sea (Sealy, 1974).

Storm Petrel

Storm petrels are among the smallest of the seabirds, measuring between 7½ and 9 inches in length and having a wingspan of 18 to 19 inches. These birds prefer the open ocean habitat and are reluctant to come ashore due to their reduced mobility on land. With the exception of the breeding and nesting period, these birds spend their entire lives on the ocean. Two species of storm petrels are known to occur in Alaska. Those species are the fork-tailed storm petrel (*Oceanodroma furcata*), and Leach's storm petrel (*Oceanodroma leucorhoa*). The fork-tailed storm petrel occurs in the Northern Pacific, from the Bering Sea to southern California (Terres, 1980). The breeding range includes the Kurile, Komandorskie, and Aleutian Islands southward along the North American Pacific coast to northern California. Leach's storm petrel occurs throughout the oceanic portion of the northern hemisphere. This species' breeding and nesting range includes coastal islands in the northern Pacific and northern Atlantic. In the Pacific, breeding occurs on the Kurile and Aleutian Islands, Alaska, southeast along the Pacific Coast to Baja California (Godfrey, 1979; Terres, 1980). The primary food sources are small fishes, crustaceans, mollusks, small squids, and oily materials gleaned from the ocean (Terres, 1980). ~~Leach's storm petrel has been known to take refuse matter left by whales, and can be attracted to a boat by throwing bits of fish liver overboard (Godfrey, 1979).~~

Habitat requirements for storm petrels include the open ocean, and coastal islands for nesting purposes. For breeding purposes, storm petrels prefer offshore islands. The preferred breeding and nesting habitats are burrows or rock crevices on marine islands and islets, although they have been known to nest up to one mile inland (Terres, 1980). The forked-tail storm petrel will breed on turf, in the open or among trees, but rarely among rocks. Leach's storm petrel will breed on turf or rocky slopes, and also makes no preference to wooded or treeless sites (Harrison, 1978). As these species are dense colonial nesters, the ground at the nesting site may be honeycombed with their burrows. The burrow entrances are often camouflaged by growing vegetation (Godfrey, 1979). The burrow is usually three feet long, somewhat angled, and is excavated by the petrel. Both the male and female fork-tailed storm petrel participate in excavating their burrow, while the male Leach's petrel excavates the burrow for that species. Some plant debris may accumulate at the nest site. Banding has shown that older breeding birds are the first to return to the nesting site in spring, and that pairs often return to the same nest burrow each year. It is thought that the species mates for life (Terres, 1980).

The breeding season begins in late May for Leach's storm petrel and in June for the forked-tailed storm petrel. The female produces a single clutch consisting of one egg. If that clutch is destroyed, storm petrels will not produce a second ~~clutch~~ egg (Harrison, 1978). Incubation begins when the first egg is laid, usually in late May or early June for

Leach's storm petrel and June to July for the forked-tailed storm petrel. Both male and female participate in the incubation which usually lasts from 5½ to 7 weeks (Terres, 1980). During the day, incubating birds do not stir, and their mates remain far out at sea. At night, however, the colony becomes active as the birds return from the sea to relieve their mates (Godfrey, 1979). The young are downy, with usually two successive down coats followed by the first feathers. Although there may be long intervals between feedings for the young, they become much larger and heavier than the adults. Leach's storm petrels are brooded by one parent for the first five days, then tended at irregular intervals thereafter. The fledglings are usually deserted by the parents after 40 days. The young remain in the nest, living on fat reserves, and emerge at night to exercise as their feathers grow. The fledglings leave the nest for the sea at 63 to 70 days (Harrison, 1978).

Black-legged Kittiwake

The black-legged kittiwake (*Rissa tridactyla*) is a marine bird occurring throughout the northern part of the northern hemisphere. With the exception of the breeding season, this species occurs almost exclusively in offshore waters. The nesting range includes islands and shores of the Arctic Ocean south to the Aleutian Islands and southern Alaska, southern Newfoundland, France, the Kurile Islands, and Sakhalin. The winter habitat range extends south to Baja California, southern New Jersey, northwestern Africa, and Japan (Godfrey, 1979).

Black-legged kittiwakes spend the majority of their life at sea. It is known that they drink only salt water, and have rejected fresh water in captivity. ~~This species assembles in enormous flocks to gather scraps thrown into the water from ships. However,~~ the primary food sources are small fishes and small mollusks, crustaceans, and other plankton (Terres, 1980).

Black-legged kittiwakes often nest in dense colonies, usually on high cliffs overlooking the sea and in sea caves. Their nest sites may be associated with murres and other seabirds. The breeding season begins in May. Nests are deeply cupped, and constructed of grass, mud, moss, and seaweed (Terres, 1980). Nests are often built on small projections or irregularities in the rock face. The female produces, on the average, a single clutch consisting of two eggs. Both male and female participate in incubation, which lasts from 25 to 30 days (Harrison, 1978). Although black-legged kittiwakes are a single-brooded species, lost clutches are often replaced. The nestlings are tended by both adults, and are fledged between 38 and 48 days of hatching (Terres, 1980).

Pigeon Guillemot

Along the Pacific coast, the pigeon guillemot (*Cepphus columba*) is one of the most widespread members of the Auk family (Family Alcidae). These birds frequent saltwater, are skillful divers and swimmers, and prefer open seas (Terres, 1980). Pigeon guillemots have been documented as year-round residents of the Gulf of Alaska and the Aleutians. They are generally dispersed as single birds or small colonies of well under

1,000 individuals. In the winter, they move from exposed coastlines to sheltered bays and inlets. The winter range encompasses the Pribilof and Aleutian islands to Kamchatka and the Kurile Islands, and south to California. During the nonbreeding season, the birds are nonpelagic and fairly sedentary. They rarely move into water more than 50 meters deep, and tend to spread out thinly along coastlines in winter. Their breeding range extends from Chukotski Peninsula and Diomede Islands to southern Kamchatka, and from Saint Lawrence and Saint Matthew islands and the Aleutians west to Attu, Bogoslof, and Shumagin Islands, Kodiak, and southeastern Alaska south to Santa Barbara Island, California. Population estimates of the pigeon guillemot have suggested approximately 200,000 birds in Alaskan waters in the late 1970's (Johnsgard, 1987).

The pigeon guillemot is a diving bird, and feeds on bottom dwelling small fishes, mollusks, crustaceans, and marine worms (Terres, 1980). Most of the prey are to be found on or over rocky bottoms within the subtidal zone (Johnsgard, 1987). Dietary preference may vary between individuals of this species.

The pigeon guillemot breeding season begins in mid-May to mid-June, depending on latitude. The pigeon guillemot nests either solitarily or in small colonies of up to 50 pair (Terres, 1980). Nesting distribution may be dictated by the availability of nesting sites rather than by any colonial tendency. Breeding densities have been documented to range from 5 to 110 pair per colony (Johnsgard, 1987). Nests are often located in crevices or cavities under rocks, in a crevice, or a similar cavity site (Harrison, 1978). This species is also known to nest under railroad ties, use abandoned puffin and rabbit burrows, and nest on bridges and beneath wooden piers (Terres, 1980). In rocky habitats, the nests are usually close to water, often near the high-tide line. Throughout the breeding season, pigeon guillemots use the supratidal and intertidal areas in front of the nest sites for feeding and social activities (Johnsgard, 1987). Eggs are typically deposited on the bare cavity floor of the nest site, as no nest-lining materials are ever brought into the cavity. The female produces one clutch consisting of two eggs. This species is thought to be single-brooded, and since the incidence of renesting after the loss of the initial clutch is still ~~undetermined~~ (Johnsgard, 1987). Both sexes incubate, with incubation lasting from 30 to 32 days (Terres, 1980). Losses of eggs before hatching are sometimes fairly high. Causes of egg failure are diverse, and include human disturbance, heavy rainfall causing nest desertion or chilling, or predation (Johnsgard, 1987). Egg survival may be affected by ~~the usual~~ crow and gull predators. The northwestern crow (*Corvus caurinus*) has been mentioned as a serious egg predator (Bent, 1919).

The young are tended by both parents and may leave the nest after the first few days, but do not leave the nesting cavity until fledging (Harrison, 1978). The young are able to fly 29 to 39 days after hatching (Terres, 1980). At fledging time, the chicks are led from the nest, ~~after which they waddle~~ down to the water or, if necessary, fly or glide down from higher sites. The adults then cease to tend the chicks, leaving them to feed in nearby kelp beds (Thoreson and Booth, 1958). Alternatively, the chicks may be convoyed to deeper water where they are tended by adults for about a month after leaving the nest (Johnsgard, 1987). It is thought that pigeon guillemots do not begin

breeding until they are three to five years of age.

Glaucous-winged Gull

The glaucous-winged gull (*Larus glaucescens*) occurs primarily along the Pacific coast of North America. The summer range extends from Alaska and the islands of St. Lawrence, Pribilofs, and Aleutians south to northwestern Washington. The winter range extends from southeastern Alaska along the Pacific coast to Baja California (Terres, 1980).

The glaucous-winged gull is oceanic in its habits, and is most often found in the vicinity of salt and brackish water along the northern Pacific coast. This species is omnivorous, scavenging for garbage on docks, dumps, and shores near coastal cities, and will feed on the carcasses of animals or birds killed by hunters. Glaucous-winged gulls follow boats and ships in search of ~~garbage~~ feed, and will eat carrion and fishes at sea. Although this gull often follows sea-going vessels, it rarely forages more than a few miles off shore. From the near-shore areas, this species will gather barnacles, mollusks, and sea urchins for food (Terres, 1980, Godfrey, 1979).

Glaucous-winged gulls breed on steep coastal cliffs and rocky islands offshore. They often nest colonially, usually on flat, low islands, rock ledges of higher islands, or rock outcroppings. Nests are well-made bulky cups of grasses, seaweeds, feathers, fish-bones, and other debris built among tufts of plant life or left in the open on rocky ledges. The breeding season begins in late May. The female produces a single clutch of two to three eggs, that are incubated for 26 to 28 days. The young are tended by both adults and leave the nest between 35 and 54 days. Glaucous-winged gulls are single-brooded, but usually replace lost clutches (Harrison, 1978; Terres, 1980).

Harlequin Duck

The harlequin duck (*Histrionicus histrionicus*) is a diving duck common to the northern coastal areas of North America, and is a very familiar species along the coasts of the Aleutian Islands and Alaska. The harlequin duck occupies both an eastern and western range in the Northern Hemisphere. The eastern range includes Iceland, parts of Greenland, and Labrador, and may extend as far south as New Jersey in the winter. The western range includes northeastern Siberia north to the Arctic Circle, across the Bering Sea to the Aleutian Islands, much of the Alaskan interior, and south to northwest Wyoming and central California. The western population is much more abundant than the eastern population, with the main western stronghold being Alaska. The greatest abundance of harlequin ducks is in the Alexander Archipelago, the Alaska Peninsula, and the Aleutian Islands (Bellrose, 1980; Johnsgard, 1978; Terres, 1980).

Fall and spring migration patterns consist of lateral movements from interior breeding grounds to coastal habitat. A number of ducks migrate from the Alaskan interior to the Aleutians each fall. In the late 1960's, the May to August population estimates for the Aleutian Islands National Wildlife Refuge ranged from 100,000 to 150,000. Population estimates for this wildlife refuge peaked, however, during the winter season (September

to April) with ranges from 600,000 to 1 million individuals (Bellrose, 1980).

During the summer breeding season, the preferred habitat of the harlequin duck is a cold, turbulent mountain stream, or ponds or lakes along rocky arctic shores. The species will favor a forested mountain stream over a non-forested stream. In winter, the preferred habitat is heavy surf adjacent to a rocky coastline with shelves, reefs, and sunken rocks (Terres, 1980). This habitat of rocky shores and rushing mountain streams is not conducive to other duck species, making the harlequin duck a distinctive species in this habitat (Johnsgard, 1978). The breeding and wintering ranges of the harlequin duck lie within relatively remote areas. ~~Therefore, this species has not historically been affected by habitat destruction or hunting (Bellrose, 1980). It should be noted, however, that harlequin ducks can be legally harvested in Alaska in the fall.~~

Leave in

Harlequin ducks are not known to breed until their second year. Their breeding season begins in mid-May of each year. Adults congregate at the mouths of anadromous fish streams in spring, and most are paired by the time they leave the coastal wintering area for their interior breeding grounds. ~~The females~~ may use the same nest site each year. Harlequin ducks are primarily surface nesters. The male follows the female as she searches for an appropriate nesting site, inspecting crevices in rocks and densely vegetated shorelines. The nests are always well concealed by dense vegetation and are located along the rocky shores of turbulent mountain streams, often adjacent to rapids, in mature forests. Nests are composed of thin layers of grass, twigs, and leaves, and lined with white down (Bellrose, 1980).

The female produces one clutch consisting of three to seven eggs, laid at a rate of one every two days. The male leaves the female shortly after incubation begins, and leaves the breeding ground in preparation for the molt. The incubation period lasts from 27 to 33 days, although the time period has not been firmly established. The female incubates intently, taking feeding breaks every 48 hours. The ducklings are tended by the female only, and are capable of flying in about 40 days (Johnsgard, 1978; Harrison, 1978; Terres, 1980). The female remains with the brood in the freshwater stream until late summer when they migrate to the coastal habitat. Adults breed annually after reaching maturity.

Harlequin ducks feed by day, usually by themselves, and roost on rocks at night. They prefer water rich in aquatic life. This duck is a diving duck, ~~feeding much like a torrent duck~~, and is well adapted to swimming in torrential currents. Harlequins have been observed diving to depths of three to five feet in swift currents in search of food. They often emerge at their points of entry, indicating an ability to walk along the bottom of the stream against the current. At times they feed by immersing their heads or upending like dabbling ducks. Harlequin ducks have been observed feeding in the late afternoon and early morning hours (Terres, 1980; Bellrose, 1980).

The harlequin duck feeds primarily on ~~animal life~~. Crustaceans, mollusks, insects, echinoderms, and fishes ~~have all been taken as prey~~. In the mountain streams during summer, the harlequin will prey on mayfly nymphs, stone flies, caddis fly larvae, and

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Chapter III. Affected Environment

This chapter describes the areas within Prince William Sound (PWS) and the Gulf of Alaska directly affected by the *Exxon Valdez* oil spill. Part A covers the physical setting, including climate, oceanography, habitat types, geology, and mineral resources. Part B describes the fish and wildlife of PWS and summarizes the results of the NRDA studies on the biological impacts of the spill, including injury to biota in affected aquatic, intertidal, and terrestrial habitats.Part C provides an overview of the socioeconomic environment and conditions in the affected area before and after the spill. This section gives the historical background of the affected regions, as well as information about the socioeconomic and cultural impacts of the spill on affected communities.

A. Physical Description

1. Setting

Map IIIA shows the location of the area oiled by the *Exxon Valdez* spill in relation to the rest of the State of Alaska. Within this area, PWS was the most severely affected.

[MAP HERE.]

PWS is located in southcentral Alaska, north of the Gulf of Alaska, encompassing a surface area of approximately 15,000 square miles (38,850 sq km). PWS contains an open water area of approximately 100 miles (161 km) in diameter and up to 2,850 feet (869 m) deep (Mickelson, 1988). It is ~~an estuary~~ about the size of Maryland's Chesapeake Bay or ½ of an estuary Washington State's Puget Sound, with a mainland shoreline of more than 1,500 miles (2,413 km). It is approximately 15 times the size of San Francisco Bay. The total mainland shoreline of PWS is approximately 1,500 miles (2,413 km). PWS contains 15 major islands, including Montague, ~~Kodiak, and Afognak;~~ 19 minor islands; and 150 lesser islands. The combined island shorelines measure approximately 1,500 miles (2,413 km). PWS is one of the largest and least developed marine ecosystems in the United States.

Southwest of PWS are the Kenai Peninsula and Kodiak Island. South of the Kenai Peninsula is the Shelikof Strait, which lies between Kodiak Island and the Alaska Peninsula. The Alaska Peninsula narrows into the Aleutian chain of islands. In this diverse system of land, marine, and freshwater habitats are located the following public (State- or Federal-owned) lands: Chugach National Forest, Kenai Fjords National Park, the Alaska Maritime National

PWS?

Wildlife Refuge, Kodiak National Wildlife Refuge, Katmai National Park and Preserve, the Alaska Peninsula/Becharof National Wildlife Refuge, Aniakchak National Monument and Preserve, and Kachemak Bay State Park.

The geology of the PWS region is young and relatively unstable. Glaciers, earthquakes, and active volcanoes are common. Two major rock formations prevail, the Valdez group and the Orca group. It is estimated that the Valdez group, which is composed of marine sandstone and slate, is 180 million years old. The younger Orca group contains both sedimentary and volcanic rock. The Chugach Mountains, part of the Orca group, rise to heights of 13,000 feet (3,965 m) and surround much of PWS (Mickelson, 1988).

In March 1964, an earthquake with an epicenter west of Columbia Glacier shook PWS for approximately 5 minutes. The towns of Valdez, Whittier, and Chenega were destroyed by waves, and people in several small villages were killed. Damaging effects of the earthquake were felt as far away as Anchorage. As a result of the quake, the south end of Montague Island rose 38 feet (11.58 m), shorelines and river mouths were forever changed, and much of PWS to the ~~southeast~~ west rose an average of 6 feet (1.83 m).[1]

2. Air and Water Quality

PWS has a maritime climate with heavy precipitation, averaging 150 inches (381 cm) annually with a range of 64 to 179 inches (163 to 455 cm). The area is snow covered in the winter, with up to 21 feet (6.4 m) of snowfall per year in Valdez; 15 percent of the total area, mostly in the mountains, is covered with permanent ice and snow. Snow falls in the high country of the Chugach Range from September through April. Temperatures in the region range from approximately 20° F (-4° C) in January to a high of approximately 50° F (13° C) in the summer. The ports of Homer and Seward usually remain ice-free (Mickelson, 1988).

Winter winds in the Gulf of Alaska are generally easterly or southeasterly and interact with currents to push waters into PWS. This produces complex flow patterns resulting in strong downwelling and an outflow of surface waters to the southwest. Various distinct local wind patterns exist; however, PWS winds are predominantly from the north. In central and southern PWS, dominant winds are from the east (Michel et al., 1991 Oil Spill Conference). The southerly wind pattern pushes surface waters out of PWS and into the Gulf of Alaska.

[1]Ownership of ~~evulsive (i.e., lands brought~~ above sea level by the earthquake) is one issue the public wishes the Restoration Plan and ~~the EIS to~~ address.

spelled

Data from water samples in the spill area indicate that concentrations of VOA, PAH, PHC, and TPH in PWS and the Gulf of Alaska peaked immediately after the spill and decreased shortly thereafter. Peak concentrations for all subject compounds were well below State and Federal standards. Isolated samples that showed elevated concentrations were observed to contain mousse. Analysts concluded that no long-term contamination of the water column resulted from the spill. [NEED GRAPH HERE THAT SHOWS MEASURED CONCENTRATIONS OVER TIME, PLUS ANALYTICAL LIMITS AND FED/STATE STDS.]

Ken: T&E species will go @ end of this section. 4/9

B. Biological Description

The Prince William Sound region supports a diverse collection of wildlife. The Exxon Valdez oil spill occurred in March, just before the most biologically active season of the year. It affected the migration of birds, and the primary breeding season for most species of birds, mammals, fish and marine invertebrates in the spill's path. The spill affected each species differently. For some the population measurably declined. For example, an estimated 3,500 to 5,000 sea otters were killed by the spill, and the population will not recover for many generations. Other species were killed or otherwise injured by the spill, but the injury did not measurably lower the overall population. Some species, such as marbled murrelets, pigeon guillemots, and harbor seals were declining before the spill. Their rate of decline was accelerated by the spill, but other factors such as variations in climatic conditions, habitat loss, or increased competition for food may also have influenced long-term trends in the health and populations of these other species. Still other species may have been indirectly affected by changes in food supplies or disruption of their habitats.

The availability of population and habitat data varies from species to species. Some PWS species (e.g., invertebrates such as clams and barnacles) have never been inventoried. Others, such as the brown bear and the bald eagle, are counted annually for management purposes. And much is known about species that have played a significant historic or economic role in the region, such as sea otters and salmon. Federal and State environmental agencies had conducted baseline surveys of some native species prior to the oil spill; these surveys documented selected species' populations and critical habitats.

This section provides a summary of the baseline conditions for species and resources found the oil spill area. It will be used in evaluating potential impacts, either direct or indirect, of the various restoration options.

1. Marine Mammals

Harbor Seals

Harbor seals (*Phoca vitulina richardsi*) are found only in the North Pacific Ocean from northern Mexico to Alaska and the Bering Sea, and in the western Pacific from Japan to Siberia. They are found in Prince William Sound year round (Frost et al., 1993). Harbor seals prefer coastal waters less than 60 meters deep. They live close to shore, and often enter estuaries and rivers to hunt for fish (Van Gelder, 1982). Rocky areas, isolated

beaches, ice flows, sand bars, and mud bars are used by the seals as haulout areas. Haulout areas are important to seals for pupping, nursing young, resting, and molting (Ronald et al., 1982). Harbor seals feed on abundant area fishes and often interfere with commercial fishing activities by damaging nets. Harbor seals also feed on benthic invertebrates such as crabs, crayfish, shrimp, and starfish, as well as squid, herring, sardine, salmon, rockfish, and other fish. Larger ~~food is taken to the surface and eaten in pieces; smaller food is swallowed whole.~~ Seals require only one large meal a day (Ronald et al., 1982).

Harbor seals become sexually mature between 2-5 years for females and 3-6 years for males. Mating occurs in late June through July with a single pup born between May and July at a haulout. The pup usually stays with its mother for 3 to 6 weeks (Van Gelder, 1982). Much of this time is spent at the haulout area. Molting in the late summer months also occurs on the haulout areas, and disturbances during molting can threaten the survival of the seals.

Harbor seals have a life span of approximately 18 years, though they have been known to live as long as 40 years (Ronald et al., 1982). The population in Alaska has been declining at about 11-14% per year since the mid 1970s for unknown reasons (Frost and Lowry, 1993). After the Exxon Valdez oil spill, seal populations at oiled areas were declining at 44%, while nearby unoiled populations were declining at 8% (Frost and Lowry, 1993). In August 1991, the population of harbor seals was estimated at 2,875 in the Prince William Sound (Exxon Valdez Oil Spill Trustees, 1992).

Steller's Sea Lions

Steller's sea lions (*Eumetopias jubatus*) range along the Pacific coast of North America from southern California through Alaska (Ronald et al., 1982). The north Gulf of Alaska contains a major portion of the worldwide habitat (NRDA, 1990). During the spring, several thousand sea lions move through the Gulf of Alaska returning to rookeries (sometimes called haulouts) to mate and give birth. Sexual maturity is reached in 4-5 years for females, and 5-7 years for males. Mating and pupping occur from mid-May to late June, with gestation lasting for approximately 12 months (Ronald et al., 1982). Major breeding rookeries along the Alaskan coast include the entrance to Prince William Sound, along the eastern Kenai Peninsula coastline, Barren Islands, northern Kodiak area, Chirikof Island to the south of Kodiak, and the Semidi Islands to the south of Shelikof Strait (NRDA, 1990).

spill area? all of AK?

Prior to 1982, the population of sea lions in the Alaska area was 200,000 (Ronald et al., 1982), however, the population has been declining substantially since the 1970s (NRDA, 1990). The reasons for the population decline are unknown.

The sea lion prefers shallow waters near the coast, with access to gravel beaches, and ice flows. The sea lion diet consists of coelenterates, sand dollars, worms, and mollusks, as wells as cod, herring, halibut, and salmon (Ronald et al., 1982).

Sea Otters

Sea otters (*Enhydra lutris*) are found only in the North Pacific Ocean. Historically, sea otters ranged from Baja California, up the coast of the United States and Canada, along Alaska and the Aleutian Islands, to the northern islands of Japan (Kenyon, 1982). Due to extensive fur hunting of sea otters through the eighteenth and nineteenth centuries, the present population is thinly distributed, with the bulk of the population located near the Aleutian Islands. The Marine Mammal Protection Act of 1972 placed a moratorium on harvesting many marine mammals, including sea otters. Native Alaskans are exempt, and continue to hunt sea otters for subsistence. Range areas along the state of Alaska include Prince William Sound, Kenai Peninsula, Kodiak Islands, and the Alaska Peninsula (Gibbons, 1993).

Prior to 1989, the population of sea otters was estimated at over 100,000 along the coast of Alaska (Van Gelder, 1982). The population may have been as high as 10,000 in Prince William Sound and 20,000 in the Gulf of Alaska prior to the oil spill (Exxon Valdez Oil Spill Trustees, 1992). When the Exxon Valdez oil spill occurred, the sea otter populations along Prince William Sound and the Kenai Peninsula were particularly affected (Exxon Valdez Oil Spill Trustees, 1992). Frost et al. (1993) reports that more than 4,000 sea otters died from the oil spill, with over 2,000 deaths specifically in Prince William Sound. Up to 1,011 sea otter carcasses have been reported due to the spill (Exxon Valdez Oil Spill Trustees, 1992). In the year after the spill, the sea otter population in the oiled areas declined by 35% while nearby unoiled populations increased by 13% (Frost et al., 1993). In 1991 estimates, the sea otter population in the oiled areas appeared to have stabilized, but remains below the pre-spill levels (Frost et al., 1993).

The habitat of sea otters is restricted to shallow coastal waters. They do not inhabit inland waterways (Kenyon, 1982). Sea otters are known to rest in kelp beds and use intertidal rocks and exposed beaches as haulouts. The importance of haulouts for sea otters is not fully understood. Haulouts appear to be necessary for the sea otter to clean

and dry its fur (Van Gelder, 1982). Maintaining their fur is an important activity because sea otters do not have a blubber layer like many marine mammals. They are dependent on the ability of their fur to trap air to insulate against the cold (Kenyon, 1982).

Sea otters feed in intertidal and subtidal areas on mussels, clams, crabs, and other benthic invertebrates, as well as slow moving benthic fish (Van Gelder, 1982). To feed, sea otters dive into the water, catch their food with their paws, and return to the surface to eat while floating on their backs, often using their chest as a table (Van Gelder, 1982). Mother-pup pairs tend to hunt in shallower areas, preferring shorter dives (Exxon Valdez Oil Spill Trustees, 1992). Sea otters are prey for eagles, sharks, and killer whales (Kenyon, 1982).

Sea otters reach sexual maturity between the ages of 4 and 7 years. They can breed throughout the year, but they usually mate between September and October. Males and females do not remain paired after mating. A single pup is born between May and June, and is dependent on its mother for 6 to 8 months after birth (Van Gelder, 1982).

According to Monson and Ballachey (1993), the natural mortality pattern for sea otters is for 45% of deaths to be juveniles (0 to 1 year olds), 15% prime age (2 to 8 year olds), and 40% old individuals (greater than 9 year olds). Monson and Ballachey (1993) report that the mortality patterns of the sea otters have changed since the oil spill. Instead of the mortality proportions of 45%, 15%, and 40% for juvenile, prime age, and old otters, respectively; the pattern in the spill year (1989) was 32%, 44%, and 24%, respectively. The altered pattern was still present in 1990 and 1991, and indicates that the sea otter population has yet to enter a recovery phase (Rotterman and Monnett, 1993).

Killer Whales

Killer whales (*Orcinus orca*), the largest member of the Dolphin family, live and migrate in groups of up to 50 individuals called pods. A typical pod will contain 5 to 20 individuals composed of 23% mature males, 34% mature females, 39% juveniles and 4% calves or young of the year (Grzimek, 1990). There are two types of pods, resident and transient. Transient pods travel great distances throughout the year. Individuals from transient pods may leave their pods for a period of several months to several years and swim with other transient pods. Resident pods have a more defined social structure, including a home range that may cover an area up to several hundred square miles. Maternal groups of the resident pod remain together throughout their entire life span. Offspring will remain with the pod, and when they mature their offspring also remain

with the pod (Matkin, Dahlheim, Ellis and Saulitis, 1993).

Killer whales, although observed in oceans throughout the world, prefer cooler coastal waters and sometimes enter shallow bays, estuaries and mouths of rivers. Salmon, cod, Pacific herring, flatfish, blackcod, squid, pinnipeds and other cetaceans are documented food sources of the killer whale. Resident pods primarily eat fish, although sometimes they will eat small mammals and birds. Transient pods also eat fish and birds, but prey on small marine mammals more than resident pods.

Killer whales reach lengths of 21 to 26 feet for males and 16 to 21 feet for females, and weigh between 5,500 and 15,400 pounds (Grzimek, 1990). Killer whales have a life span of approximately 25 years and reach sexual maturity at an age of approximately 7 years. Breeding may occur at any time of year, but in the Northern Hemisphere mating peaks from May to July with births occurring in the fall (Walker, 1983). The gestation period is about 16 to 17 months and the cows give birth to a single calf. The females will nurse their calves for about 12 months and care for them for up to 2 years (Trustees, 1992). The birthing rate of killer whales varies, with 5 years being an average time between calves.

need to discuss mortality from spill

Humpback Whales

Humpback whales, (*Megaptera novaengliae*), are currently listed under the U.S. Endangered Species Act of 1973. The estimated worldwide population of humpback whales is 10,000, with approximately 1,500 occurring in the North Pacific (von Ziegesar and Dahlheim, 1993). The humpback whale grows to a length of 36 to 47 feet for males and 38 to 48 feet for females, and weighs 33 to 50 tons (Grzimek, 1990). Their preferred habitat is along shallow shelves and bank areas, instead of deeper ocean waters. During spring migration, the humpback whale travels well defined routes along the continental coastline to higher latitude waters for feeding. In the Northern Hemisphere the mating and calving season is October to March (Walker, 1983). During the breeding season, the humpback whales migrate to tropical waters, usually in groups of only two or three individuals. Humpback whales give birth to 1 calf every 1 to 3 years. After birth, calves nurse for approximately 11 months. The life span of the humpback whale is unclear but is estimated to be up to 77 years. The humpback whale reaches sexual maturity in 7 to 10 years.

Humpback whales primarily feed on krill and schooling fishes such as herring, anchovies, and sardines.

not injured by spill

2. Terrestrial Mammals

Sitka Black-tailed Deer

The range of the Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) lies along the Pacific Coast of Canada, Prince William Sound, and the Kodiak Islands (Wallmo, 1978). The black-tailed deer is the most abundant large mammal in its range area in Alaska. In Prince William Sound, the deer population is estimated at 15,000 to 20,000, and up to 100,000 in the Kodiak Islands. Most of the deer habitat at Prince William Sound is on the Hinchinbrook, Montague, and Hawkins Islands (NRDA, 1990).

Sitka black-tailed deer live in coniferous forested areas for most of the year. Studies have indicated that old-growth forest habitat is essential for maintenance of a healthy deer population (Smith and Trent, 1991). In winter/early spring, the deer forage on beaches in intertidal areas due to snow accumulation in higher altitudes. When the uplands begin to melt in the spring, the deer move further inland.

Deer eat intertidal marine vegetation, kelp, coastal sedges, grasses, shrubs, and herbaceous vegetation in the forest understory (NRDA, 1990). They have a seasonal eating cycle, eating more in summer and fall when food is more abundant, and relying more on fat stores in the lean winter months. Body weight generally peaks in October and reaches a low point in March (Mackie et al., 1982). They are a subsistence source used by Native Alaskans and hunted for sport. Brown bears occasionally kill young deer for food.

The Sitka black-tailed deer reaches sexual maturity at approximately one and a half years of age (Mackie et al., 1982). Mating occurs between September and November. One to two fawns are born the following summer (Wallmo, 1978).

Black Bear

Black bears (*Ursus americanus*) live in less settled, forested areas in the major mountain ranges of the U.S. and in all of the Canadian provinces. Black bears are found throughout the state of Alaska with dense populations in Prince William Sound (Jonkel, 1978; NRDA, 1990). Black bears prefer inaccessible terrain with thick understory vegetation, but also range over early successional areas including high tidelands, riparian areas, and wet and dry meadows (Pelton, 1982).

Black bears are omnivorous. They eat grasses, berries, tree borne fruit, and colonial insects and beetles (Pelton, 1982). Prior to hibernation, foraging activities become more intense and black bears will travel over large distances searching for food, often leaving the forested areas. Foraging may take them to beaches where black bears eat intertidal organisms and scavenge carcasses of marine mammals and birds (NRDA, 1990).

DOI.

Attachment A

Chapter III. Affected Environment

This chapter describes the areas within Prince William Sound (PWS) and the Gulf of Alaska directly affected by the *Exxon Valdez* oil spill. Part A covers the physical setting, including climate, oceanography, habitat types, geology, and mineral resources. Part B describes the fish and wildlife of PWS and summarizes the results of the ~~NRDA~~ damage assessment studies on the biological impacts of the spill, including injury to biota in affected aquatic, intertidal, and terrestrial habitats.Part C provides an overview of the socioeconomic environment and conditions in the affected area before and after the spill. This section gives the historical background of the affected regions, as well as information about the socioeconomic and cultural impacts of the spill on affected communities.

Sections 1 and 2 need to provide parallel info. for all of the EVOS area

A. Physical Description

1. Setting

Map IIIA shows the location of the area oiled by the *Exxon Valdez* spill in relation to the rest of the State of Alaska. Within this area, PWS was the most severely affected.

[MAP HERE.]

PWS is located in southcentral Alaska, north of the Gulf of Alaska, encompassing a surface area of approximately 15,000 square miles (38,850 sq km). PWS contains an open water area of approximately 100 miles (161 km) in diameter and up to 2,850 feet (869 m) deep (Mickelson, 1988). It is an estuary about the size of Maryland's Chesapeake Bay or Washington State's Puget Sound, with a mainland shoreline of more than 1,500 miles (2,413 km). It is approximately 15 times the size of San Francisco Bay. The total mainland shoreline of PWS is approximately 1,500 miles (2,413 km). PWS contains 15 major islands, including Montague, ~~Kodiak, and Afognak~~; 19 minor islands; and 150 lesser islands. The combined island shorelines measure approximately 1,500 miles (2,413 km). PWS is one of the largest and least developed marine ecosystems in the United States.

Southwest of PWS are the Kenai Peninsula and Kodiak Island. South of the Kenai Peninsula is the Shelikof Strait, which lies between Kodiak Island and the Alaska Peninsula. The Alaska Peninsula narrows into the Aleutian chain of islands. In this diverse system of land. marine, and freshwater habitats are located the following public (State- or Federal-owned) lands: Chugach National Forest, Kenai Fjords National Park, the Alaska Maritime National

Wildlife Refuge, Kodiak National Wildlife Refuge, Katmai National Park and Preserve, the Alaska Peninsula/Becharof National Wildlife Refuge, Aniakchak National Monument and Preserve, and Kachemak Bay State Park.

not in PWS

.The geology of the PWS region is young and relatively unstable. Glaciers, earthquakes, and active volcanoes are common. ~~Two major rock formations prevail, the Valdez group and the Orca group. It is estimated that the Valdez group, which is composed of marine sandstone and slate, is 180 million years old. The younger Orca group contains both sedimentary and volcanic rock.~~ The Chugach Mountains, part of the Orca group, rise to heights of 13,000 feet (3,965 m) and surround much of PWS (Mickelson, 1988).

Re-write: focus on EVOS studied area communities

destroyed?

In March 1964, an earthquake with an epicenter west of Columbia Glacier shook PWS for approximately 5 minutes. The towns of Valdez, Whittier, and Chenega, and Portage were destroyed by waves, and people in several small villages were killed. Damaging effects of the earthquake were felt as far away as ~~Anchorage~~ Washington/Oregon. As a result of the quake, the south end of Montague Island rose 38 feet (11.58 m), shorelines and river mouths were forever changed, and much of PWS to the southeast rose an average of 6 feet (1.83 m).[1] △ also a lot of subsidence

2. Air and Water Quality

this is typical for Valdez, but not for other oil-spill area communities

PWS has a maritime climate with heavy precipitation, averaging 150 inches (381 cm) annually with a range of 64 to 179 inches (163 to 455 cm). The area is snow covered in the winter, with up to 21 feet (6.4 m) of snowfall per year in Valdez; 15 percent of the total area, mostly in the mountains, is covered with permanent ice and snow. Snow falls in the high country of the Chugach Range from September through April. Temperatures in the region range from approximately 20° F (-4° C) in January to a high of approximately 50° F (13° C) in the summer. The ports of Homer and Seward usually remain ice-free (Mickelson, 1988).

Winter winds in the Gulf of Alaska are generally easterly or southeasterly and interact with currents to push waters into PWS. This produces complex flow patterns resulting in strong downwelling and an outflow of surface waters to the southwest. Various distinct local wind patterns exist; however, PWS winds are predominantly from the north. In central and southern PWS, dominant winds are from the east (Michel et al., 1991 Oil Spill Conference). The southerly wind pattern pushes surface waters out of PWS and into the Gulf of Alaska.

[1]Ownership of evulsive (i.e., lands brought above sea level by the earthquake) is one issue the public wishes the Restoration Plan and the EIS to address.

Edit to ensure life history information is relevant to DETS analyses

Ken: THE species will go @ end of this section. 4/9

B. Biological Description

The Prince William Sound region supports a diverse collection of wildlife. The Exxon Valdez oil spill occurred in March, just before the most biologically active season of the year. It affected the migration of birds, and the primary breeding season for most species of birds, mammals, fish and marine invertebrates in the spill's path. The spill affected each species differently. For some the population measurably declined. For example, an estimated 3,500 to 5,000 sea otters were killed by the spill, and the population will not recover for many generations. Other species were killed or otherwise injured by the spill, but the injury did not measurably lower the overall population. Some species, such as marbled murrelets, pigeon guillemots, and harbor seals were declining before the spill. Their rate of decline was accelerated by the spill, but other factors such as variations in climatic conditions, habitat loss, or increased competition for food may also have influenced long-term trends in the health and populations of these other species. Still other species may have been indirectly affected by changes in food supplies or disruption of their habitats.

The availability of population and habitat data varies from species to species. Some PWS species (e.g., invertebrates such as clams and barnacles) have never been inventoried. Others, such as the brown bear and the bald eagle, are counted annually for management purposes. And much is known about species that have played a significant historic or economic role in the region, such as sea otters and salmon. Federal and State environmental agencies had conducted baseline surveys of some native species prior to the oil spill; these surveys documented selected species' populations and critical habitats.

This section provides a summary of the baseline conditions for species and resources found the oil spill area. It will be used in evaluating potential impacts, either direct or indirect, of the various restoration options.

1. Marine Mammals

Harbor Seals

Harbor seals (*Phoca vitulina richardsi*) are found only in the North Pacific Ocean from northern Mexico to Alaska and the Bering Sea, and in the western Pacific from Japan to Siberia. They are found in Prince William Sound year round (Frost et al., 1993). Harbor seals prefer coastal waters less than 60 meters deep. They live close to shore, and often enter estuaries and rivers to hunt for fish (Van Gelder, 1982). Rocky areas, isolated

Black bears become sexually mature at 3 to 5 years old. They reproduce every other year. Breeding occurs in the summer, peaking in late June and July. Two to three cubs are born in winter during hibernation. Bears emerge from their dens in late March to early May. Cubs stay with their mother until spring or summer of the following year (Pelton, 1982).

Brown Bear

Historically, brown bears (*Ursus arctos*) ranged from the North American Great Plains to northern Alaska. Presently, they are abundant only in remote areas of western Canada, and coastal southcentral and southwest Alaska (Craighead and Mitchell, 1982). Besides the Alaskan Peninsula, brown bears live on the islands of Kodiak, Afognak, and Shuyak. Brown bears have seasonal movement patterns. They emerge from their dens in early April and May, forage along the coastline during the spring, move to anadromous streams in the summer, and travel upland when berries ripen in the fall. Between October and November, brown bears enter dens in the mountains for hibernation (Craighead and Mitchell, 1982).

Brown bears are omnivorous and eat a wide variety of foods. Favored plant food includes roots, acorns, berries, sedges, and grasses. Brown bears forage in intertidal areas for clams and mussels. They scavenge beaches for dead marine mammals. They are capable of killing small ungulates, and in spring they will feed on young moose, deer, and caribou. During the spawning season, bears will fish at areas of salmon runs. They are also attracted to garbage dumps for foraging (Craighead and Mitchell, 1982).

Brown bears reach sexual maturity between 3.5 and 9.5 years. Mating occurs between mid-May and mid-July, with a peak in early June. The following February, 2 to 3 cubs are born. Cubs stay with their mother until they are weaned as two-year olds (Craighead and Mitchell, 1982; Jonkel, 1978). Only 45 to 69% of cubs survive to be yearlings (1.5 years old).

Thousands of visitors come to Katmai National Park and McNeil River State Game Sanctuary annually to observe and photograph brown bears. Approximately 250 brown bears are harvested annually by residents and non-residents (NRDA, 1990).

River Otters

The River Otter (*Lutra canadensis*), has been found throughout North America except for the extreme Southwest (Trustee, 1992). The river otter is one of the largest members of the Weasel family. Found in marshes, wooded stream banks, and all types of inland waterways, the river otter is almost completely aquatic, although it will travel great distances across land, moving from one stream to another (Forsyth, 1985). River otters do not excavate their own dens, but instead use natural cavities in shores or use dens

4. Fish

Pink Salmon — Remove references to fishing & stick to biological information

Pink salmon (*Oncorhynchus gorbuscha*) are anadromous in rivers and streams from northern California to Canada, Alaska, and the Soviet Union. Washington is considered the southern end of the range of exploitable spawning migration stocks of pink salmon. They also occur in Asia as far south as Japan (Bonar *et al*, 1989). Pink salmon are the most abundant salmon in Cook Inlet, as well as Prince William Sound. For the years 1973 to 1982, this species made up 39.6% of the total catch (numbers of fish) in Cook Inlet, with an annual averge catch of 1.8 million. This was about 4.4% of the statewide catch of this species during those years.

Major pink salmon producing streams that feed into Cook Inlet include the Kenai and Susitna Rivers located at the head of the inlet. The Talachulitna River, a tributary of the Susitna, is probably the most important pink producer, with as many as 1 million pink salmon spawners in some years (Alaska Geographic, 1983). old + not best source

On Kodiak Island, at the mouth of Cook Inlet, during the time period of 1973 to 1982 salmon fishermen caught an annual average of 10 million salmon of all five species, or about 15% of the total statewide catch of salmon. Most of these fish were pink salmon (85%), for the many short streams of Kodiak are ideal for this species. ~~Chum salmon are the second most abundant salmon of the Kodiak area, and in recent years about 7.2% of the catch has been of chums~~ (Alaska Geographic, 1983). ditto

In general, major glacial watersheds, except where buffered by lake systems, contain only a small proportion of the spawning and rearing salmon. This is primarily because of stream instability; flow volume and shifting sediment loads. Consequently, small steep streams lying in the lateral zones of the fjords or in small bays contain most of the salmon stocks. There are 500 or more of these streams utilized by salmon, and the dominant pink and chum species have adapted to heavy use of intertidal zones for deposition of eggs. The 35 to 77 percent range of intertidal use by pink and chum salmon exceeds all other Pacific coast salmon areas in this regard. In contrast, red and coho salmon are in low abundance in the Prince William Sound/Cook Inlet area, owing to the blockage by barrier falls of most lake systems required by these species for early life rearing (PWSAC, 19??).

delet chum info

This is supposed to be about Pink salmon

Because of their spawning patterns, oil from the spill of the Exxon Valdez did not threaten the spawning and rearing areas of the sockeye, chinook and coho salmon, which are located in freshwater lakes and streams far from the spill area. Unlike pinks, these species mature for one, two and sometimes three years in these areas before heading for the ocean. For example, the commercially important sockeye or red salmon is four or five inches long when it heads to sea as a one- or two-year old. It is a much larger, older and stronger fish than the tiny pinks that head for salt water. If the spill did not harm the pink salmon fry of 1989, the larger sockeye juveniles were even more likely to survive. King and coho juveniles are even larger when they head to sea, averaging

?

those found in uncontaminated areas (Exxon Valdez Oil Spill Trustees, 1992). Some degree of recovery has been observed in the lower intertidal and the mid intertidal zones. Recovery of the upper intertidal zone, where the mussel beds are located, has not occurred (Restoration Planning Working Group, 1993).

In 1991, high concentrations of oil remained in mussels and the underlying mats of the mussel beds. Because the mussel beds were not cleaned or removed following the spill, they present sources of fresh oil for the organisms that feed upon mussels. The extent of the oil-contaminated mussel beds have not been determined; however, investigative studies are ongoing (Exxon Valdez Oil Spill Trustees, 1992). Studies have identified 31 mussel beds within Prince William Sound and 9 along the Kenai Peninsula and Alaska Peninsula that have sediment petroleum hydrocarbon levels greater than 1,700 µg/g wet weight oil equivalents. The contamination of mussels presents a potential for continued food chain contamination (Babcock, et.al., 1993).

Populations of *Fucus*, the primary intertidal plant, were reduced following the oil spill and clean-up operations. The reduction in intertidal area covered by *Fucus* was accompanied by an increase in coverage of opportunistic plant species that thrive in disturbed habitats. In addition to the decrease in *Fucus* coverage, the size of the *Fucus* plants decreased, the number of reproductive-sized plants decreased, and the number of fertile receptacles per reproductive-sized plants were reduced. Therefore, not only was the actual coverage of *Fucus* reduced, its ability to replenish itself was decreased (Exxon Valdez Oil Spill Trustees, 1992). *Fucus* is the primary structural habitat in the Alaskan intertidal zone, and its reduction effects other intertidal zone inhabitants (Peterson, 1993).

Characterizations of the following intertidal inhabitants are presented in subsequent paragraphs: bay (blue) mussel (*Mytilus edulis*), common littleneck clam (*Protothaca staminea*), and Pacific razor clam (*Siliqua patula*). Profiles of these selected organisms are being presented because of their important function within Alaska and the surrounding area (i.e., mussels provide a source of food for many other organisms, and clams are harvested both recreationally and commercially).

Bay Mussel. The bay (blue) mussel is distributed from the Arctic Ocean to Cape San Lucas, Baja California. It is found along rocky coastlines, in bays, and in estuaries. Bay mussels are harvested commercially for bait and for food. Bay mussels are suspension feeders and feed on dinoflagellates, organic particles, small diatoms, zoospores, ova and spermatozoa, flagellates, unicellular algae, and detritus. There is limited culture of these mussels for food. These mussels are preyed upon by sea stars, gastropods, crabs, sea otters, black oystercatchers, and ducks (Shaw *et. al.*, 1988).

The spawning period for bay mussels occurs in July through November in northern California. Spawning is not initiated by temperature changes, rather it may be stimulated by other factors such as a pulling on the byssal threads or a chain reaction caused by the spawning of one organism. Larvae are subject to movement by water currents, which may effect the ability of the mussel to set by carrying it away from

C. Socioeconomic Description

1. Overview

This section describes the social, cultural, and economic conditions of the PWS region and its people. Included are descriptions of the communities affected by the spill; a discussion of the impact of the spill on traditional Native and non-Native subsistence hunting and fishing; information about spill-related injury to cultural and anthropological resources; and a description of the economic base of the area.

2. Relevant State History [PLACEMENT?]

The Alaska Statehood Act (48 U.S.C. [CITE?]) admitted Alaska to the Union in January 1959. The act allowed the State to select 400,000 acres (161,880 ha) of National Forest and unreserved land for community use. In addition, the State was also empowered to choose 102.55 million acres (41.5 million ha) of public lands from other unreserved U.S. lands.

The Alaska Native Claims Settlement Act (33 U.S.C. § 1601-1624) settled the aboriginal rights and established the legal claims for Alaska Natives. It also authorized formation of the Regional Native Corporations. This act also addressed the public land withdrawals and established a Joint Federal State Land Use Planning Commission, which began the land selection procedures that resulted in the existing pattern of Federal, State, Native, and private ownership of lands in Alaska.

After Alaska became a State, oil exploration and development continued to grow. In 1968, a discovery well at Prudhoe Bay on the North Slope uncovered the largest known oil field in the United States. The North Slope oil lease, completed in 1969, granted oil rights to an oil consortium and brought more than $900 million in bonuses to Alaskans. To provide for transporting the oil from the North Slope to a shipping point, Congress passed the Trans-Alaska Pipeline Authorization Act in 1973. Construction of the pipeline was completed in 1977. Today, the pipeline moves almost 2 million barrels (84,000,000 gallons, or 317,940,000 liters) from Prudhoe Bay to Valdez every day. Since 1977, the Port of Valdez has shipped the bulk of crude oil taken from Prudhoe Bay.

In 1976, the first of DOI's Minerals Management Service lease sales for outer continental shelf (OCS) oil and gas were completed in the eastern Gulf of Alaska. Sales followed in Lower Cook Inlet (1977 and 1981), in the northeastern Gulf of Alaska (1980), and east of Kodiak Island (1980). Although Valdez and PWS have little or no known oil or gas potential, the area is part of Lease Sale 88.

[NATIVE CORPS GO HERE. KATHY, ARE YOU GETTING THIS INFORMATION?]

The Alaska National Interest Lands and Conservation Act of 1980 (ANILCA, 16 U.S.C. 3111 *et seq.*) implemented the Alaska Native Claims Settlement Act and the Statehood Act. ANILCA allowed the Alaska Native allotments, State land selections, and

established the Alaska Land Bank. It also provided for the designation and conservation of Federal public lands, including the National Parks, National Wildlife Refuges, National Forests, Wild and Scenic Rivers, and the National Wilderness Preservation System. ANILCA also authorized the subsistence management system and allowed for the use of public resources, including the continued use of those resources in the National Parks and Forests.

3. Affected Communities — Refer to map

The communities affected by the *Exxon Valdez* spill are grouped into four regions: the Kenai Peninsula Borough (KPB), the Kodiak Island Borough (KIB), the Lake and Peninsula Borough, and the Valdez–Cordova Census Area. The effects of the spill differ for each region and its communities. In general, the communities that experienced the most disruption were the Native villages, which are mixed cash-subsistence hunting and fishing based economies.

a. Kenai Peninsula Borough

The Kenai Peninsula Borough, which is located south of Anchorage, includes both sides of Cook Inlet from the southern tip of the Kenai Peninsula north to the Knik Arm–Turnagain Arm split. ? The Kenai Peninsula holds 99 percent of the borough's population and most of the area's development because it is linked by roads to Anchorage. ? Sixty-three percent of the borough's population (27,338 people) lives in Kenai and Soldotna. The area is economically dependent on the oil and gas industry, as well as fishing and tourism. Communities within the central Kenai Peninsula region are the cities of Kenai, Soldotna, and Seward.

The southern Kenai Peninsula contains the cities of Homer and Seldovia and the Native villages of Port Graham and English Bay. Homer is the economic and population hub ? of the region, with revenues from commercial fishing, tourism, government and commercial offices, and agriculture. In contrast, the Native villages are largely dependent upon subsistence hunting and fishing. Within this region, Homer was least affected by the spill, both because it was least severely oiled and because its residents were relatively less dependent upon subsistence. Port Graham and English Bay were heavily oiled, yet these communities were farthest removed from the cleanup efforts. ? Residents of these communities who relied upon subsistence were adversely affected by actual contamination or perceived contamination of subsistence foods. — does ADF&G subsistence survey support this?

See Galt Daytop article

b. Kodiak Island Borough

The Kodiak Island region includes the city of Kodiak and the six Native villages of Port Lions, Ouzinkie, Larsen Bay, Karluk, Old Harbor, and Akhiok. These communities are part of the Kodiak Island Borough (KIB). The KIB population is between 13,000 and 15,000 and includes Natives of Alutic [ALEUTIC?] background and immigrants from the Philippines and from Central and Meso-America. ? As in other parts of Alaska, Kodiak

Does anyone in AK use this acronym?

Island's population grows significantly in the summer. The KIB provides some social services to villages, and the Kodiak Area Native Association (KANA) provides medical and social services through the tribal governments in each village.

describe more thorough!

Nearly two-thirds of the Kodiak Island shoreline ~~was~~ were oiled. Oil in varying forms spread from the northern end of the island along the west coast and through the many passages, coves, and small islands that make up the Kodiak Island group. In addition to the physical effects of the oil on these communities' land, social effects were associated with the cleanup activities that followed the spill. Daily life in many Native villages was disrupted by the presence of outsiders and by changes in the local economy caused by the influx of visitors and cash. Local governments and relations with service providers were strained in many villages, and the introduction of provisional regulations added to the tension. ~~The communities of Akhiok, Karluk, Kodiak, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions are located in the Kodiak Island Borough~~.

see Galt/Payton article

?

c. Lake and Peninsula Borough

The Lake and Peninsula Borough contains three communities Chignik Bay, Chignik Lagoon, Chignik Lake, which were exposed to oil in the form of tar balls and oil sheen. Some remote beaches were also oiled. Residents of all three communities are ethnically mixed, Aleut, Russian and Scandinavian. The economy of the communities is mixed cash-subsistence.

?

Discuss oiling

d. Valdez-Cordova Census Area

The Prince William Sound region covers an area of about 20,000 square miles [EQUIV] of water, ice, and land. For the purpose of this study the region includes five communities: Valdez, Cordova, Whittier, Chenega Bay and Tatitlek. Each is accessible by air or water, and all have dock or harbor facilities. Only Valdez is accessible by road.

what about other regions

The region has an abundant supply of fish, shellfish, and marine mammals. These and the other natural resources of PWS play a part in the lives of area residents. In addition, the area is considered by many to be a unique, pristine wilderness, offering unparalleled opportunities for outdoor recreation, adventure, and travel.

Communities in the PWS region depend on a variety of economic activities, as shown in Table IIIX.

Table IIIa Valdez-Cordova Employment by Industry

Occupational Classification	Number employed
Agriculture, Forestry, Fisheries	574
Mining	115
Construction	421

Occupational Classification	Number employed
Manufacturing (nondurable goods)	146
Manufacturing (durable goods)	110
Transportation	618
Communication and public utilities	149
Wholesale trade	84
Retail trade	612
Finance, insurance, and real estate	102
Business and repair service	87
Personal services	154
Entertainment and recreation	60
Health services	316
Education services	523
Other professional and related services	447

Source: [KATHY—CAN WE GET SOURCE HERE.]

The economic bases of the five communities is diverse. Cordova's economy is based on commercial fishing, primarily for red salmon. As the terminus of the Trans-Alaska Pipeline, Valdez is dependent on the oil industry; but commercial fishing and fish processing are also important to the local economy. Whittier residents work as government employees, longshoremen, commercial fishermen, and service providers to tourists. The Alaska Native people of Chenega Bay and Tatitlek, by contrast, rely on subsistence fishing, hunting, and gathering for their livelihood.

Table III# Cordova Wage and Salary Employment, 1989 - 1990

Occupational Classification	1989	1990
Nonagricultural wage and salary	1,301	1,321
Construction	29	51
Transportation, Communications, and Utilities	197	96
Trade	178	190
Finance, Insurance, and Real Estate	24	24
Services	120	127

Occupational Classification	1989	1990
Miscellaneous	92	101
Government	335	372
Federal	40	49
State	112	121
Local	184	202

Source: [KATHY, I NEED SOURCE FOR THIS!]

Table III# Valdez Wage and Salary Employment, 1989 - 1990

Occupational Category	1988	1989	1990
Nonagricultural wage and salary	1,789	2,887	2,200
Mining	0	0	0
Constuction	38	23	26
Manufacturing	206	261	247
Transportation, Communication, and Utilities	388	1,129	563
Trade	175	237	265
Finance, Insurance, Real Estate	15	24	30
Services, Miscellaneous	294	462	346
Government	673	751	749
Federal	17	18	17
State	377	448	422
Local	280	285	310

Source: Alaska Department of Labor, Research and Analysis Section

4. Subsistence [THIS SECTION TO BE REORGANIZED, CUT CONSIDERABLY.]

needs review by ADF+G subsistence division

a. Overview

The term "subsistence" refers to a particular pattern of harvesting and using naturally occurring renewable resources. In a subsistence system, land and labor are allocated in accordance with kinship, political, or tribal rights and obligations. Subsistence systems define a relationship with the earth and its resources, shape the economy, provide material sustenance, and form the basis of community life. Subsistence systems depend on natural resources in a way that Western industrialized societies do not.

Alaska is the only State in which a significant proportion of the population lives off the

land. The Alaska Lands Act defines subsistence as follows:

> . . . customary and traditional uses by Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for making and selling of handicraft articles out of non-edible by-products of fish and wildlife resources taken for personal or family consumption; for bartering or sharing for personal or family consumption; and for customary trade. (Alaska Lands Act, § 803)

Residents of communities legally defined as "rural" under State regulations may hunt and fish under subsistence regulations. Since there are only a few urban areas in Alaska, the majority of the State's 300 inhabited areas fall into the rural category. ← what about communities discussed above?

Subsistence systems are characterized by four important attributes.

- Subsistence activities are seasonal. Fishing, hunting, and gathering follow the natural rhythm of the tides, wildlife and fish migration, and plant life cycles. The form of settlement and the pace of life in PWS villages depend upon the season. ?

- Subsistence activities are localized. Productive, accessible sites are established for various subsistence activities.

- Subsistence is regulated by a system of traditional, locally recognized rights, obligations, and appropriate behaviors. The use of sites, the division of the catch or harvest, and the assignment of responsibilities are determined by tradition. Villages that share overlapping territories for hunting and fishing occupy their individual niche and adhere to the rights and responsibilities traditionally assigned to them. ← more regulations apply than mentioned here

- Subsistence is opportunity-based. [WE NEED MORE HERE] (MMS, [NEED YEAR])

b. Connection to Environment — This seems overdone

Subsistence implies a certain connection to the environment. Prior to the *Exxon Valdez* oil spill, PWS was considered a "pristine" wilderness with bountiful environmental riches. The abundant wildlife, scenic mountains, old-growth forests, clear waters, and other natural riches of PWS have made the area particularly valuable to Alaskans, both Native and non-Native. The unpolluted environment attributed to PWS was experienced as an enrichment of individual lives, a perspective somewhat less common in the lower

48 States. For many Alaskans, the spill spoiled a pure and irreplaceable resource, a place that was fundamental to their identities and values. One resident explained it this way:

> . . . [H]ere in Homer most people don't really care all that much about money or material things. They care about a quality of life that in some cases they have traveled across the entire country to find. Some things are sacred. This country is sacred. The connection of these people to the country is sacred. And no amount of money can magically undo the damage, the sacrilege. (Oil Spill Commission, 1990)

Both Alaska Natives and non-Natives in PWS experience a relationship with the environment that is unique in the United States. Many of those who choose to live there, foregoing the steady income a city job could provide, assign great value to the rural, subsistence-based way of life. When the environment is harmed, the basis of subsistence—the harmonious relationship of humans to their environment—is threatened.

c. Economic Implications

The economic aspects of the subsistence system also are dependent upon the availability of untainted natural resources. In the PWS subsistence system, food and other material resources are bartered, shared, and used to supplement supplies from other sources. Subsistence resources are the foundation of the PWS area's mixed subsistence-cash economy.

It should be noted that none of the rural communities in PWS is so isolated or so traditional as to be totally uninvolved in the modern market economy. Most PWS communities are characterized by a mixed subsistence-market economy. This label recognizes that a subsistence sector exists alongside a cash system, and that the socioeconomic system is viable because the sectors are complementary and mutually supportive. Even the most traditional subsistence hunter uses the most modern rifles, snow machines, boats, boat motors, nets, and traps he can afford. These goods cannot be acquired without cash.

Subsistence pursuits supply important material goods, however. Although some food is imported into PWS, a vast subsistence harvest is hunted, fished, and gathered locally. For some residents, subsistence is the primary source of food and supplies. For others, subsistence supplements resources available from other sources.

> Our beaches and waters provide us with deer and fish and game which helps

offset the high cost of food here (Kodiak Island). This is not simply a recreational question, it is everyone's livelihood and food resource that is affected. (The Day the Water Died, [YEAR])

Within Alaska Native communities, not all households participate in every subsistence harvest, but food is often shared among households. Sharing subsistence resources occurs both within and among PWS villages.

Estimates vary widely on the percentage of subsistence foods in the diet [DO WE MEAN JUST NATIVES? OR EVERYBODY IN PWS?], but studies indicate that subsistence may provide 70 to 80 percent of the total protein consumed within the households of PWS villages. [CITE?] Estimates place the share of subsistence meats and fish at 200 to 600 pounds [KG] per person per year. Among Alaska Natives, reliance on subsistence foods is greater still, with subsistence resources providing 80 to 100 percent of Natives' total protein intake, at an average of 500 pounds [KG] per person per year. Subsistence foods provide a large portion of the diet—a portion that families can ill afford to replace with imported substitutes. Fewer than 500 permits are given to subsistence fishermen each year, mostly residing in the Upper Copper River area and the southwestern area of PWS.

are dog teams common in study area Native communities

Besides making up part of the local diet, subsistence provides food for dog teams and is the only source for other material needs such as ivory for carving [CARVING WHAT?], furs for clothing, and seal hides for mukluk soles and uppers.

The PWS communities affected by the oil spill are small, relatively isolated, and economically dependent on local fish and wildlife. The noncommercial transfer and exchange of wildlife products are important institutions in PWS and in Alaska. The prevalence of direct consumption and nonmonetary transfer and exchange of fish, wildlife, and other natural resources and services makes it difficult to determine their economic value in terms of the value system of the cash economy.

d. Sociocultural Implications

Subsistence pursuits are tied to all aspects of life in the villages affected by the oil spill and are key to the Alaska Native sociocultural system. For at least 11,000 years, Alaska Native people have depended on the lands and water of PWS for their survival. Their traditional way of life is intimately tied to the harvesting, gathering, and use of subsistence foods.

The Alaska Native culture cannot easily be separated from the subsistence way of life and each person's relationship to the land, sea, and resources. In the words of [WHO?]—

> Our area is not an economically developed area. We depend on the sea for our food and clothing. There is much sharing in the catches, as we realize the needs of our brothers and they realize our needs. It is not joyful to see our children and grandchildren hungry. . . Every one of us is Eskimo around here. We all have to eat our own native food, and there is no question about it. We cannot possibly go without it. . . Please try and fathom our great desire to survive in a way somewhat different from yours, and thus see why the hunters will continue to go out. . . Over long stretches of unrecorded time, Native Americans established balances with other life on the earth. They survived over the centuries by living in balance with the fish and birds and animals . . . in balance with the subsistence resources of the natural world . . .
> When the balance, or circle of life, as it has been called, is broken, birds and fish and animals begin disappearing from the land. When they are gone, so are the people who depended upon them (Davidson, 1974).

The rules governing the harvesting and use of subsistence resources are derived from a combination of culture, tradition, and religious beliefs. Subsistence involves many social activities such as cooperative labor-sharing, the exchange of resources and information, transmission of knowledge and skills, and formation of values. The means of establishing prestige and maintaining peace traditionally involve the consumption, transfer, and exchange of fish, game, and their byproducts. These activities are necessary for the preservation of traditional family and community relationships that are essential to the physical and psychological well-being of Alaska Native communities. Continuous access to uncontaminated resources in a natural setting is also fundamental to the physical, spiritual, and psychological well-being of Alaska Native communities.

In Native villages, the hunt, the sharing of products of the hunt, and the beliefs surrounding the hunt tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Generous hunters are considered good men. Good hunters are often leaders. These are but some of the ways in which subsistence and beliefs about subsistence join with sociocultural values. The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and subsistence activities that occur in Native society. Subsistence also shapes the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations, employment, sports activities, and membership in voluntary organizations. Language, culture, spiritual beliefs, customs, self-esteem, and

respect for others are tied into a view of the world that is centered on the traditional hunting, fishing, and gathering way of life.

e. Effects of the Spill on Subsistence

Subsistence is the basis of a whole way of life in PWS. Recognition of this perspective is essential to understanding the significance of subsistence activities, as well as the far-reaching impacts of the *Exxon Valdez* oil spill on subsistence for Natives and non-Natives alike.

The spill fouled waters and beaches used for subsistence hunting, fishing, and gathering by 18 rural communities, including 15 Native villages, with about 15,600 inhabitants. Destruction and contamination of subsistence resources exacerbated [STRONG] the cultural disintegration and dislocation experienced by Alaska Natives in PWS.

> Livelihoods destroyed, emotional stability of people destroyed, tremendous stress—these things will be etched on my mind for the rest of my lifetime, and I think that I will be grieving for many, many years to come over what I saw in the summer of 1989. (The Day the Water Died [CITE])

Subsistence harvesting was disrupted, which in turn disrupted the traditional cultural patterns of social interaction surrounding the harvesting of local natural resources. In 1989, subsistence fishery was banned as a precaution against possible health-threatening effects of the oil spill on fish in the Sound.

Resource and habitat contamination and destruction resulted in a 77-percent decline in subsistence resource harvesting. PWS residents had to seek food from outside the local environment. In Native villages, shortages of traditional foods resulted.

Table III# Permits Issued and Estimated Harvest Values, 1989 - 1990

City/village	Permits (1988)	Harvest Earnings (1988)	Permits (1989)	Harvest Earnings (1989)	Permits (1990)	Harvest Earnings (1990)
Cordova	411	$41,500,000	309	$29,949,000	412	$31,637,000
Valdez	55	$2,710,000	30	$1,436,000	54	$1,959,000
Chenega Bay	1	not applicable	1	not applicable	3	not applicable
Tatitlek	11	$514,000	8	$196,000	6	$304,000
Whittier	16	$222,000	9	$42,000	14	$126,000

City/village	Permits (1988)	Harvest Earnings (1988)	Permits (1989)	Harvest Earnings (1989)	Permits (1990)	Harvest Earnings (1990)
Total	494	$44,946,000	357	$31,623,000	489	$34,027,000

Source: Alaska Commercial Fisheries Entry Commission

Moreover, the sociocultural system on which the traditional Alaska Native lifestyle is based was threatened by the influx of cleanup crews and the unfamiliar demands of a cash economy. Contamination of traditional foods, and fear of contamination, led potential users to stop harvesting these resources. One Alaska Native had this to say:

> We depend on ourselves. . . And we depend on the seals, sea lions, butter clams, ducks, and sea life. Now they are disappearing. The sea life is disappearing. Even if they come around, we are staying away from them. (Alaska Oil Spill Commission, 1990)

Although a number of fisheries were closed immediately following the spill and reopened once it had been determined that local fish were safe to eat, some Alaska Natives are unwilling to eat them for fear of contamination. Spot shrimp fisheries were closed in 1989 and 1990. Clams, an important part of the native diet, were shown to be contaminated after the spill. Fish, bear, moose, deer, and other Native meats were deemed safe to eat by Federal and State health officials, but not all PWS subsistence users were willing to go back to harvesting them. ~~Restoration proposals will address the contamination that continues to affect PWS species and people who harvest them~~

4. Cultural and anthropological resources

Sites important to the Alaskan culture were injured by the oil spill and by the cleanup response, mainly by increasing human activity in and around PWS. At least ~~26~~ 24 archaeological sites, including burial grounds and home sites, were injured to various degrees. Five of these sites were on private or State lands and 21 were located on Federal land—10 on national parks, six on national refuges, four within the Chugach National Forest, and one on Bureau of Land Management (BLM) land. Injuries included vandalism, ~~erosion of beachfront sites,~~ removal of artifacts, and oiled sites. With regard to the oil spill, the three major sources of potential impact were direct impacts resulting from oil in direct contact with artifacts or features; treatment methods employed to remove oil; and human activities incidental to the response actions.

Source?

Some Alaska Native sites in the PWS area are more than 11,000 years old (Clark 1984a.

1984b; Crowell 1988b). The sites affected by the oil spill fall within the larger ethnographic Pacific Eskimo region, which extends from the Copper River to the middle of the Alaska Peninsula and includes the outer reaches of Cook Inlet. Cook Inlet was originally occupied by the Tanaina Athapaskans. Trade, warfare, ceremonial exchange, and occasional intermarriage led to a sharing of many cultural traits among the Pacific Eskimo, Tanaina, Aleut, Eskimo, Athapaskan, Eyak, and Tlingit Indian tribes.

The types and locations of PWS archaeological ~~and architectural~~ sites made them particularly vulnerable to disturbances related to the oil spill. Sites found in the intertidal zone include stone and wooden fish weirs, petroglyphs, shipwrecks, piers and pilings associated with historical domestic and commercial facilities, and potentially the full range of features found in the uplands. Cultural resources were known to occur in adjacent uplands, where modified deposits, villages, rock shelters, culturally modified trees, historical domestic and commercial facilities, and other features are present. The range of physical materials incorporated into these sites includes stone, bone, shell, various metals, wood, textiles, leather, and other organic items.

The major potential physical impact of oiling is the obscuring of intertidal artifacts from observation, with the secondary possibility that solidification of oil could immobilize artifacts in the intertidal zone. Both of these effects would be temporary, as wave and tidal action would remove the oil over a period of months or years. The chemical impacts of oiling are not known. Some scientists have raised questions about whether contaminated organic items can still be dated using radiocarbon techniques, but others believe that the oil can be removed from crucial samples so that they may be successfully dated. [KATHY: I DON'T THINK THIS IS IN BIBLIO. PLEASE SUPPLY FULL CITE! (CRS 1989:103)].

Several of the cleaning methods used on the beaches were particularly damaging to archaeological resources. [KATHY: WHICH ONES WERE WORST AND WHY?] Archaeological and architectural sites located in the uplands adjacent to treated shorelines were at risk only when people visited those uplands. Although a blanket restriction on upland access by cleanup crews was in effect throughout the shoreline treatment phase, some degree of access was required to efficiently undertake treatment activities. In addition, a variety of pedestrian upland crossings resulted in ~~damage~~ injury to cultural resources, especially surface features. Vandalism and looting of cultural sites occurred as a result of uncontrolled or unsupervised access to the immediate uplands, particularly where rock shelters, historic cabins, mine sites, and other surface features or subsurface deposits were exposed.

This section does not (but needs to) describe rock fish harvest, and commercial fishing in areas impacted by EVOS outside PWS

5. Economic base of the region

COMMERCIAL FISHING

Introduction

Alaska is considered the most important fishing state in the United States. In 1989 Alaska accounted for almost half the nation's catch in pounds, and 38% in value. No other state comes close to Alaska in either total harvest weight or value, according to statistics compiled by the U.S. Department of Commerce. Consequently, Alaska is a major exporter of fishery products. In 1987, seafood valued at $561 million was shipped overseas, 95% of which went to Japan. That represented approximately one-third of the U.S. seafood exports (Royce, 1991).

The major species groups contributing to Alaska's commercial fisheries are salmon, shellfish (primarily crabs and shrimps), groundfish (mostly pollock, flatfishes and cods), halibut and herring. Since 1976, salmon have accounted for roughly 50% of the ex-vessel value (gross receipts). Shellfish accounted for 40-45% until the early 1980's, when declines in several major shellfish fisheries occurred. Since the early 1980's Alaskan groundfish landings have increased, accounting for nearly one-quarter of the 1986 ex-vessel value of commercial fishery harvests. In 1986, which can be considered a representative year, salmon accounted for 46% of the total gross receipts to fishermen, groundfish amounted to 22%, shellfish were 21%, halibut were 7%, and herring were 4% (Kruse, 1988). In 1988, the value of the harvest for salmon fisheries in Prince William Sound (PWS) alone totalled $76 million, herring, $12.2 million, and shellfish, $2.4 million (AF&G, 1989).

The ex-vessel value of Alaska's commercial fishing industry ranks first among all U.S. states. The ex-vessel value of fishery landings in Alaska is more than twice the landed values of Washington, Oregon and California combined. In 1985, Alaska's salmon catch (in numbers) exceeded the other Pacific states by more than 14 times, and landings (in weight) of shellfish into Alaskan ports was greater than three times the total amount of landings into the other west coast states. Between 1976 and 1985, 74-81 % of all annual west coast shellfish were landed in Alaska.

Since 1978, the number of fishing vessels participating in commercial fishing has increased slightly (9% increase between 1978 and 1986). Excluding vessels in the Arctic-Yukon-Kuskokwim region, there were 15,839 vessels licensed to fish commercially in

Alaska in 1986. Of these, 11,062 (70%) were registered to residents of Alaska, 2,674 were registered to non-residents, and 2,103 to individuals of unknown residency (Kruse, 1988).

In 1986, there were 28,663 commercial fishing permits purchased. Of these, 84% (24,059) were purchased by Alaskan residents; the remainder (4,604) were purchased by non-residents. These permits were purchased by 17,340 individuals, 81% (14,024) of whom were Alaska residents and the remainder (3,316) were non-residents. Between 1974 and 1986, the number of permits purchased for commercial fishing and the number of individuals purchasing permits has increased 53% and 45%, respectively. Also, in 1986, there were 29,904 licenses sold to crew members for participation in commercial fisheries in Alaska; 67% of these were purchased by Alaska residents.

Where are these districts?

Legal gear for the commercial harvest of salmon include purse seines and both drift and set gill nets. Drift gill net fishermen are the most numerous and are permitted to fish in the Bering River, Copper River, Coghill, Unakwik, and Eshamy districts. During the 1989 season, 408 drift gill net permit holders participated. Set gill net gear is legal only in the Eshamy district. There are 30 total permits for this gear type. Purse seine gear is legal in the Eastern, Northern, Unakwik, Cogill, Northwestern, Southwestern, Montague and Southeastern Districts. An estimated 243 purse seine permits were active during the 1989 season (ADF&G, 1991).

Where are these districts?

Purse seiners, which catch most of the fish in the sound, fish all PWS districts, except Eshamy, usually beginning in early or mid-July, depending upon the strength of early pink salmon runs. Purse seine fishing continues usually into the first or second week of August (Alaska Geographic, 1983).

we can do better than this for source material

Fishing Industry Employment

In 1983, the average annual employment in fish harvesting was roughly 8,000, with peak monthly employment in fish harvesting at 26,000. Of the average annual employment in the harvesting industry, approximately 6,300 (79%) were Alaska residents and 1,600 were nonresidents. The 1983 annual average employment in salmon fisheries was 5,000, shellfish fisheries employed 1,400, and 1,000 were employed in fisheries for halibut (Kruse, 1988).

Between 1976 and 1985, the number of fish processing facilities more than tripled to 629. The large increase in the number of floating processing vessels accounted for a major portion of this growth. In 1986 these processing plants were owned by 442 companies,

which reflects a nearly three-fold increase over 1976.

The estimated number of employees in food processing (primarily seafood processing) equalled 18,683 in 1984 and 19,943 in 1985 (Jensvold et al. 1987). Of these totals, 12,068 (65%) and 13,512 (68%) were nonresidents in 1984 and 1985, respectively. These estimates considered employees to be the number of individual people who worked in seafood processing and received most of their annual wages in this industry. Those who worked in seafood processing, but earned more wages in another sector of the economy, were not included in the estimate. Thus, for 1984 there were an estimated 48,287 employees in fish harvesting and processing combined. Approximately 28,738 of these employees were Alaska residents (Kruse, 1988).

The seafood industry is the largest non-governmental employer in Alaska, providing approximately 16.4% of the state's jobs. It has been estimated that the Alaskan seafood industry provides nearly 70,000 seasonal jobs, and as many as 33,000 direct, indirect and induced year-round jobs. Based on these figures, the 1987 estimated total seafood industry payroll was $596 million (Royce, 1991).

Salmon Hatcheries and Management

Article VIII, Section 5 of the Alaska Constitution authorizes the state legislature to "provide for facilities improvements and services to assure further utilization and development of the fisheries". In 1974, the Private Nonprofit Hatcheries Act (Chapter III, SLA 1974) was enacted which "authorized private ownership of salmon hatcheries by qualified nonprofit corporations for the purpose of contributing by artificial means to the rehabilitation of the state's depleted and depressed salmon fishery."

hatchery locations
→ show on a map

Salmon hatcheries in the PWS area include the Solomon Gulch Hatchery at Valdez operated by the nonprofit corporation, Valdez Fisheries Development Association (VFDA). Two ADF&G Fisheries Rehabilitation, Enhancement and Development (FRED) facilities are state managed (Main Bay and Gulkana Hatcheries); Prince William Sound Aquaculture Corporation (PWSAC) operates three hatcheries: Armin F. Koering or AFK Hatchery; Esther Hatchery, now the Wally H Nuerenberg Hatchery; and Cannery Creek, which is a FRED facility under a 20 year management lease to PWSAC **(Figure I)**. Today, seven regional associations from Southeast Alaska to Kodiak produce salmon for common property fisheries (PWSAC, 1990).

The AFK and Cannery Creek Hatcheries produce primarily pink salmon; Nuerenberg

limiting hand trollers.

The Fish and Wildlife Protection Division of the Alaska Department of Public Safety enforces the state regulations that are promulgated by the Board of Fisheries (NPFMC, 1990).

The ADF&G FRED is responsible for the development of the state's fisheries. The Division encourages the investment of private non-profit (PNP) organizations in the fisheries to ensure continuing and increasing production and use of the food resources of Alaska's waters.

explain how this differs from EVOS rehabilitation/enhancement

Along with FRED, the U.S. Forest Service and PNPs are largely responsible for the rehabilitation and enhancement of salmon populations in the PWS area. Rehabilitation efforts are aimed at restoring wild stocks to former levels of abundance through stream improvements, fish ladders, and other activities that improve natural spawning conditions. Stream rehabilitation projects are carried out by the U.S. Forest Service in cooperation with the ADF&G. The Forest Service has this responsibility since many of the spawning streams are located in the Chugach National Forest which surrounds PWS and the headwaters of the Copper River. Between 1963 and 1982 there were 78 fish habitat improvement projects, 66 of which were completed by the Forest Service in PWS and Copper River areas.

In 1987, the largest state general fund expenditures on fisheries management were associated with ADF&G ($34.2 million), followed by the Department of Public Safety ($7.5 million). The estimated total expenditures for all state departments involved in fisheries management in FY-87 was $45.2 million from state general funds or $64.3 million from all funding sources combined. When expenditures on Sea Grant and the Marine Advisory Program of the University of Alaska are added, the totals come to $46.3 million (general funds) and $67.0 million (all funds). As a basis for comparison, approximately 1.6% of the total $2.145 billion in general fund expenditures by the state of Alaska for FY-87 went toward fisheries management activities by ADF&G. The estimated general fund expenditures on fisheries management of all departments in FY-87 was 2.1% of the state total or 2.2%, when Sea Grant and Marine Advisory Programs expenditures are included.

In contrast, for all west coast states, the largest 1987 annual budget for a state fish and game agency belongs to California ($106.6 million), followed by Alaska ($75.6 million), then Washington ($59.8 million) and Oregon($50.0 million). California spent the greatest

1985 (Kruse, 1988).

Shellfish landings accounted for 21% of the total ex-vessel value of commercial fisheries harvests in Alaska for 1986. The $182 million in gross receipts paid to fishermen for shellfish in 1986 was the highest amount since 1982. The increase is primarily attributable to the steady growth of fisheries for brown king and Dungeness crabs, and 1986 openings for Bristol Bay king and Tanner crabs. Because many shellfish fisheries remain closed due to low stock sizes, significant potential for growth exists (Kruse, 1988).

Transportation — Focus on oil spill area! — depends on where you are

The prime mode of transportation in Alaska is by aircraft. Approximately three-quarters of the state can not be reached via a road system. overland. Small aircraft fly to towns and attractions throughout the state. The planes are usually 9 - 16 seaters, but in remote areas smaller planes, usually 2 - 4 seaters, fly (Castleman and Pitcher 1992). — Also have jet service b/w Another major mode of transportation in Alaska is the ferry service known as the Alaska Marine Highway. There are two major routes for the Alaska Marine Highway system: the Southeast system serving almost every town in Southeast Alaska, and the Southwest system serving most of the coastal towns in Southcentral, Kodiak Island, the Kenai and Alaska peninsulas, and the Aleutian Chain as far west as Dutch Harbor/Unalaska (ADT 1990 Alaska Marine Highway System, 1989 Traffic Volume). However, the two systems do not interconnect. The Alaska Airlines flight from Juneau to Cordova provides connection (Castleman and Pitcher 1992).

Public transportation systems by land in Alaska consist of train, bus, and van services. Alaska has over 12,200 miles of public roads. Of these land miles, over 5,500 miles are under state jurisdiction, over 4,200 miles are under local government jurisdiction, and the remainder are under the jurisdiction of various federal agencies. Approximately one half of the public roads are paved. The major highway systems consist of Alaska Highway and George Parks Highway. The Alaska Highway is mostly paved, two-lane highway running in north-southeast direction, connecting Fairbanks to Prudhoe Bay in north and Dawson Creek, British Columbia in east. The George Parks Highway traverses in northsouth direction between Fairbanks and Anchorage. Anchorage and Seward are also connected by a highway, which is the most travelled highway in the state. Another highway (Richardson Highway) runs in northsouth direction connecting Fairbanks and Valdez. Getting around in private cars is a popular mode of transportation. Public bus service is highly primitive in Alaska. However, major destinations are served by bus or minibus, and some of the smaller towns are served by

vans (Castleman and Pitcher 1992).

The only train in Alaska is the Alaska Railroad which runs 470 miles between Seward and Fairbanks passing through Portage and Anchorage. A seven- mile stretch of the railroad connects Portage to Whittier, where travelers transfer from cruise ships, ferries, and tour boats to Alaska Railroad. Two expresses, one northbound and one southbound, run between Seward and Fairbanks daily. A shuttle train transports passengers between Portage and Whittier several times a day (Castleman and Pitcher 1992).

6. Recreation and Commercial Tourism — Re-write to focus on oil-spill area

a. Overview

Alaska has the largest assemblage of park, refuge and forest lands in the United States, and much of this land is still natural.? The nation's two largest national forests are located in Alaska: Tongass in Southeast (16 million acres) and Chugach in Southcentral (4.8 million acres). The Alaska State Park System, with more than 3.2 million acres of land and water, and 100 park units, is the largest state park system in the United States. This vast expanse of undeveloped land together with freshwater and marine systems has created a wide range of outdoor recreational opportunities in Alaska including hunting, fishing, hiking, camping, skiing, sightseeing, backpacking, climbing, dogsledding, snowmobiling, snowshoeing, kayaking, canoeing, power boating, flightseeing, photographing, and filming. In recent years, mountain biking, wind-surfing, river rafting, paragliding, paraskiing, winter camping, ice fishing, and scuba diving have also increased in popularity (Castleman and Pitcher 1992). These ~~limitless~~ recreational opportunities has helped create a growing tourism industry which offers a variety of professional services enabling visitors to use and enjoy the wilderness. ← sounds like an ad

Hiking and camping, being relatively inexpensive and easily available, are by far the most preferred outdoor recreation for the majority of Alaska's residents and visitors. Although, there are very few trails in Alaska, the vast taiga and tundra terrain along with the perpetual daylight during hiking season allow freedom to deviate from normal hiking/camping cycles (Castleman and Pitcher 1992). In addition, while hiking there is a possibility of encountering yikes! the abundant wildlife. Photography of the scenery and the fauna and flora go hand in hand with hiking and camping.

define

The Exxon Valdez oil spill has impacted some of the recreational activities in Southcentral and Southwest Alaska. More than ----% (this figure would be provided later on) of the land in the oil spill area is designated as national and state parks, forests, and wildlife refuges and is managed by various Federal and State government agencies. A full range of private and commercial recreation activity occurs in these areas supported by facilities like mooring buoys, boat ramps, recreational-user cabins, camping sites and trails. The national parks and forests include the Chugach National Forest, Kenai Fjords National Park, Katmai National Park and Preserve, Lake Clark National Park and Preserve, and Aniakchak National Monument and Preserve; the national wildlife refuges include Alaska Maritime National Wildlife Refuge, Kenai National Wildlife Refuge, Kodiak National Wildlife Refuge, Alaska Peninsula National Wildlife Refuge, and Becharof National Wildlife Refuge; and the state parks include the Chugach State Park and Kachemak Bay State Wilderness Park (Gousha 1991). Several other areas under the state management designated for various purposes such as, State Historic Sites, Marine Parks, Recreation Areas, and Recreation Parks attrast recreationists. Large portions of land within Katmai National Park and the Becharof National Wildlife Refuge have been designated wilderness areas by the Congress. Both of these areas and the Kachemak Bay State Wilderness Park were oiled by the Exxon Valdez spill. The following sections describe the recreation and tourism in the spill-affected area.

b. Recreation

re-name

For the purposes of this section, the oil spill area is divided into two regions: Southcentral region which includes Anchorage, Kenai Peninsula, and Prince William Sound; and Southwest region which includes Kodiak Island, Katmai, and other southwest locations. A brief description of recreational opportunities provided by each region follows.

this all sounds like a tourist brochure

Southcentral Alaska

Southcentral Alaska is a land of short rivers, long mountain ranges, and wide valleys, which extends north from the Gulf of Alaska to the crest of the Alaska range. Southcentral is the rich heartland of Alaska, with one big metropolis many small towns, some of the State's finest scenery, and best hiking/camping opportunities (Castleman and Pitcher 1992). Chugach National Forest, the second largest national forest, encompasses much of this region. The Chugach National Forest provides a highly visible and popular recreation program in the Kenai mountain range. The Forest Service operates and maintains 37 public recreation cabins and 16 campgrounds. There are over

200 miles of trail, including two National Recreation trails. In addition, there are 149 recreation special use permit facilities, including one major ski resort and six other resort facilities. The Portage visitor center and the Russian River, located within the Forest are among the three most heavily visited area in the state. Approximately 90% of the Forest's recorded recreational activities occurs on the Kenai Peninsula. The most popular activities are auto driving, camping, hiking, skiing, and fishing (USDA 1984). Alaska's second-largest state facility, Chugach State Park, located within this region, encompasses nearly half a million acres. Hiking is the main recreational activity in this park with about a dozen well-maintained, well-used, moderate-to-difficult trails. Along with hiking, photography and wildlife-watching are popular recreational activities.

Southcentral Alaska includes some of the premier kayaking areas in the world. Kayaking trips are taken from Valdez, Kodiak, Homer, Whittier, and Seward to the western portion of PWS and the bays along the Kenai Peninsula and Kodiak Island. A typical trip involves charter boat transportation to a site some distance from port. Most trips last more than one day and thus include both kayaking and wilderness camping.

The Kenai Peninsula is like a mini-Alaska, compressing all of the country's features. The Kenai is the most popular all around destination for all Alaskans and visitors (Kenai 1993). It is the most often viewed landscape in Alaska with the Seward/Anchorage highway being the most heavily used travel route in the state (USDA 1984). Captain Cook State Recreation Area, Kenai National Wildlife Refuge, Kenai Fjords National Park, Alaska Maritime National Wildlife Refuge, Kachemak Bay State Park, and Chugach National Forest are some of the areas affording a wide variety of recreational opportunities in the Kenai Peninsula and making it best in the state for wildlife viewing. The Kenai Fjords National Park, under the management of National Park Service, is an area with ice fields and a deep-water fjord coastline providing opportunities to see whales, ~~tortoise~~, sea otters, and birds of all kinds. At locations in the western and southern parts of the peninsula, the Alaska Department of Natural Resources maintains public access and recreation sites (including the Kachemak Bay State Park) totaling several thousand acres (Kenai 1993).

Few refuges contain as diverse landscape, abundant fish and wildlife populations, and varied recreational opportunities as the Kenai Refuge. Although not large compared to refuges in Alaska, the Kenai Refuge supports more recreational use than any other refuge in the world. ~~The Kenai refuge has natural and man-made features necessary to support a wide variety of outdoor activities.~~ The wide array of facilities that support and encourage public use and protect refuge resources include a headquarter, visitor

centers, and 47 recreational sites including campgrounds, access areas, wayside, and trailheads. These facilities vary from small undeveloped sites to large campgrounds with tables, fire grates, parking-spurs, boat ramps, water wells, and sanitary facilities. Recreational opportunities in the Kenai Refuge include salmon fishing, camping in developed campgrounds along roads and trails to isolated and primitive areas, hunting, wildlife observation, sightseeing, canoeing, boating, horseback riding, crosscountry skiing, snowmobiling, and berry picking. Most visitors participate in several activities while on the refuge (U.S. FWS 1983).

Besides the public lands, various small communities offer recreational opportunities on the Kenai Peninsula and their economy, to some extent, is based on recreation and tourism. The city of Seward, located at the head of deep-water inlet known as Resurrection Bay, is popular for fishing and sightseeing. The city of Soldotna, located in the Central Peninsula region, is famous for salmon fishing in Kenai River along with scenic views across Cook Inlet. The city of Kenai sits on a bluff where the Kenai River meets Cook Inlet and where some of the greatest tidal ranges occur, is famous for whale watching. Incoming tides actually reverse the flow of the river, influencing the movement of fish and the white beluga whales that follow them. Homer, located on the southern tip of the Kenai Peninsula provides charter boat tours to Gull Island for viewing thousands of birds. Homer is also visited for ~~salmon~~ halibut fishing (Kenai 1993).

Prince William Sound (PWS), located within the Southcentral region at the northern-most point of the Gulf of Alaska, is considered by many to be a unique, pristine, wilderness abundant with land and marine wildlife. The Sound is filled with deep fjords, ice-covered mountain ranges, tidewater glaciers, and hundreds of islands with innumerous sea birds. Murre colonies on Chiswell Islands, located in this region, are colonies most visited by tourists in Alaska. PWS is primarily used by boat with some areas accessed by float-equipped or wheel aircraft (USDA 1984). PWS covers over 2,700 miles of coastline, 4.4 million acres of National Forest and three of North America's major icefields. Prince William Sound offers tremendous opportunities for hiking, sightseeing, wildlife viewing, glaciers viewing, and fishing (PWS 1993).

Several communities located within the Prince William Sound area offer recreational opportunities and services expected from large cities. The city of Cordova, a modern thriving community, offers a wide variety of lodging options and recreational services including flightseeing, several boat charter services, and recreation centers. The city of Valdez, surrounded by towering mountains, provides a wide variety of local tours and sightseeing opportunities. Numerous scheduled cruises to Columbia and Shoup Glaciers

start here. In addition, several guided walking and bus tours showing historic Valdez and the Alyeska Pipeline Terminal are also available (PWS 1993).

Outdoor recreation plays an important role in the lifestyles of many Alaskan residents. A public survey conducted on the lifestyles of Southcentral Alaskans yielded information on the recreational activities that these residents engage in (Table I) (USDA 1984) The results of the survey indicated that driving, walking, and fishing were the most popular activities among the Southcentral Alaskans. Respondents also indicated that the important attributes of their favorite activities include getting away from usual demands, being close to nature, doing something exciting, experiencing new and different things, and being with family and friends. Attributes of favorite recreational places considered important by the respondents included fishing opportunities, scenery, and remoteness.

Table I

Participation of Southcentral Residents in Various Activities

Activity	% of Respondents Who Engaged in Activity
Driving for pleasure	59
Walking or running for pleasure	53
Freshwater fishing	42
Attending outdoor sport	37
Tent camping	31
Motor boating	30
Bicycling	29
Cross Country skiing	26
Target shooting	25
RV camping	24
Hiking with pack	22
Baseball, softball	19
Flying for pleasure	19
Sledding, toboggan	17
Kayaking, canoeing	17
ORV winter	17
ORV summer	14
Outdoor tennis	17

Swimming, scuba diving	16
Alpine skiing	14

Southwest Alaska

Southwest region includes the Kodiak Island group, the Alaska Peninsula, the Aleutian Islands, and Katmai. In this region Katmai National Park and Preserve, Alaska Peninsula National Wildlife Refuge, Becharof National Wildlife Refuge, Kodiak National Wildlife Refuge, and Aniakchak National Monument and Preserve are located.

Kodiak Island is the largest island in Alaska and the second largest in the U.S. Kodiak has Alaska's longest history, largest fishing fleet, and biggest brown bear population. Kodiak Refuge, established in 1941 to protect the habitat of brown bear and other wildlife, occupies about two-thirds of the island. Five species of Pacific salmon rearing and spawning habitat is provided within the refuge. Over 200 species of birds, large brown bear and bald eagle populations make the refuge an exciting place for wildlife viewing. Other recreational activities include photography, rafting, canoeing, camping, backpacking, hiking, hunting, and fishing. A visitors center and a limited number of recreational cabins are also located within the refuge. The town of Kodiak, where the majority of the Kodiak Island population live, is accessible by air and is a tourist attraction for viewing commercial fishing operations. The communities of Larsen Bay and Ports Lion on the Kodiak Island are visited for hiking, fishing, and hunting opportunities and their economy to a large extent is dependent on tourism (U.S. FWS 1987).

c. Tourism

Tourism is Alaska's third-largest industry behind petroleum production and commercial fishing. Tourism was, and is, an industry of growing economic importance to the state. Once regarded as a stepchild of the major traditional resource industries, tourism's obvious growth in the 1980s gave it legitimacy as a major industry. A visitor survey conducted by the Alaska Division of Tourism under the Alaska Visitors Statistics Program II (AVSP) revealed important statistics on the tourism industry. The survey results indicated that more than 750,000 people visited Alaska in 1989 from all around the world and of this 521,000 people visited in summer generating $304 million in revenue in summer alone. The Southcentral region was the major beneficiary of visitor spending, capturing 44% of the $304 million (ADT 1989a). Sixty-nine percent of the total

summer visitors were vacation/pleasure (VP) visitors. Southcentral Alaska accommodated more visitors per year than any other region but among VP visitors, Southeast was the most visited region, with nearly three out of every four VPs visiting the region. Southcentral was second with two-thirds of the VP visiting market (ADT 1989b). Southwest was visited by only 6% of the total VP visitors (ADT 1989a) and thus captured 5% of the $304 million (ADT 1989b).

Information on vacation planning for tourists is available through various sources such as, Alaska Division of Tourism, travel agents, and newspaper travel sections. The State Vacation Planner is widely used by the visitors in planning their Alaska trip. Once in Alaska, the majority of the visitors used visitor information centers (VICs) and reported that the VICs were doing a good job. Past studies have shown that the use of VICs enhanced visitor satisfaction and the likelihood of returning to Alaska in the future. A visitor using a VIC is more likely to see the best attractions in the local area, have contact with friendly locals, and be more active as a result. However, with the exception of one visitor information center at Tok, the state of Alaska relies on local communities and government agencies (usually Federal) to provide information to visitors. While many communities and agencies do a good job, brochure distribution practices are inconsistent, as are training, hours and seasons of operations, signage, and facility size and quality. Additionally, most agency information centers are oriented towards single attractions and some communities limit the types of information and brochures which they offer (ADT 1989b).

Survey results also revealed that Anchorage, Seward, Kenai/Soldotna, Homer, Valdez/PWS, and Whittier were among the most visited communities in the Southcentral region and King Salmon, Kodiak, Bethel were among the most visited communities in the Southwest region. The most visited attractions on the Kenai Peninsula were Kenai River, Kenai National Wildlife Refuge, Resurrection Bay, Kachemak Bay, and Kenai Fjords National monument. In the Prince William Sound area the most visited attractions were Columbia Glacier, Prince William Sound, Valdez Pipeline Terminal, and College Fjord. In the Southwest region the most visited attractions were Kodiak Russian Orthodox Church, Katmai National Park, and Kodiak National Wildlife Refuge. In addition, cultural attractions and museums were popular among Southcentral visitors (ADT 1989b).

Among the wide variety of recreational opportunities offered in Alaska, wildlife viewing was the most common activity in every region among the VP visitors and was the main activity in the Denali region. Bird watching was also common in all regions. Rafting

was most popular in Southeast and Denali. Hiking was universal but Southwest and Denali visitors did it most. Southwest was fishing country, with twice the participation of the next leading fishing region, Southcentral (ADT 1989b).

The visitors of Southcentral rated flightseeing and day cruises highly in the tour list while rafting, hiking, and canoeing/kayaking lead the activities list in satisfaction. Southwest VP visitors give that region's activities the highest marks in the state. Fishing (fresh water more than salt water), hunting, rafting, and canoeing/kayaking all score very well, and the state's highest flightseeing score was in Southwest (ADT 1989b).

7. Sport Fishing and Hunting

a. Sport Fishing

Sport fishing is one of the most popular recreational activity for both residents and visitors of Alaska. A wide variety of sport fishing opportunities exist in the oil-affected region. Marine recreational fishing originates in all major towns on the PWS as well as Cook Inlet, Kodiak Island, the Kenai Peninsula, and the Alaska Peninsula. Fishing trips are taken in several ways - from shore, from private boats, and from charter vessels. Several species of Pacific salmon, rockfish and halibut are available in both fresh and salt water and Dolly Varden, rainbow and cutthroat trout are found in ~~several~~ freshwater streams and lakes. Although sport fishing is popular throughout the state, seventy percent of Alaska's sport fishing occur in the Southcentral region and majority of which occur in the Kenai Peninsula because access by car from Anchorage to Kenai Peninsula is relatively easy (Castleman and Pitcher 1992). The Kenai River is well known for king salmon fishing. Sport fishing throughout the state is conducted according to the Alaska Sport Fishing Regulations, formulated by the Alaska Department of Fish and Game. The fishing regulations specify bag, possession, and size limits for the fishes to be taken from different streams/rivers/lakes etc. (ADF&G 1992a). In addition, there are management plans for king salmon on the Kenai River.

Historically (between 1984 and 1988), the number of anglers, fishing days, and fish harvest in the oil-affected area had been increasing at a rate of 10 - 16% per year. However, following the oil spill, there have been decline in the number of anglers, fishing days, and fish harvest, whereas, the area outside the oil spill continued to experience increase. The estimated number of anglers in the oil-affected region decreased 13% from 120,160 in 1988 to 104,739 in 1989, the number of days fished decreased 6% from 312,521 to 294,598, and the number of fish harvested decreased 10%

WALCOFF & ASSOCIATES

M E M O R A N D U M

TO: Ken Rice

FROM: Jacquie Glover-Brown

DATE: April 13, 1993

SUBJECT: Draft EIS Chapter 3 (Last Section)

Ken, as promised on Friday, April 9, enclosed is a draft copy of the last portion of Chapter 3. Please call if you have any questions.

We are looking forward to your visit.

C. Socioeconomic Description

1. Overview

This section describes the social, cultural, and economic conditions of the PWS region and its people. Included are descriptions of the communities affected by the spill; a discussion of the impact of the spill on traditional Native and non-Native subsistence hunting and fishing; information about spill-related injury to cultural and anthropological resources; and a description of the economic base of the area.

2. Relevant State History [PLACEMENT?]

The Alaska Statehood Act (48 U.S.C. [CITE?]) admitted Alaska to the Union in January 1959. The act allowed the State to select 400,000 acres (161,880 ha) of National Forest and unreserved land for community use. In addition, the State was also empowered to choose 102.55 million acres (41.5 million ha) of public lands from other unreserved U.S. lands.

dare

The Alaska Native Claims Settlement Act (33 U.S.C. § 1601-1624) settled the aboriginal rights and established the legal claims for Alaska Natives. It also authorized formation of the Regional Native Corporations. This act also addressed the public land withdrawals and established a Joint Federal State Land Use Planning Commission, which began the land selection procedures that resulted in the existing pattern of Federal, State, Native, and private ownership of lands in Alaska.

After Alaska became a State, oil exploration and development continued to grow. In 1968, a discovery well at Prudhoe Bay on the North Slope uncovered the largest known oil field in the United States. The North Slope oil lease, completed in 1969, granted oil rights to an oil consortium and brought more than $900 million in bonuses to Alaskans. To provide for transporting the oil from the North Slope to a shipping point, Congress passed the Trans-Alaska Pipeline Authorization Act in 1973. Construction of the pipeline was completed in 1977. Today, the pipeline moves almost 2 million barrels (84,000,000 gallons, or 317,940,000 liters) from Prudhoe Bay to Valdez every day. Since 1977, the Port of Valdez has shipped the bulk of crude oil taken from Prudhoe Bay.

In 1976, the first of DOI's Minerals Management Service lease sales for outer continental shelf (OCS) oil and gas were completed in the eastern Gulf of Alaska. Sales followed in Lower Cook Inlet (1977 and 1981), in the northeastern Gulf of Alaska (1980), and east of Kodiak Island (1980). Although Valdez and PWS have little or no known oil or gas potential, the area is part of Lease Sale 88.

[NATIVE CORPS GO HERE. KATHY, ARE YOU GETTING THIS INFORMATION?]

The Alaska National Interest Lands and Conservation Act of 1980 (ANILCA, 16 U.S.C. 3111 *et seq.*) implemented the Alaska Native Claims Settlement Act and the Statehood Act. ANILCA allowed the Alaska Native allotments, State land selections, and

?, ALLOTMENTS are individual selections upto 160 acres. IS this what you mean?

established the Alaska Land Bank. It also provided for the designation and conservation of Federal public lands, including the National Parks, National Wildlife Refuges, National Forests, Wild and Scenic Rivers, and the National Wilderness Preservation System. ANILCA also authorized the subsistence management system and allowed for the use of public resources, including the continued use of those resources in the National Parks and Forests.

3. Affected Communities

The communities affected by the *Exxon Valdez* spill are grouped into four regions: the Kenai Peninsula Borough (KPB), the Kodiak Island Borough (KIB), the Lake and Peninsula Borough, and the Valdez–Cordova Census Area. The effects of the spill differ for each region and its communities. In general, the communities that experienced the most disruption were the Native villages, which are mixed cash-subsistence hunting and fishing based economies.

a. Kenai Peninsula Borough

The Kenai Peninsula Borough, which is located south of Anchorage, includes both sides of Cook Inlet from the southern tip of the Kenai Peninsula north to the Knik Arm–Turnagain Arm split. The Kenai Peninsula holds 99 percent of the borough's population and most of the area's development because it is linked by roads to Anchorage. Sixty-three percent of the borough's population (27,338 people) lives in Kenai and Soldotna. The area is economically dependent on the oil and gas industry, as well as fishing and tourism. Communities within the central Kenai Peninsula region are the cities of Kenai, Soldotna, and Seward.

The southern Kenai Peninsula contains the cities of Homer and Seldovia and the Native villages of Port Graham and English Bay. Homer is the economic and population hub of the region, with revenues from commercial fishing, tourism, government and commercial offices, and agriculture. In contrast, the Native villages are largely dependent upon subsistence hunting and fishing. Within this region, Homer was least affected by the spill, both because it was least severely oiled and because its residents were relatively less dependent upon subsistence. Port Graham and English Bay were heavily oiled, yet these communities were farthest removed from the cleanup efforts. Residents of these communities who relied upon subsistence were adversely affected by actual contamination or perceived contamination of subsistence foods.

b. Kodiak Island Borough

The Kodiak Island region includes the city of Kodiak and the six Native villages of Port Lions, Ouzinkie, Larsen Bay, Karluk, Old Harbor, and Akhiok. These communities are part of the Kodiak Island Borough (KIB). The KIB population is between 13,000 and 15,000 and includes Natives of Alutic [ALEUTIC?] background and immigrants from the Philippines and from Central and Meso-America. As in other parts of Alaska, Kodiak

Island's population grows significantly in the summer. The KIB provides some social services to villages, and the Kodiak Area Native Association (KANA) provides medical and social services through the tribal governments in each village.

Nearly two-thirds of the Kodiak Island shoreline was oiled. Oil in varying forms spread from the northern end of the island along the west coast and through the many passages, coves, and small islands that make up the Kodiak Island group. In addition to the physical effects of the oil on these communities' land, social effects were associated with the cleanup activities that followed the spill. Daily life in many Native villages was disrupted by the presence of outsiders and by changes in the local economy caused by the influx of visitors and cash. Local governments and relations with service providers were strained in many villages, and the introduction of provisional regulations added to the tension. The communities of Akhiok, Karluk, Kodiak, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions are located in the Kodiak Island Borough.

c. Lake and Peninsula Borough

The Lake and Peninsula Borough contains three communities Chignik Bay, Chignik Lagoon, Chignik Lake, which were exposed to oil in the form of tar balls and oil sheen. Some remote beaches were also oiled. Residents of all three communities are ethnically mixed, Aleut, Russian and Scandinavian. The economy of the communities is mixed cash-subsistence.

d. Valdez-Cordova Census Area

The Prince William Sound region covers an area of about 20,000 square miles [EQUIV] of water, ice, and land. For the purpose of this study, the region includes five communities: Valdez, Cordova, Whittier, Chenega Bay and Tatitlek. Each is accessible by air or water, and all have dock or harbor facilities. Only Valdez is accessible by road.

The region has an abundant supply of fish, shellfish, and marine mammals. These and the other natural resources of PWS play a part in the lives of area residents. In addition, the area is considered by many to be a unique, pristine wilderness, offering unparalleled opportunities for outdoor recreation, adventure, and travel.

Communities in the PWS region depend on a variety of economic activities, as shown in Table IIIX.

Table IIIa Valdez-Cordova Employment by Industry

Occupational Classification	Number employed
Agriculture, Forestry, Fisheries	574
Mining	115
Construction	421

Occupational Classification	Number employed
Manufacturing (nondurable goods)	146
Manufacturing (durable goods)	110
Transportation	618
Communication and public utilities	149
Wholesale trade	84
Retail trade	612
Finance, insurance, and real estate	102
Business and repair service	87
Personal services	154
Entertainment and recreation	60
Health services	316
Education services	523
Other professional and related services	447

Source: [KATHY—CAN WE GET SOURCE HERE.]

The economic bases of the five communities is diverse. Cordova's economy is based on commercial fishing, primarily for ~~red~~ salmon. As the terminus of the Trans-Alaska Pipeline, Valdez is dependent on the oil industry; but commercial fishing and fish processing are also important to the local economy. Whittier residents work as government employees, longshoremen, commercial fishermen, and service providers to tourists. The Alaska Native people of Chenega Bay and Tatitlek, by contrast, rely on subsistence fishing, hunting, and gathering for their livelihood.

Table III# Cordova Wage and Salary Employment, 1989 - 1990

Occupational Classification	1989	1990
Nonagricultural wage and salary	1,301	1,321
Construction	29	51
Transportation, Communications, and Utilities	197	96
Trade	178	190
Finance, Insurance, and Real Estate	24	24
Services	120	127

Occupational Classification	1989	1990
Miscellaneous	92	101
Government	335	372
Federal	40	49
State	112	121
Local	184	202

Source: [KATHY, I NEED SOURCE FOR THIS!]

Table III# Valdez Wage and Salary Employment, 1989 - 1990

Occupational Category	1988	1989	1990
Nonagricultural wage and salary	1,789	2,887	2,200
Mining	0	0	0
Constuction	38	23	26
Manufacturing	206	261	247
Transportation, Communication, and Utilities	388	1,129	563
Trade	175	237	265
Finance, Insurance, Real Estate	15	24	30
Services, Miscellaneous	294	462	346
Government	673	751	749
Federal	17	18	17
State	377	448	422
Local	280	285	310

Source: Alaska Department of Labor, Research and Analysis Section

4. Subsistence [THIS SECTION TO BE REORGANIZED, CUT CONSIDERABLY.]

a. Overview

The term "subsistence" refers to a particular pattern of harvesting and using naturally occurring renewable resources. In a subsistence system, land and labor are allocated in accordance with kinship, political, or tribal rights and obligations. Subsistence systems define a relationship with the earth and its resources, shape the economy, provide material sustenance, and form the basis of community life. Subsistence systems depend on natural resources in a way that Western industrialized societies do not.

Alaska is the only State in which a significant proportion of the population lives off the

land. The Alaska Lands Act defines subsistence as follows:

> . . . customary and traditional uses by Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for making and selling of handicraft articles out of non-edible by-products of fish and wildlife resources taken for personal or family consumption; for bartering or sharing for personal or family consumption; and for customary trade. (Alaska Lands Act, § 803)

Residents of communities legally defined as "rural" under Fed/State regulations may hunt and fish under subsistence regulations. Since there are only ~~a few~~ urban areas in Alaska, the majority of the State's 300 inhabited areas fall into the rural category. Fed lands managed separately than state for subsistence uses.

Subsistence systems are characterized by four important attributes.

- Subsistence activities are seasonal. Fishing, hunting, and gathering follow the natural rhythm of the tides, wildlife and fish migration, and plant life cycles. The form of settlement and the pace of life in PWS villages depend upon the season.

- Subsistence activities are localized. Productive, accessible sites are established for various subsistence activities.

- Subsistence is regulated by a system of traditional, locally recognized rights, obligations, and appropriate behaviors. The use of sites, the division of the catch or harvest, and the assignment of responsibilities are determined by tradition. Villages that share overlapping territories for hunting and fishing occupy their individual niche and adhere to the rights and responsibilities traditionally assigned to them.

- Subsistence is opportunity-based. [WE NEED MORE HERE] (MMS, [NEED YEAR])

b. Connection to Environment

Subsistence implies a certain connection to the environment. Prior to the *Exxon Valdez* oil spill, much of the Spill area PWS was considered a "pristine" wilderness with bountiful environmental riches. The abundant wildlife, scenic mountains, old-growth forests, clear waters, and other natural riches of ~~PWS~~ have made the area particularly valuable to Alaskans, both Native and non-Native. The unpolluted environment attributed to ~~PWS~~ was experienced as an enrichment of individual lives, a perspective somewhat less common in the lower

48 States. For many Alaskans, the spill spoiled a pure and irreplaceable resource, a place that was fundamental to their identities and values. One resident explained it this way:

> . . . [H]ere in Homer most people don't really care all that much about money or material things. They care about a quality of life that in some cases they have traveled across the entire country to find. Some things are sacred. This country is sacred. The connection of these people to the country is sacred. And no amount of money can magically undo the damage, the sacrilege. (Oil Spill Commission, 1990)

Both Alaska Natives and non-Natives in PWS experience a relationship with the environment that is unique in the United States. Many of those who choose to live there, foregoing the steady income a city job could provide, assign great value to the rural, subsistence-based way of life. When the environment is harmed, the basis of subsistence—the harmonious relationship of humans to their environment—is threatened.

c. Economic Implications

The economic aspects of the subsistence system also are dependent upon the availability of untainted natural resources. In the ~~PWS~~ subsistence system, food and other material resources are bartered, shared, and used to supplement supplies from other sources. Subsistence resources are the foundation of the ~~PWS~~ area's mixed subsistence-cash economy.

It should be noted that none of the rural communities in ~~PWS~~ is so isolated or so traditional as to be totally uninvolved in the modern market economy. Most ~~PWS~~ communities are characterized by a mixed subsistence-market economy. This label recognizes that a subsistence sector exists alongside a cash system, and that the socioeconomic system is viable because the sectors are complementary and mutually supportive. Even the most traditional subsistence hunter uses the most modern rifles, snow machines, boats, boat motors, nets, and traps he can afford. These goods cannot be acquired without cash.

Subsistence pursuits supply important material goods, however. Although some food is imported into PWS, a vast subsistence harvest is hunted, fished, and gathered locally. For some residents, subsistence is the primary source of food and supplies. For others, subsistence supplements resources available from other sources.

> Our beaches and waters provide us with deer and fish and game which helps

offset the high cost of food here (Kodiak Island). This is not simply a recreational question, it is everyone's livelihood and food resource that is affected. (The Day the Water Died, [YEAR])

Within Alaska Native communities, not all households participate in every subsistence harvest, but food is often shared among households. Sharing subsistence resources occurs both within and among PWS villages.

not true - good studies available showing consumption by community

Estimates vary widely on the percentage of subsistence foods in the diet [DO WE MEAN JUST NATIVES? OR EVERYBODY IN PWS?], but studies indicate that subsistence may provide 70 to 80 percent of the total protein consumed within the households of PWS villages. [CITE?] Estimates place the share of subsistence meats and fish at 200 to 600 pounds [KG] per person per year. Among Alaska Natives, reliance on subsistence foods is greater still, with subsistence resources providing 80 to 100 percent of Natives' total protein intake, at an average of 500 pounds [KG] per person per year. Subsistence foods provide a large portion of the diet—a portion that families can ill afford to replace with imported substitutes. Fewer than 500 permits are given to subsistence fishermen each year, mostly residing in the Upper Copper River area and the southwestern area of PWS.

Besides making up part of the local diet, subsistence provides food for dog teams and is the only source for other material needs such as ivory for carving [CARVING WHAT?], furs for clothing, and seal hides for mukluk soles and uppers.

The ~~PWS~~ communities affected by the oil spill are small, relatively isolated, and economically dependent on local fish and wildlife. The noncommercial transfer and exchange of wildlife products are important institutions in PWS and in Alaska. The prevalence of direct consumption and nonmonetary transfer and exchange of fish, wildlife, and other natural resources and services makes it difficult to determine their economic value in terms of the value system of the cash economy.

d. Sociocultural Implications

Subsistence pursuits are tied to all aspects of life in the villages affected by the oil spill and are key to the Alaska Native sociocultural system. For at least 11,000 years, Alaska Native people have depended on the lands and water of PWS for their survival. Their traditional way of life is intimately tied to the harvesting, gathering, and use of subsistence foods.

subsistence should not be painted as a native only use. Even though the majority of customary subsistence users are native it is clearly an Alaskan use by rural residents.

The Alaska Native culture cannot easily be separated from the subsistence way of life and each person's relationship to the land, sea, and resources. In the words of [WHO?]—

> Our area is not an economically developed area. We depend on the sea for our food and clothing. There is much sharing in the catches, as we realize the needs of our brothers and they realize our needs. It is not joyful to see our children and grandchildren hungry. . . Every one of us is Eskimo around here. We all have to eat our own native food, and there is no question about it. We cannot possibly go without it. . . Please try and fathom our great desire to survive in a way somewhat different from yours, and thus see why the hunters will continue to go out. . . Over long stretches of unrecorded time, Native Americans established balances with other life on the earth. They survived over the centuries by living in balance with the fish and birds and animals . . . in balance with the subsistence resources of the natural world . . .
> When the balance, or circle of life, as it has been called, is broken, birds and fish and animals begin disappearing from the land. When they are gone, so are the people who depended upon them (Davidson, 1974).

not necessary

The rules governing the harvesting and use of subsistence resources are derived from a combination of culture, tradition, and religious beliefs. Subsistence involves many social activities such as cooperative labor-sharing, the exchange of resources and information, transmission of knowledge and skills, and formation of values. The means of establishing prestige and maintaining peace traditionally involve the consumption, transfer, and exchange of fish, game, and their byproducts. These activities are necessary for the preservation of traditional family and community relationships that are essential to the physical and psychological well-being of Alaska Native communities. Continuous access to uncontaminated resources in a natural setting is also fundamental to the physical, spiritual, and psychological well-being of Alaska Native communities.

In Native villages, the hunt, the sharing of products of the hunt, and the beliefs surrounding the hunt tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Generous hunters are considered good men. Good hunters are often leaders. These are but some of the ways in which subsistence and beliefs about subsistence join with sociocultural values. The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and subsistence activities that occur in Native society. Subsistence also shapes the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations, employment, sports activities, and membership in voluntary organizations. Language, culture, spiritual beliefs, customs, self-esteem, and

respect for others are tied into a view of the world that is centered on the traditional hunting, fishing, and gathering way of life.

e. Effects of the Spill on Subsistence

Subsistence is the basis of a whole way of life in PWS. Recognition of this perspective is essential to understanding the significance of subsistence activities, as well as the far-reaching impacts of the *Exxon Valdez* oil spill on subsistence for Natives and non-Natives alike.

The spill fouled waters and beaches used for subsistence hunting, fishing, and gathering by 18 rural communities, including 15 Native villages, with about 15,600 inhabitants. Destruction and contamination of subsistence resources exacerbated [STRONG] the cultural disintegration and dislocation experienced by Alaska Natives in ~~PWS~~.

> Livelihoods destroyed, emotional stability of people destroyed, tremendous stress—these things will be etched on my mind for the rest of my lifetime, and I think that I will be grieving for many, many years to come over what I saw in the summer of 1989. (The Day the Water Died [CITE])

Subsistence harvesting was disrupted, which in turn disrupted the traditional cultural patterns of social interaction surrounding the harvesting of local natural resources. In 1989, subsistence fishery was banned as a precaution against possible health-threatening effects of the oil spill on fish in the Sound.

Commercial fishing was banned was subsistence harvest also closed?

Resource and habitat contamination and destruction resulted in a 77-percent decline in subsistence resource harvesting. PWS residents had to seek food from outside the local environment. In Native villages, shortages of traditional foods resulted.

Table III# Permits Issued and Estimated Harvest Values, 1989 - 1990

City/village	Permits (1988)	Harvest Earnings (1988)	Permits (1989)	Harvest Earnings (1989)	Permits (1990)	Harvest Earnings (1990)
Cordova	411	$41,500,000	309	$29,949,000	412	$31,637,000
Valdez	55	$2,710,000	30	$1,436,000	54	$1,959,000
Chenega Bay	1	not applicable	1	not applicable	3	not applicable
Tatitlek	11	$514,000	8	$196,000	6	$304,000
Whittier	16	$222,000	9	$42,000	14	$126,000

City/village	Permits (1988)	Harvest Earnings (1988)	Permits (1989)	Harvest Earnings (1989)	Permits (1990)	Harvest Earnings (1990)
Total	494	$44,946,000	357	$31,623,000	489	$34,027,000

Source: Alaska Commercial Fisheries Entry Commission

Moreover, the sociocultural system on which the traditional Alaska Native lifestyle is based was threatened by the influx of cleanup crews and the unfamiliar demands of a cash economy. Contamination of traditional foods, and fear of contamination, led potential users to stop harvesting these resources. One Alaska Native had this to say:

> We depend on ourselves. . . And we depend on the seals, sea lions, butter clams, ducks, and sea life. Now they are disappearing. The sea life is disappearing. Even if they come around, we are staying away from them. (Alaska Oil Spill Commission, 1990)

Although a number of fisheries were closed immediately following the spill and reopened once it had been determined that local fish were safe to eat, some Alaska Natives are unwilling to eat them for fear of contamination. Spot shrimp fisheries were closed in 1989 and 1990. Clams, an important part of the native diet, were shown to be contaminated after the spill. Fish, bear, moose, deer, and other Native meats were deemed safe to eat by Federal and State health officials, but not all PWS subsistence users were willing to go back to harvesting them. ~~Restoration proposals will address the contamination that continues to affect PWS species and people who harvest them.~~

4. Cultural and anthropological resources

Sites important to the Alaskan culture were injured by the oil spill and by the cleanup response, mainly by increasing human activity in and around PWS. At least 26 archaeological sites, including burial grounds and home sites, were injured to various degrees. Five of these sites were on private or State lands and 21 were located on Federal land—10 on national parks, six on national refuges, four within the Chugach National Forest, and one on Bureau of Land Management (BLM) land. Injuries included vandalism, erosion of beachfront sites, removal of artifacts, and oiled sites. With regard to the oil spill, the three major sources of potential impact were direct impacts resulting from oil in direct contact with artifacts or features; treatment methods employed to remove oil; and human activities incidental to the response actions.

Some Alaska Native sites in the PWS area are more than 11,000 years old (Clark 1984a.

1984b; Crowell 1988b). The sites affected by the oil spill fall within the larger ethnographic Pacific Eskimo region, which extends from the Copper River to the middle of the Alaska Peninsula and includes the outer reaches of Cook Inlet. Cook Inlet was originally occupied by the Tanaina Athapaskans. Trade, warfare, ceremonial exchange, and occasional intermarriage led to a sharing of many cultural traits among the Pacific Eskimo, Tanaina, Aleut, Eskimo, Athapaskan, Eyak, and Tlingit Indian tribes.

The types and locations of PWS archaeological and architectural sites made them particularly vulnerable to disturbances related to the oil spill. Sites found in the intertidal zone include stone and wooden fish weirs, petroglyphs, shipwrecks, piers and pilings associated with historical domestic and commercial facilities, and potentially the full range of features found in the uplands. Cultural resources were known to occur in adjacent uplands, where modified deposits, villages, rock shelters, culturally modified trees, historical domestic and commercial facilities, and other features are present. The range of physical materials incorporated into these sites includes stone, bone, shell, various metals, wood, textiles, leather, and other organic items.

The major potential physical impact of oiling is the obscuring of intertidal artifacts from observation, with the secondary possibility that solidification of oil could immobilize artifacts in the intertidal zone. Both of these effects would be temporary, as wave and tidal action would remove the oil over a period of months or years. The chemical impacts of oiling are not known. Some scientists have raised questions about whether contaminated organic items can still be dated using radiocarbon techniques, but others believe that the oil can be removed from crucial samples so that they may be successfully dated. [KATHY: I DON'T THINK THIS IS IN BIBLIO. PLEASE SUPPLY FULL CITE! (CRS 1989:103)].

Several of the cleaning methods used on the beaches were particularly damaging to archaeological resources. [KATHY: WHICH ONES WERE WORST AND WHY?] Archaeological and architectural sites located in the uplands adjacent to treated shorelines were at risk only when people visited those uplands. Although a blanket restriction on upland access by cleanup crews was in effect throughout the shoreline treatment phase, some degree of access was required to efficiently undertake treatment activities. In addition, a variety of pedestrian upland crossings resulted in damage to cultural resources, especially surface features. Vandalism and looting of cultural sites occurred as a result of uncontrolled or unsupervised access to the immediate uplands, particularly where rock shelters, historic cabins, mine sites, and other surface features or subsurface deposits were exposed.

5. Economic base of the region

COMMERCIAL FISHING

Introduction

Alaska is considered the most important fishing state in the United States. In 1989 Alaska accounted for almost half the nation's catch in pounds, and 38% in value. No other state comes close to Alaska in either total harvest weight or value, according to statistics compiled by the U.S. Department of Commerce. Consequently, Alaska is a major exporter of fishery products. In 1987, seafood valued at $561 million was shipped overseas, 95% of which went to Japan. That represented approximately one-third of the U.S. seafood exports (Royce, 1991).

The major species groups contributing to Alaska's commercial fisheries are salmon, shellfish (primarily crabs and shrimps), groundfish (mostly pollock, flatfishes and cods), halibut and herring. Since 1976, salmon have accounted for roughly 50% of the ex-vessel value (gross receipts). Shellfish accounted for 40-45% until the early 1980's, when declines in several major shellfish fisheries occurred. Since the early 1980's Alaskan groundfish landings have increased, accounting for nearly one-quarter of the 1986 ex-vessel value of commercial fishery harvests. In 1986, which can be considered a representative year, salmon accounted for 46% of the total gross receipts to fishermen, groundfish amounted to 22%, shellfish were 21%, halibut were 7%, and herring were 4% (Kruse, 1988). In 1988, the value of the harvest for salmon fisheries in Prince William Sound (PWS) alone totalled $76 million, herring, $12.2 million, and shellfish, $2.4 million (AF&G, 1989).

The ex-vessel value of Alaska's commercial fishing industry ranks first among all U.S. states. The ex-vessel value of fishery landings in Alaska is more than twice the landed values of Washington, Oregon and California combined. In 1985, Alaska's salmon catch (in numbers) exceeded the other Pacific states by more than 14 times, and landings (in weight) of shellfish into Alaskan ports was greater than three times the total amount of landings into the other west coast states. Between 1976 and 1985, 74-81 % of all annual west coast shellfish were landed in Alaska.

Since 1978, the number of fishing vessels participating in commercial fishing has increased slightly (9% increase between 1978 and 1986). Excluding vessels in the Arctic-Yukon-Kuskokwim region, there were 15,839 vessels licensed to fish commercially in

Alaska in 1986. Of these, 11,062 (70%) were registered to residents of Alaska, 2,674 were registered to non-residents, and 2,103 to individuals of unknown residency (Kruse, 1988).

In 1986, there were 28,663 commercial fishing permits purchased. Of these, 84% (24,059) were purchased by Alaskan residents; the remainder (4,604) were purchased by non-residents. These permits were purchased by 17,340 individuals, 81% (14,024) of whom were Alaska residents and the remainder (3,316) were non-residents. Between 1974 and 1986, the number of permits purchased for commercial fishing and the number of individuals purchasing permits has increased 53% and 45%, respectively. Also, in 1986, there were 29,904 licenses sold to crew members for participation in commercial fisheries in Alaska; 67% of these were purchased by Alaska residents.

Legal gear for the commercial harvest of salmon include purse seines and both drift and set gill nets. Drift gill net fishermen are the most numerous and are permitted to fish in the Bering River, Copper River, Coghill, Unakwik, and Eshamy districts. During the 1989 season, 408 drift gill net permit holders participated. Set gill net gear is legal only in the Eshamy district. There are 30 total permits for this gear type. Purse seine gear is legal in the Eastern, Northern, Unakwik, Cogill, Northwestern, Southwestern, Montague and Southeastern Districts. An estimated 243 purse seine permits were active during the 1989 season (ADF&G, 1991).

Purse seiners, which catch most of the fish in the sound, fish all PWS districts, except Eshamy, usually beginning in early or mid-July, depending upon the strength of early pink salmon runs. Purse seine fishing continues usually into the first or second week of August (Alaska Geographic, 1983).

Fishing Industry Employment

In 1983, the average annual employment in fish harvesting was roughly 8,000, with peak monthly employment in fish harvesting at 26,000. Of the average annual employment in the harvesting industry, approximately 6,300 (79%) were Alaska residents and 1,600 were nonresidents. The 1983 annual average employment in salmon fisheries was 5,000, shellfish fisheries employed 1,400, and 1,000 were employed in fisheries for halibut (Kruse, 1988).

Between 1976 and 1985, the number of fish processing facilities more than tripled to 629. The large increase in the number of floating processing vessels accounted for a major portion of this growth. In 1986 these processing plants were owned by 442 companies,

which reflects a nearly three-fold increase over 1976.

The estimated number of employees in food processing (primarily seafood processing) equalled 18,683 in 1984 and 19,943 in 1985 (Jensvold et al. 1987). Of these totals, 12,068 (65%) and 13,512 (68%) were nonresidents in 1984 and 1985, respectively. These estimates considered employees to be the number of individual people who worked in seafood processing and received most of their annual wages in this industry. Those who worked in seafood processing, but earned more wages in another sector of the economy, were not included in the estimate. Thus, for 1984 there were an estimated 48,287 employees in fish harvesting and processing combined. Approximately 28,738 of these employees were Alaska residents (Kruse, 1988).

The seafood industry is the largest non-governmental employer in Alaska, providing approximately 16.4% of the state's jobs. It has been estimated that the Alaskan seafood industry provides nearly 70,000 seasonal jobs, and as many as 33,000 direct, indirect and induced year-round jobs. Based on these figures, the 1987 estimated total seafood industry payroll was $596 million (Royce, 1991).

Salmon Hatcheries and Management

Article VIII, Section 5 of the Alaska Constitution authorizes the state legislature to "provide for facilities improvements and services to assure further utilization and development of the fisheries". In 1974, the Private Nonprofit Hatcheries Act (Chapter III, SLA 1974) was enacted which "authorized private ownership of salmon hatcheries by qualified nonprofit corporations for the purpose of contributing by artificial means to the rehabilitation of the state's depleted and depressed salmon fishery."

Salmon hatcheries in the PWS area include the Solomon Gulch Hatchery at Valdez operated by the nonprofit corporation, Valdez Fisheries Development Association (VFDA). Two ADF&G Fisheries Rehabilitation, Enhancement and Development (FRED) facilities are state managed (Main Bay and Gulkana Hatcheries); Prince William Sound NOT Aquaculture Corporation (PWSAC) operates three hatcheries: Armin F. Koering or AFK in Area Hatchery; Esther Hatchery, now the Wally H Nuerenberg Hatchery; and Cannery Creek, which is a FRED facility under a 20 year management lease to PWSAC **(Figure I)**. Today, seven regional associations from Southeast Alaska to Kodiak produce salmon for common property fisheries (PWSAC, 1990).

The AFK and Cannery Creek Hatcheries produce primarily pink salmon; Nuerenberg

Hatchery produces all five species of Pacific salmon, the majority of which are pink, chum and coho. Main Bay Hatchery produces sockeye salmon smolt in the western part of the Sound. The VFDA's Solomon Gulch hatchery in Valdez Arm produces pink, chum and coho salmon (PWSAC, 1990).

Pink converting to sockeye?

Main bay expanding EIS in progress.

From the inception of the hatchery system the intent has been to protect the fisheries from cyclical weaknesses. During the 1970's, salmon runs declined throughout the state. In PWS, seining did not open at all in 1972 and 1974 because the returning wild runs were below fisheries management escapement levels for reproduction and commercial harvest needs (PWSAC, 1990).

The importance of hatchery reared salmon was made apparent during the 1986 season, when approximately 11.5 million pink salmon were caught in PWS. Approximately 10.5 millon fish were harvested in common property fisheries, and 909,219 fish were harvested in the special harvest area sales harvests of the two major PNP hatcheries in the area. Approximately 5.8 million fish in the common property harvest were of hatchery origin. The combined common property and sales harvests of hatchery produced fish was 6.8 million fish. This marked the first time in the history of the fishery that hatchery fish constituted more than half of the pink salmon harvest (Sharr et al, 1988).

Because egg-to-fry survival is 80 percent or higher in hatcheries as opposed to 20 percent or less in natural spawning beds, hatcheries allow at least a 4-fold increase in production from a given number of spawners (PWSAC, 19??).

In an average year, the Prince William Sound hatcheries provide up to 40 percent of the salmon harvest in the Sound. In 1988, because of low natural runs of pink salmon, it is estimated that they contributed almost 90 percent of the Sound's total pink salmon harvest (AF&G, 1989).

Benefits from the introduction of the hatchery system have been achieved at some cost, not only financially, but in terms of fishery conditions, both perceived and real. Hatchery salmon production, intended to both increase catches and reduce harvest variability, has resulted in changes in the distribution of catches by species, the gear types used, seasonal opportunity to fish in historic and traditional areas, and fishing patterns.

Hatcheries in PWS have added new complexities to management of PWS salmon returns.

All major salmon returns to PWS hatcheries overlap with the timing of adjacent wild stock systems. In the general fishing districts of the Sound, hatchery fish are randomly mixed with wild stock fish, following the same migration routes to their respective points of origin. However, unlike the wild stock pink and chum systems distributed uniformly throughout the Sound, hatchery stocks return in mass to a limited number of release sites. In these areas termed terminal areas, hatchery fish are isolated from wild stocks. This provides the only management opportunity to specifically target the commercial harvest on the surplus production without risking a large incidental take of wild stock fish. There is a fairly high % of wild stock even in terminal fishery.

A shift in the composition of salmon in the harvest by the common property fishery (CPF) can be attributed to the hatchery system. Since the inception of the hatchery program in 1978, the wild stock contribution has declined. In the 1988-89 harvest seasons only 10-15% of the catch was from wild stocks (PWSAC, 1990). This is in contrast to early in the development of the hatchery program when wild stock returns were greater than hatchery returns. Wild stock returns could seemingly withstand greater exploitation rates, and returns to hatcheries fell short of brood stock and cost recovery needs. In an effort to insure that brood stock needs could be met, regulatory management plans were developed to implement closures around the hatcheries to reduce CPF interception rates. This was intended to assist hatchery operators in achieving cost recovery and brood stock goals. Because recent wild stock returns have been quite small relative to the hatchery returns, in order to achieve minimum escapement goals for wild stocks, it has been necessary to close the mixed stock areas of the general districts, and harvest a majority of the surplus hatchery returns in the hatchery terminal harvest areas (PWSAC, 1990).

Four Alaskan agencies are involved in managing Alaska's salmon fisheries. The Alaska Board of Fisheries sets policy and promulgates the regulations, the Alaska Department of Fish and Game (ADF&G) manages the fisheries according to the policies and regulations of the Board and State law, the Alaska Commercial Fisheries Entry Commission controls the amount of fishing effort, and the Alaska Department of Public Safety enforces the regulations (NPFMC, 1990).

In-season fisheries management is the responsibility of the Alaska Department of Fish and Game.

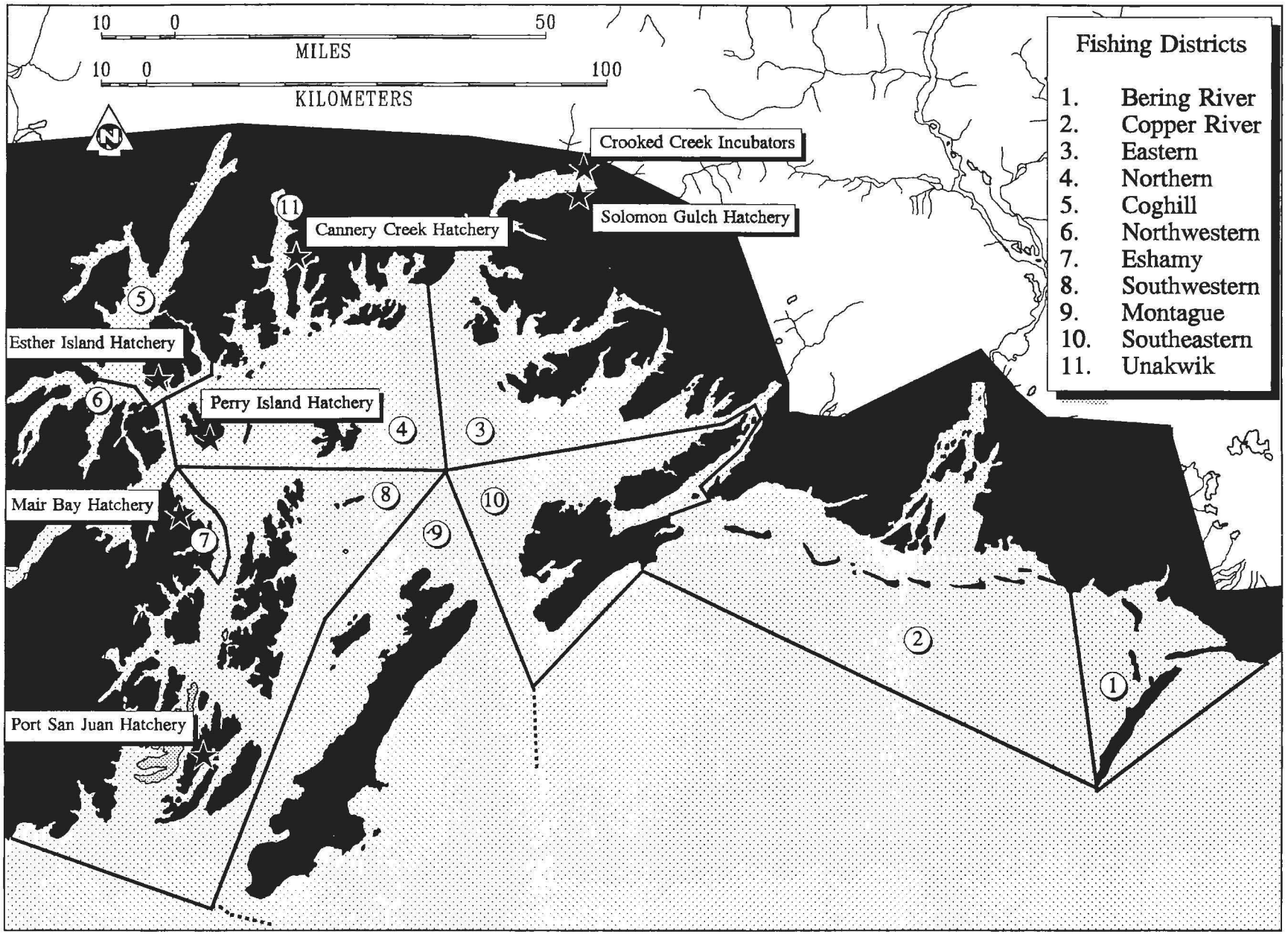
The primary management tool used by ADF&G for regulating salmon returns is emergency order authority to open and close fishing areas. The base management units in PWS for wild stock salmon are the 11 commercial fishing districts **(Figure I)**. Pink

and chum escapement performance for the aggregate index streams within a district determine the length of the weekly fishing periods that can be permitted. During years when the wild stock returns are strong, a liberal weekly fishing schedule may be permitted. However, when the wild stock pink and chum returns are weak, fishing must be restricted within the district to meet minimum spawning requirements.

Pink and chum stocks in PWS are so numerous and widely distributed that managing returns at each individual spawning stream is not feasible. Consequently, escapement performance is evaluated for an aggregate of streams sharing a common geographical area such as a district or a large bay. A subset of 200 representative streams have been identified as "index streams". These index streams are surveyed aerially on a weekly basis through the course of the season to evaluate escapement performance. Harvesting periods and closures are determined by comparing the observations at index streams with a computer data base containing historical aerial survey data dating back to the early 1960's. This comparison forms the basis for the development of timing curves with weekly anticipated escapement performance (PWSAC, 1990).

The ADF&G has not been given the authority to allocate the opportunity to utilize the salmon resources of the Sound between the various user groups. This authority is given to the Alaska Board of Fisheries, which establishes the regulations that govern PWS fisheries. Each year the Board of Fisheries solicits proposals to change regulations governing Alaska's fisheries. Usually, it is the Alaska Department of Fish and Game that responds to the Board's solicitation. The Board distributes these proposals to the public for review and comment and then conducts open public meetings to evaluate and take action on the proposals. This regularly scheduled participatory process is relied upon by the fishing community as the basis for changing Alaska's fishing regulations. Actions considered by the Board include changes in areas for the salmon fisheries, and the allocation of harvests among the various groups of fishermen. Thus while ADF&G determines when and where fishery openings can occur, the Board of Fisheries regulations determine who can fish in the designated areas.

The Alaska Commercial Fisheries Entry Commission is an independent, quasi-judicial state agency responsible for promoting the conservation and sustained yield of Alaska's fishery resources. By regulating entry into the fisheries, they ensure the economic health and stability of commercial fishing. The Commission's activities fall into three categories: licensing, research, and adjudication. As an example of their activities, in 1974, the Commission began establishing the maximum number of power trollers that may participate in the commercial salmon fisheries in Southeast Alaska; in 1982, it began


10 0 50
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KILOMETERS
N
Crooked Creek Incubators
Solomon Gulch Hatchery
Cannery Creek Hatchery
Esther Island Hatchery
Perry Island Hatchery
Mair Bay Hatchery
Port San Juan Hatchery
Fishing Districts
1. Bering River
2. Copper River
3. Eastern
4. Northern
5. Coghill
6. Northwestern
7. Eshamy
8. Southwestern
9. Montague
10. Southeastern
11. Unakwik

limiting hand trollers.

The Fish and Wildlife Protection Division of the Alaska Department of Public Safety enforces the state regulations that are promulgated by the Board of Fisheries (NPFMC, 1990).

The ADF&G FRED is responsible for the development of the state's fisheries. The Division encourages the investment of private non-profit (PNP) organizations in the fisheries to ensure continuing and increasing production and use of the food resources of Alaska's waters.

Along with FRED, the U.S. Fores Service and PNPs are largely responsible for the rehabilitation and enhancement of salmon populations in the PWS area. Rehabilitation efforts are aimed at restoring wild stocks to former levels of abundance through stream improvements, fish ladders, and other activities that improve natural spawning conditions. Stream rehabilitation projects are carried out by the U.S. Forest Service in cooperation with the ADF&G. The Forest Service has this responsibility since many of the spawning streams are located in the Chugach National Forest which surrounds PWS and the headwaters of the Copper River. Between 1963 and 1982 there were 78 fish habitat improvement projects, 66 of which were completed by the Forest Service in PWS and Copper River areas.

In 1987, the largest state general fund expenditures on fisheries management were associated with ADF&G ($34.2 million), followed by the Department of Public Safety ($7.5 million). The estimated total expenditures for all state departments involved in fisheries management in FY-87 was $45.2 million from state general funds or $64.3 million from all funding sources combined. When expenditures on Sea Grant and the Marine Advisory Program of the University of Alaska are added, the totals come to $46.3 million (general funds) and $67.0 million (all funds). As a basis for comparison, approximately 1.6% of the total $2.145 billion in general fund expenditures by the state of Alaska for FY-87 went toward fisheries management activities by ADF&G. The estimated general fund expenditures on fisheries management of all departments in FY-87 was 2.1% of the state total or 2.2%, when Sea Grant and Marine Advisory Programs expenditures are included.

In contrast, for all west coast states, the largest 1987 annual budget for a state fish and game agency belongs to California ($106.6 million), followed by Alaska ($75.6 million), then Washington ($59.8 million) and Oregon($50.0 million). California spent the greatest

amount annually on fisheries management ($68.5 million), followed by Alaska ($54.2 million for the average of FY-86 and FY-87), Washington ($47.7 million), and Oregon ($38.3 million). The FY-87 funding level form all funding sources for fisheries management by ADF&G was $50.9 million.

Commercial Herring Harvest

The pacific herring is also an important species to the Alaskan fishing industry because it eggs or roe are sold in large quantities, primarily to the Japanese market. Also, the herring is a vital part of the food chain, and it is consumed by larger commercial species of fish such as salmon and halibut (Royce, 1991).

In Alaska, there are four commercial herring fisheries. First, a small number of fish are caught for food and bait. Second, divers gather herring eggs or roe on kelp in shallow, open waters. Third, roe is gathered on kelp in man-made enclosures (this is known as the pound-kelp fishery). The fourth and most important commercial harvest is the "sac-roe" fishery, in which herring are netted to collect the mature female's egg filled membrane or sac. Each year the state limits the sac-roe harvest to 20% of the estimated herring stocks. (Herring) continue to reproduce until they are nine years old or older. The bulk of the herring harvested in PWS are three to seven years old (Royce, 1991).

There are five different herring fisheries in the PWS management area, that all target on what is treated as a single major stock of herring in the Sound. Management of the PWS herring fishery involves a maximum exploitation rate of 20% for the PWS herring biomass for all fisheries combined. The food and bait fishery is the only one that occurs in the fall and winter, generally in the Knowles Head area. This fishery is not limited, but generally has fewer than 10 boats participating annually. The four spring fisheries usually occur in the month of April, coinciding with the spawn timing of the PWS herring stock. The spring fisheries include: 1) a purse seine sac row fishery, that accounts for a large portion of the harvest and limited to approximately 100 permit holders, 2) a gill net sac row fishery with 25 limited entry permit holders, 3) a roe on kelp produced in pounds fishery with approximately 125 limited entry permit holders, and 4) a wild harvest fishery of natural roe on kelp, that is open to entry and has annual participation between 100 to 200 (ADF&G, 1991).

Herring are mass spawners and congregate in shallow areas (depths less than 35 feet) where eelgrass, kelp and other seaweeds can be found. From April to June, females deposit their eggs. These eggs, which are sticky, adhere to underwater plants, rocks and

other surfaces where they are fertilized by the males (Hart, 1973).

The annual harvest draws from herring within approximately a five-year age span. Thus, each year's catch is not dependent on a single year's successful survival, as with pink salmon.

Commercial Harvest Value

In 1984 there were approximately 30,000 harvesters and 19,000 others earned most of their personal income from in-state seafood processing. Approximately 22,100 (74%) of the harvesters and 6,600 (35%) of the processing employees were Alaskan residents. In 1984, approximately $597 million was paid to fishermen for commercial fishery harvests from waters off Alaska. Approximately $509 million was paid to fishermen for landings (1.0 billion lbs) into Alaskan ports, and gross receipts paid to Alaskan seafood processors totalled $1.044 billion. The harvest and processing of these seafood products resulted in personal income of $583 million to all workers in the state. Alaskan residents earned approximately $431 million of that total. This included $239 million to harvesters (57% or $136 million to Alaskan residents), $104 million to processing employees (53% or $55 million to residents), $210 million to Alaska residents employed in indirect and induced activities (e.g., service industries, transportation, etc.), and approximately $30 million in taxes related to the commercial fishing industry. Excluded from these figures are $5-7 million in licenses and permits bought by fishermen, and an unknown portion of the revenues to the state's general fund that were generated directly or indirectly by commercial fishing from other assessments (e.g., corporate income taxes, business licenses, etc.). In 1984, the total direct, indirect and induced earnings from the commercial fishing industry totalled approximately 7% of the total personal income in Alaska or 27% of the total personal income generated by the private sector. Commercial fishing was most important to the southwest region of the state where it generated 47% of the total regional income or 98% of the total personal income by private basic sector activity (Kruse, 1988).

The total ex-vessel value (gross receipts) of fish and shellfish landed into Alaskan ports nearly tripled from $227 million corresponding to 616 million lbs in 1976, to $591 million representing more than 1.2 billion lbs in 1985. The ex-vessel value of all commercial fisheries harvests taken from Alaskan waters (those landed in and out of state) increased from $241 million in 1976 to $890 million in 1986. Gross receipts paid to fishermen increased 50% from 1984 to 1986 alone. Gross receipts to Alaskan processors similarly increased 50% from $1.044 billion in 1984 to approximately $1.6 billion in 1986. Even

when these figures are adjusted for inflation using the Anchorage Consumer Price Index (CPI), the ex-vessel value (measured in 1986 dollars) of Alaska's commercial fisheries doubled between 1976 and 1986 (Kruse, 1988). These ex-vessel values probably underestimate the total gross benefits transferred to fishermen. Other economic values not accountable by gross receipts may include boat storage, financing, food, fuel and other benefits that may be provided by processors (Crutchfield et al. 1982).

Aside from the ex-vessel values of Alaska's fisheries and the economic activity (in terms of employment and personal income) generated from them, fishing generates revenues directly to the State of Alaska from taxes and licenses. State revenues generated in FY-86 from fisheries equalled $47.3 million, of which $43.4 million went to the general fund and $3.9 million went to the fish and game fund. Fishery revenues included fish taxes, marine fuel taxes, fishing permits, fishing licenses and other similar items.

The PWS Area combined commercial salmon harvest for 1989 was approximately 24.4 million fish. This catch exceeds the average harvest over the past 10 years. However, an exceptionally large portion of this catch (33%) was composed of hatchery sales fish from the PNP hatcheries, leaving a common property portion of the catch below the 10 year average (ADF&G, 1991).

The value of the combined 1989 commercial salmon harvest was estimated at $41.3 million, excluding hatchery sales. The drift gill net catch was valued at $23.8 million, setting the average earnings for the estimated 480 permit holders that fished in 1989 at $49,470. Seiners harvested $18.9 million worth of fish setting the average earnings for the estimated 235 permit fleet at $80,610. Because the Eshamy district was closed for the season, set net fishermen had no opportunity to fish in the PWS area in 1989 (ADF&G, 1991).

In 1985, the 147 million salmon landed in Alaska by commercial fishermen weighed approximately 647 million lbs (ADF&G 1986b). Pink salmon accounted for 304 million lbs (45% by round weight), sockeye salmon equalled 225 million lbs (33%), and chum salmon weighed a total of 83 million lbs (12%). Coho and chinook salmon accounted for 47 (12%) and 13 (2%) million lbs, respectively. In terms of numbers (or round weight) of salmon, the largest salmon fishery in the state was the pink salmon fishery in Southeast Alaska. A total of 52 million pink salmon (166 million lbs) were caught in Southeast Alaska, compared to a total of 24 million sockeye salmon (140 million lbs) in Bristol Bay. However, in terms of ex-vessel value, the Bristol Bay fishery was the most valuable salmon fishery ($122 million for all salmon species) in the State of Alaska in

1985 (Kruse, 1988).

Shellfish landings accounted for 21% of the total ex-vessel value of commercial fisheries harvests in Alaska for 1986. The $182 million in gross receipts paid to fishermen for shellfish in 1986 was the highest amount since 1982. The increase is primarily attributable to the steady growth of fisheries for brown king and Dungeness crabs, and 1986 openings for Bristol Bay king and Tanner crabs. Because many shellfish fisheries remain closed due to low stock sizes, significant potential for growth exists (Kruse, 1988).

Transportation

The prime mode of transportation in Alaska is by aircraft. Approximately three-quarters of the state can not be reached overland. Small aircraft fly to towns and attractions throughout the state. The planes are usually 9 - 16 seaters, but in remote areas smaller planes, usually 2 - 4 seaters, fly (Castleman and Pitcher 1992).

Another major mode of transportation in Alaska is the ferry service known as the Alaska Marine Highway. There are two major routes for the Alaska Marine Highway system: the Southeast system serving almost every town in Southeast Alaska, and the Southwest system serving most of the coastal towns in Southcentral, Kodiak Island, the Kenai and Alaska peninsulas, and the Aleutian Chain as far west as Dutch Harbor/Unalaska (ADT 1990 Alaska Marine Highway System, 1989 Traffic Volume). However, the two systems do not interconnect. The Alaska Airlines flight from Juneau to Cardova provides connection (Castleman and Pitcher 1992).

Public transportation systems by land in Alaska consist of train, bus, and van services. Alaska has over 12,200 miles of public roads. Of these land miles, over 5,500 miles are under state jurisdiction, over 4,200 miles are under local government jurisdiction, and the remainder are under the jurisdiction of various federal agencies. Approximately one half of the public roads are paved. The major highway systems consist of Alaska Highway and George Parks Highway. The Alaska Highway is mostly paved, two-lane highway running in north-southeast direction, connecting Fairbanks to Prudhoe Bay in north and Dawson Creek, British Columbia in east. The George Parks Highway traverses in northsouth direction between Fairbanks and Anchorage. Anchorage and Seward are also connected by a highway, which is the most travelled highway in the state. Another highway (Richardson Highway) runs in northsouth direction connecting Fairbanks and Valdez. Getting around in private cars is a popular mode of transportation. Public bus service is highly primitive in Alaska. However, major destinations are served by bus or minibus, and some of the smaller towns are served by

vans (Castleman and Pitcher 1992).

The only train in Alaska is the Alaska Railroad which runs 470 miles between Seward and Fairbanks passing through Portage and Anchorage. A seven- mile stretch of the railroad connects Portage to Whittier, where travelers transfer from cruise ships, ferries, and tour boats to Alaska Railroad. Two expresses, one northbound and one southbound, run between Seward and Fairbanks daily. A shuttle train transports passengers between Portage and Whittier several times a day (Castleman and Pitcher 1992).

6. Recreation and Commercial Tourism

a. Overview

Alaska has the largest assemblage of park, refuge and forest lands in the United States, and much of this land is still natural. The nation's two largest national forests are located in Alaska: Tongass in Southeast (16 million acres) and Chugach in Southcentral (4.8 million acres). The Alaska State Park System, with more than 3.2 million acres of land and water, and 100 park units, is the largest state park system in the United States. This vast expanse of undeveloped land together with freshwater and marine systems has created a wide range of outdoor recreational opportunities in Alaska including hunting, fishing, hiking, camping, skiing, sightseeing, backpacking, climbing, dogsledding, snowmobiling, snowshoeing, kayaking, canoeing, power boating, flightseeing, photographing, and filming. In recent years, mountain biking, wind-surfing, river rafting, paragliding, paraskiing, winter camping, ice fishing, and scuba diving have also increased in popularity (Castleman and Pitcher 1992). These limitless recreational opportunities has helped create a growing tourism industry which offers a variety of professional services enabling visitors to use and enjoy the wilderness.

Hiking and camping, being relatively inexpensive and easily available, are by far the most preferred outdoor recreation for the majority of Alaska's residents and visitors. Although, there are very few trails in Alaska, the vast taiga and tundra terrain along with the perpetual daylight during hiking season allow freedom to deviate from normal hiking/camping cycles (Castleman and Pitcher 1992). In addition, while hiking there is a possibility of encountering the abundant wildlife. Photography of the scenery and the fauna and flora go hand in hand with hiking and camping.

The Exxon Valdez oil spill has impacted some of the recreational activities in Southcentral and Southwest Alaska. More than ----% (this figure would be provided later on) of the land in the oil spill area is designated as national and state parks, forests, and wildlife refuges and is managed by various Federal and State government agencies. A full range of private and commercial recreation activity occurs in these areas supported by facilities like mooring buoys, boat ramps, recreational-user cabins, camping sites and trails. The national parks and forests include the Chugach National Forest, Kenai Fjords National Park, Katmai National Park and Preserve, Lake Clark National Park and Preserve, and Aniakchak National Monument and Preserve; the national wildlife refuges include Alaska Maritime National Wildlife Refuge, Kenai National Wildlife Refuge, Kodiak National Wildlife Refuge, Alaska Peninsula National Wildlife Refuge, and Becharof National Wildlife Refuge; and the state parks include the Chugach State Park and Kachemak Bay State Wilderness Park (Gousha 1991). Several other areas under the state management designated for various purposes such as, State Historic Sites, Marine Parks, Recreation Areas, and Recreation Parks attrast recreationists. Large portions of land within Katmai National Park and the Becharof National Wildlife Refuge have been designated wilderness areas by the Congress. Both of these areas and the Kachemak Bay State Wilderness Park were oiled by the Exxon Valdez spill. The following sections describe the recreation and tourism in the spill-affected area.

b. Recreation

For the purposes of this section, the oil spill area is divided into two regions: Southcentral region which includes Anchorage, Kenai Peninsula, and Prince William Sound; and Southwest region which includes Kodiak Island, Katmai, and other southwest locations. A brief description of recreational opportunities provided by each region follows.

Southcentral Alaska

Southcentral Alaska is a land of short rivers, long mountain ranges, and wide valleys, which extends north from the Gulf of Alaska to the crest of the Alaska range. Southcentral is the rich heartland of Alaska, with one big metropolis, many small towns, some of the State's finest scenery, and best hiking/camping opportunities (Castleman and Pitcher 1992). Chugach National Forest, the second largest national forest, encompasses much of this region. The Chugach National Forest provides a highly visible and popular recreation program in the Kenai mountain range. The Forest operates and maintains 37 public recreation cabins and 16 campgrounds. There are over

200 miles of trail, including two National Recreation trails. In addition, there are 149 recreation special use permit facilities, including one major ski resort and six other resort facilities. The Portage visitor center and the Russian River, located within the Forest are among the three most heavily visited area in the state. Approximately 90% of the Forest's recorded recreational activities occurs on the Kenai Peninsula. The most popular activities are auto driving, camping, hiking, skiing, and fishing (USDA 1984). Alaska's second-largest state facility, Chugach State Park, located within this region, encompasses nearly half a million acres. Hiking is the main recreational activity in this park with about a dozen well-maintained, well-used, moderate-to-difficult trails. Along with hiking, photography and wildlife-watching are popular recreational activities.

Southcentral Alaska includes some of the premier kayaking areas in the world. Kayaking trips are taken from Valdez, Kodiak, Homer, Whittier, and Seward to the western portion of PWS and the bays along the Kenai Peninsula and Kodiak Island. A typical trip involves charter boat transportation to a site some distance from port. Most trips last more than one day and thus include both kayaking and wilderness camping.

The Kenai Peninsula is like a mini-Alaska, compressing all of the country's features. The Kenai is the most popular all around destination for all Alaskans and visitors (Kenai 1993). It is the most often viewed landscape in Alaska with the Seward/Anchorage highway being the most heavily used travel route in the state (USDA 1984). Captain Cook State Recreation Area, Kenai National Wildlife Refuge, Kenai Fjords National Park, Alaska Maritime National Wildlife Refuge, Kachemak Bay State Park, and Chugach National Forest are some of the areas affording a wide variety of recreational opportunities in the Kenai Peninsula and making it best in the state for wildlife viewing. The Kenai Fjords National Park, under the management of National Park Service, is an area with ice fields and a deep-water fjord coastline providing opportunities to see whales, tortoise, sea otters, and birds of all kinds. At locations in the western and southern parts of the peninsula, the Alaska Department of Natural Resources maintains public access and recreation sites (including the Kachemak Bay State Park) totaling several thousand acres (Kenai 1993).

Few refuges contain as diverse landscape, abundant fish and wildlife populations, and varied recreational opportunities as the Kenai Refuge. Although not large compared to refuges in Alaska, the Kenai Refuge supports more recreational use than any other refuge in the world. The Kenai refuge has natural and man-made features necessary to support a wide variety of outdoor activities. The wide array of facilities that support and encourage public use and protect refuge resources include a headquarter, visitor

centers, and 47 recreational sites including campgrounds, access areas, wayside, and trailheads. These facilities vary from small undeveloped sites to large campgrounds with tables, fire grates, parking-spurs, boat ramps, water wells, and sanitary facilities. Recreational opportunities in the Kenai Refuge include salmon fishing, camping in developed campgrounds along roads and trails to isolated and primitive areas, hunting, wildlife observation, sightseeing, canoeing, boating, horseback riding, crosscountry skiing, snowmobiling, and berry picking. Most visitors participate in several activities while on the refuge (U.S. FWS 1983).

Besides the public lands, various small communities offer recreational opportunities on the Kenai Peninsula and their economy, to some extent, is based on recreation and tourism. The city of Seward, located at the head of deep-water inlet known as Resurrection Bay, is popular for fishing and sightseeing. The city of Soldotna, located in the Central Peninsula region, is famous for salmon fishing in Kenai River along with scenic views across Cook Inlet. The city of Kenai sits on a bluff where the Kenai River meets Cook Inlet and where some of the greatest tidal ranges occur, is famous for whale watching. Incoming tides actually reverse the flow of the river, influencing the movement of fish and the white beluga whales that follow them. Homer, located on the southern tip of the Kenai Peninsula provides charter boat tours to Gull Island for viewing thousands of birds. Homer is also visited for salmon fishing (Kenai 1993).

Prince William Sound (PWS), located within the Southcentral region at the northern-most point of the Gulf of Alaska, is considered by many to be a unique, pristine, wilderness abundant with land and marine wildlife. The Sound is filled with deep fjords, ice-covered mountain ranges, tidewater glaciers, and hundreds of islands with innumerous sea birds. Murre colonies on Chiswell Islands, located in this region, are colonies most visited by tourists in Alaska. PWS is primarily used by boat with some areas accessed by float-equipped or wheel aircraft (USDA 1984). PWS covers over 2,700 miles of coastline, 4.4 million acres of National Forest and three of North America's major icefields. Prince William Sound offers tremendous opportunities for hiking, sightseeing, wildlife viewing, glaciers viewing, and fishing (PWS 1993).

Several communities located within the Prince William Sound area offer recreational opportunities and services expected from large cities. The city of Cardova, a modern thriving community, offers a wide variety of lodging options and recreational services including flightseeing, several boat charter services, and recreation centers. The city of Valdez, surrounded by towering mountains, provides a wide variety of local tours and sightseeing opportunities. Numerous scheduled cruises to Columbia and Shoup Glaciers

start here. In addition, several guided walking and bus tours showing historic Valdez and the Alyeska Pipeline Terminal are also available (PWS 1993).

Outdoor recreation plays an important role in the lifestyles of many Alaskan residents. A public survey conducted on the lifestyles of Southcentral Alaskans yielded information on the recreational activities that these residents engage in (Table I) (USDA 1984). The results of the survey indicated that driving, walking, and fishing were the most popular activities among the Southcentral Alaskans. Respondents also indicated that the important attributes of their favorite activities include getting away from usual demands, being close to nature, doing something exciting, experiencing new and different things, and being with family and friends. Attributes of favorite recreational places considered important by the respondents included fishing opportunities, scenery, and remoteness.

Table I

Participation of Southcentral Residents in Various Activities

Activity	% of Respondents Who Engaged in Activity
Driving for pleasure	59
Walking or running for pleasure	53
Freshwater fishing	42
Attending outdoor sport	37
Tent camping	31
Motor boating	30
Bicycling	29
Cross Country skiing	26
Target shooting	25
RV camping	24
Hiking with pack	22
Baseball, softball	19
Flying for pleasure	19
Sledding, toboggan	17
Kayaking, canoeing	17
ORV winter	17
ORV summer	14
Outdoor tennis	17

Swimming, scuba diving	16
Alpine skiing	14

Southwest Alaska

Southwest region includes the Kodiak Island group, the Alaska Peninsula, the Aleutian Islands, and Katmai. In this region Katmai National Park and Preserve, Alaska Peninsula National Wildlife Refuge, Becharof National Wildlife Refuge, Kodiak National Wildlife Refuge, and Aniakchak National Monument and Preserve are located.

Kodiak Island is the largest island in Alaska and the second largest in the U.S. Kodiak has Alaska's longest history, largest fishing fleet, and biggest brown bear population. Kodiak Refuge, established in 1941 to protect the habitat of brown bear and other wildlife, occupies about two-thirds of the island. Five species of Pacific salmon rearing and spawning habitat is provided within the refuge. Over 200 species of birds, large brown bear and bald eagle populations make the refuge an exciting place for wildlife viewing. Other recreational activities include photography, rafting, canoeing, camping, backpacking, hiking, hunting, and fishing. A visitors center and a limited number of recreational cabins are also located within the refuge. The town of Kodiak, where the majority of the Kodiak Island population live, is accessible by air and is a tourist attraction for viewing commercial fishing operations. The communities of Larsen Bay and Ports Lion on the Kodiak Island are visited for hiking, fishing, and hunting opportunities and their economy to a large extent is dependent on tourism (U.S. FWS 1987).

c. Tourism

Tourism is Alaska's third-largest industry behind petroleum production and commercial fishing. Tourism was, and is, an industry of growing economic importance to the state. Once regarded as a stepchild of the major traditional resource industries, tourism's obvious growth in the 1980s gave it legitimacy as a major industry. A visitor survey conducted by the Alaska Division of Tourism under the Alaska Visitors Statistics Program II (AVSP) revealed important statistics on the tourism industry. The survey results indicated that more than 750,000 people visited Alaska in 1989 from all around the world and of this 521,000 people visited in summer generating $304 million in revenue in summer alone. The Southcentral region was the major beneficiary of visitor spending, capturing 44% of the $304 million (ADT 1989a). Sixty-nine percent of the total

summer visitors were vacation/pleasure (VP) visitors. Southcentral Alaska accommodated more visitors per year than any other region but among VP visitors, Southeast was the most visited region, with nearly three out of every four VPs visiting the region. Southcentral was second with two-thirds of the VP visiting market (ADT 1989b). Southwest was visited by only 6% of the total VP visitors (ADT 1989a) and thus captured 5% of the $304 million (ADT 1989b).

Information on vacation planning for tourists is available through various sources such as, Alaska Division of Tourism, travel agents, and newspaper travel sections. The State Vacation Planner is widely used by the visitors in planning their Alaska trip. Once in Alaska, the majority of the visitors used visitor information centers (VICs), and reported that the VICs were doing a good job. Past studies have shown that the use of VICs enhanced visitor satisfaction and the likelihood of returning to Alaska in the future. A visitor using a VIC is more likely to see the best attractions in the local area, have contact with friendly locals, and be more active as a result. However, with the exception of one visitor information center at Tok, the state of Alaska relies on local communities and government agencies (usually Federal) to provide information to visitors. While many communities and agencies do a good job, brochure distribution practices are inconsistent, as are training, hours and seasons of operations, signage, and facility size and quality. Additionally, most agency information centers are oriented towards single attractions and some communities limit the types of information and brochures which they offer (ADT 1989b).

Survey results also revealed that Anchorage, Seward, Kenai/Soldotna, Homer, Valdez/PWS, and Whittier were among the most visited communities in the Southcentral region and King Salmon, Kodiak, Bethel were among the most visited communities in the Southwest region. The most visited attractions on the Kenai Peninsula were Kenai River, Kenai National Wildlife Refuge, Resurrection Bay, Kachemak Bay, and Kenai Fjords National monument. In the Prince William Sound area the most visited attractions were Columbia Glacier, Prince William Sound, Valdez Pipeline Terminal, and College Fjord. In the Southwest region the most visited attractions were Kodiak Russian Orthodox Church, Katmai National Park, and Kodiak National Wildlife Refuge. In addition, cultural attractions and museums were popular among Southcentral visitors (ADT 1989b).

Among the wide variety of recreational opportunities offered in Alaska, wildlife viewing was the most common activity in every region among the VP visitors and was the main activity in the Denali region. Bird watching was also common in all regions. Rafting

was most popular in Southeast and Denali. Hiking was universal but Southwest and Denali visitors did it most. Southwest was fishing country, with twice the participation of the next leading fishing region, Southcentral (ADT 1989b).

The visitors of Southcentral rated flightseeing and day cruises highly in the tour list while rafting, hiking, and canoeing/kayaking lead the activities list in satisfaction. Southwest VP visitors give that region's activities the highest marks in the state. Fishing (fresh water more than salt water), hunting, rafting, and canoeing/kayaking all score very well, and the state's highest flightseeing score was in Southwest (ADT 1989b).

7. Sport Fishing and Hunting

a. Sport Fishing

Sport fishing is one of the most popular recreational activity for both residents and visitors of Alaska. A wide variety of sport fishing opportunities exist in the oil-affected region. Marine recreational fishing originates in all major towns on the PWS as well as Cook Inlet, Kodiak Island, the Kenai Peninsula, and the Alaska Peninsula. Fishing trips are taken in several ways - from shore, from private boats, and from charter vessels. Several species of Pacific salmon, rockfish and halibut are available in both fresh and salt water and Dolly Varden, rainbow and cutthroat trout are found in several freshwater streams and lakes. Although sport fishing is popular throughout the state, seventy percent of Alaska's sport fishing occur in the Southcentral region and majority of which occur in the Kenai Peninsula because access by car from Anchorage to Kenai Peninsula is relatively easy (Castleman and Pitcher 1992). The Kenai River is well known for king salmon fishing. Sport fishing throughout the state is conducted according to the Alaska Sport Fishing Regulations, formulated by the Alaska Department of Fish and Game. The fishing regulations specify bag, possession, and size limits for the fishes to be taken from different streams/rivers/lakes etc. (ADF&G 1992a). In addition, there are management plans for king salmon on the Kenai River.

Historically (between 1984 and 1988), the number of anglers, fishing days, and fish harvest in the oil-affected area had been increasing at a rate of 10 - 16% per year. However, following the oil spill, there have been decline in the number of anglers, fishing days, and fish harvest, whereas, the area outside the oil spill continued to experience increase. The estimated number of anglers in the oil-affected region decreased 13% from 120,160 in 1988 to 104,739 in 1989, the number of days fished decreased 6% from 312,521 to 294,598, and the number of fish harvested decreased 10%

from 352,630 to 318,981 (ADF&G 1992b). Since 1977, there has been a 4.5% average annual increase in the number of residents who sport fish, while the number of non-residents sport fishing has increased 16% annually.

b. Sport Hunting

Alaska has 12 species of big game, including several not found (muskox, Dall sheep), or very rare (wolf, wolverine, brown bear, caribou), in the other 49 states. Approximately 144,000 - 166,000 moose; 835,000 caribou; 60,000 - 80,000 Dall sheep; 32,000 - 43,000 brown bears; over 100,000 black bears; 5,900-7,900 wolves; 2,100 muskoxen; 13,000 - 15,000 mountain goats; 350,000 - 400,000 black-tailed deer; 1,400 - 1,600 elk and 850 bison inhabit the state. Also abundant are 19 species of furbearers, three species of ptarmigan, four species of grouse, two species of hares and many species of waterfowl, migratory birds, raptors and marine mammals (Castleman and Pitcher 1992). Hunting is conducted according to the Alaska State Hunting and Trapping Regulations formulated by Alaska Department of Fish and Game (ADF&G 1992c, 1992d). These regulations specify bag limits and season area-wise for hunting. The many wildlife refuges, parks, and national forests located within the oil-affected region provide tremendous opportunities for hunting.

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United States Department of Agriculture | Forest Service | Alaska Region | P.O. Box 21628 Juneau, AK 99802-1628

Reply to: 1920 Date: April 23, 1993

Subject: Oil Spill Restoration EIS, Chapter 1 review

To: Ken Rice

The newsletter was fantastic! Simple, clear, concise, easy to read - congratulations!

Chapter 1 of the EIS needs some work. It is not very clear or concise! I'll try to write my comments, but will send you a marked up coy, too, in case this doesn't come across. I'll also send you the samples I refer to.

Page 1

Needs reference to a Map.

3rd par: You suggested deleting that, but then the next paragraph doesn't flow. Suggest deleting "Although...chaotic" and start sentence with "The reaction..."

4th par: replace "field" with "spill area"

What is NRDA process/plan? Was this in place before the spill, or invented for it?

Sentence "Under the direction..." is very confusing with all the names and acronyms, and it's the first time Trustee Council is mentioned, although last paragraph of A. explains it. If the council was set up before the studies, maybe it should be introduced first, then talk about studies?

List each department separately (Departments of... is confusing).

Page 2

1st sent: What is RPWG 1990p? If a cite, it should be cited as it appears in the bibliography, i.e., written out in full the first time.

3rd par: Again, agency listing is confusing- perhaps a list? Only need to do this once in this section.

What is "D.Alaska..."?

Page 3

1. Restoration Plan

I think this is the basis for your proposed action, which isn't actually stated anywhere. But it isn't clear what it is (not like in newsletter).

Last para: First sentence doesn't make sense-- the alternatives ARE different versions of the Plan. In Chapter II, you will say that one alternative is the No Action as required by law (we don't "name" one alt. the no action, and we may identify a "preferred", but it's two entirely different processes).

Page 4

2nd sent: CEQ doesn't require the Plan to do anything. CEQ requires the EIS to describe the alternatives and show differences. Each alternative Plan should stand on its own, and be compared in the EIS.

2. EIS Delete. Include in Document Organization.

a. Role.. Explain Trustees, etc., in the introduction, including role of the lead agency. Decision-making part of role could be in "Decision to be made".

c. Role.. Put in Public involvement.

Organization of chapter

The rest of the chapter is very confusing. I think it's just more complicated than it needs to be. We don't need to justify why we're doing an EIS. I'd just jump write in to "Proposed Action" which is lacking.

Somewhere you need to explain exactly what is being decided by this programmatic document and what will be analyzed/decided in subsequent documents. Perhaps D. below.

B. Proposed Action

Use the old "who, what, why, when, where"

C. Purpose and Need for Action

This should describe the "underlying need for the proposed action", NOT the EIS. I would delete the whole first paragrah of B and replace with simple statement.

D. Decision to be made

Who is going to decide what? What are the options?

E. Document Organization

Simple explanation of each chapter. We use the CEQ regs for format, not really the handbook, although the new handbook (9/1992) completely repeats CEQ now. See attached sample.

F. Scoping or Public Involvement

This section is actually very important. Define scoping from CEQ (not HB) as "an early and open process...." List all your activities (including your newsletter!)

G. Issues

Simply show how issues come out of public involvement.

Description of significant issues should be clearer, more simply stated. (see samples) Page 6, para. 2 is very confusing.

Suggest deleting the list of issues not used (pages 9-13). You could simply state that many other issues were raised and were either encompassed by the 8 issues, were out of scope, etc. No need to list them as it adds nothing to the document. Could say that they're in the planning record.

Page 13

E. DEIS content

See "E" above.

1st para: This interpretation of "tiering" is a little backwards. This EIS would tier to a higher level EIS (but I don't think there is one, since this isn't a FS only document). It does need to be explained somewhere that this is a programmatic document, not project-level decision document, and that those future projects would have there own documents-- perhaps in "Decision to be made"? But this is not the place to put this.

2nd para: We follow the CEQ regs for document format, we don't develop the format ourselves. CEQ is better cite than FS HB.

3rd para: Delete first sentence. Just state what's in each chapter.

SINE EDITORIAL/STYLE COMMENTS

Please see sample of R10 format. I don't think you have to follow this because it's not a FS document, but the purpose of the format is "easy reading." At least 30% of the page should be white space. People don't like to read huge blocks of text.

Also suggest that you drop the A.I.a. style of headings and replace with type size changes (like the R10 format). Looking at page 4 you can see that the headings don't stand out, and the numbers/letters don't help. All headings should be bolded and in Helvetica-like type.

Your larger type size is much easier to read than the 10-point in the Region 10 sample.

I sent Sam Grimes the R10 style guidelines for Main Bay a few months ago and you can probably borrow from him.

Avoid using all acronyms all the time, especially if there are several in one sentence. It's easier to read "Prince William Sound" than "PWS"-- no one can remember what all the acronyms mean!

I prefer using "Forest Service" for us; technically USFS isn't right-- it would be USDAFS.

/s/Geneen
GENEEN GRANGER
Environmental Planning Specialist