

11.4.11

Others Who Testify

Ernie Piper

ph.D.

James C. Gibeault, Res geol w/Un TX
at Austin

~~craig~~

Tillery, Alaska Dept of Law

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EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

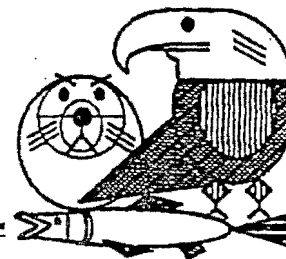
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Exxon Valdez Oil Spill Trustee Council

Restoration Office

645 G Street, Suite 402, Anchorage, Alaska 99501

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



AGENDA
EXXON VALDEZ OIL SPILL SETTLEMENT
TRUSTEE COUNCIL

NOVEMBER 30 - DECEMBER 1, 1993 @9:00am

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TRUSTEE COUNCIL MEMBERS:

EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

MICHAEL A. BARTON
Regional Forester, Alaska Region
USDA Forest Service

CHARLES E. COLE
Attorney General
State of Alaska

PAUL A. GATES
Regional Environmental Officer - Alaska
U.S. Department of the Interior

STEVEN PENNOYER
Director, Alaska Region
National Marine Fisheries Service

CARL L. ROSIER
Commissioner
Alaska Department of Fish & Game

JOHN A. SANDOR
Commissioner
Alaska Department of Environmental
Conservation

NOVEMBER 30 @9:00AM - DECEMBER 1, 1993

1. Public Advisory Group Meeting Report - Brad Phillips
2. Status Report of the 1993 Shoreline Assessment Project - Ernie Piper
3. Comprehensive Habitat Protection Evaluations - Dave Gibbons
4. Habitat Protection Negotiations Options - Dave Gibbons
5. Draft/Final Restoration Plan - Loeffler/Rabinowitch
6. 1994 Draft Work Plan - Dave Gibbons
7. Management Structure/Administrative Budget - Jim Ayers
8. NEPA Compliance - Federal Attorneys
9. Ecosystem Study Plan Status Report - Bob Spies
10. Public Comment Period 4:00 - 6:00 pm on November 30th

Trustee Agencies

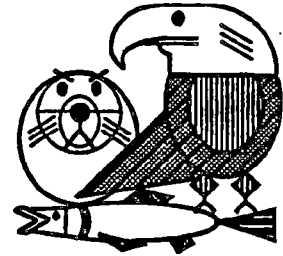
State of Alaska: Departments of Fish & Game, Law, and Environmental Conservation
United States: National Oceanic and Atmospheric Administration, Departments of Agriculture and Interior

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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RESOLUTION OF THE EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL

We, the undersigned, duly authorized members of the Exxon Valdez Oil Spill

Trustee Council do hereby certify that, in accordance with the Memorandum of Agreement and Consent Decree entered as settlement of United States of America v. State of Alaska, No. A91-081 Civil, U.S. District Court for the District of Alaska, and after public meetings, unanimous agreement has been reached to expend funds received in settlement of United States of America v. Exxon Corporation, et al., No. A91-082 Civil, U.S. District Court for the District of Alaska, and State of Alaska v. Exxon Corporation, et al., No. A91-083 Civil, U.S. District Court for the District of Alaska, for necessary natural resource damage assessment and restoration activities from October 1, 1993 to January 31, 1994, data analysis and report preparation for 1993 field work from October 1, 1993 to September 30, 1994, and administration from October 1, 1993 to December 31, 1993. The total approved budget, appended hereto, is \$8,521,700.00.

Trustee Agencies

State of Alaska: Departments of Fish & Game, Law, and Environmental Conservation

United States: National Oceanic & Atmospheric Administration, Departments of Agriculture and Interior

Printed: November 30, 1993


The moneys are to be distributed according to the following schedule:

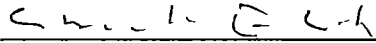
Alaska Department of Fish & Game	\$2,757,000.00
Alaska Department of Natural Resources	1,125,100.00
Alaska Department of Environmental Conservation	<u>2,072,300.00</u>
 SUBTOTAL TO STATE OF ALASKA	 \$5,954,400.00
 U.S. Department of Agriculture, Forest Service	 \$777,700.00
U.S. Department of the Interior	740,800.00
National Oceanic & Atmospheric Administration	<u>1,048,800.00</u>
 SUBTOTAL TO UNITED STATES OF AMERICA	 \$2,567,300.00
 TOTAL APPROVED BUDGET	 \$8,521,700.00


In accordance with the Financial Operating Procedures adopted by the Trustee Council, the amount of funds requested from the Joint Trust Fund is to be reduced by the amount of interest previously earned from settlement funds held by the Federal and State governments and any unobligated fund balances from previously approved budgets. Since the last disbursement from the Joint Trust Fund, the amount of interest earned is \$51,231.00 for the United States and \$64,944.32 for the State of Alaska. Accordingly, the amount to be withdrawn from the fund will be reduced by \$116,175.32 because of interest earned. The unobligated balance for the fiscal period from March 1, 1992 to February 28, 1993, is \$3,661,600.00 for the State of Alaska. The unobligated balance for that time period for the United States will be determined at a later date and subtracted from a subsequent court request. The amount to be withdrawn from the fund will be reduced by \$3,661,600.00 because of the unobligated balance.


By unanimous consent, we hereby request the Attorney General of the State of Alaska and the Assistant Attorney General of the Environmental and Natural Resources

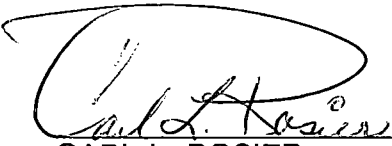
Division of the United States Department of Justice to petition the United States District Court for the District of Alaska for withdrawal of the sum of \$4,743,924.68 from the Court Registry account established as a result of the governments' settlement with the Exxon companies. Of this amount \$2,516,069.00 shall go to the United States of America and \$2,227,855.68 shall go to the State of Alaska.


 Dated 11/30/93
MICHAEL A. BARTON
Regional Forester
Alaska Region
USDA Forest Service

 Dated 11.30.93
CHARLES E. COLE
Attorney General
State of Alaska

 Dated 11-30-93
PAUL D. GATES
Regional Environmental Officer
for Alaska
U.S. Department of the Interior

 Dated 11/30/93
STEVEN PENNOYER
Director, Alaska Region
National Marine Fisheries
Service

 Dated 11/30/93
CARL L. ROSIER
Commissioner
Alaska Department of Fish &
Game

 Dated 11/30/93
JOHN A. SANDOR
Commissioner
Alaska Department of
Environmental Conservation

EXXON VALDEZ TRUSTEE COUNCIL
 1994 Federal Fiscal Year Project Budget
 October 1, 1993 - September 30, 1994

Agency	Cooperating Agency(s)	Project Number	Project Title	First Court Request		
ADEC	ADNR/ADF&G/ USFS/DOI-FWS/ DOI-NPS ADF&G/ADNR/ USFS/DOI-NPS/ NOAA ADF&G/NOAA ADF&G/ADNR/ USFS ADF&G/ADNR/ USFS/DOI/NOAA USFS/DOI ADF&G/ADNR/ USFS/DOI/NOAA	93066	Alutiiq Archeological Repository	\$1,500.0		
		94110	Habitat Protection - Data Acquisition & Support	\$6.4		
		94266	Shoreline Assessment & Oil Removal	\$33.1		
		94285	Subtidal Sediment Recovery Monitoring	\$21.4		
		940ED	Executive Director's Office	\$318.6		
		940FC	Finance Committee	\$6.3		
		94PAG	Public Advisory Group	\$5.4		
		940RT	Restoration Team Support	\$181.1		
			ADEC Total	\$2,072.3		
ADF&G	NOAA ADEC/ADNR/ USFS/DOI-FWS/ NOAA NOAA	94064	Harbor Seal Habitat Use and Monitoring	\$270.2		
		94066	Harlequin Duck Recovery Monitoring	\$104.9		
		94086	Herring Bay Experimental & Monitoring Studies	\$198.0		
		94110	Habitat Protection - Data Acquisition & Support	\$71.5		
		94137	Stock ID of Chum, Sockeye, Chinook & Coho in PWS	\$46.7		
		94166	Herring Spawn Deposition & Reproductive Impairment	\$279.4		
		94184	Coded Wire Tag Recoveries from Pinks in PWS	\$47.8		
		94185	Coded Wire Tagging of Wild Pinks for Stock ID	\$34.8		
		94191	Oil Related Egg & Alevin Mortalities	\$206.2		
		94255	Kenai River Sockeye Salmon Restoration	\$121.0		
		94258	Sockeye Salmon Overescapement	\$379.0		

07/14/93

Dollar Amounts are shown in thousands of dollars.

1994

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**FORM 1B
 AGENCY
 SUMMARY**

EXXON VALDEZ TRUSTEE COUNCIL
 1994 Federal Fiscal Year Project Budget
 October 1, 1993 - September 30, 1994

Agency	Cooperating Agency(s)	Project Number	Project Title	First Court Request		
ADF&G (cont.)	USFS	94259	Coghill Lake Sockeye Salmon Restoration	\$76.6		
	NOAA	94279	Subsistence Food Safety Testing	\$56.9		
	ADEC/NOAA	94285	Subtidal Sediment Recovery Monitoring	\$220.4		
	NOAA	94320	Ecosystem Study Plan	\$75.0		
		94504	Genetic Stock ID of Kenai River Sockeye	\$262.2		
	USFS/DOI-FWS	94505	Information Needs for Habitat Protection	\$137.5		
	ADEC/ADNR/USFS	940ED	Executive Director's Office	\$33.6		
	ADEC/ADNR/	940FC	Finance Committee	\$5.1		
	USFS/DOI/NOAA					
	ADEC/ADNR/	940RT	Restoration Team Support	\$130.0		
	USFS/DOI/NOAA					
			ADF&G Total	\$2,757.0		
ADNR	USFS/DOI-FWS/	94007	Site Specific Archeological Restoration	\$50.8		
	DOI-NPS					
	ADEC/ADF&G/	94110	Habitat Protection - Data Acquisition & Support	\$176.6		
	USFS/DOI-FWS/					
	DOI-NPS					
	USFS/DOI-FWS/	94126	Habitat Protection & Acquisition Fund	\$99.6		
	DOI-NPS					
	USFS	94217	PWS Area Recreation Implementation Plan	\$43.9		
	ADEC/ADF&G/USF	940ED	Executive Director's Office	\$628.0		
	ADEC/ADF&G/	940FC	Finance Committee	\$7.7		
	USFS/DOI/NOAA					
	ADEC/ADF&G/	940RT	Restoration Team Support	\$118.6		
	USFS/DOI/NOAA					
			ADNR Total	\$1,125.1		

07/14/93

Dollar Amounts are shown in thousands of dollars.

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**FORM 1B
 AGENCY
 SUMMARY**

EXXON VALDEZ TRUSTEE COUNCIL
 1994 Federal Fiscal Year Project Budget
 October 1, 1993 - September 30, 1994

Agency	Cooperating Agency(s)	Project Number	Project Title	First Court Request		
USFS	ADEC/ADF&G/ ADNR/DOI-FWS/ DOI-NPS	94110	Habitat Protection - Data Acquisition & Support	\$10.6		
	ADNR/DOI-FWS/ DOI-NPS	94126	Habitat Protection & Acquisition Fund	\$103.7		
	ADNR	94217	PWS Area Recreation Implementation Plan	\$32.4		
	ADF&G/DOI-FWS	94505	Information Needs for Habitat Protection	\$194.1		
	ADEC/ADF&G/ ADNR	940ED	Executive Director's Office	\$274.4		
	ADEC/ADF&G/ ADNR/DOI/NOAA	940FC	Finance Committee	\$8.4		
	ADEC/DOI	94PAG	Public Advisory Group	\$19.8		
	ADEC/ADF&G/ ADNR/DOI/NOAA	940RT	Restoration Team Support	\$134.4		
			USFS Total	\$777.7		
DOI-FWS	ADNR/USFS/ DOI-NPS	94007	Site Specific Archeological Restoration	\$12.1		
		94020	Black Oystercatcher Interaction with Intertidal	\$17.3		
		94039	Common Murre Population Monitoring	\$26.9		
	ADEC/ADF&G/ ADNR/USFS/ DOI-NPS	94110	Habitat Protection - Data Acquisition & Support	\$8.5		
	ADNR/USFS/ DOI-NPS	94126	Habitat Protection & Acquisition Fund	\$81.6		
		94159	Marine Bird & Sea Otter Boat Surveys	\$107.0		
		94246	Sea Otter Recovery Monitoring	\$207.4		
	ADF&G/USFS	94505	Information Needs for Habitat Protection	\$74.5		
		94506	Pigeon Guillemot Recovery	\$13.9		
			DOI-FWS Subtotal	\$549.0		

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**FORM 1B
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 SUMMARY**

EXXON VALDEZ TRUSTEE COUNCIL
 1994 Federal Fiscal Year Project Budget
 October 1, 1993 - September 30, 1994

Agency	Cooperating Agency(s)	Project Number	Project Title	First Court Request		
DOI-NPS	ADNR/USFS/ DOI-FWS ADEC/NOAA	94007	Site Specific Archeological Restoration	\$91.5		
		94090	Mussel Bed Restoration & Monitoring	\$19.5		
			DOI-NPS Subtotal	\$111.0		
DOI	ADEC/ADF&G/ ADNR/USFS/ NOAA ADEC/USFS ADEC/ADF&G/ ADNR/USFS/ NOAA	940FC	Finance Committee	\$3.8		
		94PAG	Public Advisory Group	\$18.6		
		940RT	Restoration Team Support	\$58.4		
			DOI Subtotal	\$80.8		
			DOI Total	\$740.8		
NOAA	ADF&G ADEC/DOI-NPS	94066	Harlequin Duck Recovery Monitoring	\$34.4		
		94090	Mussel Bed Restoration & Monitoring	\$138.6		
		94092	Killer Whale Recovery Monitoring	\$33.7		
	ADF&G	94166	Herring Spawn Deposition & Reproductive Impairment	\$186.9		
		94191	Oil Related Egg & Alevin Mortalities	\$161.3		
		94279	Subsistence Food Safety Testing	\$54.0		
	ADEC/ADF&G	94285	Subtidal Sediment Recovery Monitoring	\$209.4		
		94290	Hydrocarbon Data Analysis & Interpretation	\$74.7		
		94320	Ecosystem Study Plan	\$25.0		
	ADEC/ADF&G/ ADNR/USFS/DOI ADEC/ADF&G/ ADNR/USFS/DOI	94507	Symposium Proceedings Publication	\$69.0		
		940FC	Finance Committee	\$7.7		
		940RT	Restoration Team Support	\$54.4		
			NOAA Total	\$1,048.8		
			Total	\$8,521.7		

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Dollar Amounts are shown in thousands of dollars.

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**FORM 1B
AGENCY
SUMMARY**

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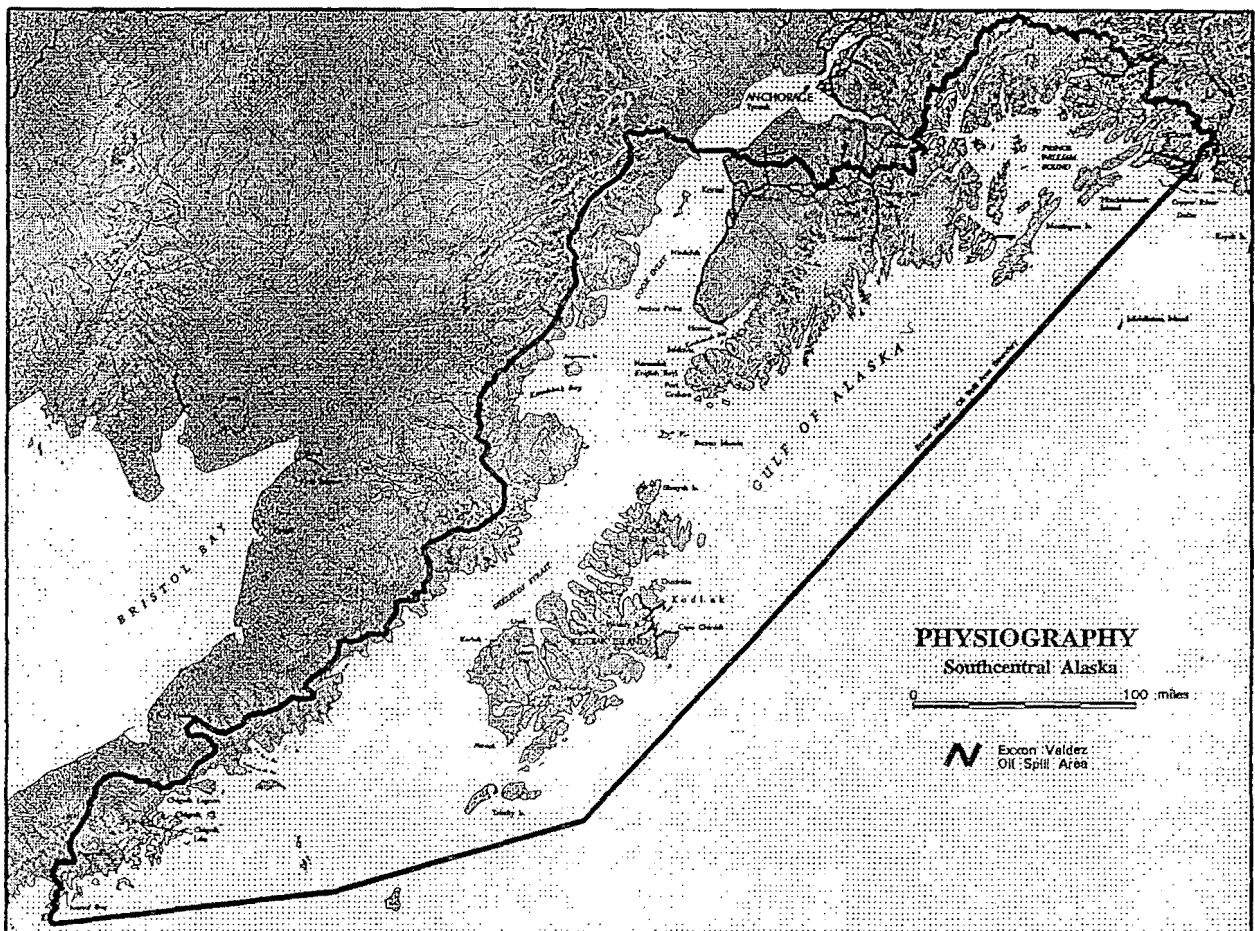
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COMPREHENSIVE HABITAT PROTECTION PROCESS:
LARGE PARCEL
EVALUATION & RANKING
VOLUME I

RECEIVED
NOV 30 1993

Prepared by:
Exxon Valdez Oil Spill Restoration Team
Habitat Protection Work Group
November 30, 1993

EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD



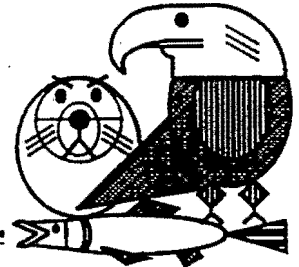
Produced by: Alaska Department of Natural Resources, Land Records Information Section

Exxon Valdez Oil Spill Trustee Council

Restoration Office

645 G Street, Suite 402, Anchorage, Alaska 99501

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



November 30, 1993

Dear Reviewer:

This document presents the results of the Comprehensive Habitat Protection Process; Large Parcel Evaluation and Ranking. We invite your comments on the evaluation process including the list of ranked parcels that will be considered for acquisition by the Exxon Valdez Oil Spill Trustee Council.

The goal of the Comprehensive Habitat Protection Process is to identify and protect habitats that will benefit the recovery of resources and services injured by the Exxon Valdez oil spill. This process is a refinement of the completed imminently threatened lands evaluation process. The Comprehensive Habitat Protection Process, an integral part of the Restoration Plan, will eventually evaluate all lands in the oil spill area where a willing seller has been identified.

The Large Parcel Evaluation and Ranking began on March 18, 1993, with the mailing of letters to 90 landowners of large parcels in the oil spill area. This area is defined by the map on page 14. Thirty-two landowners responded expressing interest in having their land considered. Based upon this response and evaluation, eighty one parcels were identified for further evaluation. Parcel boundaries were based on both ecological factors and ownership. Parcels larger than one thousand acres were evaluated and ranked. These parcels were evaluated, scored and ranked as high, moderate or low. Over 850,000 acres were evaluated in this manner.

Once the parcel boundary was determined, the parcels were subjected to detailed evaluation against a set of Evaluation/Ranking Criteria (Table 2). The evaluation determined:

- The degree of linkage for injured resources and services to specific parcels; and
- The potential for benefit that implementation of habitat protection on specific parcels would have on each linked resource and service.

Parcels larger than one thousand acres were evaluated and ranked. Larger parcels tend to have greater ecological integrity and contain more linked habitats and services. There are also advantages to protection of small areas that benefit injured resources or services. A Small Parcel Evaluation and Ranking Process will begin in January 1994.

Please send your written comments by January 30, 1994, to:

Exxon Valdez Oil Spill Trustee Council
645 "G" Street
Anchorage, AK 99501

Trustee Agencies

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

COMPREHENSIVE HABITAT PROTECTION PROCESS

LARGE PARCEL EVALUATION & RANKING

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INTRODUCTION

The purpose of the Comprehensive Habitat Protection Process is to identify and protect habitats that will benefit the recovery of resources and services injured by the Exxon Valdez oil spill. This process is a multi-step approach that is divided into evaluation, ranking, negotiation, protection, and management phases (Figure 1). The first step in the Comprehensive Process was to identify and evaluate large parcels of private lands throughout the oil spill area. Future efforts will focus on identification and evaluation of small parcels, newly nominated large parcels of private land, and public lands.

The Memorandum of Agreement and Consent Decree (MOA) is the primary authority directing use of settlement funds for restoration activities including implementation of the Comprehensive Process. The MOA was executed between the United States and the State of Alaska and approved and entered by Judge Holland on August 28, 1991.

The original Habitat Protection and Acquisition Process was presented to the public in the Restoration Framework Supplement (July, 1992) and was described in the Draft Restoration Plan, Summary of Alternatives for Public Comment (April, 1993) and in the Supplement to the Draft Restoration Plan (June, 1993). These documents provide the framework for the development of the Comprehensive Process which is included as part of the Restoration Plan.

The Comprehensive Process evolved from discussions with local experts; comments from the public; reviews of the literature; reviews of damage assessment and restoration studies; and collaboration with biologists, ecologists, resource managers, archaeologists, and realty, recreation and subsistence specialists. Existing habitat protection systems, such as the Florida Conservation and Recreation Lands program were reviewed as models. To aid in the development of this process, The Nature Conservancy produced a handbook for the Trustee Council. The handbook provides an overview of protection tools, techniques and strategies used by the Conservancy, federal and state resource agencies and by other land stewardship organizations. A workshop was held on June 7-8, 1993, to review the Comprehensive Process. Recommendations from this workshop were incorporated into the Comprehensive Process.

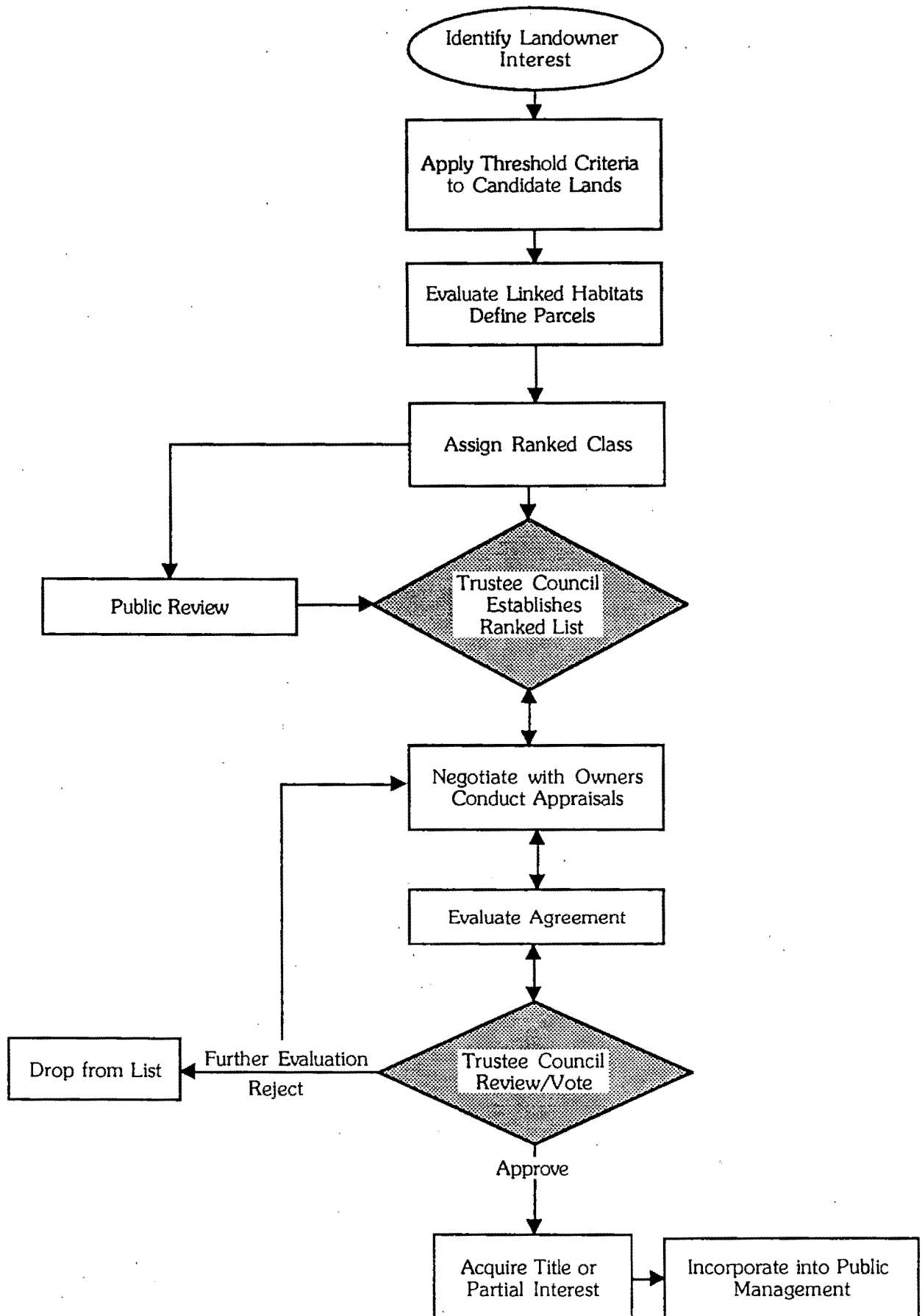
Threshold criteria were developed and included in the Comprehensive Process to eliminate lands that would not meet restoration objectives. Subsequently, evaluation and ranking criteria were used to prioritize candidate lands that met the threshold criteria. Additional lands will be evaluated as willing sellers are identified.

Some of the protection tools available include: fee title acquisition, conservation easements, acquisition of partial interests, and cooperative management agreements. Following purchase, acquired parcels will be managed in a manner that is consistent with the restoration objectives for the injured resources and/or services. The Trustee Council will decide which resource agency manages each acquired parcel.

Initially, the Trustee Council used a similar evaluation and ranking process to identify lands that contain injured resource and service habitats that were imminently threatened. The imminent threat evaluation process has been completed. That process resulted in the purchase of private lands in Kachemak Bay State Park and on northern Afognak Island.

This document describes the evaluation and ranking elements of the Comprehensive Process and presents the results of the evaluations for the 81 large parcels that have been identified to date.

Figure 1: COMPREHENSIVE HABITAT PROTECTION



THE COMPREHENSIVE HABITAT PROTECTION PROCESS

The Comprehensive Process consists of a sequence of steps leading to possible protection of those lands that contain habitats linked to the recovery or replacement of injured resources and services. This process is depicted graphically in Figure 1. The analysis to date, has progressed through the first four steps; 1) Identify Landowner Interest, 2) Apply Threshold Criteria to Candidate Lands, 3) Evaluate Linked Habitats and Define Parcels, and 4) Assign Ranked Class. The remaining steps in the process will occur in the near future. The evaluation and ranking elements of the Comprehensive Process are described below.

Identify Landowner Interest

On March 18, 1993, ninety letters and response forms were mailed via certified mail to major landowners in the oil spill area. In addition, phone calls were made to the majority of the large landowners. Thus far, 32 nominations of candidate lands have been received from this solicitation. Of these, eleven responses were evaluated as part of the Large Parcel Evaluation and Ranking and the remainder will be evaluated as part of the Small Parcel Evaluation and Ranking.

Apply Threshold Criteria to Candidate Lands

Candidate lands were evaluated to see if they met the following threshold criteria (Table 1). Candidate lands were rejected if not in compliance with ALL threshold criteria. Rejected proposals can be recycled back into the process for another review if additional information is made available that allows for compliance with all threshold criteria.

Table 1: Threshold Criteria

- 1) There is a willing seller of the parcel or property right;
- 2) The parcel contains key habitats that are linked to, replace, provide the equivalent of, or substitute for injured resources or services based on scientific data or other relevant information;
- 3) The seller acknowledges that the governments can purchase the parcel or property rights only at or below fair market value;
- 4) Recovery of the injured resource or service would benefit from protection in addition to that provided by the owner and applicable laws and regulations; and
- 5) The acquired property rights can reasonably be incorporated into public land management systems.

Evaluate Linked Habitats and Define Parcels

Parcel Design

Following application of the threshold criteria, each landowner nomination was divided into one or more evaluation parcels. The parcel boundaries were delineated based upon ecological considerations, injured resource and service concerns, and ownership patterns. For the most part, the resulting 81 parcels represent tracts of private land greater than 1,000 contiguous acres.

Large parcels were evaluated first because they generally have greater ecological integrity and contain more habitats for injured resources and services than smaller parcels. To date the Comprehensive Process evaluated over 850,000 acres of private lands. This phase of the process focused on large parcels since an analysis of smaller parcels would not have been feasible using the current methodology.

Restoration benefits can also be obtained from protection of small areas. Protection of small parcels can, for example: 1) facilitate public access to a large parcel; 2) eliminate potential threats to a specific habitat area or larger surrounding ecological unit; 3) improve management of a large parcel; 4) focus restoration efforts on individual species or key habitats/sites. A small parcel evaluation process will be developed and used for the evaluation and ranking of small parcels.

Land status was a primary factor in the design of each parcel. Native corporations are the major private landowners in the spill area. Only those lands that are conveyed or are expected to be conveyed were evaluated and ranked. The Bureau of Land Management provided information on acreage entitlements and Native corporation priorities for conveyance. This facilitated the evaluation and ranking of priority lands up to the total acreage entitlements likely to be conveyed.

Parcel Evaluation

Once parcel boundaries were determined, the parcels were subjected to detailed evaluation against a set of Evaluation/Ranking Criteria (Table 2). These evaluation criteria, listed in Table 2, were designed to determine:

- The degree of linkage for injured resources and services to specific parcels; and
- The potential for benefit that habitat protection on each parcel would have for each linked resource and service.

Table 2: Evaluation/Ranking Criteria

- 1) The parcel contains essential habitat(s)/sites for injured resources or services. Essential habitats include areas for feeding, reproduction, molting, roosting, and migration; essential sites include known or presumed high public use areas. Key factors for determining essential habitat/sites are: (a) population or number of animals or number of public users, (b) number of essential habitats/sites on parcel, and (c) quality of essential habitats/sites.
- 2) The parcel can function as an intact ecological unit or it contains essential habitats that are connected to other elements/habitats in the greater ecosystem.
- 3) Adjacent land uses will not significantly degrade the ecological function of the essential habitat(s) nominated or recommended for protection.
- 4) Protection of the habitats on a parcel would benefit more than one injured resource/service (unless protection of a single resource/service would provide a high recovery benefit).
- 5) The parcel contains critical habitat for a depleted, rare, threatened, or endangered species.
- 6) Essential habitats/sites on a parcel are vulnerable to or potentially threatened by human activity.
- 7) Management of adjacent lands is, or could easily be made compatible with protection of essential habitats on a parcel.
- 8) The parcel is located within the oil spill area.
 - * Criteria #1 was applied to a parcel as specified in Table 4, page 11, resulting in a score of High, Moderate, or Low for each injured resource / service.
 - * Criteria #2 through #8 were scored with a simple yes or no indicating potential benefit to the entire ecosystem.

A list of injured resources and services that are linked to upland and nearshore habitats was developed from the Draft Restoration Plan, Summary of Injury and the recommendations of the Chief Scientist. These are listed in Table 3, Linked Resources and Services. Severity of injury was not considered in the parcel evaluation process due to incomplete damage assessment information.

Table 3: Linked Resources and Services

Resources		Services
Sockeye Salmon	Harbor Seal	Recreation
Pink Salmon	Harlequin Duck	Wilderness
Dolly Varden	Intertidal/Subtidal	Subsistence
Cutthroat Trout	Marbled Murrelet	
Pacific Herring	Pigeon Guillemot	
Bald Eagle	River Otter	
Black Oystercatcher	Sea Otter	
Common Murre	Cultural Resources	

Injured resources are linked to a parcel if they are dependent on distinct upland and nearshore habitat(s) during critical life stages, i.e. reproduction, feeding, molting, migration. For example, anadromous streams support reproduction of anadromous fish and also act as movement corridors between the spawning and rearing habitat and the sea.

Services are linked to a parcel if the parcel includes species habitat as well as recreation sites or viewsheds. Examples of linkage for services are recreational salmon fishing or recreational use by the public in an area of high scenic value with opportunities for viewing wildlife.

In determining the potential benefits to injured resources and services that a parcel will provide, the process considers the susceptibility of injured resources / services to adverse impacts from human activities and the probability that these impacts will occur within or adjacent to the parcel. Potential threats to resources and their habitats include both disturbance and habitat degradation or loss. Examples of habitat degradation would be the pollution of spawning habitat or the fragmentation of nesting habitat due to changes in land use or development activity. Disturbance can result in the disruption of reproductive activity or displacement of animals from important feeding areas. Marine mammals, for example, when hauled out on land, are sensitive to disturbance. Some land uses within a parcel or on lands bordering a parcel could interfere with seasonal movements or create movement corridor conflicts.

Information used in the evaluation process included resource agency data on anadromous fish streams, marine mammal haul-out areas, bald eagle nest locations, seabird colony locations, and spruce bark beetle infestation areas. EVOS natural resources damage assessment studies and agency planning studies were also reviewed.

Field surveys were conducted during the spring and summer of 1993. This effort provided wildlife observations and nearshore habitat data for most of the evaluated parcels. A wide range of information was solicited from experts for all nineteen injured resources and services. This information was gathered through a workshop run by The Nature Conservancy and on an individual basis.

Parcels were evaluated independently of each other by a single evaluation team. The degree of linkage for each parcel was determined according to evaluation Criteria #1, Table 2 (page 7). The rating for Criteria #1 was derived from the quality of the habitat and the estimated benefit the injured resource / service would receive from protection of the parcel. A value of high, moderate, or low was determined for each resource / service, for every parcel, according to the criteria summarized in Table 4: Criteria for Rating Benefit of Parcel to Injured Resources / Services (page 11). The value was based on an evaluation of similar habitat throughout the oil spill area. Secondary importance was given to the local or regional importance of the habitat. Potential benefit to the associated ecosystem was determined by a Yes or No scoring of evaluation criteria #'s 2-8.

The parcel score was computed by summing the number of High plus one half the number of Moderate ratings identified in the linkage criteria (1), multiplied by the sum in the Yes responses to the potential for benefit criteria (2-8). The score can be expressed as:

$$\text{Score} = [\text{Sum of High} + 0.5 (\text{Sum of Moderate})] \times \text{Sum of Yes (Criteria 2-8)}$$

As an example, when this formula is applied to parcel ABC 01, South Cove, the analysis of Criteria #1 yielded 4 High scores and 4 Medium scores for a value of 6. This number was then multiplied by the 5 Yes (Y) scores in criteria 2-8, resulting in a parcel score of 30.

PARCEL #	PARCEL NAME	EVALUATION CRITERIA								SCORE
		1	2	3	4	5	6	7	8	
ABC01	South Cove	4H, 4M	Y	Y	Y	N	N	Y	Y	30

$$\text{Example: ABC 01 Score} = [4H + (0.5 \times 4M)] \times 5Y = (4 + 2) \times 5 = 30$$

See Volume II for a presentation of detailed individual parcel evaluations.

Resource and service ratings for all 81 parcels were reviewed by experts familiar with the area and its resources. Additional information provided by expert reviewers was incorporated into the final analysis. A list of those expert reviewers is appended to this document.

Ranking

Each of the scored parcels was assigned a ranking of high, moderate or low, based on review of evaluation results. The evaluation team created the ranked classes based on observed breaks in the distribution of parcel scores (pages 16-19). The bar graph in Figure 2, Comprehensive Parcel Analysis, depicts the relationship of the 81 parcels relative to their respective scores. Figure 3 depicts the relationship between parcel acreage and rank. In addition, parcels have also been grouped by region and by landowner.

This ranking represents the degree to which protection of a parcel will benefit the recovery of linked resources and services that occur on that parcel.

SUMMARY

In summary, 81 large parcels were identified, evaluated, and placed in ranked classes during this phase of the Comprehensive Habitat Protection Process. A description of the Comprehensive Process and summary tables and charts containing results of this process are included in this volume. Volume II of this report provides parcel-specific results and maps. In the future, small parcels, public lands, and any additional large parcels meeting threshold criteria will be evaluated for their potential benefit to restoration.

CRITERIA FOR RATING BENEFIT OF PARCEL TO INJURED RESOURCES / SERVICES

INJURED RESOURCE/SERVICE	HIGH	MODERATE	LOW
Pink Salmon	High density of pink salmon streams per parcel; system known to have exceptional production.	Average density of pink salmon streams on parcel; average production.	Few or no pink salmon streams on parcel; low production.
Sockeye Salmon	Sockeye salmon streams on parcel; system known to have exceptional production.	Sockeye salmon streams on parcel; average production.	Few or no sockeye salmon streams on parcel; low production.
Cutthroat Trout	Cutthroat trout streams on parcel; system known to have exceptional production.	Cutthroat trout streams on parcel; average production.	Few or no cutthroat trout streams on parcel; low production.
Dolly Varden	Dolly Varden streams on parcel; system known to have exceptional production.	Dolly Varden streams on parcel; average production.	Few or no Dolly Varden streams on parcel; low production.
Pacific Herring	Documented consistent annual herring spawning along parcel shoreline.	Occasional spawning along parcel shoreline.	No documented herring spawning along parcel shoreline; possible feeding.
Bald Eagle	High density (1 or more per mile of shoreline) of nests on parcel; and/or known critical feeding area.	Average density (less than one per mile of shoreline) of nests on or immediately adjacent to parcel; important feeding area.	Few or no nests on parcel.
Black Oystercatcher	Area known to support nesting or concentration area for feeding.	Probable nesting; known feeding area.	Possible feeding.
Common Murre	Known nesting on or immediately adjacent to parcel.	Feeding concentrations in nearshore waters.	Possible feeding in area.

Table 4

CRITERIA FOR RATING BENEFIT OF PARCEL TO INJURED RESOURCES / SERVICES

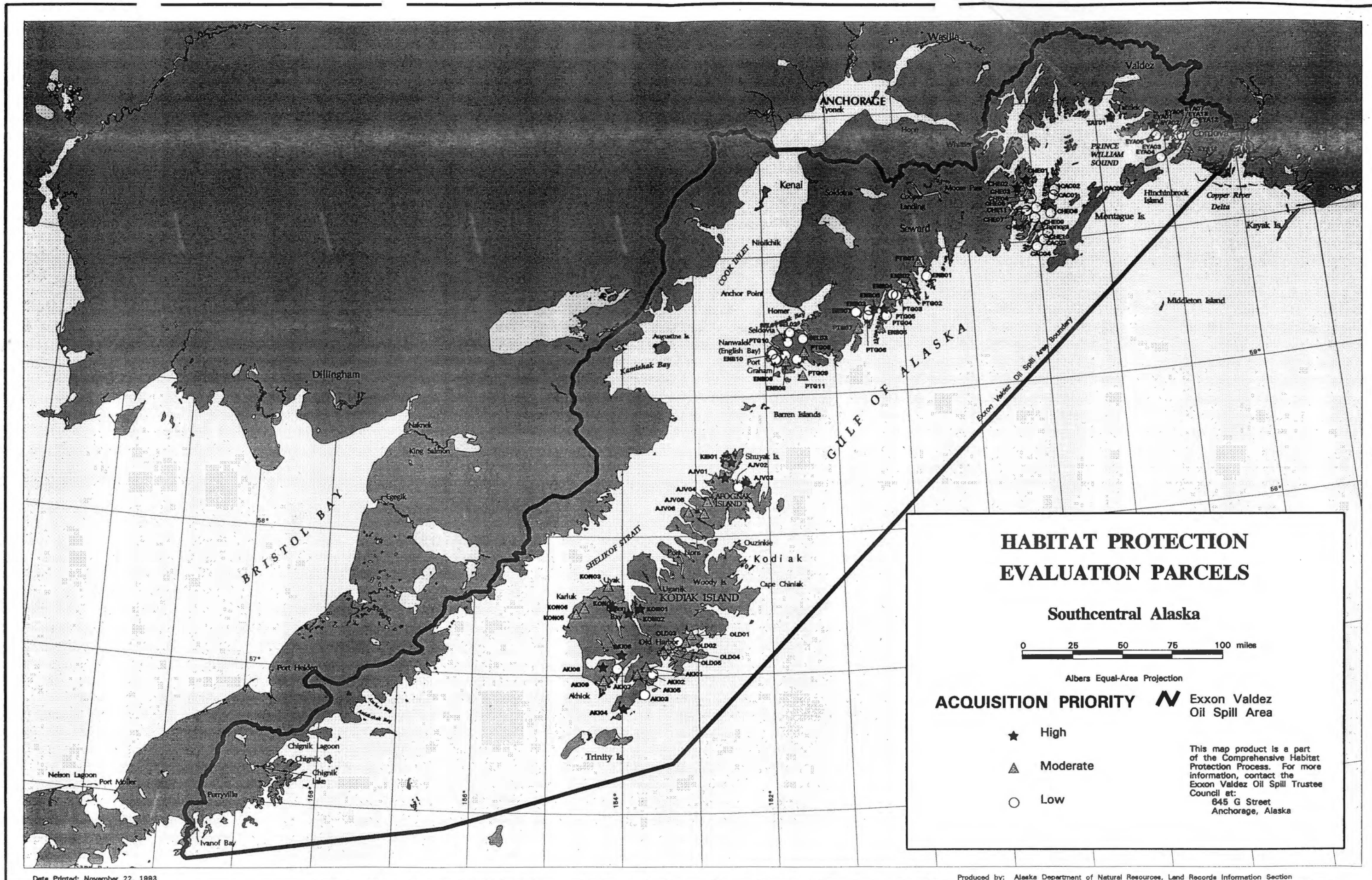
INJURED RESOURCE/SERVICE	HIGH	MODERATE	LOW
Harbor Seal	Known haul out of 10 or more seals on or immediately adjacent to parcel.	Known haulout, use sporadic, less than 10 seals. Probable haul outs in vicinity of parcel; probable feeding in nearshore waters.	Possible feeding in nearshore waters.
Harlequin Duck	Known nesting or molting concentrations on parcel; feeding concentration area.	Probable nesting on or adjacent to parcel or important for molting; probable feeding in stream, estuary, or intertidal.	Possible feeding and loafing in area adjacent to parcel; some offshore molting.
Intertidal/subtidal Biota	Known high species abundance/diversity; high quality habitat.	Extensive intertidal habitat with observed or probable moderate species diversity and abundance.	Little intertidal habitat with low species abundance.
Marbled Murrelet	Known nesting or high confidence that nesting occurs; feeding concentrations in nearshore waters.	Probable nesting on parcel; known feeding in nearshore waters.	Low likelihood of nesting; possible feeding in nearshore waters.
Pigeon Guillemot	Known nesting on or immediately adjacent to parcel; feeding concentrations in nearshore waters.	Probable nesting; known feeding in nearshore waters.	Low likelihood of nesting; possible feeding in nearshore waters.

Table 4

CRITERIA FOR RATING BENEFIT OF PARCEL TO INJURED RESOURCES / SERVICES

INJURED RESOURCE/SERVICE	HIGH	MODERATE	LOW
River Otter	Known high use of parcel for denning/latrine sites.	Known or probable latrine and/or denning sites; known feeding in adjacent intertidal/streams/nearshore area.	Possible feeding in adjacent intertidal/streams.
Sea Otter	Known pupping concentrations.	Concentration area for feeding and/or shelter; potential pupping.	Feeding in adjacent waters.
Recreation/Tourism	Receives regular, high directed public use; highly visible to a large number of recreationists/tourists.	Receives occasional public use; adjacent waters used for recreational boating; adjacent area receives high public use.	Low to no recreational use; access may be difficult.
Wilderness	Area remote; little or no evidence of human development.	Area remote; evidence of human development and/or ongoing activities.	High/moderate evidence of human development and/or ongoing activities.
Cultural Resources	Documented concentration or significant cultural resources/sites on parcel.	No significant cultural resources/sites on or adjacent to parcel.	No known or suspected cultural resources/sites on parcel.
Subsistence	Known current subsistence use area.	Known historic subsistence use area, which may be used again.	Status as a subsistence use area unknown.

Table 4



Data Printed: November 22, 1993

Produced by: Alaska Department of Natural Resources, Land Records Information Section

EVALUATION & RANKING SUMMARIES

LARGE PARCEL EVALUATION and RANKING

PARCEL #	PARCEL NAME	REGION*	RANK	LANDOWNER	ACREAGE
AJV 03	Pauls/Laura Lake	KOD	High	Afognak Joint Venture	27,100
EYA 02	Sheep Bay	PWS	High	Eyak	9,100
CHE 02	Jackpot Bay	PWS	High	Chenega	12,100
TAT 01	Bligh Island	PWS	High	Tatitlek	8,800
AKI 06	North Olga Bay	KOD	High	Akhiok Kaguyak	16,900
CHE 01	Eshamy Bay	PWS	High	Chenega	7,900
AJV 01	Shuyak Strait	KOD	High	Afognak Joint Venture	13,400
AKI 04	Aliulik Peninsula	KOD	High	Akhiok Kaguyak	34,300
EYA 03	Windy Bay/Deep Bay	PWS	High	Eyak	7,100
KIB 01	Shuyak Island	KOD	High	Kodiak Island Borough	27,900
AKI 08	Upper Station Lakes	KOD	High	Akhiok Kaguyak	15,600
KON 01	Brown's Lagoon	KOD	High	Koniag	9,900
KON 04	Karluk River	KOD	High	Koniag	28,200
ENB 06	James Lagoon	KEN	High	English Bay	3,800
EYA 01	Port Gravina	PWS	High	Eyak	3,400
KON 02	Uyak Bay	KOD	High	Koniag	7,000
PTG 05	Delight/Desire Creeks	KEN	High	Port Graham	11,500
AKI 05	Sulua/Portage Bays	KOD	Moderate	Akhiok Kaguyak	8,200
AJV 04	Paramanof Peninsula	KOD	Moderate	Afognak Joint Venture	56,700
ENB 02	Harris Peninsula	KEN	Moderate	English Bay	6,200
PTG 01	Upper Aialik	KEN	Moderate	Port Graham	4,300
AJV 06	Malina Peninsula	KOD	Moderate	Afognak Joint Venture	27,300
AKI 01	Kaiugnak Bay	KOD	Moderate	Akhiok Kaguyak	4,900
CHE 09	Northwest Evans Island	PWS	Moderate	Chenega	6,200
ENB 08	Port Chatham	KEN	Moderate	English Bay	15,700
PTG 02	Northwest Lagoon/Cup Cove	KEN	Moderate	Port Graham	3,500
PTG 11	Chugach Island	KEN	Moderate	Port Graham	3,300
AKI 09	Sukhoi/Kempff Bays	KOD	Moderate	Akhiok Kaguyak	15,900
CAC 02	Bay of Isles	PWS	Moderate	Chugach Alaska	10,800
CAC 05	Nuchek Island	PWS	Moderate	Chugach Alaska	800
EYA 11	Core Parcels (3)	PWS	Moderate	Eyak	13,700

*REGION: KEN/Kenai, KON/Kodiak, PWS/Prince William Sound

**Parcels, part of EYA 11, Core Parcels (3)

LARGE PARCEL EVALUATION and RANKING

PARCEL #	PARCEL NAME	REGION*	RANK	LANDOWNER	ACREAGE
KON 03	Larsen Bay	KOD	Moderate	Koniag	22,400
KON 05	Halibut Bay	KOD	Moderate	Koniag	21,900
AJV 05	Inner Malina Bay	KOD	Moderate	Afognak Joint Venture	12,700
PTG 07	Shelter Cove/Yalik Bay	KEN	Moderate	Port Graham	10,500
CHE 04	Northwest Chenega Island	PWS	Moderate	Chenega	7,300
OLD 05	Three Saints Bay	KOD	Moderate	Old Harbor	5,300
KON 06	Sturgeon River	KOD	Moderate	Koniag	22,400
OLD 04	Barling Bay	KOD	Moderate	Old Harbor	4,600
CHE 03	Granite/Ewan/Paddy Bays	PWS	Moderate	Chenega	15,000
OLD 01	Kiliuda Bay	KOD	Moderate	Old Harbor	9,500
EYA 04	Canoe Passage	PWS	Low	Eyak	3,700
PTG 08	Rocky Bay	KEN	Low	Port Graham	16,200
AKI 02	Kiavak Bay	KOD	Low	Akhiok Kaguyak	4,200
AKI 03	Jap/Kaguyak Bays	KOD	Low	Akhiok Kaguyak	12,400
CAC 04	South Latouche	PWS	Low	Chugach Alaska	1,600
CHE 08	Flemming Island	PWS	Low	Chenega	1,700
ENB 01	Bear Cove	KEN	Low	English Bay	1,400
ENB 05	McArthur Pass	KEN	Low	English Bay	7,600
ENB 07	Beauty Bay	KEN	Low	English Bay	8,900
EYA 05	Outer Sheep Bay	PWS	Low	Eyak	7,600
OLD 02	Sitkalidak Strait	KOD	Low	Old Harbor	8,000
SEL 02	Barbara Creek	KEN	Low	Seldovia	10,100
EYA 07	East Simpson Bay	PWS	Low	Eyak	3,300
OLD 03	Midway Bay	KOD	Low	Old Harbor	7,300
ENB 03	North Arm Nuka Bay	KEN	Low	English Bay	4,600
CAC 01	Drier Bay	PWS	Low	Chugach Alaska	3,200
CHE 06	South Knight Island	PWS	Low	Chenega	5,400
EYA 06	West Simpson Bay	PWS	Low	Eyak	4,000
AKI 07	Olga Bay Narrows	KOD	Low	Akhiok Kaguyak	15,200
PTG 06	Surprise Bay/Quartz Bay	KEN	Low	Port Graham	12,400

*REGION: KEN/Kenai, KON/Kodiak, PWS/Prince William Sound

**Parcels, part of EYA 11, Core Parcels (3)

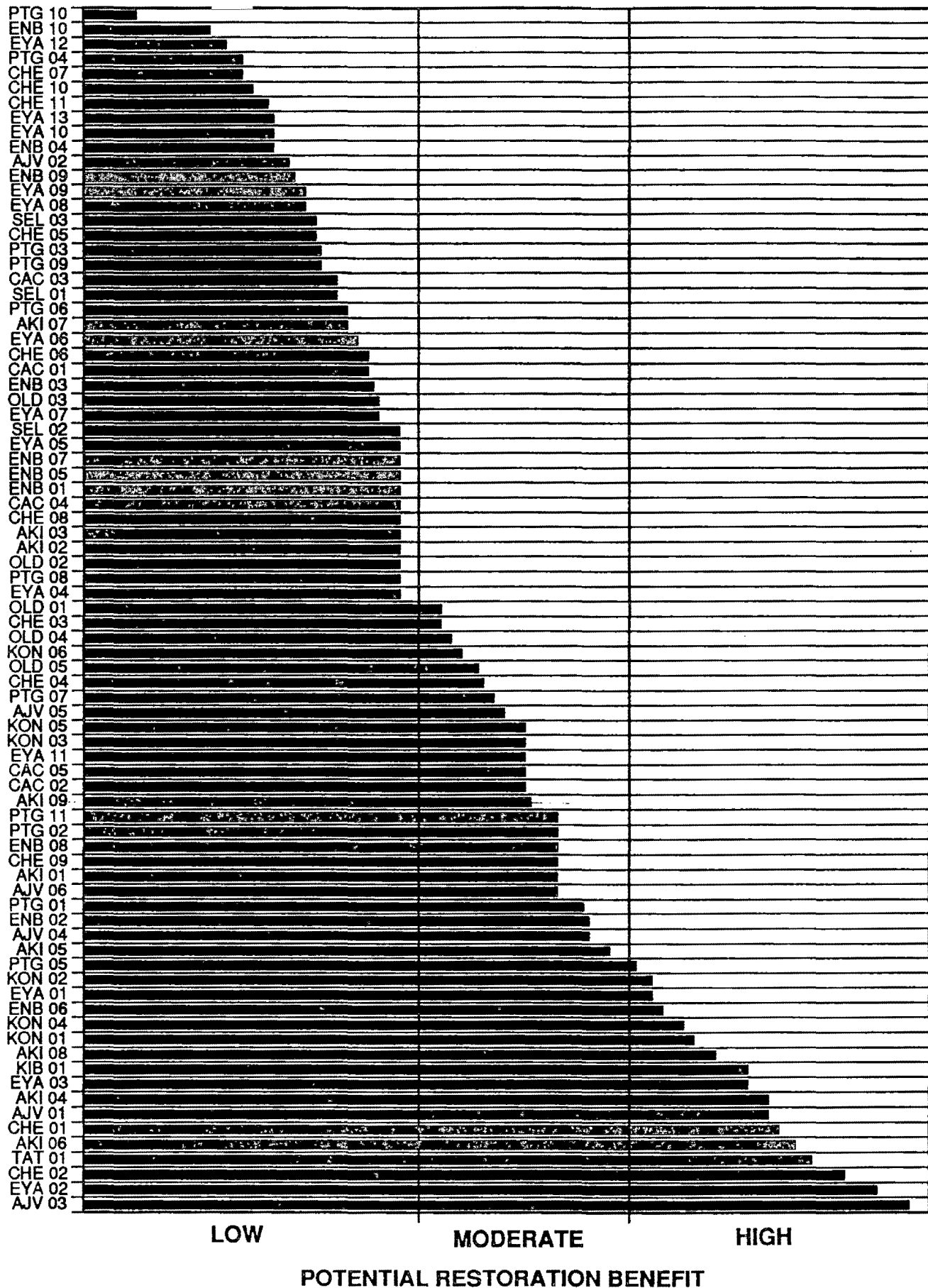
LARGE PARCEL EVALUATION and RANKING

PARCEL #	PARCEL NAME	REGION*	RANK	LANDOWNER	ACREAGE
SEL 01	Seldovia Bay	KEN	Low	Seldovia	18,600
CAC 03	Central Latouche	PWS	Low	Chugach Alaska	12,900
PTG 09	Windy/Chugach Bays	KEN	Low	Port Graham	15,300
PTG 03	Sandy Bay/Paguna Arm	KEN	Low	Port Graham	3,400
CHE 05	Southeast Chenega Island	PWS	Low	Chenega	8,300
SEL 03	Jakalof Bay	KEN	Low	Seldovia	13,100
EYA 08	**Power Creek	PWS	Low	Eyak	4,800
EYA 09	**Eyak Lake	PWS	Low	Eyak	5,100
ENB 09	Dogfish Bay	KEN	Low	English Bay	14,700
AJV 02	Delphin Point	KOD	Low	Afognak Joint Venture	2,100
ENB 04	Upper Paguna/Thunder Bay	KEN	Low	English Bay	5,900
EYA 10	**Eyak River	PWS	Low	Eyak	3,800
EYA 13	Orca Narrows/Nelson Bay	PWS	Low	Eyak	4,600
CHE 11	Pleiades Islands	PWS	Low	Chenega	400
CHE 10	Sleepy Bay	PWS	Low	Chenega	3,700
CHE 07	Northeast Whale Bay	PWS	Low	Chenega	1,500
PTG 04	Black Bay	KEN	Low	Port Graham	2,300
EYA 12	Rude River	PWS	Low	Eyak	6,900
ENB 10	English Bay River	KEN	Low	English Bay	15,400
PTG 10	Port Graham Uplands	KEN	Low	Port Graham	28,400

*REGION: KEN/Kenai, KON/Kodiak, PWS/Prince William Sound

**Parcels, part of EYA 11, Core Parcels (3)

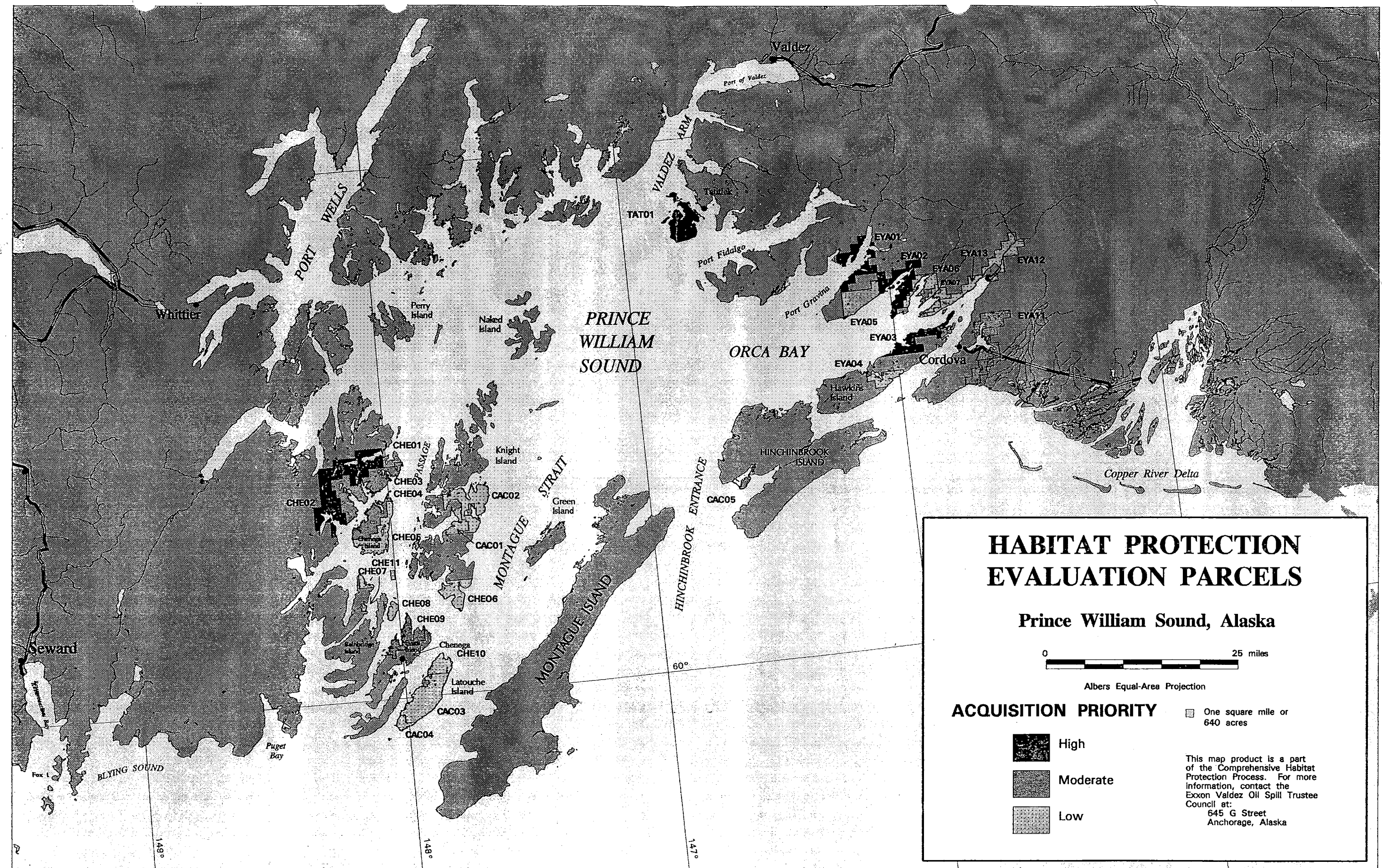
Figure 2: COMPREHENSIVE PAI L ANALYSIS



PARCEL EVALUATION & RANKING

by

REGION



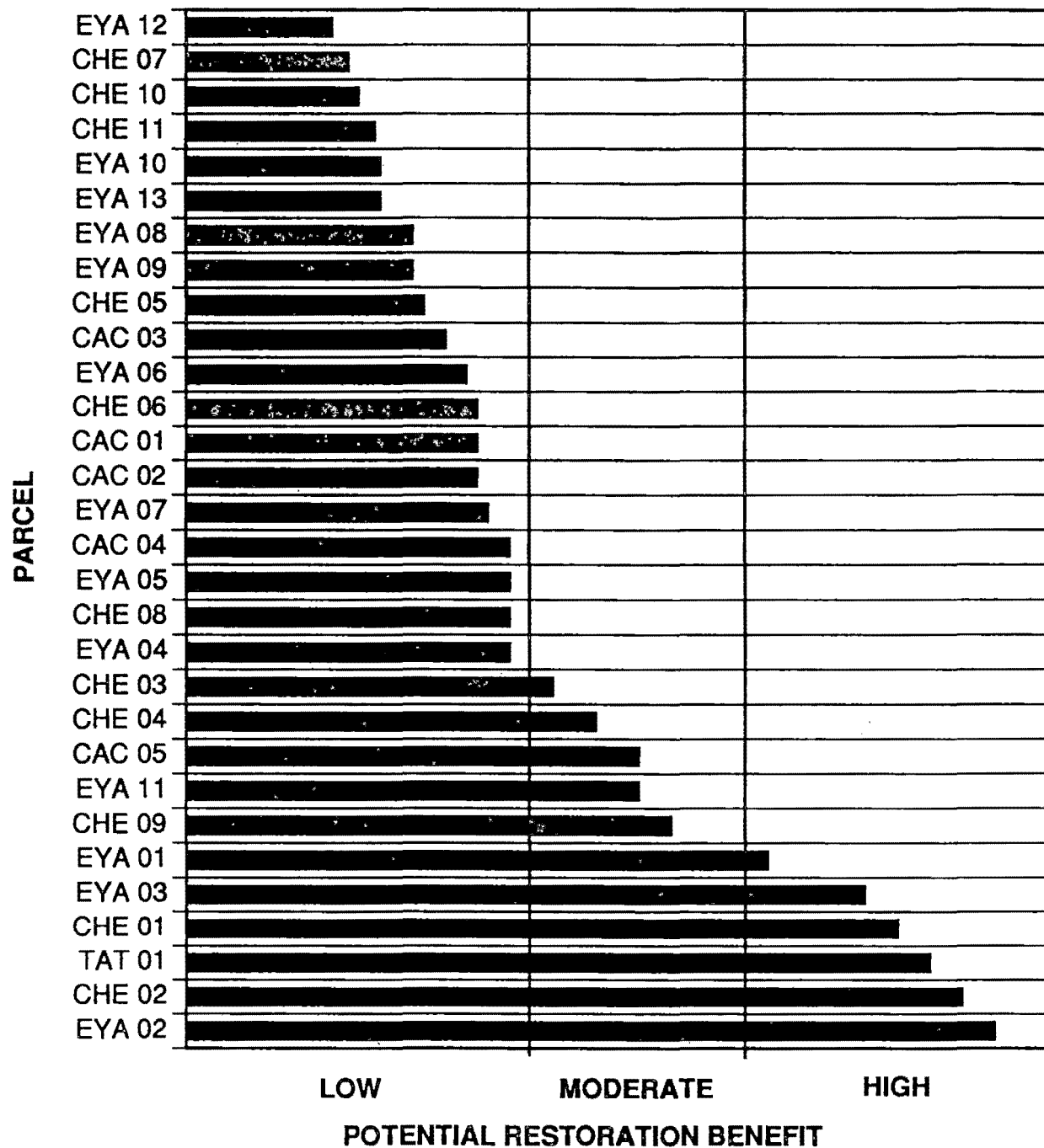
LARGE PARCEL EVALUATION and RANKING PRINCE WILLIAM SOUND

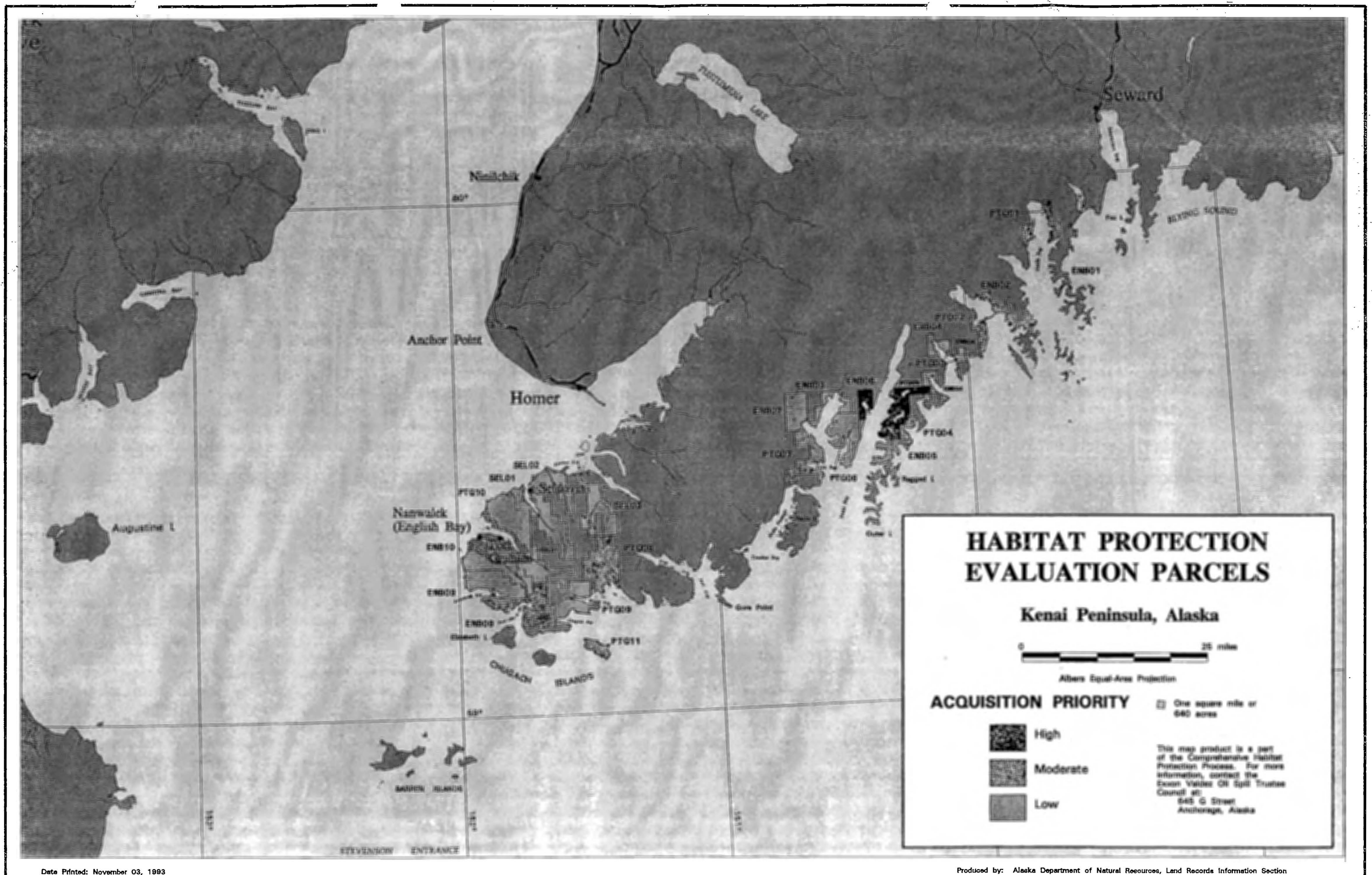
PARCEL #	PARCEL NAME	REGION*	RANK	LANDOWNER	ACREAGE
EYA 02	Sheep Bay	PWS	High	Eyak	9,100
CHE 02	Jackpot Bay	PWS	High	Chenega	12,100
TAT 01	Bligh Island	PWS	High	Tatitlek	8,800
CHE 01	Eshamy Bay	PWS	High	Chenega	7,900
EYA 03	Windy Bay/Deep Bay	PWS	High	Eyak	7,100
EYA 01	Port Gravina	PWS	High	Eyak	3,400
CHE 09	Northwest Evans Island	PWS	Moderate	Chenega	6,200
CAC 02	Bay of Isles	PWS	Moderate	Chugach Alaska	10,800
CAC 05	Nuchek Island	PWS	Moderate	Chugach Alaska	800
EYA 11	Core Parcels (3)	PWS	Moderate	Eyak	13,700
CHE 04	Northwest Chenega Island	PWS	Moderate	Chenega	7,300
CHE 03	Granite/Ewan/Paddy Bays	PWS	Moderate	Chenega	15,000
EYA 04	Canoe Passage	PWS	Low	Eyak	3,700
CHE 08	Flemming Island	PWS	Low	Chenega	1,700
CAC 04	South Latouche	PWS	Low	Chugach Alaska	1,600
EYA 05	Outer Sheep Bay	PWS	Low	Eyak	7,600
EYA 07	East Simpson Bay	PWS	Low	Eyak	3,300
CAC 01	Drier Bay	PWS	Low	Chugach Alaska	3,200
CHE 06	South Knight Island	PWS	Low	Chenega	5,400
EYA 06	West Simpson Bay	PWS	Low	Eyak	4,000
CAC 03	Central Latouche	PWS	Low	Chugach Alaska	12,900
CHE 05	Southeast Chenega Island	PWS	Low	Chenega	8,300
EYA 08	**Power Creek	PWS	Low	Eyak	4,800
EYA 09	**Eyak Lake	PWS	Low	Eyak	5,100
EYA 10	**Eyak River	PWS	Low	Eyak	3,800
EYA 13	Orca Narrows/Nelson Bay	PWS	Low	Eyak	4,600
CHE 11	Pleiades Islands	PWS	Low	Chenega	400
CHE 10	Sleepy Bay	PWS	Low	Chenega	3,700
CHE 07	Northeast Whale Bay	PWS	Low	Chenega	1,500
EYA 12	Rude River	PWS	Low	Eyak	6,900

*REGION: KEN/Kenai, KON/Kodiak, PWS/Prince William Sound

**Parcels; Part of EYA 11, Core Parcels (3)

Figure 5: COMPREHENSIVE PARCEL ANALYSIS -PRINCE WILLIAM SOUND





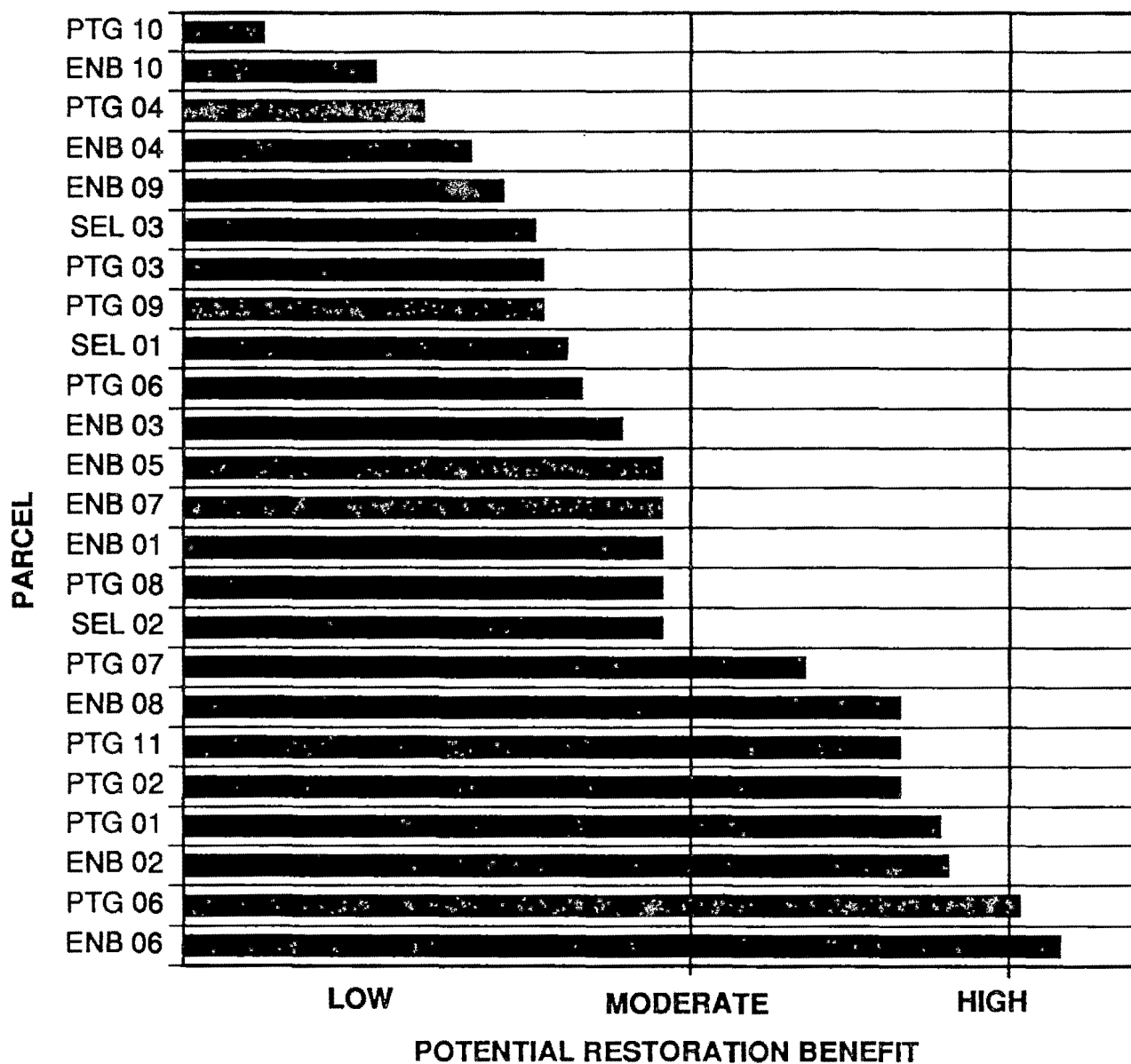
LARGE PARCEL EVALUATION and RANKING KENAI REGION

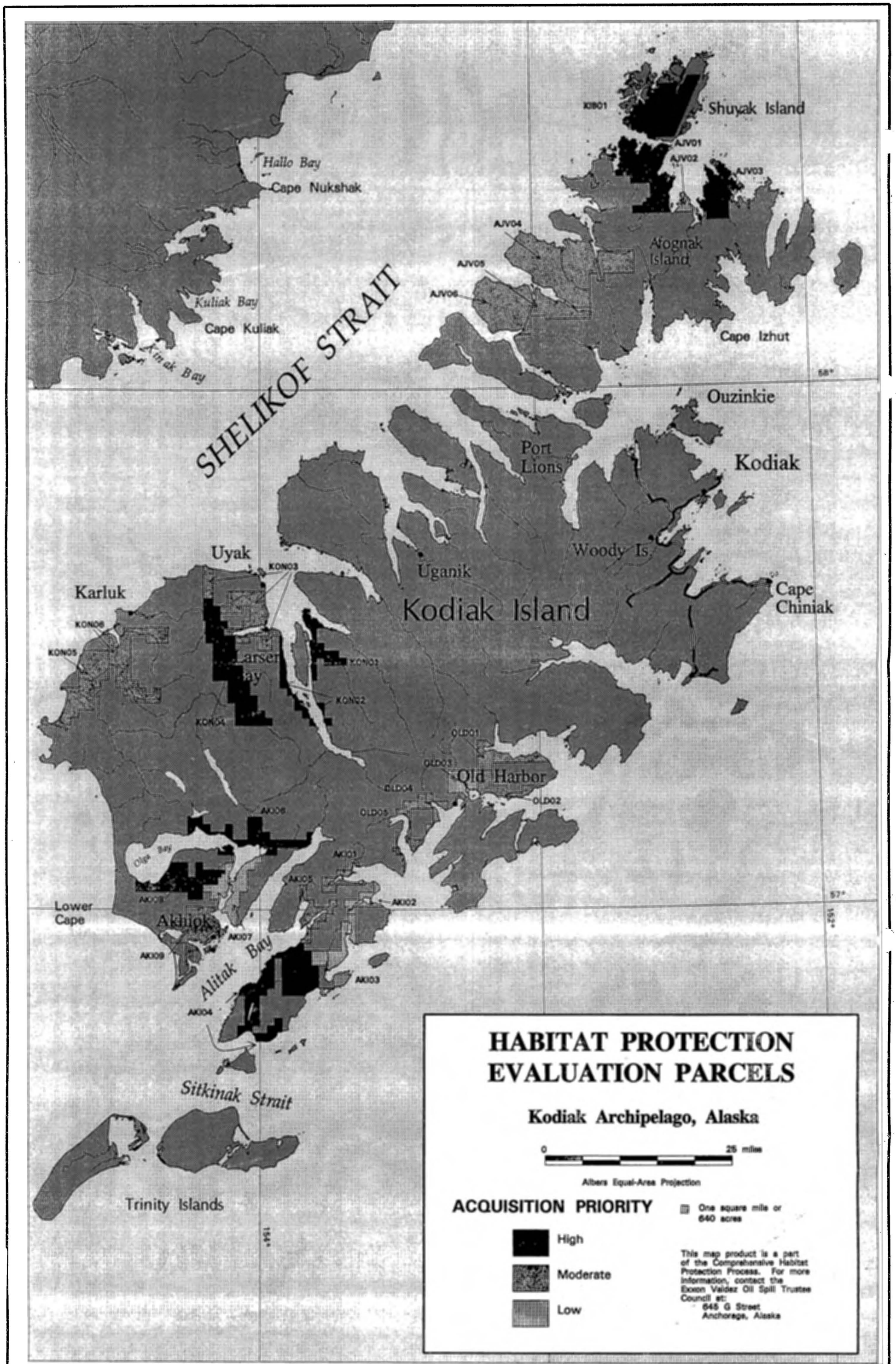
PARCEL #	PARCEL NAME	REGION*	RANK	LANDOWNER	ACREAGE
ENB 06	James Lagoon	KEN	High	English Bay	3,800
PTG 05	Delight/Desire Creeks	KEN	High	Port Graham	11,500
ENB 02	Harris Peninsula	KEN	Moderate	English Bay	6,200
PTG 01	Upper Aialik	KEN	Moderate	Port Graham	4,300
ENB 08	Port Chatham	KEN	Moderate	English Bay	15,700
PTG 02	Northwest Lagoon/Cup Cove	KEN	Moderate	Port Graham	3,500
PTG 11	Chugach Island	KEN	Moderate	Port Graham	3,300
PTG 07	Shelter Cove/Yalik Bay	KEN	Moderate	Port Graham	10,500
PTG 08	Rocky Bay	KEN	Low	Port Graham	16,200
ENB 01	Bear Cove	KEN	Low	English Bay	1,400
ENB 07	Beauty Bay	KEN	Low	English Bay	8,900
SEL 02	Barbara Creek	KEN	Low	Seldovia	10,100
ENB 05	McArthur Pass	KEN	Low	English Bay	7,600
ENB 03	North Arm Nuka Bay	KEN	Low	English Bay	4,600
PTG 06	Surprise Bay/Quartz Bay	KEN	Low	Port Graham	12,400
SEL 01	Seldovia Bay	KEN	Low	Seldovia	18,600
PTG 09	Windy/Chugach Bays	KEN	Low	Port Graham	15,300
PTG 03	Sandy Bay/Paguna Arm	KEN	Low	Port Graham	3,400
SEL 03	Jakalof Bay	KEN	Low	Seldovia	13,100
ENB 09	Dogfish Bay	KEN	Low	English Bay	14,700
ENB 04	Upper Paguna/Thunder Bay	KEN	Low	English Bay	5,900
PTG 04	Black Bay	KEN	Low	Port Graham	2,300
ENB 10	English Bay River	KEN	Low	English Bay	15,400
PTG 10	Port Graham Uplands	KEN	Low	Port Graham	28,400

*REGION: KEN/Kenai, KON/Kodiak, PWS/Prince William Sound

**Parcels; Part of EYA 11, Core Parcels (3)

Figure 3: COMPREHENSIVE PARCEL ANALYSIS - KENAI REGION





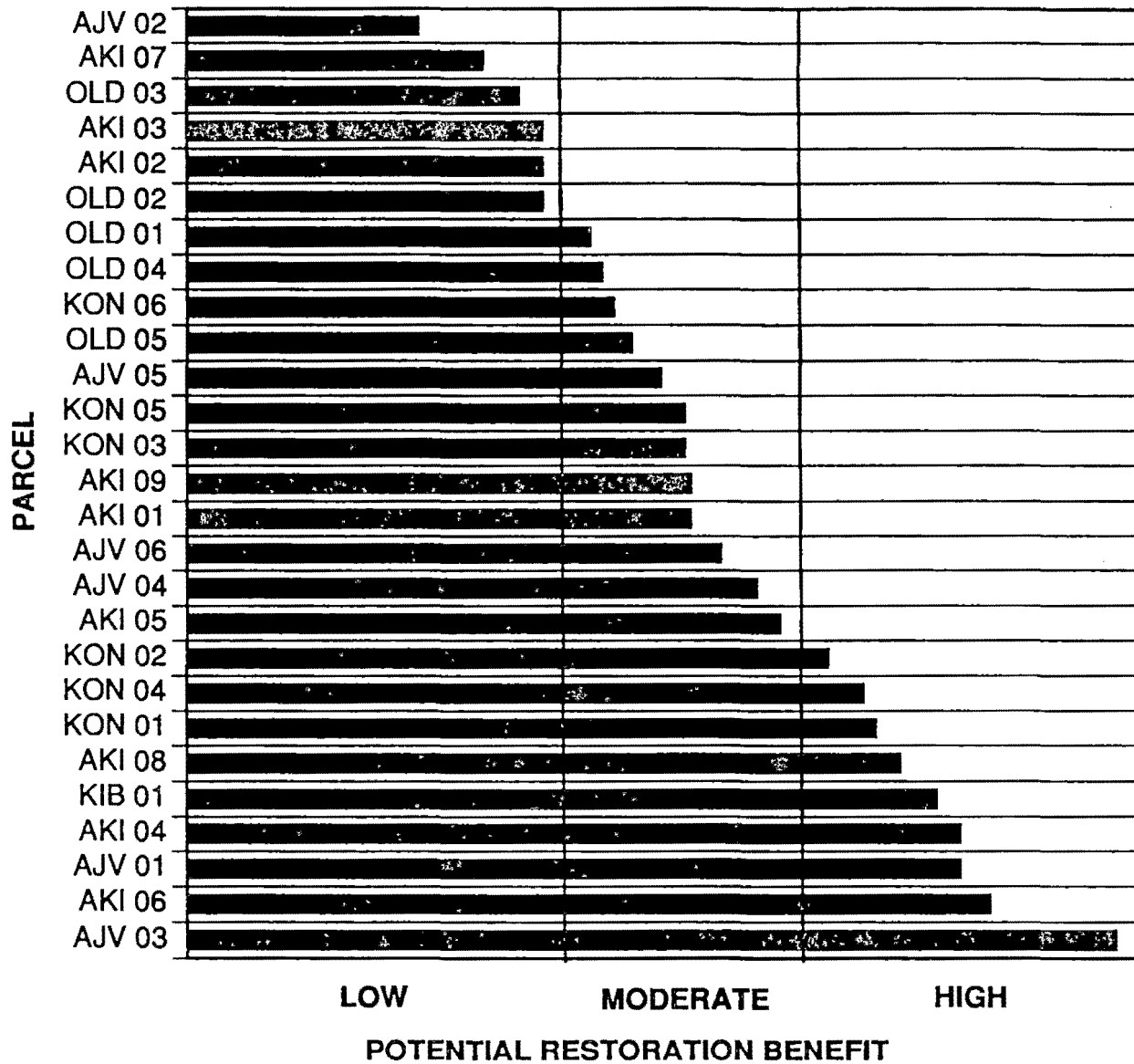
LARGE PARCEL EVALUATION and RANKING KODIAK REGION

PARCEL #	PARCEL NAME	REGION*	RANK	LANDOWNER	ACREAGE
AJV 03	Pauls/Laura Lake	KOD	High	Afognak Joint Venture	27,100
AKI 06	North Olga Bay	KOD	High	Akhiok Kaguyak	16,900
AJV 01	Shuyak Strait	KOD	High	Afognak Joint Venture	13,400
AKI 04	Aliulik Peninsula	KOD	High	Akhiok Kaguyak	34,300
KIB 01	Shuyak Island	KOD	High	Kodiak Island Borough	27,900
AKI 08	Upper Station Lakes	KOD	High	Akhiok Kaguyak	15,600
KON 01	Brown's Lagoon	KOD	High	Koniag	9,900
KON 04	Karluk River	KOD	High	Koniag	28,200
KON 02	Uyak Bay	KOD	High	Koniag	7,000
AKI 05	Sulua/Portage Bays	KOD	Moderate	Akhiok Kaguyak	8,200
AJV 04	Paramanof Peninsula	KOD	Moderate	Afognak Joint Venture	56,700
AJV 06	Malina Peninsula	KOD	Moderate	Afognak Joint Venture	27,300
AKI 01	Kaiugnak Bay	KOD	Moderate	Akhiok Kaguyak	4,900
AKI 09	Sukhoi/Kempff Bays	KOD	Moderate	Akhiok Kaguyak	15,900
KON 03	Larsen Bay	KOD	Moderate	Koniag	22,400
KON 05	Halibut Bay	KOD	Moderate	Koniag	21,900
AJV 05	Inner Malina Bay	KOD	Moderate	Afognak Joint Venture	12,700
OLD 05	Three Saints Bay	KOD	Moderate	Old Harbor	5,300
KON 06	Sturgeon River	KOD	Moderate	Koniag	22,400
OLD 04	Barling Bay	KOD	Moderate	Old Harbor	4,600
OLD 01	Kiliuda Bay	KOD	Moderate	Old Harbor	9,500
AKI 02	Kiavak Bay	KOD	Low	Akhiok Kaguyak	4,200
AKI 03	Jap/Kaguyak Bays	KOD	Low	Akhiok Kaguyak	12,400
OLD 02	Sitkalidak Strait	KOD	Low	Old Harbor	8,000
OLD 03	Midway Bay	KOD	Low	Old Harbor	7,300
AKI 07	Olga Bay Narrows	KOD	Low	Akhiok Kaguyak	15,200
AJV 02	Delphin Point	KOD	Low	Afognak Joint Venture	2,100

*REGION: KEN/Kenai, KON/Kodiak, PWS/Prince William Sound

**Parcels; Part of EYA 11, Core Parcels (3)

Figure 4: COMPREHENSIVE PARCEL ANALYSIS - KODIAK REGION



PARCEL EVALUATION & RANKING

by

LANDOWNER

LARGE PARCEL EVALUATION and RANKING LANDOWNER SUMMARY

PARCEL #	PARCEL NAME	REGION*	RANK	LANDOWNER	ACREAGE
AJV 03	Pauls/Laura Lake	KOD	High	Afognak Joint Venture	27,100
AJV 01	Shuyak Strait	KOD	High	Afognak Joint Venture	13,400
AJV 04	Paramanof Peninsula	KOD	Moderate	Afognak Joint Venture	56,700
AJV 06	Malina Peninsula	KOD	Moderate	Afognak Joint Venture	27,300
AJV 05	Inner Malina Bay	KOD	Moderate	Afognak Joint Venture	12,700
AJV 02	Delphin Point	KOD	Low	Afognak Joint Venture	2,100
AKI 06	North Olga Bay	KOD	High	Akhiok Kaguyak	16,900
AKI 04	Aliulik Peninsula	KOD	High	Akhiok Kaguyak	34,300
AKI 08	Upper Station Lakes	KOD	High	Akhiok Kaguyak	15,600
AKI 05	Sulua/Portage Bays	KOD	Moderate	Akhiok Kaguyak	8,200
AKI 01	Kaiugnak Bay	KOD	Moderate	Akhiok Kaguyak	4,900
AKI 09	Sukhoi/Kempff Bays	KOD	Moderate	Akhiok Kaguyak	15,900
AKI 02	Kiavak Bay	KOD	Low	Akhiok Kaguyak	4,200
AKI 03	Jap/Kaguyak Bays	KOD	Low	Akhiok Kaguyak	12,400
AKI 07	Olga Bay Narrows	KOD	Low	Akhiok Kaguyak	15,200
CHE 02	Jackpot Bay	PWS	High	Chenega	12,100
CHE 01	Eshamy Bay	PWS	High	Chenega	7,900
CHE 09	Northwest Evans Island	PWS	Moderate	Chenega	6,200
CHE 04	Northwest Chenega Island	PWS	Moderate	Chenega	7,300
CHE 03	Granite/Ewan/Paddy Bays	PWS	Moderate	Chenega	15,000
CHE 08	Flemming Island	PWS	Low	Chenega	1,700
CHE 06	South Knight Island	PWS	Low	Chenega	5,400
CHE 05	Southeast Chenega Island	PWS	Low	Chenega	8,300
CHE 11	Pleiades Islands	PWS	Low	Chenega	400
CHE 10	Sleepy Bay	PWS	Low	Chenega	3,700
CHE 07	Northeast Whale Bay	PWS	Low	Chenega	1,500
CAC 02	Bay of Isles	PWS	Moderate	Chugach Alaska	10,800
CAC 05	Nuchek Island	PWS	Moderate	Chugach Alaska	800
CAC 04	South Latouche	PWS	Low	Chugach Alaska	1,600
CAC 01	Drier Bay	PWS	Low	Chugach Alaska	3,200
CAC 03	Central Latouche	PWS	Low	Chugach Alaska	12,900

*REGION: KEN/Kenai, KON/Kodiak, PWS/Prince William Sound

**These parcels are part of EYA 11 Core Parcels

LARGE PARCEL EVALUATION and RANKING LANDOWNER SUMMARY

PARCEL #	PARCEL NAME	REGION*	RANK	LANDOWNER	ACREAGE
ENB 06	James Lagoon	KEN	High	English Bay	3,800
ENB 02	Harris Peninsula	KEN	Moderate	English Bay	6,200
ENB 08	Port Chatham	KEN	Moderate	English Bay	15,700
ENB 01	Bear Cove	KEN	Low	English Bay	1,400
ENB 05	McArthur Pass	KEN	Low	English Bay	7,600
ENB 07	Beauty Bay	KEN	Low	English Bay	8,900
ENB 03	North Arm Nuka Bay	KEN	Low	English Bay	4,600
ENB 09	Dogfish Bay	KEN	Low	English Bay	14,700
ENB 04	Upper Paguna/Thunder Bay	KEN	Low	English Bay	5,900
ENB 10	English Bay River	KEN	Low	English Bay	15,400
EYA 02	Sheep Bay	PWS	High	Eyak	9,100
EYA 03	Windy Bay/Deep Bay	PWS	High	Eyak	7,100
EYA 01	Port Gravina	PWS	High	Eyak	3,400
EYA 11	Core Parcels (3)	PWS	Moderate	Eyak	13,700
EYA 04	Canoe Passage	PWS	Low	Eyak	3,700
EYA 05	Outer Sheep Bay	PWS	Low	Eyak	7,600
EYA 07	East Simpson Bay	PWS	Low	Eyak	3,300
EYA 06	West Simpson Bay	PWS	Low	Eyak	4,000
EYA 08	**Power Creek	PWS	Low	Eyak	4,800
EYA 09	**Eyak Lake	PWS	Low	Eyak	5,100
EYA 10	**Eyak River	PWS	Low	Eyak	3,800
EYA 13	Orca Narrows/Nelson Bay	PWS	Low	Eyak	4,600
EYA 12	Rude River	PWS	Low	Eyak	6,900
KIB 01	Shuyak Island	KOD	High	Kodiak Island Borough	27,900
KON 01	Brown's Lagoon	KOD	High	Koniag	9,900
KON 04	Karluk River	KOD	High	Koniag	28,200
KON 02	Uyak Bay	KOD	High	Koniag	7,000
KON 03	Larsen Bay	KOD	Moderate	Koniag	22,400
KON 05	Halibut Bay	KOD	Moderate	Koniag	21,900
KON 06	Sturgeon River	KOD	Moderate	Koniag	22,400

*REGION: KEN/Kenai, KON/Kodiak, PWS/Prince William Sound

**These parcels are part of EYA 11 Core Parcels

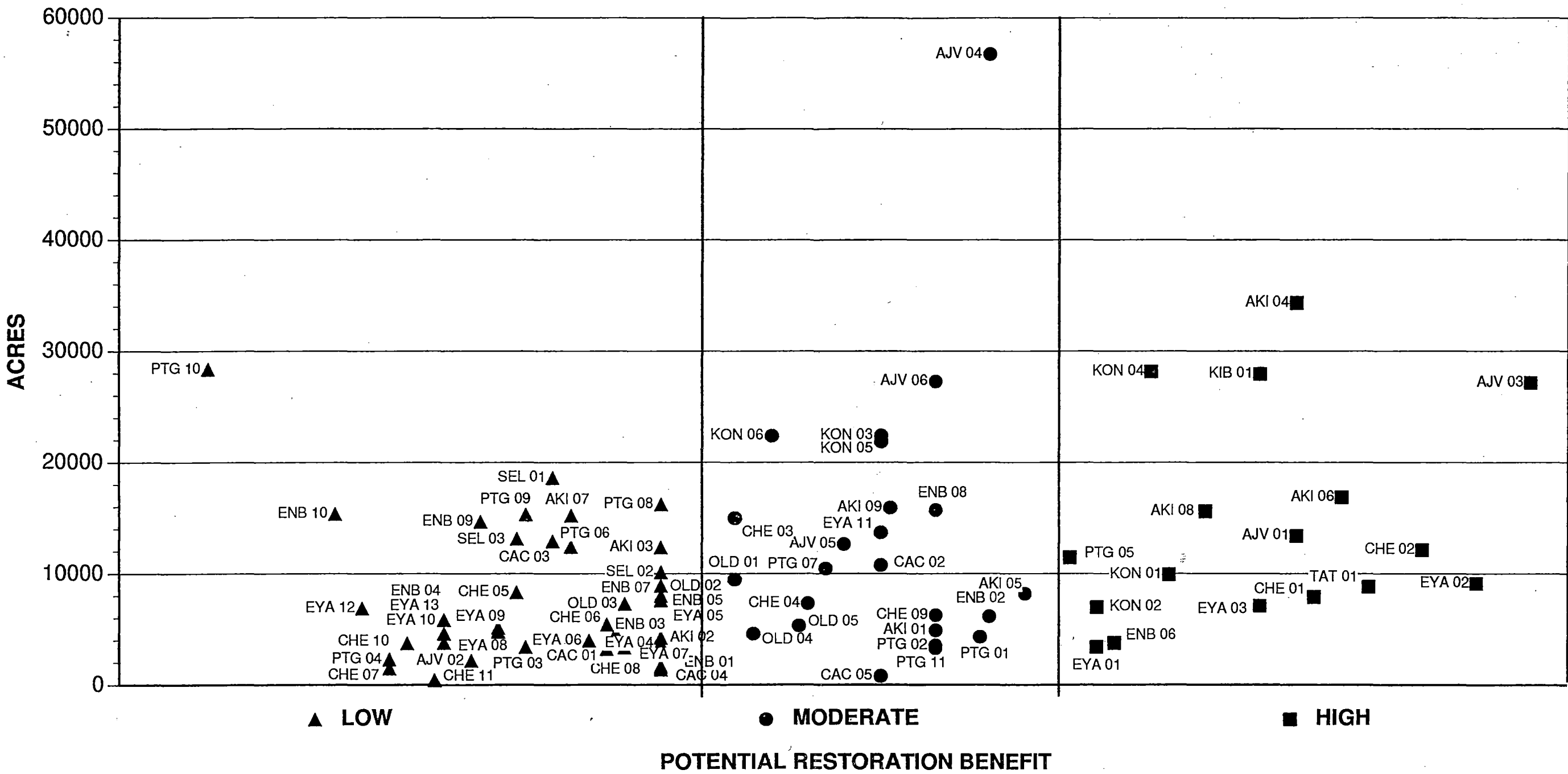
LARGE PARCEL EVALUATION and RANKING LANDOWNER SUMMARY

PARCEL #	PARCEL NAME	REGION*	RANK	LANDOWNER	ACREAGE
OLD 05	Three Saints Bay	KOD	Moderate	Old Harbor	5,300
OLD 04	Barling Bay	KOD	Moderate	Old Harbor	4,600
OLD 01	Kiliuda Bay	KOD	Moderate	Old Harbor	9,500
OLD 02	Sitkalidak Strait	KOD	Low	Old Harbor	8,000
OLD 03	Midway Bay	KOD	Low	Old Harbor	7,300
PTG 05	Delight/Desire Creeks	KEN	High	Port Graham	11,500
PTG 01	Upper Aialik	KEN	Moderate	Port Graham	4,300
PTG 02	Northwest Lagoon/Cup Cove	KEN	Moderate	Port Graham	3,500
PTG 11	Chugach Island	KEN	Moderate	Port Graham	3,300
PTG 07	Shelter Cove/Yalik Bay	KEN	Moderate	Port Graham	10,500
PTG 09	Windy/Chugach Bays	KEN	Low	Port Graham	15,300
PTG 08	Rocky Bay	KEN	Low	Port Graham	16,200
PTG 06	Surprise Bay/Quartz Bay	KEN	Low	Port Graham	12,400
PTG 03	Sandy Bay/Paguna Arm	KEN	Low	Port Graham	3,400
PTG 04	Black Bay	KEN	Low	Port Graham	2,300
PTG 10	Port Graham Uplands	KEN	Low	Port Graham	28,400
SEL 02	Barbara Creek	KEN	Low	Seldovia	10,100
SEL 01	Seldovia Bay	KEN	Low	Seldovia	18,600
SEL 03	Jakalof Bay	KEN	Low	Seldovia	13,100
TAT 01	Bligh Island	PWS	High	Tatitlek	8,800

*REGION: KEN/Kenai, KON/Kodiak, PWS/Prince William Sound

**These parcels are part of EYA 11 Core Parcels

Figure 6: COMPREHENSIVE HABITAT PROTECTION PROCESS - LARGE PARCEL ANALYSIS
RANK / ACREAGE



PARTICIPANTS/EXPERTS/REVIEWERS

NAME	SPECIALTY	AFFILIATION
Andres, Brad	Shorebird Biology	US Fish & Wildlife Service, Migratory Bird Management
Ballachey, Brenda	Sea Otter Biology	US Fish & Wildlife Service, AK Fish & Wildlife Research Center
Barnhart, Jeff	Finfish, River Otters	Alaska Department of Fish & Game, Habitat Division
Bittner, Judy	Archaeology	Alaska Department of Natural Resources, Office of History and Archaeology
Brady, James	Finfish	Alaska Department of Fish & Game, Commerical Fish Division
Brock, Greg, PhD	Biologist, Administrator	Florida Department of Natural Resources, Land Acquisition Planning, Conservation and Recreation Lands Program
Brown, Ben, PhD	Ecosystem Conservation Planning	The Nature Conservancy Director, Science and Stewardship, Major Projects The Gray Ranch
Bucher, Wes	Commercial Fish Salmon, Herring	Alaska Department of Fish & Game Commercial Fish Division
Crowe, Tom	Harlequin Ducks	Alaska Department of Fish & Game, Wildlife Conservation Division
Dale, Joan	Archaeology	Alaska Department of Natural Resources, Office of History and Archaeology
DeGange, Anthony	Sea Otter Biology	US Fish & Wildlife Service, Ecological Services
Fall, Jim	Subsistence	Alaska Department of Fish & Game, Subsistence Division
Gerlach, Tom	Seabirds	US Fish & Wildlife Service, Division of Realty
Hanemann, Michael	Economics	Consultant
Holland, Clair	Wilderness/Recreation Kodiak	Alaska Department of Natural Resources, Division of Parks
Lewis, Jon	Harbor Seals	Alaska Department of Fish & Game, Wildlife Conservation Division
Mattson, John, PhD	Archaeology	US Forest Service, Chugach National Forest

PARTICIPANTS/EXPERTS/REVIEWERS

NAME	SPECIALTY	AFFILIATION
Miraglia, Rita	Subsistence	Alaska Department of Fish & Game, Subsistence Division
Mishler, Craig	Subsistence	Alaska Department of Fish & Game, Subsistence Division
Muehlenhardt, Gary	GIS, Acquisition Planning, Wildlife Biology	US Fish & Wildlife Service, Division of Realty Land Acquisition Planning
Namtvedt, Tom	Fish Biology	USFS, ADF&G Commercial Fish Division, PWSAC Planner
Patten, Sam	Harlequin Ducks	Alaska Department of Fish & Game, Wildlife Conservation Division
Planchon, Steve	Realty and Land Management Transactions	The Nature Conservancy Conservation Programs Director
Randall, Richard	Fish Biology	ADF&G, Retired Commercial Fish Manager, Cordova and Southcentral Areas
Reger, Doug	Archaeology	Alaska Department of Natural Resources, Office of History and Archaeology
Rice, Bud	Seabirds, Bald Eagles, Marine Mammals	Kenai Fjords National Park National Park Service, Regional Office
Richardson, Jim	Recreation	Consultant
Rubin, Todd	Remote Sensing	Consultant
Ruffner, Donna	Land Management Planning	Florida Department of Natural Resources Land Acquisition Planning Conservation and Recreation Lands Program
Sanger, Gerry	Seabird Biology	US Fish & Wildlife Service, Migratory Bird Management
Seitz, Jody	Subsistence	Alaska Department of Fish & Game, Subsistence Division
Stanek, Ron	Subsistence	Alaska Department of Fish & Game, Subsistence Division
Sundet, Kathrin	Finfish	Alaska Department of Fish & Game, Habitat Division
Zweifelhoffer, Denny	Seabirds, Bald Eagles	US Fish & Wildlife Service, Kodiak National Wildlife Refuge

THE NATURE CONSERVANCY WORKSHOP PARTICIPANTS

NAME	EXPERTISE	AFFILIATION	REGION
Albert, Steve	Habitat Biology	ADF&G, Habitat Division, Anchorage	Eyak, Fidalgo/Gravina, Afognak
Andres, Brad	Black Oystercatcher	USFWS, Anchorage	Montague Island
Ballachey, Brenda	Sea Otters	USFWS, Anchorage	Prince William Sound
Bowman, Tim	Bald Eagle	USFWS, Juneau	Prince William Sound
Braund, Steve	Subsistence	Consultant, Anchorage	
Burger, Alan	Marbled Murrelet	British Colombian Biologist	
Cody, Mary	Marbled Murrelet	USFWS	Afognak
Dorhoff, Angie	Sea Otters	USFWS	
Erikson, David	Common Murre, Harlequin Duck	Consultant, Homer	Kachemak Bay
Faro, Jim	River Otter	ADF&G, Soldotna	
Ford, Don	Wilderness/Recreation	National Outdoor Leadership School	Prince William Sound
Frost, Kathy	Pacific Harbor Seal	ADF&G, Fairbanks	
Fry, Mike	Marbled Murrelet, Harlequin Duck, Pigeon Guillemot, Bald Eagle, Common Murre, Black Oystercatcher	University of California, Davis	Kachemak Bay, Kenai Fjords
Hamer, Thomas	Marbled Murrelet	Consultant, Washington State	
Hennig, Steve	Wilderness/Recreation	USFS, Anchorage	Prince William Sound
Hensel, Dick		Consultant, Anchorage	Afognak, Kodiak
Holbrook, Ken	Black Oystercatcher, Cutthroat Trout, Marbled Murrelet, Sea Otter	USFS, Anchorage	Prince William Sound
Johannsen, Neil	Wilderness/Recreation	ADNR, Division of Parks	
Juday, Glenn	Old Growth	WOFA, Fairbanks	Prince William Sound
Knecht, Rick	Subsistence	Kodiak Native Association	Afognak, Kodiak
Kuletz, Kathy	Marbled Murrelets	USFWS, Anchorage	Prince William Sound, Kachemak Bay

THE NATURE CONSERVANCY WORKSHOP PARTICIPANTS

NAME	EXPERTISE	AFFILIATION	REGION
Lemon, Moira	Pigeon Guillemot	Biologist, British Columbia	
Lensik, Cal	Seabirds	Consultant	
Lethcoe, Nancy	Wilderness/Recreation	AK Wilderness Recreation Tourism Assoc.	Prince William Sound
McAllister, Mike	Marbled Murrelet	Naturalist	
McBride, Mike		Naturalist	Kachemak Bay
McCarron, Susan	Cutthroat Trout	ADF&G, Anchorage	Prince William Sound
Meiners, Al	Wilderness/Recreation	ADNR, Division of Parks	
Million, Marsha	Sea Otters	Naturalist, Homer	Kachemak Bay
Miraglia, Rita	Subsistence	ADF&G, Anchorage	
Muehlenhardt, Gary	USFWS Acquisition Priorities	USFWS	Kodiak
Oakley, Karen	Pigeon Guillemot	USFWS, Anchorage	Naked Island
Olesiuk, Peter	Pacific Harbor Seals	Department of Ocean Fisheries, British Columbia	
Podolsky, Richard	Harlequin Duck, Marbled Murrelet	Island Institute, New York	
Rice, Bud	Wilderness/Recreation	NPS, Anchorage	Kenai Fjords
Sharr, Sam	Pink Salmon	ADF&G, Cordova	Prince William Sound
Sundberg, Kim	Marbled Murrelet	ADF&G, Anchorage	Prince William Sound
Twardock, Paul	Wilderness/Recreation	National Outdoor Leadership School	Prince William Sound
Weiland, Ann	Pigeon Guillemot, Cutthroat Trout, Harlequin Duck, Marbled Murrelet, Sea Otter, River Otter, Pacific Harbor Seal	Naturalist	Kachemak Bay
West, George	Bald Eagles, Birds-General	Ornithologist	Kachemak Bay

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COMPREHENSIVE HABITAT PROTECTION PROCESS

EVALUATION

Berg, Catherine	Fish & Wildlife Biologist	U.S. Fish & Wildlife Service
Grunblatt, Jess	Analyst Programmer	Alaska Department of Natural Resources
Holbrook, Ken	Fish Biologist	U.S. Forest Service
Kuwada, Mark	Habitat Biologist	Alaska Department of Fish & Game
Sundberg, Kim	Habitat Biologist	Alaska Department of Fish & Game
Weiner, Art, PhD	Natural Resources Manager	Alaska Department of Natural Resources

TECHNICAL SUPPORT

Fries, Carol	Natural Resources Manager	Alaska Department of Natural Resources
Mortenson, Dorothy	Analyst Programmer	Alaska Department of Natural Resources
Tam, Jean	Analyst Programmer	Alaska Department of Natural Resources
Zeiner, Kelly	Analyst Programmer	Alaska Department of Natural Resources

DATA PROCESSING SUPPORT

Bruyere, Ron	CACI	Exxon Valdez Oil Spill Restoration
Iseah, Barbara	CACI	Exxon Valdez Oil Spill Restoration
Williams, Rebecca	CACI	Exxon Valdez Oil Spill Restoration
Womac, Cherri	CACI	Exxon Valdez Oil Spill Restoration

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DISCUSSION PAPER
Who Conducts Negotiations for Habitat Acquisitions
Exxon Valdez Restoration Project

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BACKGROUND AND RECOMMENDATION

EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

The Trustee Council at its August 16, 1993 meeting requested the Restoration Team to prepare a discussion paper concerning who should conduct negotiations for habitat protection acquisitions. The current approach for the imminent threat process has been to assign individual Trustee agencies with the lead responsibility for conducting negotiations for priority parcels. This approach is described in Option A below. Considering: 1) the experience with negotiations/acquisitions for Kachemak Bay, Seal Bay, and Eyak, 2) the impending replacement of the imminent threat process with a more comprehensive habitat evaluation and acquisition process, 3) the recommendations from a habitat acquisition peer review workshop held in June, and 4) the anticipated increase in the number and complexity of future habitat acquisition negotiations, the Restoration Team recommends that the Trustee Council approve Option B, the formation of a negotiation/acquisition team staffed by Federal and State personnel.

We have attempted to analyze the costs associated with each of the options that are presented below. On the basis of current information it does not appear that the costs associated with Options A through C would differ dramatically; each are in the range of \$400,000 to \$600,000 annually and include costs for conducting negotiations; administering and approving appraisals, hazardous materials surveys, and title reports; travel; office space; utilities; supplies; and equipment. They do not include the actual costs of conducting necessary appraisals, title reports, hazardous materials surveys, boundary surveys, closing costs, and the purchase price. It is assumed that these costs will come out of the Habitat Protection Fund. The cost of each of these approaches to the restoration program could be less depending on the ability of the participating agencies to reprogram existing staff and/or absorb negotiation/acquisition costs within their existing budgets. Option D appears to result in minimal administrative costs for conducting negotiations and acquisitions. This option is dependent upon the private non-profit entities ability to negotiate acquisitions at less than fair market value.

OPTIONS

A. Negotiation by the appropriate management agency.

Under this option the agency or group who would receive the property interests would conduct negotiations while cooperating with the Habitat Protection Work Group, and process acquisitions authorized by the Trustee Council. The Trustee Council would need to designate the lead agency or group who would likely receive the interest prior to the start of negotiations. Existing staff, new hires or detailed personnel would do the work. While some agencies would likely use existing staff, others would have to bring

in new staff. Consequently, timing for starting and maintaining negotiations would vary by agency.

Pro: Each agency/group has different policies and procedures for acquiring land or lesser rights. By having each agency/group who would receive property interests do their own negotiating and purchasing, these policies/procedures would be followed. This would ensure that adequate title and/or interests are acquired to meet agency specific requirements. Agencies/groups would be able to use private entities (third parties) for acquisitions as appropriate.

Con: Because acquisition projects would be assigned to multiple agencies, there would be problems in assuring consistent approaches to negotiations throughout the spill area. Confusion may arise amongst sellers over whether negotiators represent the agency or the Trustee Council. Communication between the various negotiators, restoration staff including the Habitat Protection Working Group, and other affected agencies would be more difficult. In addition, there is the potential for conflicting commitments between agency duties and Trustee Council responsibilities.

B. Negotiation by Negotiation/Acquisition Team.

Under this option a negotiation/acquisition team would be established with staff hired or assigned from State and Federal agencies. Staff would work for the Trustee Council, perhaps under the direction of the Executive Director, coordinating with the Habitat Protection Work Group. This approach was strongly recommended by peer reviewers participating in the habitat protection workshop last June. While some agencies could likely use existing staff, others may need to bring in new staff. Consequently, full staffing of the office could take several months.

Pro: This option would provide consistency in dealing with landowners. Staff would deal with a variety of situations and would develop particular knowledge and expertise in acquiring habitat for restoration. The varying flexibility of the various agencies to acquire property interests may also offer opportunities that would not be available to individual agencies operating alone. This approach would help ensure that lands identified as high priority for habitat protection would be pursued more aggressively and more competitively than if individual agencies were dealing with specific parcels. Additionally, this approach ensures that property rights are acquired in a manner that meets agency specific requirements. This option would allow the use of private entities, as appropriate.

Con: Due to different agency policies and needs, it may be necessary to have representation by several staff representing their respective agencies. By designating a negotiation/acquisition team, there may be a perception that an additional bureaucratic entity is being created.

C. Negotiation services by a private entity - Contract.

Under this option a private entity would conduct negotiations and other acquisition steps. This entity would be under contract to the Trustee Council to provide such services. Any such private entity would need to have experience in acquisitions of property rights for conservation purposes, and have worked with land owners and State and Federal agencies in such acquisitions. The Request for Proposals (RFP) would have to be advertised and a contract awarded. Consequently, negotiations could only begin approximately four months from the time a decision is made to use a third party contract.

Pro: All negotiations would be handled in a consistent manner by a single entity. Expertise in land acquisitions for restoration would be developed. The agency staff required to purchase land interests would be minimized. Having a single group responsible for negotiations should increase competition among landowners.

Con: The private entity would have to learn and comply with all Federal and State acquisition requirements, as they would be acting as agents for these government bodies; thereby losing some flexibility. Oversight would be required to ensure that appropriate parcels and interests needed for restoration purposes were being acquired, and that the title of acquired property interests was acceptable to the receiving agencies.

Note: Federal agencies have established a history of using private non-profit conservation groups as cooperators in federal acquisitions. Private entities have only rarely been contracted to provide realty services, and thus act as agents for the Federal government. The role of private entities in Federal acquisitions is currently controversial and dynamic. Existing and evolving Federal guidelines on this subject may prohibit or limit their use in Federal acquisitions for EVOS restoration.

D. Negotiation by a private non-profit entity - Cooperator.

Under this option letters of intent would be secured between a non-profit conservation group and the affected agencies. Pursuant to the letters of intent the non-profit, as an independent agent, would conduct negotiations with landowners and execute option agreements for later assignment to agencies or groups designated by the Trustee Council. The non-profit would secure options at less than fair market value. The cost to the settlement funds would be the option price plus the costs to the non-profit, as well as the administrative costs the agencies would incur to approve the appraisals, hazardous materials surveys, title reports, etc. Any such private non-profit entity would need to have experience in acquisition of property rights for conservation purposes, and have worked with landowners and State and Federal agencies in such acquisitions. The non-profit could begin negotiations as soon as a letter of intent is signed by an agency (or Trustee Council) and the non-profit. This option could be part of either Option A or B or the Trustee Council could decide to use this approach for all negotiations and acquisitions. However, that decision would have to be made up front before the lead agencies or the project office could begin negotiations.

Pro: All negotiations could be handled in a consistent manner by a single entity. Expertise in land acquisitions for restoration would be developed. The agency staff (and costs) required to purchase land interests would be minimized. A private non-profit entity can have more latitude in dealing with private landowners, and can address such subjects as tax advantages with sellers. Having a single group responsible for negotiations should increase competition among landowners.

Con: Careful oversight would be required to ensure that appropriate parcels and interests needed for restoration purposes are acquired, and that the title of acquired interests will be acceptable to the receiving agencies. It may be perceived that the Trustee Council and agencies are not treating landowners fairly, because properties would be purchased at less than fair market value. Should landowners choose not to sell at less than fair market value, the viability of this option would be reduced unless the Trustee Council agreed to pay the negotiation/acquisition costs of the non-profit.

Note: Federal agencies have established a history of using private non-profit conservation groups as cooperators in Federal acquisitions. The role of private entities in Federal acquisitions is currently controversial and dynamic. Existing and evolving Federal guidelines on this subject may prohibit or limit their use in Federal acquisitions for EVOS restoration.

AGENDA

A Workshop on Designing Ecosystem Studies of Prince William Sound

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Afternoon of December 4, 1993

2:00 PM Welcome to the symposium. (**James Ayers**, Executive Director, Trustee Council Restoration Office)

EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

2:10 PM Brief Introductory remarks, introduction of the Trustee,
(**Bob Spies**)

2:15 PM Opening remarks by a trustee (**Rosier**)

2:30 PM Overview of the Prince William Sound ecosystem
(**Juday**)

3:00 PM Definitions of problems in Prince William Sound and
hypothesized causes (Steering Committee, 15 min.
each)

A. PWS Fisheries Ecosystem Research
Planning Group (**Torie Baker**)

B. NOAA (**Wertheimer**)

C. ADF&G (**J. Koenings**)

D. USFWS (**E. Robinson-Wilson**)

4:00 PM Break

4:30 PM Review of research approaches (**Peterson and Peer
Reviewers**)

5:30 PM Public comment

6:30 PM Reception sponsored by Prince William Sound Science Center,
Cordova Area Fisherman's Union, Cordova Area Mariculture
Association, Prince William Sound Aquaculture Association

Morning of December 5, 1993

7:15 AM Continental breakfast

8:00 AM Introduction of the facilitators (**Bob Spies, Dave Bernard**)

8:10 AM A proposed ecosystem studies plan for fisheries: PWS
Fisheries Ecosystem Research Planing Group

Introduction to the PWS fisheries ecosystem research plan
(Sharr, ADF&G)

Long and short-term climate-driven effects on fisheries
production in the Gulf of Alaska and PWS (Salmon, PWSSC)

Intertrophic energy flow at the larval fish stage (Cooney, U of A)

Sound ecosystem assessment--a trophic interaction model for
PWS (Patrick, Univ. Maryland)

9:30 AM Break

9:30 AM Critical Peer Review (Bob Spies, Pete Peterson. Peer
Reviews, PWS fisheries ecosystem group)

12:00 N A working lunch will be made available

1:30 PM Public comment

2:00 PM Introduction of the working groups, charges to the groups
(Bernard)

2:30 PM Break

Afternoon of December 5, 1993

3:00 PM Convene the following working groups, with designated
discussion leaders:

A. Physical Oceanography (Royer)

B. Primary and secondary processes (McRoy)

C. Fish: dynamics, energetics and foraging (Mundy)

B. Birds (Dave Irons)

E. Mammals (Lowry)

5:30 PM Comments from others

6:00 PM Dinner break

7:30 PM Reconvene working groups

9:00 PM Adjourn working groups

Morning of December 6, 1993

8:00 AM Panel Discussion (**Group Leaders, David Bernard**)

Summaries of working groups - 15 min. each (**Group Leaders**)

9:30 AM

Preliminary summary of peer review comments (**Pete Peterson**)

10:00 AM

Linkages between groups (**Facilitator, Group Leaders, Reviewers**)

10:30 AM

Design and implementation of ecosystem research (**Group Leaders, Peer Reviewers, Steering Committee**)

11:30 AM

Public comment

NEWS



U.S. SENATOR
FRANK MURKOWSKI
RECEIVED
NOV 30 1993
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
OF ALASKA
ADMINISTRATIVE RECORD

For Immediate Release Contact: Chuck Kleeschulte or Cindi Bookout
Nov. 29, 1993 O(202) 224-9306; H338-2414; 224-8767

MURKOWSKI INTRODUCES SPILL FUND ENDOWMENT PLAN

ANCHORAGE -- Saying it's important to guarantee a source of funds for long-term research, Alaska Sen. Frank Murkowski has introduced legislation creating a Stewardship Endowment in the aftermath of the Exxon Valdez oil spill.

Murkowski, before leaving on his annual Asian trade mission, introduced legislation to allow the trustees of the Exxon Valdez oil spill settlement fund to set some of the funds aside in an endowment with interest from the endowment to provide a secure source of funding for restoration-related projects such as long-term research needed after the 1989 Prince William Sound oil spill.

"Placing some of the funds in an endowment so that they can grow even larger for future use may be the best way to ensure that there will be funds available in the next century to combat any long-term affects of the spill," said Murkowski.

Murkowski's bill allows the trustees to decide how much, if any, of the \$900 million civil settlement they want to place in the endowment, or mini-Permanent Fund. The money would remain in the endowment until the trustees unanimously vote to remove it. The goal is to place some of the money into a fund so that annual interest and earnings can be used to fund restoration activities, such as scientific studies and wildlife restoration, long after the last of the settlement funds are received eight years from now.

So far, the trustees have received about \$340 million of the settlement funds -- about \$200 million having already been spent. Under terms of the 1991 settlement Exxon will be paying the state-federal trustees about \$70 million a year for the next eight years.

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DEPARTMENT OF
CONSERVATION

Murkowski: Spill Endowment Plan 2-2-2
Nov. 29, 1993

"The catastrophic failure of the multi-million-dollar Prince William Sound herring and pink salmon fisheries this year raises the issues of restoration and enhancement even further. Scientists have been unable to explain the disastrous disappearance of herring and pink salmon from the Sound in 1983. They lack an understanding of the Sound's natural cycles, of water temperatures and of the food chain," said Murkowski, noting that the endowment would provide a source of future research money should similar problems arise next decade.

Murkowski said his bill simply encourages the trustees to manage the settlement moneys for the long-term health of the sound. He noted that about two-thirds of the public comments on the trustees' draft Exxon Valdez Oil Spill Restoration Plan favored creation of some type of endowment fund.

He said he would be working toward passage of the bill when Congress reconvenes in January.

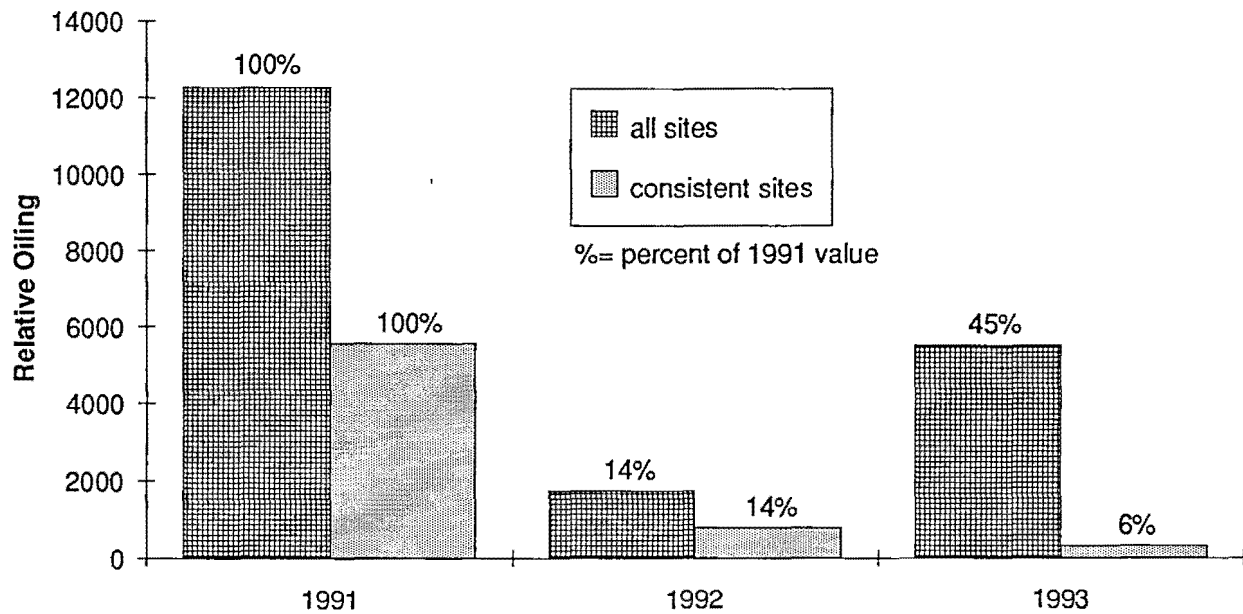
.30-

MEDIA NOTE: Video of Senator Murkowski explaining the purpose his proposal for trustees of the Exxon Valdez oil spill fund to be able to save some of the funds in a Stewardship Endowment and of his Asian trip will be available today via satellite. The 5-minute feed will be sent by satellite from 2 to 2:05 p.m. today on Galaxy 4, downlink 4160, channel 33. The feed will be repeated in the Governor's window at 3:30 p.m. -- this is a correction of a previous notice. Audio of the feed will be available on the Republican Conference audio link. For an audio actuality please call 1-800-645-1267. The line will pick up without ringing. Press 3 at the first menu. Then press 2 to hear Senator Murkowski.

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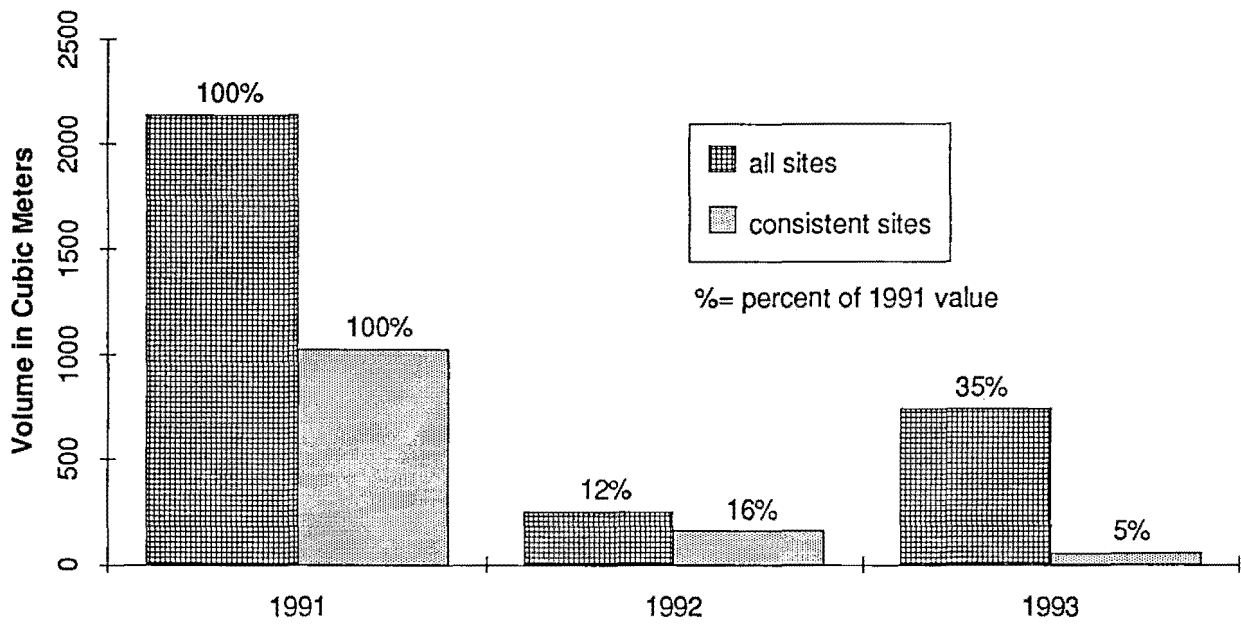
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

Weighted Oiled-Sediment Volume of LOR to OP

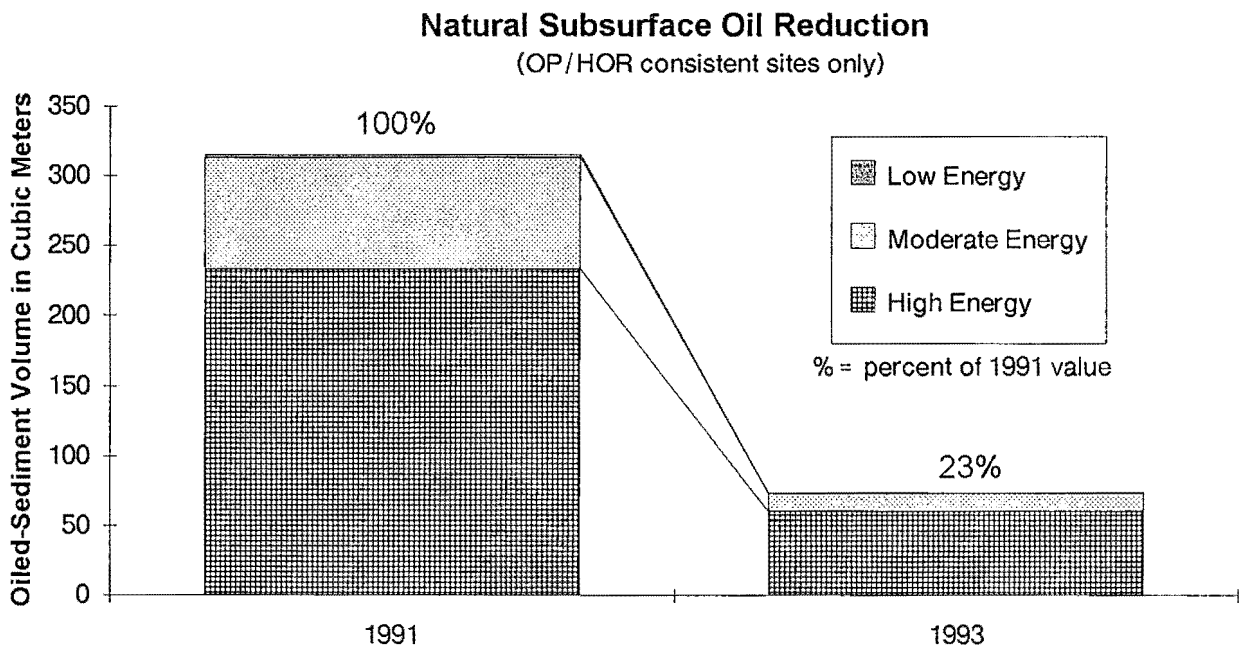


A

Oiled-Sediment Volume of OP/HOR



(B)



(F)

Exxon Valdez Oil Spill Trustee Council

Restoration Office

645 G Street, Suite 402, Anchorage, Alaska 99501

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



To: Trustee Council

From: Dave R. Gibbons *dig*
Interim Administrative Director

Date: November 26, 1993

Subj: Interim Project Funding for 1994

RECEIVED
NOV 30 1993

EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

On September 17, 1993, you approved interim funding through January 31, 1994, for eight 1994 work projects. Some of these projects only received partial funding for that period. Full funding for projects 94064 and 94166 is now being requested. Interim funding for project 94159 is also being requested. This project was withdrawn at the September 17, 1993 Trustee Council meeting with the understanding it would be brought back to you at your next meeting. Funding for these three projects is needed prior to the final approval of a 1994 Work Plan to successfully implement these projects this fiscal year. Funding needs include:

- | | |
|--|----------------|
| 1. Project 94064 - Harbor Seals (ADF&G) | \$ 25,300 |
| Travel @ \$2,500 was funded in September, additional funding is needed to purchase satellite tags. | |
| 2. Project 94166 - Herring Spawn Deposition (NOAA) | 70,000 |
| ADF&G's portion was funded in September, the increased funding request in excess of the last September request is NOAA's portion for boat charter and laboratory set-up. | |
| 3. Project 94159 - Marine Boat Surveys (DOI) | <u>107,000</u> |
| Spring survey of marine birds and sea otters. | |
| Total | \$ 203,000 |

Trustee Agencies

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

Exxon Valdez Oil Spill Public Advisory Group

Actions Approved November 23, 1993

NOV 30 1993

1. The Public Advisory Group requests that the Trustee Council prepare a status report on approved projects and distribute it to the PAG from time to time. For example, what is the status of the Kodiak Archeological Repository project?
2. The Public Advisory Group requests information about the Trustee Council's comprehensive habitat evaluation and protection process and information about how many letters of interest went to landowners.
3. The Public Advisory Group requests that the Trustee Council release detailed information justifying past reimbursements, and any future reimbursement requests, of funds to State and Federal agencies. It is noted that at least 20% of the settlement funds went to reimbursements with little explanation as to what these expenses were.
4. The Public Advisory Group requests Trustee Council approve its officers for FY1994. The present officers were re-elected by unanimous vote to fill their positions for the next year: Chairperson: Brad Phillips, Vice-Chairperson: Donna Fischer.
5. The Public Advisory Group requests the Trustee Council consider the PAG recommendations regarding the establishment of an endowment to carry on restoration and related work past the year 2001 (see attached Endowment for Restoration and Monitoring of Injury from the Exxon Valdez Oil Spill).
6. The Public Advisory Group requests that the Trustee Council make the suggested changes to the Draft Restoration Plan and provide the additional information requested (see attached Recommendations for the November 17, 1993 Review Copy Draft Restoration Plan).
7. The Public Advisory Group recommends the Trustee Council use the principles identified in the attached "Statement of Some Principles for Evaluation of EVOS Work Plans and for Their Implementation" in evaluating work plans and that these principles be incorporated into the Restoration Plan.

ENDOWMENT FOR RESTORATION AND MONITORING OF INJURY FROM THE EXXON VALDEZ OIL SPILL

I. Purpose

The Endowment is established for the purposes of restoration, enhancement, or replacement of resources injured by the *Exxon Valdez* oil spill, restoration services dependent on those resources, and monitoring of the injured ecosystems to assess the effectiveness of restoration activities. The estimated recovery times for several injured species exceeds the duration of the Exxon payments. In addition, the natural variability in the injured ecosystems is large and poorly documented. Specific activities should include long-term restoration activities and those requiring initiation after 2001, monitoring of both specific restoration activities and ecosystem interactions through food webs and the natural dynamics of Prince William Sound and the Gulf of Alaska. Systematic study of the affected ecosystems is needed to assess the natural variability within the system and the degree the natural cycles are affecting the recovery of the injured resources and the services dependent on them. Activities supported by the endowment will be consistent with the EVOS Restoration Plan.

II. Relationship to Damaged Resources and Services

The environment of the northern Gulf of Alaska and the fish species in it display numerous inter-annual and inter-decadal cycles. A large part of the variation in water temperature can be accounted for by a 18.6 year cycle. The damage, restoration and recovery of damaged resources must be assessed in the context of this changing background. To fully understand the extent of injury and to facilitate recovery it is critical to understand the species in the context of the ecosystem they depend on for survival and recovery.

A. Pink Salmon, Herring and Sockeye Salmon

The pink salmon and herring returns of 1990-1993 are a good example of how poorly fisheries scientists and managers understand the factors controlling the health of these fish populations. Although the initial estimates of recovery times were short (2-3 years), current estimates, among those who believe there were population level effects, are a decade or more. It is highly likely that other factors have played a major role in the catastrophic pink salmon and herring returns to prince William Sound in 1993 besides damage from the oil spill. It will take a rigorous, systematic plan implemented over several years to untangle this ecosystem puzzle.

B. Birds (Black Oystercatchers, Murres, Harlequin Ducks, Marbled Murrelets, and Pigeon Guillemots)

While nesting habitat may be critical to some injured populations, such as marbled murrelets, the availability of quality food sources may be a limiting factor for species feeding at sea or in the intertidal. It is necessary to improve understanding of food webs and ecosystem

dynamics to enhance prospects of recovery. Predicated recovery times are expected to be long, on the order of decades. Therefore, necessary monitoring will extend beyond 2001.

C. Marine Mammals (Harbor Seals, Killer Whales and Sea Otters)

Harbor seals and Stellar sea lions have been experiencing a steady decline since before the oil spill. Numbers of killer whales outside Prince William Sound are not accurately known. Broad ecosystem studies and analysis of food webs are necessary in order to assess the health of these populations and the course of restoration. Although sea otter ecology is better understood, restoration will still be a long process requiring monitoring beyond 2001.

D. Services

1. Commercial, Sports and Subsistence Fishing. Commercial fishing, including fishermen, processors and non-profit aquaculture associations, were all injured by the oil spill. Some injury, such as loss of markets due to unpredictable returns, is impossible to accurately assess. Recovery from other injury should accompany recovery of commercial stocks.

2. Recreations Use and Tourism. Passive use of the oil spill affected area is highly dependent on the overall health of ecosystems. Increased understanding of the interdependence of the species in Prince William Sound and the northern Gulf of Alaska should enhance the recovery of use by all passive users.

III. Establishing the Endowment

The PAG did not reach a consensus on the amount of money that should be placed into an endowment or how money should be placed into an endowment--legal questions are left to government lawyers to sort out. Two specific options are (there could be other ways to accomplish the end goal):

The Endowment would be established over the course of the next eight years by encumbering \$30,000,000 per year from the civil settlement for immediate and long- range activities. Seven million dollars would be used in each of the eight years, with the remaining \$23,000,000 being placed in a restricted account to form an endowment. After the first eight years, when the Endowment's principal would be approximately \$184,000,000 plus earnings, the program would be supported by earnings from the endowment. *[PAG endowment subgroup discussed a limited duration for the endowment. The group felt the duration could be limited to approximately twice the length of major ecosystem cycles (14-19 years). With this limitation to 30-40 years the total funding for the endowment could be reduced.]*

OR

An endowment of \$100 million should be established to carry work forward beyond 2001.

IV. Managing the Endowment Fund

A. Investment

The Endowment funds would be held and invested by the University of Alaska Foundation according to the standards followed in investing the Foundation's other restricted funds. The UA Foundation has an excellent track record in managing investments -- out performing other State investments to a significant degree. Management fees would be limited to the commercially competitive rate.

B. Expenditures

Earnings from the fund would be used exclusively to support the purposes of the Endowment, and in accordance with the Endowment Activities Plan and the Administrative rules of the Endowment.

V. Organization and Process

The PAG did not attempt to develop a detailed organization or set of operating procedures for the endowment. The group did agree that the following general principles are important to the management of the endowment.

A. Management

The process must recognize the role of the EVOS Trustees as required by the consent decree. The process should minimize the establishment of new bureaucracy. The process should include regional marine research groups and local communities affected by the Exxon Valdez Oil Spill empowered to develop regional restoration plans and help evaluate specific research projects.

B. Restoration Planning

The endowment activities should be directed by a rolling restoration plan which is consistent with the overall EVOS Restoration Plan. The restoration program should take an ecosystem approach. The plan should look forward five to ten years and be up-dated every two years to assure the continued focus of restoration and monitoring activities. The plan should also set in perspective how the endowment investments relate to the other activities in the area which affect the recovery and restoration of the natural resources of the EVOS affected region, take into consideration the needs of the local communities, industries, and the broader citizen interests in the region and its ecosystem, and reflect sound resource management and scientific principles.

C. Restoration and Monitoring Project Review

Projects proposing either applied or basic research should be submitted for a two step review process; a review of how well the proposed research targets the priorities of the plan, and a scientific peer review. Scientific peer review should be done by an open peer review process using unpaid reviewers. The concept of a Chief Scientist is unnecessary and should be abandoned.

Exxon Valdez Oil Spill Public Advisory Group

Recommendations for the November 17, 1993
Review Copy Draft Restoration Plan

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EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

The following suggested changes were passed unanimously, except where noted otherwise.

1. Page 9, Habitat Acquisition and Protection paragraph, second and third sentence, change to read:

"On existing public land within the spill area, it may include recommendations for changing agency management practices. Protecting and acquiring land may minimize further injury to resources and services, and may allow recovery to continue unimpeded." **it is important to focus on lands within the spill area and some activities do not always cause further injury.**

2. Page 11, number 3, first two sentences, change to read:

"Primarily restoration activities will occur within the spill area. Only limited restoration activities outside the spill area, but within Alaska, may be considered under the following conditions:" **vote was 12 to 2 in favor**

and the second bullet, change to read:

"when the information acquired from research and monitoring activities outside the spill area will be significant for restoration or understanding injuries within the spill area." **the focus of effort should be within the spill area**

3. Page 11, number 7, change to read:

"Restoration projects will be subject to open, independent, uncompensated scientific review before Trustee Council approval." **a truly objective review will occur when no money changes hands, as is the case with most scientific peer review activities**

4. Page 11, number 8, change to read:

"Meaningful public participation in, and review of, restoration decisions will be actively solicited." **more active public involvement in planning and oversight is needed**

5. Page 12, number 1, fourth paragraph, second sentence change to read:

The ecosystem monitoring and research program will provide an understanding of the physical and biological interactions which affect an injured resource or service to facilitate more effective restoration and management." **more clearly explains the results**

6. Page 15, number 8, title, change to read:

"Meaningful public participation in, and review of, decisions will be actively solicited." **see comment in number 4, above**

7. Page 16, number 9, last two sentences, delete. **do not want to encourage agency budget enhancement nor have them go beyond their legislative authorities**

8. Page 20, second paragraph, first sentence, change to read:

"Resource development such as harvesting timber or building subdivisions may alter habitat that supports resources or services." **vote was 11 to 3 in favor--"harm" is a value judgement and it depends upon the resource**

9. Page 20, second paragraph, second sentence, change to read:

Protecting and acquiring land may minimize further injury to resources and services already injured by the spill, and to allow recovery to continue with the least interference." **this is not an absolute, so do not use "will"**

10. Page 20, seventh paragraph, last sentence, change to read:

"For example, protecting salmon spawning streams benefits not only salmon, but also commercial, subsistence and recreational fishermen." **do not want to assume there is no protection now**

11. Page 20, eighth paragraph, last sentence, change to read:

"The Trustee Council may conduct studies within the spill areas to determine if changes to public land and water management would help restore injured resources and services." **keep focus in the spill area**

12. Page 21, add this as a last bullet:

"Subsistence use should not be displaced through acquisitions or protection of lands or changing management practices." **do not want to adversely affect traditional uses by subsistence groups who were also impacted by the spill**

13. Page 25, first paragraph, last sentence, change to read:

"The Public Information and Administration category includes these and other day-to-day public information functions such as responding to public inquiries, and seeking local opinions and advice." **want to emphasize the participation of local interests**

14. Page 28, Restoration Strategy, second paragraph, last sentence, change to read:

"However, if a resource is not expected to recover fully on its own or if waiting for natural recovery will cause long-term harm to a community or service, alternate means of restoration would be undertaken." vote was 11 to 2 in favor--want to emphasize the need for action, not just consideration

15. Page 29, Resources not Recovering, Sockeye salmon (Kenai River), no change required at this time: **request a review by the Trustee Council to determine if the population is not coming back, according to ADF&G estimates--move to "recovering" status**

16. Page B-10, Sitka Black-tailed Deer, no change required at this time: **recommend the Trustee Council scientists re-examine the conditions of this species, local input suggests a decline in the population**

17. Page C-1, add the following footnote:

"State and Federal governments will purchase lands on the basis of a willing seller and willing buyer. The above list of areas were recommended by the public. Some of the areas listed may not be available for purchase or protection." clarifies what this list contains, that not all of these areas are for sale

Exxon Valdez Oil Spill Public Advisory Group

Recommendations for the November 17, 1993 Review Copy Draft Restoration Plan

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Exxon Valdez Oil Spill Public Advisory Group

Statement of Some Principles for Evaluation of EVOS Work Plans and for Their Implementation

The Public Advisory Group recommends the Trustee Council use the following principles in evaluating work plans and that these principles be incorporated into the Restoration Plan.

1. The plan should be designed to minimize administrative costs within individual projects.
2. The plan should seek to maximize coordination of logistical operations among projects to minimize costs.
3. The plan should combine projects with similar restoration objectives.
4. The plan should use external RFPs and external review of final proposals where possible.
5. The plan should use local individuals and Alaskan organizations where cost effective.

Passed November 23, 1993 by unanimous vote

Meeting Summary

A. GROUP: Exxon Valdez Oil Spill Public Advisory Group (PAG)

B. DATE/TIME: November 23, 1993

C. LOCATION: Anchorage, Alaska

D. MEMBERS IN ATTENDANCE:

<u>Name</u>	<u>Principal Interest</u>
Rupert Andrews	Sport Hunting and Fishing
Pamela Brodie	Environmental
Jim Diehl	Recreation Users
Donna Fischer	Local Government
John French	Science/Academic
Sharon Gagnon (for Williams)	Public-at-Large
James King	Conservation
Vern McCorkle	Public-at-Large
Mary McBurney (for McCune)	Commercial Fishing
John McMullen	Aquaculture
Ken Erickson (for Pearce)	Alaska State Senate
Brad Phillips, Chair	Commercial Tourism
Kim Benton (for Sturgeon)	Forest Products
Dolly Reft (for Knecht)	Subsistence
Charles Totemoff	Native Landowners

E. NOT REPRESENTED:

<u>Name</u>	<u>Principal Interest</u>
James Cloud	Public-at-Large
Cliff Davidson (<i>ex officio</i>)	Alaska State House
Richard Eliason	Public-at-Large
Don McCumby (alternate)	Public-at-Large

F. OTHER PARTICIPANTS:

<u>Name</u>	<u>Organization</u>
Jim Ayers	Executive Director, EVOS Restoration Team
Michael Castellini	Univ. of Alaska Fairbanks
Willard Dunham	AK SeaLife Center
L.J. Evans	Restoration Team Staff
Dave Gibbons	Restoration Team Interim Administrative Director
Dane Harris	
Willie Hensley	NANA
Bill Hines	National Oceanic & Atmospheric Administration

Dan Hull	Prince William Sound Fisheries Ecosystem Research Planning Group
Karen Klinge	U.S. Forest Service
Karen Kroon	Prince William Sound Tourism Coalition
Bob Loeffler	AK Dept. Envir. Conservation
Jerome Montague	Restoration Team AK Dept. Fish and Game
Joyce Murphy	AK SeaLife Center
Doug Mutter	Designated Federal Officer Dept. of the Interior
Eric Myers	Alaska Center for the Environment
Ken Rice	Restoration Team U.S. Forest Service
Sandy Rabinowitch	National Park Service
Leif Selkregg	Heery International
Darryl Shaefermeyer	AK SeaLife Center
Lewis Stackpole	???
Ray Thompson	U.S. Forest Service

G. SUMMARY:

The meeting was opened at 9:00 a.m. by Chairperson Brad Phillips. The July 15-16, 1993 meeting summary was accepted. Dave Gibbons distributed a summary of the August 6 & 9, 23, September 16-17, and October 27, 1993 Trustee Council meetings (attachments J.7, 8, 9, 10). Gibbons introduced the new permanent Executive Director for the Restoration Office, Jim Ayers.

John French reported on the Endowment Work Group recommendations. The question of legality of an endowment was raised--it was recommended that the PAG not be concerned about legal ambiguities at this time, but that they present their concept to the Trustee Council and request that the Trustee Council obtain legal opinion. The subject was postponed to the afternoon session, when the Work Group proposal was modified and passed (13 for, 2 (Pamela Brodie and Jim Diehl) against) (see attachment J.2).

Charles Totemoff moved (second by Diehl) that the Preliminary Statement of Principles for Evaluation of EVOS Work Plans that was postponed at the July 1993 meeting of the PAG be passed on to the Trustee Council. The Statement was modified and passed unanimously (see attachment J.3).

French moved (second by Mary McBurney) to defer recommendations about projects for the 1994 Work Plan until the PAG had the full 1994 Work Plan before them for discussion (probably in January) (passed unanimously).

Diehl raised a question about the RFP and proposal process used for the killer whale project in 1993. It appeared that changes were made during the process that precluded local Alaskan scientists from participating in the scientific elements of the study. (See also attachment J.6). The issue was tabled until discussion of the 1994 Work Plan projects.

Bob Loeffler and Sandy Rabinowitch presented an overview of the review copy of the Draft Restoration Plan. This interim draft is for informal review and for use in determining 1994 projects. It is anticipated that a draft environmental impact statement will be prepared and a formal public review will occur in 1994. The plan presents general guidelines and policies, not detailed allocations of effort. After questions, answers, and discussion, specific recommendations for change were made (see attachment J.4). Some general comments made during discussion:

- will need to present alternatives and response to public comments during the EIS process

- need more information about how reimbursements were spent

- how can you allow the price of land to exceed fair market value?

- we should limit this plan to those actions approved by the court in the settlement

- this says very little about what will be done, or won't be done--there is no action identified

Darryl Shaefermeyer, Michael Castellini and Joyce Murphy presented information and answered questions about the proposed Alaska SeaLife Center in Seward (see attachment J.5).

Brodie moved (second by Benton) that the PAG request that the Trustee Council release detailed information justifying past reimbursements, and any future reimbursement requests, of funds to State and Federal agencies (passed unanimously). It was noted that at least 20% of the settlement funds went to reimbursements with little explanation as to what these expenses were.

The meeting was opened for public comment at 4:40 p.m. Testimony was presented by Karen Kroon (see attachment J.11), Dan Hull, and Charles McKee (see attachment J.12).

McCorkle moved (second by McMullen) that there be unanimous consent to retain the current officers (Chair: Brad Phillips, Vice-Chair: Donna Fischer) of the PAG for the next year (passed unanimously).

The PAG members were invited to offer comments on issues and concerns. King moved (second by Fischer) to send a letter of appreciation to Dave Gibbons (passed unanimously). Benton moved (second by Fischer) that a status report on approved projects be prepared and distributed to the PAG from time to time (passed unanimously). For example, what is the status of the Kodiak Archeological Repository project? McCorkle offered appreciation of the efforts of PAG members to review the Review Copy Draft Restoration Plan on such a short time-frame. Fischer offered appreciation to the endowment Work Group for their efforts.

The meeting adjourned at 5:20 p.m. on November 23, 1993.

H. FOLLOW-UP:

1. John French will present a summary of PAG actions at the November 30, 1993 Trustee Council meeting, since the Chairperson will be out of town at that time.
2. Mutter will meet with Ayers to determine when the 1994 Work Plan will be ready for review and will then contact Phillips about when the next PAG meeting should be.
3. Mutter will distribute to the PAG the comprehensive habitat protection process description and information about the number of landowners contacted.

I. NEXT MEETING: To be determined.

J. ATTACHMENTS:

1. Summary of PAG actions taken November 23, 1993
2. Endowment for Restoration and Monitoring
3. Recommended changes to the Review Copy Draft Restoration Plan
4. Statement of Some Principles for Evaluation of EVOS Work Plans and for Their Implementation

Handouts attached for those not present:

5. Alaska SeaLife Center Information
6. Nancy Lethcoe letter on killer whale project
7. Summary of August 6 & 9, 1993 Trustee Council Meeting
8. Summary of August 23, 1993 Trustee Council Meeting

9. Summary of September 16 & 17, 1993 Trustee Council Meeting
10. Summary of October 27, 1993 Trustee Council Meeting
11. Prince William Sound Tourism Coalition letter and recreation project list
12. McKee handouts
13. Example and blank travel itinerary forms for PAG members

K. CERTIFICATION:

PAG Chairperson

Date

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Exxon Valdez Trustee Council

1993 Shoreline Assessment

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Project 93038

Lead agency:

Alaska Department of Environmental Conservation

Participating agencies:

***United States Forest Service
Alaska Department of Natural Resources
National Marine Fisheries Service***

Advisory agencies:

***United States Department of the Interior
Alaska Department of Fish and Game
United States Coast Guard***

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1.0 Executive summary

The 1993 shoreline assessment team conducted ground surveys and transect surveys at 59 sites in western Prince William Sound from Perry Island in the north to Latouche and Elrington Islands in the south. The team looked at an additional 20-25 sites requested for survey by the public. All sites were originally oiled in 1989 following the Exxon Valdez oil spill. The 1993 field work began June 4 and ended September 27.

- Oil residue — either surface or subsurface — was present at every one of the 59 study sites, and sheening occurred at some.

- Surface oiling has become very stable. There was no measurable reduction in surface asphalt and surface oil residue from 1992 to 1993.

- Oiling was not continuous throughout the study sites.

- Within the 59 study sites, the 1993 survey discovered 109 distinct areas with visually detectable subsurface oil. The areas of these sites ranged from four square meters to several thousand square meters, with varying percentages of oil coverage.

- Also within the 59 study sites, the survey documented 69 distinct areas of subsurface oiling that could be described as high oil residue or oil saturated sediments, the two heaviest types of concentration. Total estimated volume of this heavily oiled sediment is 738 cubic meters.

- Subsurface oiling overall has decreased substantially since 1991.

- *Overall*, the amount of subsurface oil found at the study sites in 1993 is about 45 percent of the amount found in the same areas in 1991.

— The change at certain *individual* sites is probably greater. The 45 percent figure is probably a low-end number because we actually located more extensive oiling in 1993 than the crew did in 1992. So, while in fact subsurface oiling appears to be *decreasing*, some sites in 1993 will show an *increase*, only because we did a better job of finding the oil. This also dragged down the total rate of change for all sites.

- High-energy sites contain the greatest amount of subsurface oil remaining in 1993.

— This is probably because the high energy sites have more porous substrate and could absorb more oil at the outset.

— Cleanup strategies, such as leaving high-energy sites to be “cleaned” naturally after a certain point, may also have played a part in this.

- Moderate energy sites have shown the least amount of reduction.
- The heaviest concentrations of oil seem to be dispersing at a faster rate than moderate or light concentrations.

— The areas with the heaviest concentrations of oil in 1991 showed the greatest rates of reductions by 1993.

— While differing natural rates of dispersion for heavy and moderate concentrations cannot be ruled out, the more rapid reductions of heavy oil is probably related to the fact that these sites were targeted for cleanup more often than other sites.

- Cleanup effects are becoming more apparent, in terms of oil reductions over time.

— Sites that were heavily tilled or had significant sediment removal in 1991 had slightly higher rates of subsurface oil reduction by 1993 than those that were not worked aggressively.

- Three possible cleanup tasks the Trustee Council may consider are:

1. Manual remediation of stable surface oiling at sites near Chenega Bay;

2. Manual remediation of mussel beds, pending results of NOAA restoration studies of this problem;

3. Removal of rebar, flagging, signs, stakes, and other marking tools left by scientists and cleanup crews at sites around the oiled zone.

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2.0 Background

The 1993 draft restoration work plan included a brief description of a shoreline assessment project that could involve remediation in the area affected by the Exxon Valdez oil spill and cleanup. The scope of the project was refined somewhat by the lead agency, the Alaska Department of Environmental Conservation, during January-February 1993.

In March, the department submitted the project outline to the National Oceanic and Atmospheric Agency for review under the provisions of the National Environmental Policy Act. DEC requested and received a categorical exemption for the project due to its short duration, limited logistical needs, and its status as a general research project. This allowed the project to proceed without an environmental assessment or environmental impact statement.

On May 18, 1993, the Trustee Council decided to proceed with a shoreline assessment based generally on previous surveys conducted by the state and federal government with Exxon during the response to the oil spill from 1989-1992. The Trustees also voted to invite the U.S. Coast Guard and an Exxon observer to participate in the assessment with the trustee agencies and private landowners in the area.

Project staff prepared a detailed project description and submitted it to the Restoration Team and the Chief Scientist for review on May 28. After comment from the agencies, the plan was approved by both the Restoration Team and the chief scientist. Field work began during the first week in June.

2.1 Funding

The Trustees had allocated up to \$520,700 for the project, but added an additional \$15,000 in spending authority to cover transportation and associated costs incurred by the U.S. Coast Guard during its participation in the assessment.

Exxon was responsible for its own labor and transportation costs to and from Anchorage. Although the civil settlement allowed Exxon to deduct its expenses in 1991-92 from future payments to the trust fund, that was not the case in 1993, since the settlement covered Exxon's *response* costs only, and this project was under the restoration regime. Exxon, like all assessment participants, was provided with transportation to and from the home port or the work area, plus berthing space and food on the research vessel.

Actual total expenditures will probably come to considerably less than the \$520,700 budgeted for the project. At this writing (November 1993), all the bills have not come in and all the accounting has not been completed, but preliminary estimates put the total expenditures at roughly \$330,000 - \$350,000.

2.2 Authority

The project was led by the Alaska Department of Environmental Conservation and included both the Coast Guard and Exxon, however, authorities and roles for all were different than during the response phase.

Neither the DEC nor the Coast Guard was operating under their pollution control authorities based in state and federal law. During the response, these agencies led assessments designed to guide specific remediation action on the shorelines oiled during the spill. The guidelines for remediation were grounded in state and federal statutes and rules that say, essentially, that cleanup shall continue until technology has reached its limit, or until continued cleanup is more environmentally disruptive than leaving the pollution in place. (The Coast Guard, in addition, has some more explicit guidelines regarding the cost-effectiveness of a given remediation action.)

That was not the case in 1993. The response phase ended in June 1992, and authority for any actions on shorelines affected by the spill devolved to the various trustee agencies. The DEC project manager coordinated the effort, but did not carry the same kind of broad authority as an on-scene coordinator; he was, rather, operating as a general coordinator for the Trustee Council agencies, which were in turn assessing shoreline conditions as they might

relate to specific agency management or restoration goals. The DEC was designated lead agency largely because it was the only trustee agency that had detailed cleanup information area-wide. The Coast Guard was serving as a technical advisor, and because the Coast Guard personnel assigned to the project had additional detailed knowledge of the response. Exxon was invited for similar reasons.

2.3 Development of methods and objectives

In approving a shoreline assessment for 1993, the Trustee Council made clear that it wished the project to follow as closely as possible the methods and data reporting systems used during the response.

Therefore, the DEC oil spill response staff selected sites for assessment based on the last reported oiling conditions. The initial list of 52 shoreline segment subdivisions included 40 of the subdivisions that had appeared on the 1992 Final Shoreline Assessment Project (known as FINSAP) conducted jointly by the DEC, the Coast Guard, and Exxon. An additional 12 sites were included because of distinctive oiling or cleanup conditions, proximity to high-priority or well-known areas, or because of incomplete oiling information that raised questions about actual conditions in 1993. This was consistent with previous surveys, especially beginning with the 1991 May Shoreline Assessment Project (or MAYSAP).

The primary goal was to accurately locate and describe 1993 oiling conditions using the definitions and data recording methods previously employed. A secondary goal was to complete any simple, manual remediation that might speed up degradation of stranded oil, or otherwise improve the condition of a shoreline.

3.0 Operations

Field operations began June 4, 1993, and ended September 27, 1993. The field work was divided into seven phases that corresponded roughly to the times of the month when the tides were at their extremes. This procedure dated back to the early days of the response. The goal was to make sure that crews

surveyed a given set of shorelines when the tide retreated far enough to expose the lowest stretches of the intertidal zone.

This was important because many of the shorelines were originally oiled during a period of very high and very low tides in April 1989. Generally, through 1992 at least, response crew supervisors tried to schedule as much work as possible when the tidal stage was no more than seven feet above mean low water. This was critical when there was a considerable amount of oiled area in the middle and lower intertidal zones.

This was somewhat less important in 1993, as oiling had decreased or disappeared in many low and middle intertidal areas. However, we stuck to the lowest tide periods for the sake of consistency, occasionally making an exception when past oiling data suggested that most of the remaining oil was in the upper- or supralittoral. But for the most part, the survey phases were defined by those 7-8 day stretches when there were minus tides, or low tides that were a foot or two above mean low. This gave us a potential 14-16 field days per month, under ideal conditions.

3.1 Logistics and scheduling

The sites in the work plan were scattered throughout the western Sound from Perry and Lone Islands in the north to Latouche, Elrington, and Evans Islands in the south. We used a single crew and vessel and worked two low tides per day when weather and daylight permitted. Generally, there were 3-4 days at the beginning of each cycle when we could work two tides.

The weather was extremely cooperative from June through early August. We did not lose a single day to weather during that stretch, a fact that was as amazing as it was advantageous. Cruises were usually scheduled over a full 7-8 days of the available tide window, but we were able to complete each session's tasks 1-2 days early until the weather began to turn in mid-August (as it tends to do in the Sound).

We worked primarily from the M/V Pacific Star, a 65' LOA, Coast Guard inspected vessel. The vessel slept 10 comfortably but could accommodate more, if necessary.

The vessel had enough fuel capacity and speed to transit extensive stretches of the Sound either overnight, or between tides, so that we were not greatly restricted in our scheduling by distance or time. From Whittier, we could make Herring Bay and the northern Knight Island Archipelago in about 4-5 hours; the Gulf of Alaska crossing from Seward to Chenega Bay, Sawmill Bay, Evans Island, took 4-5 hours; most everything in between on the western side of the Sound was within four hours' running time.

Generally, we were able to schedule our site visits so that we could always complete two sites per day, and sometimes three when they were especially close together or not too complex in their oiling conditions.

We used helicopters for four clusters of site visits, flying out of Homer for outer Kenai Peninsula sites, Valdez for two days of community surveys, and out of Anchorage for the rest. We used the helicopters primarily when we had to finish several sites in a short time, and the vessel could not move us around quickly enough. We used Anchorage-based float planes to shuttle crew members in and out when unrelated tasks within their own agency required them to come out after the beginning of the cruise, or come in early. Usually we had one shuttle flight per cruise to change out several crew members.

If the Trustee Council decides to do further assessments of this type, I recommend building the schedule and logistical structure somewhat differently.

- **I would schedule the project for May 15 to July 15.**

This is usually the most dependable period for good weather in the Sound. It also is the "lightest" time of year, with the longest available daytime windows. This makes it most possible to work two tides in reasonable lighting conditions.

- **I would use a smaller crew — no more than 4-5 people at the most.**

For policy reasons we had a larger crew — sometimes as many as 10 people. However, the size of the areas we are surveying and the limited number of tasks involved make it difficult to keep that many people busy during the entire 3-5 hours in each field shift. Four trained people is just about right: two to observe and record data and two to dig and fill pits, and conduct other general ground survey observations.

- **Regardless of crew size, I would stage from a Prince William Sound location or port.**

We began using Whittier as the staging port later in the summer. It was a shorter drive from Anchorage to Portage (rather than Anchorage to Seward), and leaving from Whittier cut out the 4-5 hour Gulf crossing from Seward. Leaving from Seward usually meant that each cruise included 1-2 extra days of travel and crew downtime.

- **I would use a helicopter instead of a vessel (if using the smaller crew), and I would return the crew to a port in the Sound each evening.**

A helicopter would allow this smaller crew to work more sites, spaced further apart, on each tide, which would help scheduling of the project overall. Under this scenario, one could schedule a more intense, although shorter field season to fit within the optimal 60 days from mid-May to mid-July.

I also think it would increase overall productivity and reduce crew fatigue, and provide managers with some flexibility to change crew members in or out at relatively low cost, and to deal with extended stretches of bad weather. If you knew you were going to be in the middle of a week of marginal weather, you could just send people home to their regular jobs rather than leave them in the field,

unable to work. This would also mean that you wouldn't be paying transportation or charter costs on days you weren't able to fly.

- **I would be more flexible in scheduling at the outer edges of the extreme tide periods, and I would schedule at least some of the work at some of the sites during higher tides.**

At a number of the sites, the remaining, documented oiling is relatively high up the beach. If there is not real statistical or quality-control reason to make every visit at the lowest tide, I would schedule work during periods that would have been considered marginal in 1989-92. This, again, would allow you to schedule a more intense, but shorter field season and make for a more cost-effective operation.

3.2 Crew composition

The Trustee Council intended the 1993 shoreline assessment to build on data from previous surveys, and instructed the lead agency, DEC, to follow as closely as possible the methods and procedures used for assessments during the response.

The survey team was the same type of multijurisdictional cooperative that operated during the spill response itself. It included a mix of trustee agency representatives, major private landowners, the U.S. Coast Guard, and Exxon. In theory, everyone was to come along on every survey; as a practical matter, some agencies chose to participate on a spot basis, or not at all. In most cases, the crew included at a minimum 3-4 DEC environmental specialists, one land manager from the Department of Natural Resources, an area ranger from the U.S. Forest Service, a pollution control specialist from the U.S. Coast Guard, an Exxon employee or contract specialist, and a marine biologist under contract to Exxon. Most, if not all the crew members had one or more seasons' experience on the Exxon Valdez response.

NOAA contributed technical staff on two of the cruises, and the Chenega Corporation sent a representative on most occasions when the survey sites were adjacent to corporation uplands, or in the general vicinity of the village. Dr. James C. Gibeaut, under contract to the Trustee Council, was the project technical advisor on geomorphology and accompanied the crew on two of the cruises. DEC staff led the crews on the shorelines, scheduled the work, recorded the data, and coordinated comment from other field representatives.

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3.3 Objectives

The primary objective of the 1993 assessment was to observe and document residual oiling on selected shorelines in Prince William Sound and the Gulf of Alaska, using the same definitions, techniques and methods used during response-era assessments. The second principal objective was to compare 1993 information to that of previous years and provide at least a general qualitative analysis of how conditions are changing over time. A third objective was to provide advice and information to the Trustee Council about site-specific remediation as a possible restoration option.

While the methods, definitions, and procedures mirrored those of the response-era surveys, there were several differences worth noting. First, the response surveys included more and different types of qualitative observation. During the surveys from 1989-1992, Exxon contract biologists listed types of plants and animals observed in the intertidal areas and made general speculations about the relative health or abundance of the things they saw; crew members were asked to report sightings of large animals such as otters, seals, and eagles; field representatives of all disciplines were given wide latitude to comment on biological recovery, the apparent chemical composition of the oiling, the effectiveness of previous treatment, the need for future treatment, and so on. Technical staff also assessed the likely logistical demands of remediation efforts. The goal of all this, of course, was to figure out whether a site ought to be treated, and if so, how it should be done, how extensively it should be done, and what side-effects of treatment could be anticipated or avoided.

It was not necessary for the 1993 assessment to be quite so inclusive. Remediation was not a primary goal, which meant that certain types of

qualitative observations no longer triggered or excluded certain actions on a shoreline. General qualitative biological observations were likely to be weaker, scientifically, and less specific than more quantitative and targeted efforts undertaken under other restoration projects. (We certainly made note of natural conditions that seemed relevant to each of us, based on what we had seen on shorelines over several summers, but these were not a primary focus.) In short, we looked at what the response surveys did best and concentrated on building on the best aspects of the previous surveys. The instructions from the Trustee Council and the work plan it approved assumed a qualitative approach and analysis, so we tried to produce the most defensible qualitative information. We decided, therefore, to determine as completely as possible the absence or presence of residual oiling, the extent of residual oiling (in spatial terms), the visual characteristics of the oiling, and the concentration of residual oiling.

The work plan was written broadly, since we did not know beforehand exactly what the conditions would be and how they could best be documented. We made several adjustments to our program based on what we were finding in the field at the outset.

For example, we decided to depend on still photographs and slides for documenting specific oiling conditions rather than videotape. The kinds of oiling conditions we saw in previous years were better suited to the "big screen" of video; extensive oiling was better portrayed by sweeping video shots. Much of the 1993 oiling was very localized and hard to shoot with a video camera; thin subsurface oiling lenses were hard to distinguish on video, particularly since the lighting in a hole in the ground is usually pretty poor. Also, as a practical matter, it is easier for the average person to take good still photos as opposed to good video.

We also did not sample widely for total petroleum hydrocarbon in sediments or for oil chemistry. Other agencies, especially NOAA, sampled on a more targeted basis under other restoration projects and I did not think it necessary for us to duplicate this type of data.

3.4 Site selection

At the end of the 1992 response season, DEC staff went over the field data from that year and listed approximately 50 shoreline sites that might be included on future assessments, if any. This was standard practice during the response; the intent was to flag potential trouble spots that ought to be either monitored or treated the following season.

It is important to note that this methodology was developed with remediation as the driving force. None of the response surveys, with the possible exception of the 1989-90 fall/winter state-sponsored assessment, were intended as a compilation or documentation of *all* oiled shoreline. The survey list for each subsequent year was made up of those shorelines on which:

- a) remediation was possible or likely,
- b) there was a question about the accuracy or completeness of last-recorded data, or
- c) there was some special agency or public concern.

Therefore, the absence of a given shoreline segment from a subsequent survey list did not necessarily mean there was no longer any oil there, it meant, rather, that treatment was not likely for some reason. The reasons ranged from accessibility of the oiling, weather or logistical concerns, environmental or archeological sensitivities, or even a relative judgment about whether the residual oiling was "bad enough" to warrant treatment. While this worked for purposes of planning response activities, the methodology for selecting survey sites was not likely to produce an accurate picture of specific oiling conditions throughout the spill area.

At the start of this project, we had two general options for selecting sites. If documenting *all* the residual oiling from the Exxon Valdez spill was the goal, we would have had to go back to original oiling reports, then sift through subsequent survey development records to determine which sites "dropped off" because there was little or no oil, and which were deleted because of access or

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other complication not directly related to actual oiling conditions. This is certainly possible, but the budget and time frame allotted for the project made this impractical.

Therefore, we decided to work from the DEC 1992 post-assessment list, with the goal of documenting and describing the oiling conditions at sites that had the longest and most extensive history of being "hot spots" during the response. For the purposes of practical information, preliminary policy-making, and limited extrapolation, this was a useful, achievable and cost-effective goal. The methodology was not likely to produce that accurate picture of all remaining oiling, but it could give the public and policy-makers a good sense of how things were changing and what one could expect to see — or not see, for that matter — on a visit to Prince William Sound.

As in previous years, sites were included on the 1993 survey list for reasons of public policy and public responsiveness. The Trustee Council, by resolution, instructed the assessment team to attempt to make an additional 70 sites visits requested for survey by the community of Chenega Bay, putting the final survey list at 122 for 1993, actually an increase over the previous year.

3.5 Field work

We used as a guide oiling data going back to initial field observations made by state, federal, and/or Exxon survey teams in the spring of 1989, and subsequent survey data at those sites. We found the most useful information to be the detailed field sketch maps made by Exxon geomorphologists who accompanied each survey team over time. These "OG maps" were, in most cases, excellent guides to locating most residual oiling at most of the sites. (Note to acronym collectors: The "OG map" relates to the title of the people making the sketches — the **Oil Geomorphologists**.) We attempted to update each of these maps, marking both 1993 oiling conditions and any significant changes in beach profile, general physical setting, or other notable aspects of the area.

We also depended on the personal knowledge of individual crew members, several of whom had been at many of the sites — sometimes many times — over the four previous summers. All the DEC and Coast Guard staff had served

throughout the spill area since 1989 and 1990, the chief Forest Service ranger assigned to the project was a member of the first interagency resource assessment teams in 1989, and DNR's representatives were either area park rangers or a resource specialist who had worked the spill response.

Therefore, at most of the sites, we allowed experience, the physical setting of the site, and significant obstacles to determine the boundaries of the 1993 assessment. This was a change from previous years, when surveys were strictly limited to the discrete work sites from the season before. This was partly a function of procedural policy, partly because of the number of sites on most surveys (the 1991 survey included nearly 600 sites), and partly because the response assessments had to take place within a short period in the spring so that the summer could be devoted to actual treatment. We did not have these kinds of pressures driving the 1993 project, and could therefore take more time to explore the sites and map them more precisely. However, most of the time we limited our ground surveys to specific areas mapped in 1992 and allowed the so-called "OG maps" of 1991 and 1992 as our primary guides.

3.3.1 General ground surveys

We actually completed 48 of the 52 general ground survey sites on the original work plan list. Two of the sites (BP004A and SE042) were dropped for logistical and technical reasons, and two study sites in the Gulf of Alaska were not logged on the data sheets because the adjacent landowner opted to do less detailed inspections. The project's technical advisor approved these field changes and did not think they would affect the data analysis.

Sites were identified by the segment, subdivision, and work site designations developed during the response. In 1989, Exxon and DEC cartographers and analyst-programmers used satellite photographs, NOAA marine charts, and USGS topographical maps to create an "electronic shoreline," which was then broken into segments defined primarily by major topographical or geographical features. The segments were identified by two letters corresponding to the island or area's name, and three or more digits corresponding to areas between the headlands, bay, bight, etc. used as border markers on the electronic shoreline.

As surveys and cleanups became more targeted, smaller areas within shoreline segments were identified by letters and numbers of subdivisions and work sites. For almost all of the 1993 general ground surveys, we were working primary at the "segment-subdivision" level of precision to start off. All of the segments, by this time, were made up of extended areas of little or no oiling, so survey by *segment* set too large a target; survey by *work site* set a target far too small to get a reasonable picture of the conditions.

Using the "OG maps" and other previous oiling data as a guide, the crew came ashore and would begin digging pits in the general vicinity of the last reported oiling. The pits varied in depth from roughly 10 to 50 centimeters, depending on previous oiling information and the physical characteristics of the substrate. Usually one first had to peel back a layer of larger, armor material such as rounded boulders and cobble before digging into the smaller sand and pebble and gravel layers could begin. We tried to space the pits no greater than 10-12 feet apart, parallel to the water line. In cases where we had found oil in several zones (upper, middle and lower intertidal areas) moving upslope, we tried to keep the upslope pits roughly in line with those immediately downslope.

It was not a true grid system, but it established a ground survey plan with four variables: surface oiling, subsurface oiling, area parallel, and area up and downslope. We dug the test pits both inside and outside the last reported areas of oiling. The number of pits varied widely, depending on previous data and what we were finding. In some cases, we dug as few as six pits; in a few others, we dug as many as 60. For surface oiling, crew members fanned out and made visual observations, usually covering the entire subdivision or topographical unit.

The goal was to delineate as precisely as practical the area encompassed by the oiling. We defined areas on the maps by areas that appeared to be continuous under the surface; surface areas were often more broken and sporadic and were described as a percentage of the total area surveyed, or a percentage of the total area of the intertidal zone where the oiling was found. This was consistent with the methods and descriptions of previous surveys.

3.3.2 Additional transects

The project's consulting geologist expanded the work plan to include 15 sites at which NOAA and/or DEC had previously laid out transects. These sites were selected primarily for the consistency and quality of the data over time, and were intended to add some level of quantitative analysis to the project. We completed 11 of these additional surveys.

At these sites, crew members dug pits and recorded surface and subsurface data along the transect only. (In some cases, the pits were dug two meters to the left or right of the transect line because we thought repeated pit-digging along a certain transect over the years could have actually been the same thing as treatment, and the data would not really reflect natural changes in oiling over the period.) The data from the transect sites were more tightly tied to geomorphology of the site. In addition to oiling descriptions, crew members measured the beach profile and recorded the sediment types both on the surface and in the distinct strata shown in the pits.

3.3.3 Community surveys

On May 17, 1993, leaders from the community of Chenega Bay submitted a list of 82 sites the community members wanted to be included in the shoreline assessment. (See attachment.)

The Trustee Council included these sites in the 1993 shoreline assessment. This presented some technical and logistical issues.

Although 12 of the Chenega sites were already on the work plan list, the rest were not. Most of the sites had been surveyed by response teams and been recommended for no further treatment or assessment, some as far back as 1990. Therefore, according to the methodology for site selection, they had been deleted from subsequent assessments. Since we used essentially the same methodology in 1993, these sites were not on the work plan list for full ground survey. They were, in fact, unlikely places to find residual oiling, which conflicted with the principal goal of the 1993 assessment, which was to locate and describe residual oiling. We had to find a reasonable way to be responsive

to public concerns without compromising the technical validity of the project. In addition, we had to find a reasonable way to visit more than twice as many sites as planned while staying within the original budget.

With Restoration Team concurrence, we decided to stick to the original schedule and survey the 52 sites, plus the additional transects, using the full crew and the vessel. This would allow us to assess the dozen, most heavily oiled Chenega sites as a priority. We would then visit as many secondary Chenega sites as possible, using a helicopter and a smaller crew of DEC staff and a Chenega Bay representative. Since these sites were primarily adjacent to Chenega Corporation uplands, the Restoration Team did not require additional trustee agency participation.

On July 6-7, we conducted aerial and ground surveys along the entire coast of Chenega Island. This encompassed about 20 segments and subdivisions, but we actually landed and walked the shorelines of 10 segments at the northern and southern tips of the island, which were the two areas with the heaviest initial impact in 1989. We also visited a site at Eshamy Bay on the mainland at the request of Gail Evanoff of Chenega Bay. During our July and August vessel-based survey cruises, we completed full ground surveys at the highest priority sites in and around the village, Elrington, Latouche, and Bettles Islands.

The third tier priority cluster of sites, Shelter Bay on Evans Island, were not surveyed during this project due to weather.

On July 2-3, I visited sites at Windy Bay, Chugach Bay, Gore Point, Nuka Passage, Yalik Glacier and Port Dick on the Kenai Peninsula mainland with Pat Norman of Port Graham and two Kachemak Bay State Park rangers. Like the community surveys with Chenega Bay representatives, this helicopter-based assessment was intended as a quick check-up of former "trouble spots," rather than a full-scale assessment. (One Kenai site, TB004A at Tonsina Bay, received a full ground survey in late September, because during the first visit in July the tide was not low enough to allow us to find the oiling.)

4.0 Policy and management evaluation

Of the 48 ground survey sites and the 11 transect sites, all showed surface and/or subsurface oiling. Judging from treatment histories, previous surveys, and the 1993 assessment, the oiling is sporadic along these coasts, but it present at sites throughout western Prince William Sound.

The surface oiling consisted primarily of asphalt pavement, tar splatters, tar trapped in shales, and the chocolate-brown emulsion generally known as mousse.

On cobble beaches where asphalts were found, they generally appeared as sporadic clusters bound up with rocks and sand. These patches ranged from rock-hard and dry to some with a hard surface "scab" covering a fudge-like brown, weathered oil. We broke up these patches whenever we could during the course of the survey. Some sites, especially those with heavy initial oiling in boulder fields, showed bands of hardened tar and weathering mousse. With a few exceptions, the larger clusters of patches and bands of asphalts occurred in the upper intertidal areas, or in areas that were sheltered in some way from wave energy.

Boulder fields in areas with heavy initial impacts occasionally proved to be still heavily contaminated with asphalt and mousse. The oiling at these sites consisted primarily of large, thick patches of asphalt trapped between boulders, and mousse about the consistency of chocolate syrup. The mousse at a few sites was visible from the surface, but at many of these sites it was trapped beneath boulders and exposed only when the rocks were turned over.

The clues to subsurface oiling were not generally visible. Many of the sites with subsurface oiling had little or no visible contamination. Several sites gave off sheens at the tide came in, or as surface runoff trickled through the oiled zone. Very few sites appeared to sheen on their own. (Some sites sheened lightly after we had dug pits or turned over rocks.)

All the sites we visited had oiling data from 1989 through 1992. The original oiling conditions in April and May after the Exxon Valdez can be compared to

successive site visits in 1990, 1991 and 1992, and the progressive changes can be tracked fairly easily. For this reason, I am confident that with a few possible exceptions, all the oiling observed can be tied to the Exxon Valdez oil spill.

The exceptions could be occasional patches of surface asphalt or tar splatter, which this survey and others (Kvenfolden, 1993) suggest can be very resilient over long periods of time once the oil has been reduced by weathering to its paraffin and asphaltine fractions. However, it is highly unlikely that the large areas of surface and subsurface oiling we documented could have come from some other source.

First, as stated above, the impact of fresh oil coming ashore in 1989 has been documented at these sites, and progressive changes can be tracked over time.

In addition, there have been no other reports of large crude or heavy fuel spills in this area. While one cannot automatically exclude this as a possibility, had such large spills occurred, they would have had to come from large-volume carriers such as tankers or commercial fuel delivery barges. Spills from these type of carriers probably would have been reported at the time, or discovered when the spiller made port and had to account for fuel loss or use, or cargo lost. The only crude carriers in the area are the major carriers out of the Valdez terminal.

Further, the types of fuel that would leave a heavy asphaltine fraction are not generally used by the types of vessels that have transited the area in the 1980s. Diesel and gasoline, the primary fuels for recreational and small commercial fishing vessels, do not contain heavy asphaltine fractions; when these fuels do contaminate soils, they leave a different, less persistent kind of residue than a crude or heavy bunker fuel.

For these reasons, we suggest that for the purpose of analysis, a reasonable person would conclude that the residual oiling we describe is a result of the Exxon Valdez oil spill.

For purposes of description, we have separated the survey area into six general groups:

- The Northern Islands (Perry, Lone, Applegate, Culross)
- The Outer Islands (Smith, Green, Seal)
- Knight Island North (Eleanor, Disk, and Ingot Islands, Herring Bay)
- Knight Island Outer (The exposed eastern shore of Knight)
- Bay of Isles
- The Chenega Area (Evans, Bettles, Elrington, Latouche Islands)

We grouped the areas this way based on primary uses in the area, topography, oiling impacts and treatment histories, and proximity to settlements.

4.1 The Northern Islands

We assessed six sites in this area: two on Lone Island, two on Applegate, and one on Perry. This is a relatively busy, multi-use area of the Sound that receives most of its traffic from the port of Whittier. The area is easily reached by small recreational or commercial vessel from Whittier, and the islands are within the ferry and commercial marine corridor to Esther Island hatchery and Valdez. There is a long, documented history of recreational and commercial tourism use at Applegate and Perry Islands. Until last year, there was a small trespass sauna at Applegate; there is trash and other evidence that several sites have been frequently and recently used as camp sites on the island. Perry Island is part of a well-known kayak tour route, and we noted several trails leading either into the uplands or across island to other beaches. There is also a commercial oyster farm now in the twin bays that cut deeply into the island.

This area had some of the heaviest initial impacts from the Exxon Valdez spill, and was the scene of some of the earliest shoreline cleanup efforts.

We found two small areas of subsurface and surface oiling at the Lone Island sites. One was in a boulder field, the other in a small pocket cove with substantial bedrock outcrops that break wave energy. The Applegate Island sites were largely free of oil, with the exception of a few areas of very hard and persistent tar and asphalt packed between leaves of thin shale that has been tilted vertically and exposed along the shorelines.

There is also obvious evidence of scientific study at the Applegate coves, in the form of barely exposed rebar and leftover flagging that presumably defined study sites or marked transects. Some of the rebar is in the middle and lower intertidal and could present a hazard to kayaks, inflatables, or skiffs coming ashore at these well-used recreational anchorages.

The Perry Island (PR16) site is one with a long treatment history. It was heavily oiled in 1989 and heavily worked in 1989, 1990, and 1991 with large-scale washing and mechanical tilling operations at various points in time. It is a steep, high-energy, rounded boulder and cobble beach. However, two large bedrock outcrops in the center of the site break some wave energy. Behind this outcrop, and in a boulder field to the west, there are two areas of subsurface oiling beginning about 15 cm below the surface. This oiling is not visible at the surface and was characterized in 1993 as medium oil residue. It does not appear to have an impact on recreational uses, and, due to the porous nature of the site, is a good candidate for continued improvement on its own.

4.2 The Outer Islands

We visited four sites in this area, two from the ground survey list and two on the transect site list. A fifth site that we originally planned to visit was deleted for weather reasons.

The two work plan ground survey sites were both on Green Island, an island of low hills and shallow, sheltered bays and coves. For an island that is relatively exposed, it has fairly high biological values (Juday, 1990), probably due to the various sheltering areas of bedrock both on the shoreline and just off the southwestern shore. Several areas were heavily oiled in 1989 and received treatment through 1991, although work had to be scheduled around shorebird

nesting and rearing times and other biological sensitivities. We found areas of surface and near-surface oiling at both sites we visited, and in each case the oil was either extremely weathered or primarily characterized as light oil residue.

It is also worth noting that while one crew was walking from one site to meet up with a second group at the other site, we encountered extended areas of tar and chunks of asphalt pavement at sites not on the 1993 survey list. These other sites, at the north end of the island, were last visited in 1991 for the most part. After the 1991 season, they were deleted from future surveys because it was judged that no further treatment was possible. Indeed, treatment here would have been extraordinarily difficult and probably not very effective, but the oiling is still present. Like Applegate, this area has extended areas of exposed shale bedrock that has been tilted vertically and was filled when oil came ashore and soaked the rocks. The oil is thick and weathered and tightly packed in the leaves of shale; in some areas, there were sheens on the tide pools. In a more sheltered cove to the east of this area, there were thick chunks of asphalt mixed with gravel, some of them somewhat less than a meter across and 5-8 centimeters thick.

We worked one transect at SM008, at the southeastern end of Smith Island. This is a high-energy beach made up of very large, rounded boulders and cobbles that are tightly wedged together, and occasionally mixed with sand and pebbles below the upper layers of armor. This transect had oil from the lower intertidal (just above the *Fucus* line) all the way to a platform just below the storm berm.

We visited one site at Seal Island, SE041A, a complex site consisting of a large tide pool, an extended tombolo, tall bedrock outcrops and a sheltered platform covered with disk-shaped boulders and rocks. It has a thin gravel substrate underlain with a thick organic layer very close to the surface. There are seabird nesting sites (we observed two pairs of oyster catchers) and more than a dozen harbor seals bobbing just offshore the tombolo.

This area was soaked heavily by oil in 1989. In 1991 it was still heavily oiled and received about three days of work. The armor was removed from an area of the platform and crews used a cold sea water flush, manual agitation of

sediments by rakes, and sorbent material to release and contain the oil. A smaller, similar manual operation (minus the flush) was used in 1992 on a smaller area. In 1993, along the DEC transect and in the areas adjacent to it, the thin sediments above the organic barrier layer were still substantially oiled and sheened readily when disturbed, so we dug as few pits as possible and did not stray far from the transect line. This site should be monitored further. Because of an approaching storm and the fact we were some distance from safe anchorage, we did not conduct a scheduled ground survey at SE042.

4.3 Knight Island North

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This area includes the smaller islands of the Knight Island Group, along with Herring Bay and a small portion of the mainland to the west at Main Bay. This was an area that was heavily oiled by the initial impacts of the spill as well as what DEC termed secondary oiling, which occurred during the on-the-water recovery period in April and May 1989. Because of local currents, tides, and circulation patterns, the oil that arrived from the vessel tended to stay around this area, moving continuously in a clockwise pattern (Hull, 1989). Oil came around the island group and entered the west-facing bays, such as Herring Bay, Knight Island and Northwest Bay, Eleanor Island, and remained trapped. There was quite a bit of "saturation" oiling, as large slugs of crude and mousse came ashore and soaked area shorelines.

This area also received considerable cleanup effort early on, especially in Herring and Northwest Bays, which were protected from weather and thus provided more stable working conditions.

We visited 13 sites during ground surveys in this area, and worked an additional four transects. This area, especially within Herring Bay and at Herring Point, is one of the two areas where one could find groups of contaminated sites fairly close together.

For the amount of oil documented within Herring Bay in 1989, the overall current picture of the area seems remarkable. There are several localized areas of significant surface and subsurface oiling that should be noted, however. Near the back of Herring Bay, on an east-facing subdivision with a major

anadromous stream, is KN132B. The area immediately around the stream is relatively oil-free, but moving north, there are three noticeable bands of heavily weathered, very hard asphalt mixed with angular cobbles and gravels. In the biggest band, which measures roughly 145 meters long by four meters wide, the asphalt is rock-hard and difficult to break up. It does not sheen when pieces are placed in the water, which suggests a very advanced state of weathering. There are also some remnants of a Fish and Game camp site in the adjacent uplands, including a wooden tent platform and other small shells of structures.

A cluster of pocket beaches near Herring Point makes up KN300. At each of these sites, we found areas (the largest about 100 meters square) of high oil residue buried a few centimeters below the surface. Several of the pits showing HOR were in the extreme lower intertidal, including some below the Fucus line. While this oil sheened readily, it was not immediately obvious from the surface. When peeling back the cobble armor to dig the pits, we noticed amphopods, tiny eels, limpets and other small plants and animals in the active zone above the oiled sites.

Just outside of Herring Point, at KN500A and KN500B, the crew had little difficulty finding oil in pits within the previously documented oiled zone, but most of these pits showed medium or even light oil residue. These sites were the subject of intense work in 1989 and 1990, with some additional work in 1991.

On the other, west-facing side of the bay, the crew made three site visits, one for a ground survey and two others to run transects. Both transect sites had little or no visible surface oil, and very light or no subsurface oil on the transect. A third site in between the transect shorelines was largely free of oil, but the crew did locate a thin band of subsurface oiling buried very deep (40-50 centimeters) under the cobble beach in the mid-intertidal zone.

In general, there was little visible surface oiling in the areas we surveyed, although the crew did not walk the long, steep, boulder-field foot of the bay's western shore.

We visited five sites at Eleanor Island, two within the sheltered, northwest-facing bays and the rest on the high energy shorelines on the east. Of particular note is

the site at EL056C, which even in 1993 had strong—smelling, black oil buried in an area of the middle and low intertidal zone. This area did not receive much treatment, at least not in the lower intertidal, because of access and environmental sensitivities; because it is so far down the intertidal zone, it is not exposed for long. This site should be monitored in the future. Also of note was the transect at EL107, which, while not on this year's ground survey list, still showed consistent subsurface oiling under the rounded cobble armor. This site is a steep, high-energy beach that presumably gets hit fairly hard by wave action fairly frequently.

The crew located oiled boulder fields at three, mid- to high-energy sites on Ingot Island.

There was one site visit at Disk Island, DI067, which contains a large mussel bed that was heavily oiled and is the subject of additional study by trustee agencies. There was some surface oiling around the site, and heavy and medium oil residue under the mussel bed in the middle intertidal.

The crew visited two small islets in Foul Bay, just off the mainland. (These are part of a Main Bay segment, MA002.) Generally, the area looked oil-free on the surface. It was interesting to note the abundance of *Fucus* and other seaweeds at one of the sites, which had been cleaned aggressively with hot water in 1989. Also of note was a small tide pool at MA002A, in which workers in 1992 had cleared out rocks and agitated heavily-oiled sediments. The area still shows signs of obvious oiling — the tide pool sheens spontaneously from its outlet — but there is extensive and diverse plant and animal life within the zone.

4.4 Knight Island Outer

This area includes all the shorelines on the eastern shore of Knight Island, with the exception of the Bay of Isles. Four of the five sites we visited in this area are relatively exposed, and did not receive much treatment until the latter part of the 1989 cleanup season.

Due to the amount of oil that came ashore and the limited treatment (mostly manual after 1989) in subsequent years, it is not difficult to find mousse and

other heavy oil residue in these boulder beaches. There are visual clues, and more oiling can be located by turning over rocks and small boulders. They have improved in their condition since 1991 and presumably weather and wave energy will continue dispersing or breaking up the oiling. However, these sites (KN211, KN209, KN213) continue to contain areas of heavy oil residue. At Point Helen, KN405A, the crew found some traces of surface oiling and various low levels of subsurface oiling along the whole subdivision. This area was very heavily oiled in 1989 and was treated aggressively through 1991. It was a particularly complex area to treat due to the fact that it was so heavily oiled, so exposed, and subject to a complicated energy pattern (Hays and Michel 1990). Oiling here in 1993, however, appeared significantly lighter than during pre-treatment surveys in 1991.

4.5 Bay of Isles

The Bay of Isles is a visually stunning area, the entrance through a narrow, mountain-edged mouth, the mountains of Knight Island's spine rising at the back of the bay, islets scattered about the inside waters, and a variety of angular cobble beaches nestled at the foot of steep-sided, spruce covered slopes. Large slugs of oil surged through the entrance in 1989 and settled primarily on beaches in the south arm. Segments KN134, KN135, and KN136 received much of the attention of the response teams in this area through 1991.

The most publicized area was probably KN136, sometimes described as a marsh and sometimes as a lagoon. This segment actually consists of a rocky buttress and high intertidal platform that shelters a tide pool that is primarily a settling place for organic material. There is a thick layer of peat, or a similar woody compound in the basin. This peat bog is above low water and drains at low tide. It was heavily oiled and primarily left alone after experiments with treatment that included laying sheets of plywood so workers could walk into the peat without stirring up the muck or sinking oil more deeply into it by tromping through it. It still smells of oil, and the platform in the supratidal is still heavily contaminated, although quite a bit less so than in 1989 and 1990. The bog itself is still oily. We did not conduct a ground survey in the bog, although we did run a transect near the back of it. There isn't much one can do about this area other

than leave it alone. It is improving slowly, judging from previous data and crew member observations.

It is interesting to contrast this site with adjacent beaches, especially at KN134 and KN135, both of which received aggressive and continuing treatment throughout the response period. These sites seem to show considerable improvement; KN135 showed a few pits with light to medium oil residue, and a transect site in the area showed similar characteristics. While one could not tie this improvement to treatment efforts in a quantitative manner, it is worth noting that these areas are sheltered, low energy sites that are not likely to "clean themselves up." It is my opinion that the treatment here was well worth it, at least in terms of releasing and recovering oil. Judging from the angular nature of the cobble beaches, I have some question about whether weathering and wave energy alone (or primarily) effected the big changes we see here.

4.6 The Chenega Area

This is a tough area to assess, because the technical issues and the social and economic issues are closely intertwined.

Based on my conversations with village representatives this summer, it is obvious that they are not satisfied with the condition of several clusters of beaches, regardless of how they compare to conditions at sites in other areas of the Sound. We visited 16 individual sites in the area, not counting the aerial survey of Chenega Island and surveys at the southern end of Knight Island. This area contains some of the most persistent, heavy- and medium oil residue concentrations that we found on this assessment.

Some of the areas are small and localized, such as those at Bettles and northeast Evans Island, and some are more broadly and consistently oiled, especially the area within Sleepy Bay and the headlands on either side of this bay on Latouche Island. There are long bands of oiling in boulder fields and buried in the mid- to upper intertidal areas of Sleepy Bay's northwest shores. At least two of them are more than 100 meters long, and indeed, one can find residual oiling at the surface and in the subsurface throughout this northwestern area defined at LA20B and LA20C. The boulder fields at LA20B are scarred

with areas of pavement, and the mid- to upper intertidal areas of LA20C have easily accessible areas of subsurface medium and high oil residue. Outside the bay itself, on the arms at LA21 to the northwest and LA15 to the northeast, oiling occurs sporadically — and occasionally significantly — throughout the segment. (Again, aggressive treatment may have combined with a favorable physical setting at some sites — notably LA15C and LA20A — to produce the best results over these past five seasons.)

These areas will probably continue to improve over time, as others in the western Sound have. However, this does not appear to be acceptable to the people of Chenega Bay, who hunt and fish and beachcomb in the area adjacent to their village on a day to day basis. They have expressed continuing interest in accelerating the improvement through treatment of some kind.

The most heavily oiled areas are significant when compared with others on the survey, and they are near the village. This exacerbates the social and economic effects of the oiling. Perhaps because villagers can locate oil so close to home, they often perceive that the oiling is broader or more extensive — hence the request to survey those 70 additional sites. In fact, our experience on the community surveys tended to support the information on file, which showed that these sites were largely free of oil. However, there are lingering doubts among certain village representatives and they hope that a remediation effort will reduce or eliminate problems both real and perceived.

4.7 Restoration and remediation

In a purely technical sense, beach cleaning at this point — especially by manual means — would likely produce only incremental results. A handful of sites lend themselves to manual work, and the amount of work is probably low relative to the time, money, and effort required to conduct it. (See attached.) Agency representatives from ADNR and the U.S. Forest Service expressed some interest in limited remediation at some sites, but this did not appear from their comments to be a high priority. In Chenega, however, remediation remains a priority.

There may be good policy reasons for pursuing remediation at sites, whether that be in the vicinity of Chenega Bay village or at recreational use sites at Applegate Island. Surface oiling, because it is stabilizing, may be a better target for remediation than subsurface oiling, which appears to be dispersing or breaking up more quickly. It is interesting to note that at some well-surveyed sites on our list, the decrease in subsurface oiling since 1991 is 94 percent. This is probably a high end figure, and not applicable to all kinds of sites, but it is certainly an indicator that subsurface oiling tends to disperse naturally better than surface oiling, especially where aggressive treatment gave the process a boost.

I suggest three practical options for remediation as a restoration strategy:

- *Clean up debris*

We frequently came across rebar, signs, back-stakes, flagging and other evidence of study work at shorelines throughout the area. It would be worthwhile to find out who has marking out there and whether they are still using it. If they're not, it ought to be pulled up.

- *Manual cleanup of selected, high priority sites*

I estimate that one crew, working 30 field days, could complete manual work at 10-12 sites around Chenega Bay if the Trustee Council felt this was an appropriate policy action.

- *Manual remediation of mussel beds that remain oiled.*

This is largely a biological assessment issue that this project did not address. NOAA is studying this problem under a separate restoration project, and there may turn out to be sound biological reasons for removing these sediments rather than waiting for them to disperse naturally. If that turns out to be the case, we have determined that manual remediation at some of the sites is technically feasible, as long as any releases of oil are properly contained and cleaned up.

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Exxon Valdez Trustee Council

1993 Shoreline Assessment

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Project 93038

EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

Lead agency:

Alaska Department of Environmental Conservation

Participating agencies:

***United States Forest Service
Alaska Department of Natural Resources
National Marine Fisheries Service***

Advisory agencies:

***United States Department of the Interior
Alaska Department of Fish and Game
United States Coast Guard***

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November 30, 1993

1.0 Executive summary

The 1993 shoreline assessment team conducted ground surveys and transect surveys at 59 sites in western Prince William Sound from Perry Island in the north to Latouche and Elrington Islands in the south. The team looked at an additional 20-25 sites requested for survey by the public. All sites were originally oiled in 1989 following the Exxon Valdez oil spill. The 1993 field work began June 4 and ended September 27.

- Oil residue — either surface or subsurface — was present at every one of the 59 study sites, and sheening occurred at some.

- Surface oiling has become very stable. There was no measurable reduction in surface asphalt and surface oil residue from 1992 to 1993.

- Oiling was not continuous throughout the study sites.

- Within the 59 study sites, the 1993 survey discovered 109 distinct areas with visually detectable surface oil. The areas of these sites ranged from four square meters to several thousand square meters, with varying percentages of oil coverage.

- Also within the 59 study sites, the survey documented 69 distinct areas of subsurface oiling that could be described as high oil residue or oil saturated sediments, the two heaviest types of concentration. Total estimated volume of this heavily oiled sediment is 738 cubic meters.

- Subsurface oiling overall has decreased substantially since 1991.

- *Overall*, the amount of subsurface oil found at the study sites in 1993 is about 45 percent of the amount found in the same areas in 1991.

— The change at certain *individual* sites is probably greater. The 45 percent figure is probably a low-end number because we actually located more extensive oiling in 1993 than the crew did in 1992. So, while in fact subsurface oiling appears to be *decreasing*, some sites in 1993 will show an *increase*, only because we did a better job of finding the oil. This also dragged down the total rate of change for all sites.

- High-energy sites contain the greatest amount of subsurface oil remaining in 1993.

— This is probably because the high energy sites have more porous substrate and could absorb more oil at the outset.

— Cleanup strategies, such as leaving high-energy sites to be “cleaned” naturally after a certain point, may also have played a part in this.

- Moderate energy sites have shown the least amount of reduction.
- The heaviest concentrations of oil seem to be dispersing at a faster rate than moderate or light concentrations.

— The areas with the heaviest concentrations of oil in 1991 showed the greatest rates of reductions by 1993.

— While differing natural rates of dispersion for heavy and moderate concentrations cannot be ruled out, the more rapid reductions of heavy oil is probably related to the fact that these sites were targeted for cleanup more often than other sites.

- Cleanup effects are becoming more apparent, in terms of oil reductions over time.

— Sites that were heavily tilled or had significant sediment removal in 1991 had slightly higher rates of subsurface oil reduction by 1993 than those that were not worked aggressively.

- Three possible cleanup tasks the Trustee Council may consider are:
 1. Manual remediation of stable surface oiling at sites near Chenega Bay;
 2. Manual remediation of mussel beds, pending results of NOAA restoration studies of this problem;
 3. Removal of rebar, flagging, signs, stakes, and other marking tools left by scientists and cleanup crews at sites around the oiled zone.

November 17, 1993
Review Copy
Draft Restoration Plan

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NOV 30 1993

EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

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Chapter 1

Introduction

Purpose of the Document

In 1989, the *Exxon Valdez* oil spill contaminated thousands of miles of Alaska's coastline. It killed birds, mammals, and fish, and disrupted the ecosystem in the path of the oil. In 1991, Exxon agreed to pay the United States and the State of Alaska \$900 million over ten years to restore the resources injured by the spill, and the reduced or lost services (human uses) they provide. Of that amount, approximately \$600 million remains available to fund restoration activities.

The *Exxon Valdez* Restoration Plan provides long-term guidance for restoring the resources and services injured by the oil spill. It contains policies for making restoration decisions and describes how restoration activities will be implemented.

Background

The Oil Spill. Shortly after midnight on March 24, 1989, the T/V *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska, spilling eleven million gallons of North Slope crude oil. It was the largest tanker spill in United States' history. That spring the oil moved along the coastline of Alaska, contaminating portions of the shoreline of Prince William Sound, the Kenai Peninsula, lower Cook Inlet, the Kodiak Archipelago, and the Alaska Peninsula. Oiled areas include a National Forest, four National Wildlife Refuges, three National Parks, five State Parks, four State Critical Habitat Areas, and a State Game Sanctuary. Oil eventually reached shorelines nearly 600 miles southwest from Bligh Reef where the spill occurred. The map on page two shows the spill area. The spill area includes all of the shoreline oiled by the spill, severely affected communities, and adjacent uplands to the watershed divide.

Response. During 1989, efforts focused on containing and cleaning up the spill, and rescuing oiled wildlife. Skimmers worked to remove oil from the water. Booms were positioned to keep oil from reaching salmon hatcheries in Prince William Sound and Kodiak. A fleet of private fishing vessels known as the "Mosquito Fleet" played an important role in protecting these hatcheries, assisting the skimmers, and capturing oiled wildlife and transporting them to rehabilitation centers. Exxon began to clean up beaches under the direction of the U.S. Coast Guard with advice from federal and state agencies and local communities. Several thousand workers cleaned shorelines, using techniques ranging from cleaning rocks by hand to high pressure hot-water washing. Fertilizers were applied to some oiled shorelines to increase the activity of oil-metabolizing microbes, an activity known as bioremediation.

Spill Area Map

The 1989 shoreline assessment, completed after the summer cleanup ended, showed that a large amount of oil remained on the shorelines. In the spring of 1990, the shoreline was again surveyed in a joint effort by Exxon and the state and federal governments. The survey showed that much work remained to be done in 1990. The principal cleanup method used in 1990 was manually cleaning the remaining oil, but bioremediation and relocation of oiled beach material to the active surf zone were also used in some areas.

Shoreline surveys and limited cleanup work occurred in 1991, 1992, and 1993. In 1992, crews from Exxon and the state and federal governments visited eighty-one sites in Prince William Sound and the Kenai Peninsula. They reported that an estimated seven miles of the 21.4 miles of shoreline surveyed still showed some surface oiling. This number does not include oiling that may have remained on shorelines set aside for monitoring natural recovery. The surveys also indicated that subsurface oil remained at many sites that were heavily oiled in 1989. However, the subsurface oil appears to be inert. No sites were surveyed on Kodiak Island or the Alaska Peninsula in 1992. Earlier surveys suggested that most of the light oil (scattered tar balls and mousse) which remained on Kodiak Island and the Alaska Peninsula would degrade by 1992. While there may be a few exceptions, the surveys determined that the cost and potential environmental impact of further cleanup was greater than the problems caused by leaving the oil in place. Time and funds for assessment were limited, and the 1992 and 1993 assessment and cleanup were concentrated in those areas where oil remained to a greater degree — Prince William Sound and the Kenai Peninsula.

Natural Resource Damage Assessment. During the first summer after the spill, one state and three federal government agencies directed the Natural Resource Damage Assessment field studies to determine the nature and extent of the injuries as needed for litigation purposes. The federal agencies were the U.S. Department of the Interior, U.S. Department of Agriculture, and the National Oceanic and Atmospheric Administration. The state agency was the Alaska Department of Fish and Game. Expert peer reviewers provided independent scientific review of ongoing and planned studies and assisted with synthesis of results. Most damage assessment field studies were completed during 1991.

Settlements

On October 8, 1991, the U.S. District Court approved a plea agreement that resolved various criminal charges against Exxon, and a civil settlement that resolved the claims of the United States and the State of Alaska against Exxon for recovery of civil damages resulting from the oil spill.

The Criminal Plea Agreement. As part of the criminal plea agreement, the court fined Exxon \$150 million -- the largest fine ever imposed for an environmental crime. Of this amount, \$125 million was remitted due to Exxon's cooperation with the governments during the cleanup, timely payment of many private claims, and environmental precautions taken since the oil spill. Of the remaining \$25 million, \$12 million was paid to the North American Wetlands Conservation Fund

for wetlands enhancement in the U.S., Canada and Mexico, and \$13 million was paid to the federal treasury. As part of the Plea Agreement, Exxon also agreed to pay restitution of \$50 million to the United States and \$50 million to the State of Alaska. The state and federal governments separately manage these \$50 million payments. Funds from the criminal plea agreement are *not* under the authority of the Trustee Council, and the use of these funds is not guided by this plan.

Civil Settlement and Restoration Fund. The Federal Water Pollution Control Act, 33 USC. 1321 (f)(5) provides the authority for the civil settlement. The civil settlement includes two documents: The first is a Consent Decree between Exxon, the State of Alaska, and the United States that requires Exxon to pay the United States and the State of Alaska \$900 million over a period of ten years. The second is the Memorandum of Agreement between the State of the Alaska and the United States. Both were approved by the U.S District Court.

According to the Consent Decree between Exxon and the state and federal governments, Exxon must make ten annual payments totaling \$900 million. The first payment was made in December 1991; the last payment is due in September 2001. As of November 1993, three payments totaling \$340 million have been received. The payment schedule is provided in Appendix A. The terms of the Consent Decree and Memorandum of Agreement require that funds paid by Exxon are first be used to reimburse the federal and state governments for the costs of cleanup, damage assessment, and litigation. Settlement funds remaining after the reimbursements are to be used for purposes of restoration. The use of the restoration fund is guided by this plan.

The Consent Decree with Exxon also has a reopener provision that allows the governments to claim up to an additional \$100 million between September 1, 2002 and September 1, 2006 to restore one or more resources or habitats that suffered a substantial loss or decline as a result of the spill. The Consent Decree stipulates that any such losses or declines could not reasonably have been known or anticipated from information available at the time of the settlement.

The Memorandum of Agreement provides the rules for spending the restoration funds. Those rules are:

- Restoration funds must be used "...for the purposes of restoring, replacing, enhancing, or acquiring the equivalent of *natural resources* injured as a result of the Oil Spill and the reduced or lost *services* provided by such resources..."
- Restoration funds must be spent on restoration of natural resources in Alaska unless the Trustees unanimously agree that spending funds outside of the state is necessary for effective restoration.
- All decisions made by the Trustees (such as spending restoration funds) must be made by unanimous consent.

The Memorandum of Agreement and other settlement documents define a number of important terms.

Restore or Restoration means any action, in addition to response and cleanup activities required or authorized by state or federal law, which endeavors to restore to their prespill condition any natural resource injured, lost, or destroyed as a result of the Oil Spill and the services provided by the resource or which replaces or substitutes for the injured, lost or destroyed resource and affected services. Restoration includes all phases of injury assessment, restoration, replacement, and enhancement of natural resources, and acquisition of equivalent resources and services.

Replacement or acquisition of the equivalent means compensation for an injured, lost or destroyed resource by substituting another resource that provides the same or substantially similar services as the injured resource.

Enhancement means any action that improves on or creates additional natural resources or services where the basis for improvement is the prespill condition, population, or use.

Natural resources means the land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to or managed by the state or federal governments. Examples of natural resources are birds, fish, mammals, and subtidal plants and animals.

The Consent Decree also provides that funds may be used to restore archaeological sites and artifacts injured or destroyed by the spill.

In addition to restoring natural resources, funds may be used to restore reduced or lost services (human uses) provided by injured natural resources. For example, subsistence, commercial fishing, recreation (including sport fishing, sport hunting, camping, and boating), and tourism are services that were affected by injuries to fish and wildlife. Injured services also include the value derived from simply knowing that a resource exists. (This service is called "passive use.")

Restoration funds may not be used to compensate individuals for their own private losses. For example, the personal loss of income by individual fishermen or commercial guides must be settled through private lawsuits. Although the federal and state governments have settled their claims against Exxon, private lawsuits against Exxon are still pending.

Past Expenditures

Of the \$900 million from the civil settlement, approximately \$600 million remain to fund future restoration activities. A summary of past expenditures is given in the table below. Further detail about the past expenditures from civil settlement funds and a schedule of future payments are presented in Appendix A.

The Civil Settlement Funds as of November 1993

Figures in Millions of Dollars

Past Payments by Exxon	Past Reimbursements, Deductions, Withdrawals & Commitments
\$340 million	\$252.1 million: <ul style="list-style-type: none"> • \$139.1 to reimburse the federal and state governments for past damage assessment, clean-up, response, restoration, and litigation expenses; • \$39.9 deducted by Exxon for costs of cleanup completed after January 1, 1991; • \$15.5 for the 1992 work plan; • \$51.3 for the 1993 work plan (including Kachemak Bay purchase, and downpayment toward purchase of Seal Bay); • \$6.3 for interim funding for the 1994 work plan.
Future Payments	Future Commitments
\$560 million by 2001	Between \$40 - \$70 million, to reimburse the governments for past expenses.
	Total remaining for restoration
	Approximately \$580 - \$610 million
Total Payments	Total Expenses
\$900 million	\$900 million

Post-settlement Trustee Organization

The Clean Water Act requires that the President and the Governor appoint natural resource trustees to oversee the restoration fund. In 1991, three federal and three state trustees were appointed to administer the restoration fund and to restore resources and services injured by the oil spill. The members are:

State of Alaska Trustees

- Commissioner of the Department of Environmental Conservation
- Commissioner of the Department of Fish and Game
- Attorney General

Federal Trustees

- Secretary of the U.S. Department of the Interior
- Secretary of the U.S. Department of Agriculture
- Administrator of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce

The Trustees created the Trustee Council to administer the Restoration Fund. The State Trustees serve directly on the Trustee Council. The Federal Trustees have each appointed a representative in Alaska to serve on the Council.

The Trustee Council uses funds from the civil settlement for activities to restore injured resources and services. It *does not* manage fish and wildlife resources or manage land. Fish and game management decisions are made by fish and game boards, or by appropriate federal or state agencies. The Trustee Council may fund research to provide information to those agencies or other groups.

Public Involvement and Information

The importance of public participation in the restoration process was recognized in the Exxon settlement and is an integral part of the agreement between the state and federal governments. The Memorandum of Agreement and Consent Decree approved by the court specify that:

"...the Trustees shall agree to an organizational structure for decision making under this MOA and shall establish procedures providing for meaningful public participation in the injury assessment and restoration process, which shall include establishment of a public advisory group to advise the Trustees..."

In January 1992, public meetings were held and written comments requested for recommendations about establishing a Public Advisory Group. Comments addressed the role, structure, and operating procedures for the group. The Public Advisory Group was formed in October 1992 to

advise the Trustee Council on all matters relating to the planning, evaluation, and allocation of funds, as well as the planning, evaluation, and conduct of injury assessments and restoration activities. This group consists of seventeen members who represent a cross-section of the interest groups and public affected by and concerned about the spill. There are also two ex-officio members chosen by the Alaska State House of Representatives and the Alaska State Senate.

Additional public meetings were held in May 1992 on the *Restoration Framework Volume I*, which outlined restoration issues and a general framework for restoration. A third set of meetings was held in April-May 1993 to discuss Alternatives for the Draft Restoration Plan. Many of the policies in this plan were suggested by the public during the 1993 meetings.

Most Trustee Council meetings include a public comment period that is teleconferenced to sites in the spill area. Verbatim transcripts of the meetings are available to the public a few days after the meeting. Documents, such as those proposing projects for funding, are distributed for public review before Trustee Council decisions.

Implementing the Restoration Plan

The Restoration Plan provides long-term guidance for restoring the resources and services injured by the oil spill. It does not list individual restoration projects. Each year, the Restoration Plan will be implemented through an annual or multi-year work plan. The work plan describes the projects funded by the Trustee Council from the restoration fund. To be funded, projects must be consistent with the rules for use of the restoration fund (see page 5), and with the policies, objectives, and restoration strategies of this Restoration Plan.

The Trustee Council may change the Restoration Plan in response to new scientific data, or to changing social and economic conditions. However, new scientific data may be incorporated into restoration decisions without the need to change the plan. It will be necessary to change the plan only if the Trustee Council determines that the plan is no longer responsive to restoration needs.

Legal Compliance. This plan and individual restoration projects must comply with a variety of state and federal laws and regulations, including the National Environmental Policy Act (NEPA). Projects that are likely to have little or no significant environmental effect require only minimal additional work. Projects with significant environmental impact may require that an Environmental Assessment or an Environmental Impact Statement be prepared. In addition, other permits may be required before final approval and implementation of the project.

Concepts Important to Understanding this Plan

Public Comment on Alternatives. Many of the policies in this plan respond to issues that were raised during public discussion of the Alternatives for the Draft Restoration Plan (the "newspaper brochure"). The public comment period for alternatives began in April and ended August 6, 1993. Approximately 2,000 people commented during that time. Many of these comments were in response to a questionnaire included in the newspaper brochure that focused public attention on specific policy questions. The policies in the next chapter address those policy questions or other issues raised by the public. To obtain a copy of The *Summary of Public Comment on Alternatives*, please write or call the *Exxon Valdez* Restoration Office. See Appendix D for a complete list of restoration planning documents.

Categories of Restoration. This plan divides restoration activities into four categories:

- General Restoration
- Habitat Protection and Acquisition
- Monitoring and Research
- Public Information and Administration

General Restoration includes a wide variety of restoration activities. Some General Restoration activities will improve the rate of natural recovery by directly manipulating the environment. Other activities protect natural recovery by managing human uses or reducing marine pollution. A few general restoration activities may involve facilities. Facilities may direct human use away from sensitive areas, support other restoration activities, or replace facilities needed for access and damaged by the spill.

Habitat Acquisition and Protection may include the purchase of private land or interest in land such as conservation easements, mineral rights, or timber rights. On existing public land, it may include recommendations for changing agency management practices. Protecting and acquiring land will minimize further injury to resources and services, and will allow recovery to continue unimpeded.

Monitoring and Research includes gathering information about how resources and services are recovering, whether restoration activities are successful, and what continuing problems exist in the general health of the affected ecosystems. It provides important information to help direct the restoration program. In addition, it will provide useful information to resource managers and the scientific community that will help restore the injured resources and services.

Public Information and Administration includes activities required to prepare work plans, negotiate for habitat protection, involve the public, and operate the restoration program. These are necessary administrative expenses that are not attributable to a particular project. The category includes these and other day-to-day public information functions such as responding to public inquiries.

Chapter 2

Policies

This chapter presents policies to guide restoration activities. Each policy addresses an issue that was raised during public discussion of the Alternatives for the Draft Restoration Plan. This chapter lists the policies and then discusses the rationale for each.

Policies

1. The restoration program will take an ecosystem approach.
2. Restoration activities may be considered for any injured resource or service.
3. Most restoration activities will occur within the spill area. However, restoration activities outside the spill area, but within Alaska, may be considered under the following conditions:
 - when the most effective restoration actions for an injured migratory population are in a part of its range outside the spill area, or
 - when the information acquired from research and monitoring activities outside the spill area will be important for restoration or understanding injuries within the spill area.
4. Restoration activities will emphasize resources and services that have not recovered. Resources and services will be enhanced, as appropriate, to promote restoration. Restoration projects should not adversely affect the ecosystem.
5. Projects designed to restore or enhance an injured service:
 - must have a sufficient relationship to an injured resource,
 - must benefit the same user group that was injured, and
 - should be compatible with the character and public uses of the area.
6. Competitive proposals for restoration projects will be encouraged.
7. Restoration projects will be subject to independent scientific review before Trustee Council approval.
8. Meaningful public participation in restoration decisions will be actively solicited.
9. Government agencies will be funded only for restoration work that they do not normally conduct.

Discussion

This section restates each policy and explains the reasons for adopting it.

1. The restoration program will take an ecosystem approach.

Recovery from the oil spill involves restoring the ecosystem as well as restoring individual resources. An ecosystem includes the entire community of organisms that interact with each other and their physical surroundings, including people and their relationship with other organisms. The ecosystem will have recovered when the population of flora and fauna are again present, healthy, and productive; there is a full complement of age classes; and people have the same opportunities for the use of public resources as they would have had if the oil spill not occurred.

For General Restoration activities, preference is given to projects that benefit multiple species rather than to those that benefit a single species. However, effective projects for restoring individual resources will also be considered. This approach will maximize benefits to ecosystems and to injured resources and services.

Habitat Protection and Acquisition emphasizes protection of multiple species, ecosystem areas, such as entire watersheds, or areas around critical habitats. This approach will be more likely to ensure that the habitat supporting an injured resource or service is protected. In some cases, protection of a small area will benefit larger surrounding areas, or provide critical protection to a single resource or service.

Monitoring and Research activities include an ecosystem monitoring and research program. The ecological monitoring and research program will provide an understanding of problems with food sources, habitat requirements, and other ecosystem relationships of an injured resource or service to permit more effective restoration and management.

The public has frequently commented on the need to take an ecosystem approach to restoration. This policy adopts that view.

2. Restoration activities may be considered for any injured resource or service.

This policy allows restoration of any natural resource or service injured by the spill. Data on population injury is incomplete because prespill data is lacking for many resources, and because some resources would require much more study to determine whether a population decline

occurred. Thus, restricting restoration to spill-caused population declines, as some public comments advocated, would result in partial restoration of spill-related injuries. However, all expenditures of settlement funds must be linked to injured resources and services, and the proposed policy would permit restoration activities for all resources and service with a spill-related injury, not just those that suffered a measured decline in population.

Knowledge of spill-related injuries will improve as continuing research and monitoring work provides more information about the effects of the spill. Improved understanding of injuries and ecosystem problems will be incorporated into restoration decisions. Current understanding of injuries is presented in Appendix B.

During the 1993 public review of Alternatives for the Draft Restoration Plan, most people supported targeting activities to all injured resources or services.

3. Most restoration activities will occur within the spill area. However, restoration activities outside the spill area, but within Alaska, may be considered under the following conditions:

- when the most effective restoration actions for an injured migratory population are in a part of its range outside of the spill area, or
- when the information acquired from recovery and monitoring activities outside the spill area will be important for restoration or understanding injuries within the spill area.

This policy directs the majority of funds to be focused on the spill area, where the most serious injur occurred and the need for restoration is greatest. It also provides the flexibility to restore and monitor outside the spill area under limited circumstances. Examples are restoration and monitoring for migratory seabirds and marine mammals.

There is enough need for restoration activities within the spill area and within Alaska to use all of the remaining settlement fund. However, there is also need for flexibility to consider restoration activities outside the spill area. If restoration were prohibited outside the spill area, effective restoration techniques might be excluded. If monitoring were restricted to the spill area, biological information useful for the restoration and management of an injured resource might be missed.

This policy is consistent with the majority of public comment made on the Alternatives for the Draft Restoration Plan. Two-thirds of all comments favored restricting restoration to the spill area because the link to injury is strongest in the spill area, funds are limited, and needs are great in the spill area. Those who favored restoration outside the spill area said that activities can sometimes be more effective there, especially for migratory seabirds and marine mammals.

4. Restoration activities will emphasize resources and services that have not recovered. Resources and services will be enhanced, as appropriate, to promote restoration. Restoration projects should not adversely affect the ecosystem.

This policy focuses restoration efforts on recovery of injured resources and services. These are frequently the resources in most need of attention. The policy also recognizes that protection or other restoration activities may increase populations above the level that existed before the spill.

Some people expressed concern that some restoration activities, such as those that increase populations beyond prespill levels, could upset the natural balance of the ecosystem and divert limited funds away from resources that have not yet recovered. This policy addresses those concerns by discouraging restoration activities that adversely affect the ecosystem.

5. Projects designed to restore or enhance an injured service:

- must have a sufficient relationship to an injured resource,
- must benefit the same user group that was injured, and
- should be compatible with the character and public uses of the area.

The restoration fund may be used to restore the reduced or lost services provided by injured resources. The relationship between the proposed activity and the injured resource which caused the reduced or lost service is the subject of the first part of this policy. The policy requires that a project to restore or enhance an injured service must be sufficiently related to a natural resource. It can be related to a natural resource in various ways. It could directly restore a resource, provide an alternative resource, or restore access or people's use of the resource. The strength of the required relationship has not been defined by law, regulation, or the courts. However, a connection with an injured resource is necessary. In determining whether to fund a project to restore services, the strength of the project's relationship to injured resources will be considered.

A few examples may help understanding. One way to aid commercial fishing is to restore injured salmon runs or to provide alternative runs. However, the restoration fund cannot be used to give cash grants to fishermen to cover spill-related losses. This latter idea is unrelated to an injured resource.

As a second example, recreation was injured, in part, because the resources it relies on were injured. Habitat may be purchased to provide alternative areas for recreation where uninjured resources exist. The restoration fund may also be used to provide access to recreation areas, compatible with the character and public uses of the area. In these cases the restoration activity has a relationship to injured resources — it provides replacement resources or better use of the injured resources. However, the restoration fund could not be used to promote recreation in general, such as through subsidy of a boat show, because there is no relationship to an injured

resource.

The second part of the policy ensures that the injured user groups are the beneficiaries of restoration. If the justification for an action is to restore a service, it is important that the user group that was injured be the one that is helped.

The last part of the policy addresses a public concern about possible changes in the use of the spill area. It allows improvements in the services without producing major changes in use patterns. For example, a mooring buoy in an anchorage may improve boating safety without changing patterns of use. Projects to be avoided are those that create different uses for an area, such as constructing a small-boat servicing facility in an area that is wild and undeveloped.

During the review of the Alternatives for the Draft Restoration Plan, public comments varied on the issue of using restoration funds for providing opportunities for human use. Some responses opposed providing these opportunities, because people said that human use is unrelated to restoration. Others favored actions that decrease the impact of human use or said that these kinds of projects would improve the lifestyle of those affected by the spill.

6. Competitive proposals for restoration projects will be encouraged.

Most restoration projects have been undertaken by state or federal agencies. However, the number of competitive contracts awarded to nongovernmental agencies have increased each year and will continue to increase.

This policy encourages active participation from individuals and groups in addition to the trustee agencies and may generate innovation and cost savings. This approach may be inappropriate for some restoration projects, but, where appropriate, competitive proposals will be sought for new project ideas and to implement the projects themselves.

7. Restoration projects will be subject to independent scientific review before Trustee Council approval.

This policy continues an existing practice. Independent scientific review gives an objective evaluation of the scientific merits of the project. It also better assures the public that scientific judgements are without bias.

8. Meaningful public participation in restoration decisions will be actively solicited.

Public participation has been an important part of the restoration process, and a public concern since the spill occurred. This policy continues existing practices. Public review and user group participation will continue to play a key role in future Trustee Council activities such as developing work plans, and will precede Trustee Council decisions.

9. Government agencies will be funded only for restoration work that they do not normally conduct.

Many public comments have expressed concern that restoration funds will support activities that government agencies would do anyway. This policy addresses that concern. It also affirms the practice that has been in effect since the beginning of the restoration process. To determine whether work is normally conducted by agencies, the Trustee Council will consider agency authorities and the historic level of agency activities. An agency may be funded to accomplish a restoration task if the work is beyond that usually conducted by that agency. For example, a task may be beyond the usual level of agency activities because it is not within the agency's legislative authorities, or because historic budget levels have not allowed the agency to accomplish it.

Chapter 3

Categories of Restoration Actions

The restoration program includes four categories of restoration actions: General Restoration, Habitat Protection and Acquisition, Monitoring and Research, and Public Information and Administration. This chapter describes activities within each category. It also describes how decisions are made about projects and presents policies that apply to each category.

The Alternatives for the Draft Restoration Plan asked the public to indicate the emphasis they would place on each restoration category. Although this approach was useful in asking the public about the relative importance to place on these categories, this plan does not prescribe a fixed allocation of the restoration fund. The restoration program must be able to respond to changing conditions and new information about injury, recovery, and the cost and effectiveness of restoration projects. When making annual funding decisions, the Trustee Council will use the public comments received on the restoration alternatives as well as comments that may be received in the future.

General Restoration

General Restoration activities are a principal tool used to focus on the restoration of individual injured resources and services. General Restoration includes a wide variety of restoration activities. This plan uses the term to include all activities that are not Habitat Protection and Acquisition, Monitoring and Research, or Public Information and Administration. General Restoration activities fall into one of the following three types:

- Manipulation of the Environment;
- Management of Human Use; or
- Reduction of Marine Pollution.

A few General Restoration activities will improve the rate of natural recovery. Most of these activities involve manipulation of the environment. Other activities protect natural recovery by managing human uses or reducing marine pollution. A few general restoration activities may involve facilities. Facilities may direct human use away from sensitive areas, support other restoration activities, or replace facilities needed for access and damaged by the spill.

Manipulation of the Environment. Some General Restoration techniques restore injured resources and services by directly manipulating the environment. Examples include building fish passes to restore fish populations, or replanting seaweed to restore the intertidal zone to prespill conditions.

A common public comment on alternatives was that manipulation of the environment has the potential to adversely affect the ecosystem. While some people recommended individual projects,

others recommended relying on natural recovery where appropriate.

When evaluating projects that manipulate the environment, the potential for adverse effects on the ecosystem will be considered. Those projects that will effectively accomplish an important restoration objective without adversely affecting the ecosystem are more likely to be funded.

Management of Human Use. Some General Restoration projects involve managing human use to aid restoration. Examples include redirecting hunting and fishing harvest, or reducing human disturbance around sensitive bird colonies. Many projects that manage human use do so to protect injured resources, services, or their habitat.

Reduction of Marine Pollution. Reducing marine pollution can remove a source of stress that may delay natural recovery. The public frequently recommended preventive actions to stop ongoing marine pollution. However, expenditures for most activities designed to prevent catastrophic oil spills or to plan for their cleanup are not allowed by the terms of the civil settlement.

Restoration projects whose primary emphasis is to reduce marine pollution may be considered:

- where the marine pollution is likely to affect the recovery of a part of the injured marine ecosystem, or of injured resources or services; and
- where the project will not duplicate existing agency activities.

Making Decisions about General Restoration Projects

Deciding which General Restoration projects deserve funding involves deciding which restoration tasks are most important, and which projects best accomplish those tasks. When assessing the importance of a General Restoration project, at least the following factors will be considered:

- *Natural recovery.* Is the resource or service recovering? Is it likely to recover even if the General Restoration project is not funded? Will recovery take a very long time? Will the project significantly decrease the time to recovery?
- *The value of an injured resource to the ecosystem and to the public.* Is the resource an endangered or threatened species? What is its ecological significance? To what extent is it used for human purposes such as commercial fishing, recreation, or subsistence?
- *Duration of benefits.* Will the benefits be recognized twenty or thirty years from now?
- *Technical feasibility.* Are the technology and the management skills available to successfully implement the project? Projects of unproven feasibility may be funded if demonstrating the feasibility and then carrying out the project is likely to be an effective method of achieving restoration.

- *Likelihood of Success.* If a project is successfully implemented, how likely is it to accomplish its objective? Is it possible to tell whether a project has an effect on recovery?
- *Relationship of costs to expected benefits.* Do benefits equal or exceed costs? Ability to meet this criterion will not be based on a cost/benefit analysis, but on a broad consideration of the direct and indirect costs, and the primary and secondary benefits. It will also take into account whether there is a less expensive method of achieving substantially similar results.
- *Will the project cause harmful side effects?* Restoration projects should neither adversely affect ecosystem relations nor adversely affect any injured or noninjured resource or service.
- *Will the project help a single resource or benefit multiple resources?* Preference will be given to projects that benefit multiple resources rather than to those that benefit a single resource. However, appropriate single-resource projects will be considered when they provide effective restoration. This approach will maximize benefits to ecosystem and to injured resources and services.
- *Effects on health and human safety.* Are there any potential health or safety hazards to the general public?
- *Consistency with applicable laws and policies.* Is the project consistent with federal and state laws and regulations, and with the policies of this plan?
- *Duplication.* Does a project duplicate the actions of another agency or group?

Habitat Protection and Acquisition

Habitat protection and acquisition is one of the principal tools of restoration. It is important in ensuring continued recovery in the spill area.

Resource development such as harvesting timber or building subdivisions may harm habitat that supports resources or services. Protecting and acquiring land will minimize further injury to resources and services already injured by the spill, and to allow recovery to continue with the least interference. For example, the recovery of harlequin ducks might be helped by protecting nesting habitat from future changes that may hamper recovery.

Habitat protection and acquisition may include purchase of private land or interests in land such as conservation easements, mineral rights, or timber rights. Different payment options are possible, including multi-year payment schedules to a landowner. Acquired lands would be managed to protect injured resources and services. In addition, cooperative agreements with private owners to provide increased habitat protection are also possible.

Most public comments on the restoration alternatives favored using habitat protection and acquisition as a means of restoration. In addition, most of those who commented also asked that it receive a majority of the remaining settlement fund.

In the Alternatives for the Draft Restoration Plan, the public was asked to describe areas they would like the Trustee Council to acquire or protect. Many people recommended areas for purchase. The areas recommended are distributed throughout the spill area and are listed in Appendix C.

If restoration funds are used to protect a parcel, it must contain habitat important to an injured resource or service. The following injured resources might benefit from the purchase of private land or property rights: pink and sockeye salmon, Dolly Varden and cutthroat trout, Pacific herring, bald eagle, black oystercatcher, common murre, harbor seal, harlequin duck, marbled murrelet, pigeon guillemot, river otter, sea otter, intertidal organisms, and archaeological sites.

Habitat protection and acquisition is a means of restoring not only injured resources, but also the services (human use) dependent on those resources. Subsistence, recreation, and tourism, benefit from the protection of important fish and wildlife habitats, scenic areas such as those viewed from important recreation or tourist routes, or important subsistence harvest areas. For example, protecting salmon spawning streams will benefit not only the salmon, but also commercial, subsistence and recreational fishermen.

Habitat protection on existing public land and water may include recommendations for changing agency management practices. The purpose, in appropriate situations, is to increase the level of protection for recovering resources and services above that provided by existing management practices. The Trustee Council may conduct studies to determine if changes to public land and

water management would help restore injured resources and services. If appropriate, changes will be recommended to state and federal management agencies. Recommendations for special designations, such as parks, critical habitats, or recreation areas, may be made to the Alaska legislature or the U.S. Congress.

Habitat and Acquisition Protection Policies

In addition to the policies of Chapter 2, the following specific policies apply to Habitat Protection and Acquisition.

- Private lands considered for purchase will be ranked according to the potential benefits that purchase and protection would provide to injured resources and services. Those parcels that greatly benefit the injured resources and services will be highly ranked.
- State and federal governments will purchase lands on the basis of a willing seller and a willing buyer.
- In order to make the best use of restoration funds, purchases will in most cases not exceed fair market value. Appraisal of individual parcels of land will precede all purchases.
- Habitat protection will follow an ecosystem approach by emphasizing acquisition of large parcels, such as watersheds, that support multiple injured species and ecologically linked groups of species. Protecting and acquiring small parcels may benefit larger surrounding areas, provide access to public land, or provide critical benefits to a single resource or service.
- Public comments will be considered when determining habitat protection priorities. Many comments about specific parcels have already been received.
- Acquired land will be managed by the most appropriate state or federal agency based on the resources to be protected, management needs, and ownership of surrounding and nearby lands.
- Except where specific restoration activities for acquired land exceeds normal agency efforts, land management costs will be met from existing agency budgets.
- Lands acquired with restoration funds will be managed in a manner benefitting injured resources and services. Covenants that outline management objectives will be determined by the time of purchase.

Making Decisions About Habitat Protection and Acquisition

The Restoration Plan provides general guidance for Habitat Protection and Acquisition activities. More detailed guidance will be given in the *Comprehensive Habitat Protection and Acquisition Process: Large Parcel* Evaluation and Ranking. That document will be completed in late November 1993. This comprehensive process will outline criteria and procedures for evaluating and ranking large parcels of private lands for protection and acquisition.

The large parcel analysis will address private property parcels larger than 1,000 acres that are within the spill area and whose owners have indicated an interest in having their lands evaluated for the protection and acquisition program. Smaller parcels may be evaluated in the future. For each parcel of land, the Trustee Council will decide the type of protection or ownership rights needed for restoration, and how it will be managed. In addition, for each parcel the Council will decide whether and when to begin negotiations with the landowner. The type of protection and management will also be the subject of negotiation with the landowner.

Monitoring and Research

The monitoring and research program provides important information to help guide restoration activities. This information includes how well resources and services are recovering, whether restoration activities are successful, and what continuing problems exist in the general health of the affected ecosystems.

A lack of long-term research into ecosystem relationships and problems may result in less effective restoration and possibly continued injury. Inadequate information may require managers to unduly restrict human use of the resources, and could compound the injury to services such as commercial fishing and subsistence. Inadequate information may also lead to management actions that inadvertently reduce the productivity and health of a resource, inappropriate restoration actions, or restoration opportunities missed for lack of knowledge.

The monitoring and research program includes three parts:

- Recovery Monitoring;
- Restoration Monitoring; and
- An Ecological Monitoring and Research Program.

Recovery Monitoring. Information about recovery is important in designing restoration activities, and determining which activities deserve funding. Recovery monitoring will track the rate and degree of recovery of the resources and services injured by the spill. It will also determine when recovery has occurred. For resources that are already recovering, it may detect reversals or problems with recovery. For resources that are not recovering, recovery monitoring will determine the status of the injury, whether it is worsening, and when the population stabilizes or recovery begins.

Restoration Monitoring. To maintain an effective restoration program, the Trustee Council must learn whether the projects it funds accomplish their purposes. Restoration monitoring will provide that assessment. It evaluates the effectiveness of individual restoration activities. Most restoration projects will incorporate evaluation procedures into their project design.

An Ecological Monitoring and Research Program. This program will provide information about key relationships in the ecosystem that affect injured resources and services. For example, understanding problems with food sources, habitat requirements, and other ecosystem relationships of an injured resource or service will provide information for more effective restoration and management. The program may include research to determine why some resources are not recovering. It may also provide a baseline for early identification of future problems. Finally, the Ecological Monitoring and Research program may also provide new information about previously unknown spill injuries or change the understanding about known injuries.

Long-term Monitoring and Research: Recovery Monitoring, and Ecological Monitoring and Research After 2001. The need for monitoring the status of spill-affected ecosystems will continue for a long time. For example, some salmon return in cycles of four to six years, and other resources have lives that are much longer. To be effective, monitoring may have to span more than one salmon generation. Sometimes research is necessary to understand why a resource is not recovering. In many cases, research must precede effective restoration or improved management decisions that will protect a resource or service. For these reasons, some research and monitoring activities will require long study times.

Long-term research cannot be accomplished without long-term funding. Because the monitoring and research program is currently being developed, a reliable estimate of long-term funding needs is not available. The Trustee Council will provide funding to continue monitoring and research activities after the last Exxon payment is made in 2001. However, until the program is designed and more cost information is known, the amount of money, length of time, and funding mechanisms cannot be determined.

Other Monitoring and Research Policies

In addition to the policies of Chapter 2, the following specific policies apply to Monitoring and Research.

- The Trustee Council will make or approve funding decisions about monitoring and research activities. The Council is responsible for the restoration of resources and services, including the monitoring and research component of restoration, and cannot assign that responsibility elsewhere.
- Monitoring and research proposals, as well as the overall program design, will be subject to independent scientific review. Without independent review, the Trustee Council and the public cannot be assured that scientific judgements are free of bias.
- Local advice about problems and priorities will be integrated into the decision process. The spill area is over 600 miles long. The ecological conditions and problems of the Kodiak Area are different from those of Prince William Sound. For the program to be responsive to local conditions, local advice must be integrated into the annual and long-term decisions about problems, projects, and priorities.
- To ensure the maximum benefit from a monitoring and research program, all parts of the program must be integrated, and techniques and protocols should be consistent where appropriate. As much as possible, the program should follow a long-term plan.
- The monitoring and research program will be integrated with existing monitoring and research activities by agencies and other groups, but it will not duplicate or replace them.

Public Information and Administration

Funding is required to prepare work plans, negotiate for habitat purchases, involve the public, and operate the restoration program. These are necessary administrative expenses that are not attributable to a particular project. The Public Information and Administration category includes these and other day-to-day public information functions such as responding to public inquiries.

The public has voiced concern that too much money is being spent on administration. Administrative expenses averaged 26% of the 1992 work plan, and 8% of the 1993 work plan. As more restoration activities occur, and as initial planning and implementation expenses are finished, administrative expenses will decrease both in absolute terms and as a percentage of the work plan.

Public Information and Administration Policy

The Trustee Council will seek to minimize the administrative cost of the restoration program. The goal is for administrative costs to average no more than 5% of overall restoration expenditures over the remainder of the settlement period (through October 2001).

Chapter 4

Objectives

The goal of restoration is recovery of all injured resources and services. This chapter expresses objectives to meet this goal. Objectives are defined as the recovery of individual injured resources and services. This chapter also presents strategies for achieving objectives. For some resources, little is known about their injury and recovery, so it is difficult to define recovery or develop restoration strategies.

In general, resources and services will have recovered when they return to conditions that would have existed had the spill not occurred. Because it is difficult to predict conditions that would have existed in the absence of the spill, recovery is often defined as a return to prespill conditions. For resources that were in decline before the spill, like marbled murrelets, recovery may consist of stabilizing the population at a lower level than before the spill.

Where there were little prespill data, injury is inferred from comparison of oiled and unoiled areas and recovery is usually defined as a return to conditions comparable to those of unoiled areas. Because the differences between oiled and unoiled areas may have existed before the spill, statements of injury and definitions of recovery based on these differences are often less certain than in those cases where prespill data exist. However, there can also be some uncertainty associated with interpreting the significance of prespill population data since populations undergo natural fluctuations. Indicators of recovery can include increased numbers of individuals, reproductive success, improved growth and survival rates, and normal age and sex composition of the injured population.

Restoration strategies are presented under three headings: Natural Resources, Other Resources, and Services. Because restoration strategies for natural resources differ according to the degree of recovery, they are subdivided into strategies for recovering resources, resources that are not recovering, and resources whose recovery is unknown.

The combination of individual restoration objectives and strategies into a unified restoration program will result in an ecosystem approach that recognizes the interconnections between species, and between species and their physical environment. The definitions of recovery and the restoration strategies also reflect consideration of ecosystem relationships. For example, recovery of intertidal and subtidal communities are defined, in part, as a return to ecosystem functions and services that would have existed in the absence of the spill; and the restoration strategy for some injured resources includes research into why they are not recovering, such as declining or contaminated food sources or disruption of ecosystem relationships. Appendix B presents more detailed information about the status of injury and recovery of resources and services.

Natural Resources

Recovering Resources

The following resources are believed to be recovering. This list is expected to change as the condition of injured resources changes and knowledge about them improves.

Bald eagles

Black oystercatchers

Killer whales

Sockeye salmon (Red Lake)

Restoration Strategy. Restoration of recovering resources will rely primarily on natural recovery because, for most recovering resources:

- They are expected to fully recover over time;
- People can do little to accelerate their recovery; and
- Waiting for natural recovery is not likely to significantly harm a community or industry in the long term. (Subsistence, commercial fishing, and recreation are addressed under "Services.")

However, if a resource is not expected to recover fully on its own or if waiting for natural recovery will cause long-term harm to a community or service, alternate means of restoration would be considered.

The restoration strategy for recovering resources has three parts:

Rely on natural recovery. Natural processes aided by protective measures will be the main agents of restoration.

Monitor recovery. For resources believed to be recovering, the monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that a resource may not recover as expected, alternate means of restoration will be considered.

Protect injured resources and their habitats. Recovering resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Definitions of Recovery. This section defines recovery for each recovering resource.

Bald eagles: 200 to 300 bald eagles may have been killed in the spill. However, population estimates made in 1989, 1990, and 1991 indicate that there may have been an increase in the

bald eagle population since the previous survey conducted in 1984. Productivity also decreased in 1989, but appeared to have recovered by 1990. Because population and productivity appear to have returned to prespill levels, bald eagles may have already recovered from the effects of the spill.

Black oystercatchers are recovering, although they may still be exposed to hydrocarbons when feeding in intertidal areas. They will have recovered when populations attain prespill levels and when reproduction and growth in oiled areas are comparable to those in unoiled areas.

Killer whales: Thirteen whales disappeared from one pod in Prince William Sound between 1988 and 1990. The injured pod is growing again. Killer whales will have recovered when the injured pod grows to at least 36 individuals (1988 level).

Sockeye salmon (Red Lake) declined in population because of adult overescapement in 1989. The Red Lake system may be recovering because the plankton has recovered and fry survival improved in 1993. Sockeye salmon in Red Lake will have recovered when populations are healthy and productive and exist at prespill abundances. One indication of recovery is when fry production in Red Lake is at prespill levels.

Resources Not Recovering

The following resources show little or no sign of recovery nearly five years after the spill. This list is expected to change as the condition of injured resources changes and knowledge about them improves.

Common murre	Pigeon guillemots
Harbor seals	Pink salmon
Harlequin ducks	Sea otters
Intertidal Ecosystem	Sockeye salmon (Kenai River)
Marbled murrelets	Subtidal Ecosystem
Pacific herring	

Restoration Strategy. Except for certain protective measures, attempts to restore these resources without knowing why they are not recovering may be ineffectual or even detrimental. For this reason, the restoration strategy for these resources emphasizes determining why they are not recovering and eliminating threats to the remaining populations. Where sufficient knowledge about the nature of injury exists, the restoration strategy also encourages actions to promote recovery because:

- The populations of some of these resources are in a steep decline and may not recover without help; and
- Some of these resources have subsistence or economic importance and their recovery

is linked to the recovery of these services. (Restoration strategies under "Services" also apply to these resources.)

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

Conduct research to find out why these resources are not recovering. Effective restoration requires an understanding of why resources are not recovering. For some resources the reason is known; however, for most the reason is unknown. Suspected causes include declining or contaminated food sources and disruption of ecosystem relationships.

Initiate, sustain, or accelerate recovery. The primary objective is to initiate recovery if possible. Once a resource is recovering, decisions about continuing restoration to sustain or accelerate the rate of recovery would depend on such factors as the cost and benefits of additional restoration activities and the importance of the resource for recovery of a service. However, if a resource is expected to recover fully through natural recovery alone and waiting for natural recovery to occur will not cause long-term harm to a community or industry, the restoration strategy would rely primarily on natural recovery.

Monitor recovery. The monitoring program will track changes in the condition of these resources. The condition of these resources may change due to natural causes or restoration actions.

Protect injured resources and their habitats. While protective measures alone may not ensure the recovery of these resources, they may prevent additional impacts due to loss of habitat and other disturbances. Protection and acquisition of important habitat, protective management practices, or the reduction of marine pollution are principal ways of providing protection.

Definition of Recovery. This section defines recovery for each resource that is not recovering. Some of these resources were in decline before the spill and may never return to prespill levels.

*Common murre*s show signs of recovery in some colonies. However, breeding is still inhibited in some colonies, although differences in breeding patterns may be attributable to conditions that existed before the spill. They will have recovered when populations return to prespill levels at all the injured colonies.

Harbor seals were in decline before the spill. Census counts from 1990 to 1992 at haulouts in Prince William Sound may indicate that the population has stabilized in the Sound. If the population has stabilized, normal growth may replace the animals lost. However, if the long-term decline continues, the affected population may not recover. Recovery will have occurred when harbor seals within the oiled area are at a population level comparable to that which would likely have occurred in the absence of the spill.

Harlequin ducks: There are indications of population decline and possibly reproductive failure. Harlequin ducks will have recovered when populations have returned to prespill levels, or when differences between oiled and unoled areas are eliminated.

Intertidal ecosystem: The lower intertidal zone and, to some extent, the middle intertidal zone are recovering. However, injuries persist in the upper intertidal zone, especially on rocky sheltered shores. Recovery of this zone appears to depend, in part, on the return of adult *Fucus* in large numbers. Intertidal communities in the upper intertidal zone will have recovered when community composition, population abundance of component species, and ecosystem functions and services in each injured intertidal habitat have returned to levels that would have prevailed in the absence of the oil spill.

Marbled murrelets and pigeon guillemots were in decline before the spill and may not attain prespill population levels. The causes of the prespill decline are unknown, but the decline is expected to continue. They will have recovered when population trends are stable or increasing.

Pacific herring studies have demonstrated egg mortality and larval deformities. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, the stocks in Prince William Sound do not appear to be healthy. They will have recovered when populations are healthy and productive and exist at prespill abundances. One indication of recovery is when the age-class structure and the relative strength of the spawning run in Prince William Sound are comparable to those in Sitka Sound. Historically, the size and age structure of herring populations in Prince William Sound and Sitka Sound have been closely correlated.

Pink salmon studies have demonstrated egg mortality, fry deformities, and reduced growth in juveniles. Populations may have declined, but there is uncertainty as to the full extent and mechanism of injury. However, the stocks in Prince William Sound do not appear to be healthy. They will have recovered when populations are healthy and productive and exist at prespill abundances. An indication of recovery is when egg mortalities in oiled areas match prespill levels or levels in unoled areas.

Sea otters do not appear to be recovering, but are expected to eventually recover to their prespill population. Exactly what population increases would constitute recovery is very uncertain, as there are no population data from 1986 to 1989 and the population may have been increasing in Eastern Prince William Sound during that time. In addition, only large changes in the population can be reliably detected with current measuring techniques. However, there are recent indications that the patterns of juvenile and mid-aged mortalities are returning to prespill conditions. Sea otters will be considered recovered when population abundance and distribution are comparable to prespill abundance and distribution, and when all ages appear healthy.

Sockeye salmon (Kenai River): Because of fisheries closures in 1989, a third year of high escapements of adult salmon exceeded the fry rearing capacity of the lakes in the Kenai River system. Smolt production declined from 30 million in 1989 to six million in 1990 and continued to decline to less than one million in 1992 and 1993. Sockeye salmon will have recovered when populations are healthy and productive and exist at prespill levels. One indication of recovery is when Kenai and Skilak Lakes support sockeye Smolt outmigrations comparable to prespill levels.

Subtidal ecosystem: Certain subtidal organisms, like eelgrass and some species of algae, appear to be recovering. Other subtidal organisms, like leather stars and helmet crabs, showed little sign of recovery through 1991. Subtidal communities will have recovered when community composition, population abundance of component species, and ecosystem functions and services in each injured subtidal habitat have returned to levels that would have prevailed in the absence of the oil spill.

Recovery Unknown

It is not known whether the following resources are recovering because insufficient data are available. This list may be modified as knowledge about these resources improves.

Clams
Cutthroat trout
Dolly Varden

River otter
Rockfish

Restoration Strategy. Until more is known about the nature and extent of injuries and the degree of recovery for these resources, restoration will rely primarily on natural recovery, aided by monitoring and protective measures.

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

Rely on natural recovery. Natural processes aided by protective measures will be the main agents of restoration.

Monitor recovery. For resources whose recovery is unknown, the monitoring program will track the progress of recovery and detect major reversals. If results of the monitoring program suggest that a resource is not recovering, alternate means of restoration will be considered.

Protect injured resources and their habitats. All injured resources need protection from other sources of potential injury. Protection and acquisition of important habitat, protective management practices, and the reduction of marine pollution are principal ways of providing protection.

Definition of Recovery. This section defines recovery for each resource for which the status of recovery is unknown.

Clams: Littleneck clams and butter clams on sheltered beaches were killed by oiling and cleanup activities. In addition, growth appeared to be reduced by oil, but determination of sublethal or chronic effects is awaiting final analyses. Clams will have recovered when populations and productivity are at prespill levels.

Cutthroat trout and Dolly Varden have grown more slowly in oiled areas than in unoiled areas. They will have recovered when growth rates within oiled areas are comparable to those for unoiled areas.

River otters may have suffered sublethal effects from the spill and continuing exposure to hydrocarbons. Indications of recovery are when habitat use and physiological indices have returned to prespill conditions.

Rockfish were exposed to hydrocarbons and showed sublethal effects. Furthermore, closures to salmon fisheries increased fishing pressures on rockfish which may be affecting their population. However, the extent and mechanism of injury to this species are unknown. Without further study, recovery cannot be defined.

Other Resources

Archaeological Resources

Injury to archaeological resources stems from increased looting and vandalism of sites and artifacts, and erosion within and around the sites resulting from cleanup activities. In addition, archaeological artifacts may have been oiled. Injuries attributed to looting and vandalism still occur. These injuries diminish the availability or quality of scientific data and opportunities to learn about the cultural heritage of people in the spill area.

Archaeological resources cannot recover in the same sense as biological resources. Restoration cannot regenerate what has been destroyed, but it can prevent further degradation of both sites and the scientific information that would otherwise be lost.

Restoration Strategy. The restoration strategy for archaeological resources has three parts:

Repair spill-related injury to archaeological sites and artifacts. Injuries may be repaired to some extent through stabilizing eroding sites, or removing and restoring artifacts.

Protect sites and artifacts from further injury and store them in appropriate facilities. Archaeological sites and artifacts could be protected from further injury through the reduction

of looting and vandalism, or the removal of artifacts from sites and storage in an appropriate facility. Opportunity for people to view or learn about the cultural heritage of people in the spill area would also provide protection by increasing awareness and appreciation of cultural heritage and would replace services lost as a result of irretrievable damage to some artifacts.

Monitor recovery. Monitoring of archaeological resources may detect increases or decreases in rates of looting, vandalism and erosion of archaeological sites.

Definition of Recovery. Because they are nonrenewable, archaeological resources cannot recover in the same sense as biological resources. They will be considered recovered when spill-related injury ends, and looting and vandalism are at or below prespill levels.

Designated Wilderness Areas

The oil spill delivered oil in varying quantities to the waters adjoining the seven areas designated as wilderness within the spill area. Oil was also deposited above the mean high tide line in these areas. During the intense cleanup seasons of 1989 to 1990, hundreds of workers and thousands of pieces of equipment were at work in the spill area. This activity was an unprecedented imposition of people, noise and activity on the area's undeveloped and normally sparsely occupied landscape.

Restoration Strategy. Any restoration objective which aids recovery of injured resources, or prevents further injuries, will assist recovery of designated wilderness areas. No objectives have been identified which benefit only designated wilderness areas without also addressing injured resources.

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

Services

Subsistence

Subsistence users say that maintaining their subsistence culture depends upon uninterrupted use of subsistence resources. The more time users spend away from subsistence activities, the less likely they will return to it. Continuing injury to natural resources used for subsistence may affect the way of life of entire communities.

Residual oil exists on some beaches with high value for subsistence. Continued presence of hydrocarbons may contaminate subsistence food resources or, at a minimum, create

uncertainty about the safety of subsistence food resources that reduces their use and value for subsistence.

Restoration Strategy. Restoration of fish and wildlife resources are covered elsewhere in this chapter. The restoration strategy for subsistence services has four parts:

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

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

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

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

Definition of Recovery. Subsistence will have recovered when injured subsistence resources are healthy and productive and exist at prespill levels and people are confident that the resources are safe to eat. One indication that recovery has occurred is when the cultural values provided by gathering, preparing, and sharing food are reintegrated into community life.

Commercial Fishing

Commercial fishing was injured through injury to commercial fish species and also through fishing closures. Continuing injuries to commercial fishing may cause hardships for fishermen and related businesses. Each year that commercial fishing remains below prespill levels compounds the injury to the fishermen and, in many instances, the communities in which they live or work.

The Trustee Council recognizes the impact to communities and people of the Prince William Sound region resulting from the sharp drop in pink salmon and herring fisheries in past years. In the 1994 work program, the Trustee Council has committed to the expenditure of five million dollars to help address these issues through the development of an ecosystem study for Prince William Sound. The Council will continue to address these important problems as they relate to the oil spill.

Restoration Strategy. Restoration of fish and wildlife resources are covered elsewhere in this chapter. The restoration strategy for commercial fishing has three parts:

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

Protect commercial fish resources from further degradation. Further stress on commercial fish resources could impede recovery. Appropriate protection can take the form of habitat protection and acquisition if a resource faces loss of habitat. Protective action could also include protective management practices if a resource or service faces further injury from human use and activities.

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

Definition of Recovery. Commercial fishing will have recovered when the population levels and distribution of injured or replacement fish used by the commercial fish industry match prespill conditions.

Recreation and Tourism

The spill disrupted use of the spill area for recreation and tourism. Resources important for wildlife viewing include killer whale, sea otter, harbor seal, bald eagle, and various seabirds. Residual oil exists on some beaches with high value for recreation. It may decrease the quality of recreational experience and discourage recreational use of these beaches.

Closures on sport hunting and fishing also affected use of the spill area for recreation and tourism. Sport fishing resources include salmon, Rockfish, Dolly Varden, and cutthroat trout. Harlequin duck are hunted in the spill area.

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

Restoration Strategy. Restoration of fish and wildlife resources are covered elsewhere in this chapter. The following strategy applies specifically to recreation and tourism services.

Preserve or improve the recreational and tourism values of the spill area. Habitat protection and acquisition are important means of preserving and enhancing the opportunities offered by the spill area. Facilities damaged during cleanup may be repaired if they are still needed.

New facilities may restore or enhance opportunities for recreational use of natural resources. Improved or intensified public recreation management may be warranted in some circumstances. Projects that restore or enhance recreation and tourism would be considered only if they are consistent with the character and public uses of the area.

Remove or reduce residual oil if it is cost effective and less harmful than leaving it in place.

Removal of residual oil on beaches with high value for recreation and tourism may restore these services for some users. However, this benefit would have to be balanced against cost and the potential for disrupting the recovering intertidal ecosystem.

Monitor recovery. Monitoring the recovery of recreation and tourism services will track the progress of recovery, detect major reversals, and identify problems with the resources and resource management that may affect the rate or degree of recovery.

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

Passive Uses

Passive use of resources includes the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other nonuse values. Injuries to passive uses are tied to public perceptions of injured resources.

Restoration Strategy. Any restoration objective which aids recovery of injured resources, or prevents further injuries, will assist recovery of passive use values. No objectives have been identified which benefit only passive uses, without also addressing injured resources. Since recovery of passive uses requires that people know when recovery has occurred, the availability to the public of the latest scientific information will continue to play an important role in the restoration of passive uses.

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

Appendix A

Allocation of the Civil Settlement Fund (November 1993)

In a civil settlement, Exxon Corporation agreed to pay the United States and the State of Alaska \$900 million over a 10-year period to restore resources injured and services reduced or lost as a result of the *Exxon Valdez* oil spill.

Table A-1 shows the schedule of payments over this period.

As of September 1993, \$340 million of the \$900 million civil settlement had been paid by Exxon Corporation. Exxon makes its payments to a Joint Trust Fund held by the U.S. District Court for use by the Trustee Council. About \$250 million has been reimbursed to the governments, credited to Exxon, or committed for restoration or damage assessment. Some of the approved expenditures have not yet been withdrawn from the Joint Trust Fund.

Table A-2 presents the allocation of expenditures as of November 1993. Although only 38% of the \$900 million settlement has been received, expenditures are shown as percentages of the total settlement: 16% has been reimbursed to the state and federal governments for expenses; 9% has been committed to annual Work Plans; and 4% has been credited to Exxon for cleanup expenses. Seventy-two percent is uncommitted.

Table A-3 shows how the 1992 Work Plan allocated funds among habitat protection and acquisition, other restoration projects, damage assessment, and administration. The 1992 Work Plan emphasized completion of damage assessment studies.

Table A-4 shows how the 1993 Work Plan allocated funds among habitat protection and acquisition, other restoration projects, damage assessment, and administration. The figures reported for the 1993 Work Plan are for the period 3/1/93 to 9/30/93. The 1993 Work Plan was for a seven-month period of transition to the federal fiscal year, which began 10/1/93. The 1993 Work Plan emphasized restoration.

Table A-5 presents interim allocations for the 1994 Work Plan. Many of these allocations are for the three-month period 10/1/93 to 12/31/93. Additional allocations will be made after the Restoration Plan is completed.

Table A-1
Schedule of Payments

Date	Amount
December 1991	\$90 million
December 1992	\$150 million
September 1993	\$100 million
September 1994	\$70 million
September 1995	\$70 million
September 1996	\$70 million
September 1997	\$70 million
September 1998	\$70 million
September 1999	\$70 million
September 2000	\$70 million
September 2001	\$70 million
Total	\$900 million

Table A-2
Allocation of Expenditures as of November 1993

Purpose	Amount	Percent	Comments
Reimbursements to state government	\$78,300,000	9%	
Reimbursements to federal government	60,817,165	7%	
1992 Work Plan	15,549,400	2%	See Table A-3.
1993 Work Plan	51,326,800	6%	See Table A-4.
1994 Work Plan	6,276,600	1%	See Table A-5.
Credit to Exxon for cleanup costs after 1/1/91	39,900,000	4%	
Uncommitted	647,830,035	72%	
TOTAL	\$900,000,000	100%¹	

Funds not yet withdrawn from the Joint Trust Fund are earning interest.

¹ Percentages do not add up to 100 because of rounding.

Table A-3
1992 Work Plan

The Trustee Council approved \$19,211,000 for the 1992 Work Plan, which was undertaken during the period 3/1/92 through 2/28/93. Thirty-nine percent was budgeted to close out or continue Natural Resource Damage Assessment, 26% was for administration, and 35% was for restoration. The unobligated balance for the State for that period was \$3,661,600. Future withdrawals from the fund will be reduced by that amount. The unobligated balance for the federal government will be determined at a later date. Considering the unobligated balance reported so far, a total of \$15,549,400 was actually spent on the 1992 Work Plan.

ALLOCATIONS: 1992

Purpose	Amount	Percent
Habitat Protection and Acquisition	\$1,243,400	6%
Other Restoration Projects	5,484,000	29%
Damage Assessment	7,407,500	39%
Administration	5,076,100	26%
Total Budgeted	\$19,211,000	100%
Unobligated Balance	3,661,600	
Total Spent	\$15,549,400	

The remainder of this table describes restoration projects approved in the 1992 Work Plan. It does not describe damage assessment or administration projects. Habitat protection and acquisition projects are listed separately from other restoration projects because of the high degree of interest shown in them.

Table A-3 (cont'd)

HABITAT PROTECTION AND ACQUISITION PROJECTS: 1992

No.	Project Title	Project Description	Budget
R15	Marbled Murrelet Restoration Study	Determine marbled murrelet nesting habitat in the spill area and identify their use of those habitats.	\$419,300
R47	Stream Habitat Assessment	Identify and prioritize private lands where an imminent and significant habitat alteration threat exists.	399,600
R71	Harlequin Duck Restoration and Monitoring	Locate, identify, and describe harlequin duck nesting habitat in PWS; determine width of forested buffer strips, and feasibility of stream habitat enhancement techniques.	424,500
Habitat Protection & Acquisition - Subtotal			\$1,243,400

OTHER RESTORATION PROJECTS: 1992

No.	Project Title	Project Description	Budget
R11	Murre Recovery Monitoring	Document rate of recovery of murre breeding in the Barren Islands and Puale Bay.	\$316,700
R53	Kenai River Sockeye Salmon Restoration	Restore injured Kenai River sockeye salmon stocks through improved stock assessment, capabilities, regulation of spawning levels, and modification of human use.	674,200
R59	Genetic Stock Identification	Evaluate the use of all possible techniques to maximize the accuracy and precision of stock identification analyses and incorporate parasite data into models.	320,900
R60AB	Prince William Sound Pink Salmon	Recover coded-wire tags in the catches and spawning populations of pink salmon in Prince William Sound.	1,479,700
R60C	Pink Salmon Egg/Fry	Monitor recovery of wild pink salmon stocks in Prince William Sound.	492,800

Table A-3 (cont'd)

OTHER RESTORATION PROJECTS: 1992 (cont'd)

No.	Project Title	Project Description	Budget
R73	Harbor Seals	Monitor movements, hauling out, and diving behavior of harbor seals in PWS.	\$25,000
R90	Dolly Varden Char Monitoring	Remove weir material and camp equipment and produce final report.	91,500
R92	GIS Mapping and Analysis	Develop information as needed to evaluate or implement restoration projects.	125,500
R102	Herring Bay Experimental and Monitoring Study	Determine what factors limit or facilitate recolonization of the intertidal by algae, especially <i>Fucus</i> , and invertebrates; and to provide controlled, long-term natural recovery monitoring of intertidal communities.	485,600
R103	Oiled Mussels	Determine the geographical extent of oiled mussel beds in the spill area, the intensity of oil remaining in mussels, and the underlying organic mat in order to assess possible linkage with continuing injury to harlequin ducks, oystercatchers, sea otters, and river otters.	874,000
R104A	Site Stewardship	Recruit, educate, and involve local people to protect archaeological resources in their areas.	159,200
R105	Instream Habitat and Stock Restoration Techniques for Anadromous Fish	Determine preliminary restoration techniques for specific sites; select the most appropriate fish restoration projects.	348,100
R106	Dolly Varden Restoration	Prepare final report for the data collected in this project through 1991.	34,900
R113	Red Lake Sockeye Salmon Restoration	Increase survival of wild salmon in Red Lake (Kodiak Island) by incubating eggs and rearing fry in Pillar Creek Hatchery and transplanting them to the lake.	55,900
OTHER RESTORATION PROJECTS -Subtotal			\$5,484,000

Table A-4
1993 Work Plan

The Trustee Council approved \$51,326,800 for the 1993 Work Plan, which was undertaken during the seven-month period 3/1/93 through 9/30/93. Of that amount, 77% was for habitat protection and acquisition, 14% for other restoration projects, 1% for Natural Resource Damage Assessment, and 8% for administration.

ALLOCATIONS: 1993

Purpose	Amount	Percent
Habitat Protection and Acquisition	\$39,666,600	77%
Other Restoration Projects	6,932,300	14%
Damage Assessment	592,100	1%
Administration	4,135,800	8%
Total	\$51,326,800	100%

The remainder of this table describes restoration projects approved in the 1993 Work Plan. It does not describe damage assessment or administration projects. Habitat protection and acquisition projects are listed separately from other restoration projects because of the high degree of interest shown in them. Two major actions were taken in 1993 to protect important areas of habitat under imminent threat: purchase of private inholdings in Kachemak Bay State Park (near Homer) and commitment to purchase lands near Seal Bay on Afognak Island (near Kodiak).

In addition to the projects listed below, the Trustee Council has tentatively approved the expenditure of \$1.5 million toward construction of the Alutiiq Repository and Culture Center, a Native museum and culture center to educate the public and provide a center for research and preservation of artifacts injured by the oil spill.

Table A-4 (cont'd)

HABITAT PROTECTION AND ACQUISITION PROJECTS: 1993

No.	Project Title	Project Description	Budget
93033	Harlequin Duck Restoration Monitoring Study in PWS, Kenai and Afognak	Study harlequin duck reproductive failure in western Prince William Sound; on outer Kenai coast and Afognak Island determine if there is reproductive failure and characterize their nesting habitat.	\$300,000
93034	Pigeon Guillemot Colony Survey	Identify and map pigeon guillemot colonies.	165,800
93051	Anadromous Streams and Marbled Murrelets	Assess marbled murrelet nesting habitat; survey anadromous fish streams on candidate lands for habitat protection.	1,222,300
93059	Habitat Identification Workshop	Identify parcels of nonpublic lands with habitat necessary for recovery of injured resources and services under imminent threat.	42,300
93060	Accelerated Data Acquisition	Collect and organize existing resource data needed to evaluate habitat protection and acquisition proposals.	43,900
93064	Imminent Threat Habitat Protection	Protect habitat under imminent threat. The amount budgeted for this project includes \$7.5 million toward the purchase of inholdings in Kachemak Bay State Park, and a downpayment of \$29,950,000 toward the purchase of uplands near Seal Bay on Afognak Island. The total purchase price for Seal Bay parcels will not exceed \$38.7 million. The rest of the allocation is for actions necessary to complete acquisitions, such as title search and appraisal.	37,850,000
Habitat Protection and Acquisition - Subtotal			\$39,666,600

Table A-4 (cont'd)

OTHER RESTORATION PROJECTS: 1993

No.	Project Title	Project Description	Budget
93003	Salmon Egg to Pre-emergent Fry Survival	Continue to monitor egg mortalities in the oiled and unoiled wild pink salmon streams.	\$686,000
93006	Site-Specific Archaeological Restoration	Assess injury at 24 sites and restore 19 of them.	260,100
93012	Genetic Stock Identification of Kenai River Sockeye Salmon	Develop a comprehensive database of sockeye salmon stocks in Cook Inlet.	300,600
93015	Kenai River Sockeye Salmon Restoration	Increased monitoring and management of the sockeye salmon stocks in the Kenai River and Upper Cook Inlet north of Anchor Point.	512,600
93016	Chenega Bay Chinook and Silver Salmon (NEPA Compliance)	NEPA compliance for the replacement of subsistence resources by permitted releases of chinook and coho salmon at designated sites near Chenega village from stocks of hatchery near Esther Island. The Trustee Council has deferred action on the decision whether to implement this project.	10,700
93017	Subsistence Food Safety Survey and Testing	Work with communities to identify and map areas and resources of continuing concern to subsistence users; sample subsistence foods from these areas.	307,100
93022	Monitor Murre Colony Recovery	Monitor the recovery of murre in the Barren Islands.	177,200
93024	Restoration of Coghill Lake Sockeye Salmon Stock	Restore natural productivity of Coghill Lake for sockeye salmon through use of lake fertilization techniques.	191,900
93035	Black Oystercatchers/Oiled Mussel Beds	Determine whether black oystercatchers breeding on shorelines with persistent oil contamination in Prince William Sound are affected by their use of these habitats.	107,900
93036	Oiled Mussel Beds	Document continued bioavailability of petroleum hydrocarbons to consumers of contaminated mussels and determine the rate of recovery of oiled mussel beds.	404,800

Table A-4 (cont'd)

OTHER RESTORATION PROJECTS: 1993 (cont'd)

No.	Project Title	Project Description	Budget
93038	Shoreline Assessment	Assess the shoreline hydrocarbon concentrations and, where appropriate, carry out necessary treatment using local work crews. Cost includes \$15,000 for U.S. Coast Guard transportation.	\$539,200
93039	Herring Bay Experimental and Monitoring	Determine what factors limit or facilitate recolonization of the intertidal by algae, especially <i>Fucus</i> , and invertebrates; and to provide controlled, long-term natural recovery monitoring of intertidal communities.	507,500
93041	Comprehensive Monitoring	Design the monitoring component of the Restoration Plan.	237,900
93042	Killer Whale Recovery	Obtain photographs of individual killer whales occurring in AB pod and document natural recovery.	127,100
93043	Sea Otter Demographics and Habitat	Restore sea otter populations by determining what is limiting their recovery and identifying important sea otter habitat in Prince William Sound for possible protection.	291,900
93045	Marine Bird / Sea Otter Surveys	Obtain annual estimates of the summer and winter populations of marine birds and sea otters in Prince William Sound to determine whether populations that had declined are recovering.	262,400
93046	Habitat Use, Behavior, and Monitoring of harbor Seals	Monitor the abundance and trends of harbor seals in oiled and unoled areas of Prince William Sound and characterize habitat use, hauling out and diving behavior.	233,500
93047	Subtidal Monitoring	Monitor recovery of sediments, hydrocarbon-degrading microorganisms, eelgrass beds, and shallow fish species in the subtidal environment.	1,000,800
93053	Hydrocarbon Database	Estimate the amount of Exxon Valdez oil that is present in environmental samples analyzed for hydrocarbons that are collected during restoration.	105,500

Table A-4 (cont'd)

OTHER RESTORATION PROJECTS: 1993 (cont'd)

No.	Project Title	Project Description	Budget
93057	Damage Assessment Geographic Information System	Complete statistical analysis and geographic information system mapping support for existing damage assessment studies and provide a database for restoration.	67,500
93062	Restoration Geographic Information System	Provide statistical and spatial analysis and geographic information system mapping support for approved restoration projects.	123,300
93063	Anadromous Stream Surveys	Develop proposals and designs for appropriate and cost-effective instream habitat and stock restoration projects.	59,400
93065	Prince William Sound Recreation Project	Develop a statement of injury, management goals, and proposals for restoration of recreation in Prince William Sound and identify and evaluate potential special designations that would benefit recreation and management of Prince William Sound. The estimated project cost is \$71,000. Unused funds will be used to fund other activities approved by the Trustee Council.	72,000
93067	Pink Salmon Coded-Wire Tag Recovery	Recover coded-wire tags from pink salmon in Prince William Sound to distinguish between wild stocks and hatchery stocks.	220,000
93068	Non-Pink Salmon Coded-Wire Tag Recovery	Recover coded-wire tags from fish other than pink salmon.	126,400
OTHER RESTORATION PROJECTS - Subtotal			\$6,932,300

Table A-5
1994 Work Plan

The Trustee Council approved interim funding of \$6,276,600 for the 1994 Work Plan, which began on 10/1/93. Many of the allocations were for the three-month period 10/1/93 to 12/31/93. Additional allocations will be made after the Restoration Plan is completed. The interim funding for administrative expenses includes certain 12-month costs, such as lease of office space. Once all allocations are made, administrative expenses are expected to be about five percent of the total.

ALLOCATIONS: 1994

Purpose	Amount	Percent
Habitat Protection and Acquisition	\$558,500	9%
Other Restoration Projects	430,800	7%
Data Analysis and Report Preparation for 1993	3,273,000	52%
Administration	2,014,300	32%
Total	\$6,276,600	100%

The remainder of this table describes restoration projects approved in the 1994 Work Plan. It does not describe damage assessment or administration projects. Habitat protection and acquisition projects are listed separately from other restoration projects because of the high degree of interest shown in them.

Table A-5 (cont'd)

HABITAT PROTECTION AND ACQUISITION PROJECTS: 1994

No.	Project Title	Project Description	Budget
94110	Data Acquisition and Support	Provide logistical and technical support for habitat evaluation.	\$273,600
94126	Habitat Protection and Acquisition Fund	Facilitate purchase of habitat protection rights and develop post-acquisition management recommendations.	284,900
Habitat Protection and Acquisition - Subtotal			\$558,500

OTHER RESTORATION PROJECTS: 1994

No.	Project Title	Project Description	Budget
94064	Habitat Use, Behavior, and Monitoring of Harbor Seals in PWS	Monitor the abundance and trends of harbor seals in oiled and unoled areas of Prince William Sound.	\$2,500
94166	Herring Spawn Deposition and Reproductive Impairment	Improve the accuracy of the fisheries management of herring resources in Prince William Sound and determine if genetic damage occurred because of the spill.	37,100
94185	Coded-wire Tagging of Wild Pink Salmon in Prince William Sound	Provide marked fish of known origin for eventual recovery in either the commercial catch or the escapement.	34,800
94191	Investigating and Monitoring of Oil Related Egg and Alevin Mortalities	Continue to monitor egg mortalities in the oiled and unoled wild pink salmon streams.	85,400
94217	Prince William Sound Area Recreation Implementation Plan	Develop a prioritized list of recreation restoration projects, identify and describe potential special designations, identify real or perceived injury to the recreation resource and services in Prince William Sound, and develop management goals to restore recreation in Prince William Sound.	30,000

Table A-5 (cont'd)

OTHER RESTORATION PROJECTS: 1994 (cont'd)

No.	Project Title	Project Description	Budget
94258	Sockeye Salmon Overescapement	Continue to examine the effects of large 1989 overescapements.	141,000
94320	Ecosystem Monitoring	Develop an ecosystem monitoring plan.	100,000
OTHER RESTORATION PROJECTS - Subtotal			\$430,800

Appendix B Injury and Recovery

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BACKGROUND

The T/V *Exxon Valdez* struck Bligh Reef in March, just before the most biologically active season of the year. The resulting oil spill occurred during the seaward migration of salmon fry, major migrations of birds, and the primary breeding season of most species of birds, mammals, fish, and marine invertebrates in the spill's path. Many animals, such as sea otters and marine birds, were killed by the oil in open water. Approximately 1500 miles of southcentral Alaska's coastline were oiled (about 350 miles were heavily oiled), frequently with devastating impact to the upper intertidal zone. Direct oiling killed many organisms, and beach cleaning, particularly high-pressure, hot-water washing had a devastating effect on some intertidal communities. The spill also affected services (human uses), including subsistence, recreation, commercial fishing, and other uses. Some resources and services remain vulnerable to persistent oil in intertidal areas.

This appendix was originally presented in June of 1993 in the Supplement to the Summary of Alternatives. It has been updated to reflect new information gained from further analysis or completion of damage assessment studies. This appendix describes in detail the injuries sustained by individual resources and services, and what scientists and resource managers know about the present status of recovery. Table B-1 lists injured resources and lost or reduced services. Where possible, expectations for the progress of natural recovery are also projected. Information on injury and recovery is summarized in Tables B-4, B-5 and B-6.

INJURY TO NATURAL RESOURCES

Natural resource injuries from exposure to oil spilled by the T/V *Exxon Valdez* or due to the cleanup include:

- (1) **Mortality.** Death caused immediately or after a period of time by contact with oil, cleanup activities, reductions in critical food sources caused by the spill, or other causes.
- (2) **Sublethal Effects.** Injuries that effect the health and physical condition of organisms (including eggs and larvae), but do not result in the death of juvenile or adult organisms. However, injuries that initially appear to be sublethal can, over time, be fatal. Also, some sublethal effects, such as reproductive impairment, can eventually result in population reductions.
- (3) **Degradation of Habitat.** Alteration or contamination of flora, fauna, and the physical components of the habitat.

Due to the large geographical area, multiple habitat types and many species impacted by the spill, it is highly unlikely that all injuries to natural resources will be studied or fully documented.

Injuries Resulting in a Population Decline

The most serious injuries result in large population declines. In these cases, injury may persist for more than one generation. For example, the common murre was the most severely impacted bird species. Several large colonies in the Gulf of Alaska may have lost 35% to 70% of their breeding adults, a loss that may not be restored for many generations. Another example is in intertidal areas where populations of many species of plants and invertebrates declined as a result of oiling and cleanup.

If serious enough, mortality, sublethal injuries, or degradation of habitat may result in measurable population declines. For example, sublethal injuries that impair reproductive ability in a large portion of a population could result in a population decline.

Injuries Not Resulting in a Measurable Population Decline

There are several reasons why population declines were not measured in some species.

- (1) The injury may not have been severe enough to cause mortality or a population decline.
- (2) Spill-related population declines may have been impossible to distinguish from natural variations in population levels. Population census techniques are usually able to detect only relatively large population changes.
- (3) Population declines may have occurred initially but some species may have compensated by increasing productivity. The net effect would be no reduction in population.
- (4) Some species were not studied or were studied insufficiently to determine any injury, including population declines.

INJURY TO OTHER NATURAL RESOURCES

The cleanup increased public knowledge of archaeological site locations, which resulted in looting and vandalism of archaeological resources. Also, archaeological sites may have been damaged by oiling. Archaeological resources could be irretrievably lost if looting and vandalism continue. Since archaeological resources, such as sites and artifacts, are not living, renewable resources, they have no capacity to heal themselves.

The spilled oil also contaminated waters adjacent to designated Wilderness Areas, and was deposited above the high tide line in many cases. The intense cleanup resulted in an unprecedented disturbance of the area's undeveloped and normally uninhabited landscape. The massive intrusion of people and equipment associated with cleanup has ended, but direct injury to wilderness and intrinsic values lingers.

REDUCED OR LOST SERVICES

The oil spill impacted a wide range of services (human uses), including commercial fishing, subsistence (hunting, fishing, and gathering), passive use, recreation and tourism. Examples of recreation include sea kayaking, backcountry camping, sport fishing, and hunting.

Services were reduced or lost if the *Exxon Valdez* oil spill or cleanup:

- (1) reduced the physical or biological functions performed by natural resources that support services; or
- (2) reduced aesthetic and intrinsic values, or other indirect uses provided by natural resources; or
- (3) reduced the desire of people to use a natural resource or area.

DEFINING AND ESTIMATING RECOVERY

Many resources and services will recover without intervention. Other resources and services, especially those that were declining before the spill, may continue to decline if present trends continue. For many resources and services, there is no known restoration approach that will effectively accelerate recovery. However, in most cases, there are actions that can prevent further stress on resources.

To maximize the benefits of restoration expenditures, the Trustee Council will consider the rate and degree of natural recovery before investing restoration dollars. The Trustee Council has adopted the following definition of recovery for the purpose of restoration.

In general, resources and services will have recovered when they return to conditions that would have existed had the spill not occurred. Because it is difficult to predict conditions that would have existed in the absence of the spill, recovery is usually defined as a return to prespill conditions or to conditions comparable to those of nonoiled areas. For resources that were in decline before the spill, like marbled murrelets, recovery may consist of stabilization of the population at a lower level than before the spill. Factors to be considered when assessing recovery include reproductive success, growth and survival rates, and the age and sex composition of the injured population.

Full ecological recovery will have been achieved when the population of flora and fauna are again present at former or prespill abundances, healthy and productive, and there is a full complement of age classes at the level that would have been present had the spill not occurred. A recovered ecosystem provides the same functions and services as would have been provided had the spill not occurred.

It is extremely difficult to predict the amount of time needed for a species to recover. Scientists

often use models based on factors such as growth, mortality and reproductive rates. However, for many of the biological resources injured by the *Exxon Valdez* oil spill, the background information was not available to develop these predictive models. For those resources, peer reviewers and agency scientists based their estimates of recovery on the best available information from the damage assessment and restoration studies, the scientific literature and other sources.

Estimates of recovery provided in this section should be used with caution, but they are the best that can currently be provided. For some estimates, there is also substantial disagreement within the scientific community. The estimates are likely to change as recovery continues, more information is provided through monitoring, and more is learned about the species. Recovery estimates for services are not provided. Recovery of services is linked, in part, to the resources that support the service, but is also linked to changes in human perception of injury and can vary widely among user groups.

Table B-1 lists injured resources and lost or reduced services. The table breaks down biological resources into those that are recovering and not recovering, and those for which the recovery status is unknown. The table reflects the current understanding, but the recovery status of each resource and service will change over time. If new injuries are documented in the future, resources and services will be added to the list.

Table B-1 List of Injured Resources and Lost or Reduced Services

INJURED RESOURCES			LOST OR REDUCED
BIOLOGICAL	RESOURCES	OTHER	SERVICES (Human Uses)
Recovering Bald eagle Black oystercatcher Intertidal organisms (some) Killer whale Sockeye salmon (Red Lake) Subtidal organisms (some)	Not Recovering Common murre Harbor seal Harlequin duck Intertidal organisms (some) Marbled murrelet Pacific herring Pigeon guillemot Pink salmon Sea otter Sockeye salmon (Kenai River) Subtidal organisms (some)	Archaeological resources Designated Wilderness Areas	Commercial fishing Passive uses Recreation and Tourism including sport fishing, sport hunting, and other recreation uses Subsistence
Recovery Unknown Clams Cutthroat trout Dolly Varden River otter Rockfish			

A SUMMARY OF INJURY AND RECOVERY

MARINE MAMMALS

Harbor Seals

Injury: The oil spill caused population declines and sublethal injuries to harbor seals in Prince William Sound. Many were directly oiled and an estimated 300 died. The prespill population of harbor seals in Prince William Sound was estimated to be between 2,000 to 5,000 animals. While some dead seals were recovered from the Kenai Peninsula, the extent of injury outside Prince William Sound is unknown.

Many seals were exposed to oil in 1989. At 25 haul-out areas in Prince William Sound that have been regularly surveyed since 1984, 86% of the seals seen in the postspill spring (April) survey were extensively oiled and a further 10% were lightly oiled. This included many pups. By late May, 74% of the animals continued to be heavily oiled. Tissues from harbor seals in Prince William Sound contained many times the concentrations of aromatic hydrocarbons than did tissues from seals in the Gulf of Alaska. This trend persisted in 1990, when high concentrations of petroleum hydrocarbons again were found in the bile of surviving seals. In addition, pathology studies revealed damage to nerve cells in the thalamus of the brain, which is consistent with exposure to relatively high concentrations of low molecular weight aromatic (petroleum) hydrocarbons.

Recovery: Because harbor seal populations have declined precipitously since 1984, and the underlying causes of this decline are unknown, it is difficult to predict recovery from the oil spill. However, stable counts in 1990 to 1992 at haulouts within Prince William Sound may indicate an end to the ongoing decline within the Sound. There is evidence suggesting that the subsistence harvest has declined since the spill, which may contribute to the stabilization of the population. If the population has stabilized, normal production growth may soon begin to replace the estimated 300 seals killed during the spill. However, additional information on the rate of exchange between seal populations in Prince William Sound and the Gulf of Alaska, particularly with the large Copper River Delta population, as well as a better understanding of the causes of the prespill decline, would be required to improve predictions of the time needed for recovery.

Humpback Whales

Injury: The only apparent effect of the spill on humpback whales was a temporary displacement from preferred habitat in Lower Knight Island Passage during the summer of 1989. There is no evidence that any humpbacks were killed by the spill, nor has reproduction been affected. Photodocumentation studies confirmed that normal use of lower Knight Island Passage resumed in late 1989.

Recovery: Other than a temporary displacement, there is no evidence of injury. No estimate of recovery was made.

Killer Whales

Injury: Thirteen killer whales disappeared from one pod (extended family group) between 1988 and 1990, and are presumed to have died. Approximately 140 killer whales forming nine distinct pods regularly use Prince William Sound, and are considered resident pods. There are also transient pods and other resident pods with wider ranges that enter the Sound occasionally.

In the summer of 1989, there were more than 9 whales missing from resident pods. The AB pod, which had 36 individuals when last seen in the Sound in the fall of 1988, was missing 7 animals, for an unprecedented 19.4% mortality rate. In 1990, an additional 6 individuals were found missing from AB pod, resulting in an annual mortality rate of 20.7% (prespill mortality for the resident AB pod typically ranged from 3.1 to 9.1% from 1984 to 1988). The rate of natural mortality in killer whales in the North Pacific is about 2% per year. All of the missing whales were either females or immature animals, and in several cases calves were orphaned. No births were recorded in 1989 or 1990. Due to the fidelity of killer whales to the pod, and the strong bonds observed between mothers and calves, the missing whales are presumed to have died. However, no dead individuals were ever recovered.

The cause of death is uncertain. Some experts think that the circumstantial evidence points to the spill. Other experts acknowledge that something very unusual happened to AB pod in 1989 and 1990, but that based on current knowledge of whale biology, the circumstances of the spill and the toxicity of crude oil, these deaths may not be due to contact with oil spilled by the T/V *Exxon Valdez*.

Recovery: Despite the loss of a large number of reproductive females, AB pod is growing again. One birth was recorded in 1991; two births in 1992, and one in 1993. It is expected that AB pod may not recover to its prespill level of 32 to 36 individuals for more than a decade.

Sea Lions

Injury: Results from sea lion studies were inconclusive concerning the effects of the spill. Several sea lions were observed with oiled pelts, and oil was likely absorbed by some tissues.

Sea lions have experienced a severe decline over the last 30 years in the north Pacific Ocean--as great as 93%. This decline combined with seasonal movements, which are significant but not well understood, precluded determining if the sea lion population in the Gulf of Alaska

was affected by the spill. Sea lions were counted at eight haul-out sites, located mainly in the Gulf of Alaska. Some of these sites were oiled, although oiling was patchy and generally short-lived, but away from these sites sea lions were observed swimming through oil. Ten sea lions were found dead in oiled areas, mainly on rocky beaches, but it is not known how many of these deaths were attributable to natural mortality, or if any were due to oiling.

Recovery: Since there is no evidence that sea lions were injured by the oil spill, no estimate of recovery time was made.

Sea Otters

Injury: The oil spill caused declines in populations of sea otters in Prince William Sound and possibly in the Gulf of Alaska. Sea otters were the most abundant marine mammal in the path of the spreading oil slick and were particularly vulnerable to its effects. Their estimated population before the spill included as many as 10,000 sea otters in Prince William Sound and 20,000 in the Gulf of Alaska. It also is estimated that there are a total of 150,000 sea otters in Alaska.

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

Studies conducted throughout the spill area in 1990 and 1991 indicated that sea otters were still being affected by the spill. Carcasses found in these years included an unusually large proportion of prime-age adult otters, rather than mainly juvenile and old otters, as were found before the spill. A study of survival of recently weaned sea otters also showed a 22% higher death rate during the winter of 1990-1991 and spring of 1991 in areas affected by the spill. In 1992-1993 juvenile mortality rates had decreased dramatically, but were still higher in oiled than nonoiled areas.

Recovery: While little or no evidence of recovery has been detected, sea otters are expected to eventually recover to their prespill population. The rate of recovery will be dependent on the growth rate of the injured population. Under ideal conditions sea otters can expand their population at 9% per year. For sea otter populations already established in an area like Prince William Sound, the growth rate is usually closer to 2 -3% per year. Future rates of population increase are difficult to estimate. However, if stress remains negligible, recovery may take less than two decades.

TERRESTRIAL MAMMALS

Brown Bear

Injury: In the Kodiak Archipelago and on the Alaska Peninsula, brown bears forage in the intertidal zone, where clams are a favorite food. Brown bears also apparently scavenged the carcasses of sea otters and birds that washed ashore after the spill. Analyses of fecal material and samples of bile indicated that some brown bears had been exposed to oil. High concentrations of oil were found in the bile of one yearling brown bear found dead in 1989. The mortality rate for cubs is close to 50% for the first two years, and it is uncertain if this death was associated with oil exposure.

Recovery: Since there is no evidence that brown bears were injured by the spill, no estimate of recovery time was made.

Black Bear

Injury: There was an initial attempt to study the potential effects of the spill on black bears, but due to the difficulty of finding, tagging or observing this species in dense vegetation, the effort was quickly abandoned. No carcasses or other indications of oil spill-related injuries were ever reported.

Recovery: Since there is no evidence that black bears were injured by the spill, no estimate of recovery time was made.

River Otters

Injury: Following the oil spill, twelve river otter carcasses were found on beaches, representing some unknown fraction of the total number killed. The bile from two river otters collected from oiled areas in 1989 was analyzed and found to contain elevated concentrations of hydrocarbons. This indicates that surviving river otters could have ingested contaminated food.

There are indications that chronic oil exposure may affect river otters in Prince William Sound, although there is uncertainty about the evidence. First, river otters captured in oiled areas after the winter of 1989-1990 weighed less than those captured in unoiled areas, while they were of the same overall length. Since the oiled population is an island population (Knight Island) and the unoiled population is from a mainland location (Ester Passage), and there are no comparative prespill length and weight data from the two areas, it is difficult to determine whether this represents an effect of the spill. Second, chemical factors in the blood show slight differences between study areas: in the oiled population, haptoglobin

concentrations and some amino transferase enzyme activities are slightly elevated. These differences could be caused by disease, handling stress, parasites, oil exposure, or a combination of these factors.

A reduction in the number of prey species (but not in the quantity of food ingested) was noted in the diets of river otters in the oiled areas between 1989 and 1990; this reduction was not seen in the nonoiled study areas. This reduction was probably due to the severe impact of the spill on the intertidal and shallow subtidal fauna in the oiled portions of Knight Island. Also, on Knight Island the average size of territories of river otters was larger than on the mainland, potentially a result of having to forage over a larger area to find sufficient food. However, the significance of this size difference is uncertain because of the lack of prespill data and follow-up studies.

Finally, data from an analysis of river otter droppings in latrine sites was equivocal. The results of one analysis suggested that estimated populations sizes were not different between the study areas, and another suggested differences. Conclusions are problematic because of the relatively small sample sizes employed and the possibility that populations in the two study areas were different before the spill.

Recovery: Most of the evidence of injury to the river otters was gathered in 1989 and 1990, although some of the parameters that are designed to indicate continuing sublethal injury still showed differences in 1991, including length-weight differences. Without a reliable way to detect small changes in populations (it is probable that a small number of river otters were killed), it is difficult to predict when the population will recover. With a population density of approximately one otter for every two to three kilometers of shoreline in suitable habitats, the percentage of the population that requires replacement appears to be relatively small.

Sitka Black-tailed Deer

Injury: Deer often forage in the intertidal zone on seaweed. Since seaweeds were extensively contaminated on oiled shores, deer were probably exposed to oil. In fact, tissues from deer taken by subsistence hunters and chemically analyzed were found to contain, in some cases, indications of oil contamination. The deer were, however, determined to be safe to eat. No evidence was found that populations of Sitka black-tailed deer were injured by the spill. Most deer carcasses found in 1989 on islands in Prince William Sound were probably the result of winter kill.

Recovery: Since there was no evidence from the damage assessment studies that Sitka black-tailed deer were injured by the spill, no estimate of recovery time was made.

Mink

Injury: Mink forage in the intertidal zone and, therefore, could have been exposed to oil by contact or by ingestion of contaminated food. However, due to the lack of prespill information on population abundance and distribution and the difficulties of assessing population trends postspill, an assessment of injury to mink employing field studies was judged impractical. Instead, a laboratory study of mink was carried out to determine if oil-contaminated food affected reproduction. However, no reproductive effects were documented, even when high concentrations of weathered crude oil were added to their diet.

Recovery: Since there is no evidence that mink or other small mammals were injured by the spill, no estimate of recovery time is required.

BIRDS

Bald Eagles

Injury: There are estimated to be 27,000 adult bald eagles in Alaska. About 2,000 of these are in Prince William Sound and about 6,000 are found along the northern coast of the Gulf of Alaska. Bald eagles encountered floating oil while preying on fish and oil-contaminated carcasses, and heavy oiling of the plumage led to loss of flight and probably also loss of body heat. Preening also exposed eagles to oil ingestion.

There were 151 eagles found dead after the spill, an estimated 200 to 300 may have been killed. However, there is considerable uncertainty as to the total number of eagles killed by the spill. Seventy-four percent of radio-tagged eagles that died of natural causes in a postspill study were found in forests and other inland areas. If this carcass deposition pattern is representative of eagles dying from acute oil exposure, then total mortality based mainly on the recovery of carcasses during beach searches would be about 430 individuals. However, it seems unlikely that acutely oiled birds would die in similar locations as those that died of natural causes.

Most aerial surveys to estimate population size and productivity were conducted in Prince William Sound. Population estimates made in 1989, 1990 and 1991 indicate that there may have been an increase in the bald eagle population since the previous survey conducted in 1984, although considerable variability was associated with this data. Population estimates for the three postspill years were not significantly different from one another.

Estimates of productivity indicate that in 1989, 85% of nests in moderately and heavily oiled areas failed, compared to 55% in lightly oiled and nonoiled areas. In 1990, there was actually higher productivity in oiled than in nonoiled areas. It is estimated that the loss of production in 1989 was equivalent to 133 chicks.

Recovery: Since the number of eagles lost appears to be less than the change that can be detected by the aerial survey techniques, it may not be possible to follow recovery to prespill numbers. It also appears that the lost chick production in 1989 will not have a measurable impact on the population. Bald eagles are recovering, and may have already recovered from the effects of the spill.

Black Oystercatchers

Injury: The spill caused population declines and sublethal injuries to black oystercatchers. Nine black oystercatcher carcasses were recovered from beaches after the spill. It is unknown how many additional oystercatchers were killed by the spill but were not recovered. Prespill (1972-1973, 1984) and postspill population surveys suggest that within Prince William Sound, an estimated 120 - 150 black oystercatchers representing 12% to 15% of the total estimated population, died as a result of the spill. Mortality outside of Prince William Sound is unknown, but the total spill-area population is thought to be approximately 2,000 birds.

In addition to mortality caused directly by the spill, oiling also affected their reproductive success. Egg volume and the weight of chicks raised in oiled areas were lower compared to those raised in nonoiled areas; however, there are no prespill data, and it is not known if those conditions existed before the spill. Other measures such as hatching success, fledgling success, and chick production were not different between oiled and nonoiled areas. It is quite possible that in 1989 and 1990, disturbance associated with cleanup activities of oiled study areas, for example, Green Island, contributed to these differences.

Recovery: While black oystercatchers are recovering, an estimate of their recovery time is difficult to make. There is significant uncertainty associated with any estimate of recovery made because the population growth rate for black oystercatchers is unknown. However, if the growth rate is equal to Eurasian oystercatchers (6.25%) and there are no lingering sublethal injuries, the calculated estimate of recovery is several decades. Finally, the potential contribution of immigration from nonoiled areas on recovery is not easily estimated.

Murres

Injury: The oil spill caused population declines and sublethal injuries at murre colonies in the Gulf of Alaska. Including both common murres and thick-billed murres, there are about 12 million murres in Alaska, and 1.4 million in the Gulf of Alaska region. About 1.2 million of the total population in the Gulf of Alaska nest on the Semidi Islands, which were not directly impacted by the oil. Murres are particularly vulnerable to floating oil and have been killed in large numbers by oil spills elsewhere in the world.

At the major breeding colonies studied (Chiswell Islands, Barren Islands, Puale Bay, and the

Triplets), an estimated 120,000 to 134,000 adult breeders were killed by contact with oil. The oil arrived in early April just as birds were beginning to congregate at the colonies in anticipation of breeding. If the rate of mortality is adjusted for birds not counted on the colonies, but feeding at sea, it is estimated that 170,000 to 190,000 breeding birds were killed. In general, it is estimated that between 35% and 70% of the breeding adults at the above colonies were killed by the spill. It is not known where pre-breeding juveniles were at the time of the spill, or if many were killed.

The timing of reproduction was found to be different between oiled and unoiled areas after the spill. At the Barren Islands and at Puale Bay, egg laying was about a month late in 1989, 1990, and 1991, compared to the unoiled Semidi Islands. In 1992 there were some indications that breeding was returning to normal at places in the Barren Islands colony. At the Chiswell Islands, laying was not observed in 1989, and laying was late in 1990. Because fewer birds were occupying these colonies, it is likely that the rate of predation was much greater than normal, since these colonies rely on sheer numbers of birds to discourage predation by gulls and eagles. Furthermore, the delay in egg-laying (estimated to be one month) in the Barren Islands, Puale Bay and the Chiswell Islands since the spill, may result in an additional loss of chicks unable to survive the first autumn storms in the Gulf of Alaska. Conservatively, the estimate of lost production associated with delayed reproduction could exceed 300,000 chicks.

In February and March 1993, there was a major die off of murres around the Kenai Peninsula. Exact figures are not available but thousands of murres probably died during this time. Although lack of food has been implicated in this die off, other explanations have not been eliminated.

Recovery: The degree of recovery necessarily varies among the affected colonies. There are preliminary indications of recovery at the Barren Islands in 1991 and 1992, but it is not yet known when the timing of reproduction will return to normal. Agency scientists estimate that it could take many decades and perhaps a century before the injured murre populations return to their prespill levels. Variables affecting recovery time include the amount of disturbance near colonies and the rate of migration from healthy colonies.

Harlequin Ducks

Injury: The oil spill caused population declines and appears to have caused sublethal injuries in harlequin ducks. Of the six species of sea ducks studied, harlequin ducks feed highest in the intertidal zone where most of the stranded oil was initially deposited and in some cases still persists. An estimated 1000 harlequin ducks were killed by the spill. The resident prespill population of harlequin ducks in western Prince William Sound was estimated to be approximately 2000. Wintering migrants increase this population in the western Sound annually by 10,000. With few exceptions since 1989, neither breeding adults nor fledglings have been located in the heavily oiled areas of western Prince William Sound. Breeding

activity in the nonoiled eastern Prince William Sound appears to be normal.

Elevated concentrations of hydrocarbons and their metabolites were found in the bile of harlequin ducks collected in western Prince William Sound in 1989. If residual oil in the diet is affecting reproduction, then the effect should begin to diminish once the threshold for toxicity is reached and the levels of persistent oil decrease in the environment. Unfortunately, we have no information after 1989 that determined exposure levels in bile for harlequin ducks in western Sound. Also, there is so little known about how oil may affect reproduction and what physiological changes can be induced by feeding on oiled prey. For these reasons, the possible causes of breeding failure have not been established.

Recovery: There appears to be diminished reproduction in harlequin ducks in oiled areas of western Prince William Sound. There are no indications that recovery has occurred. Scientists disagree on the time it will take harlequin ducks to recover to their prespill levels, but estimates suggest that recovery may not occur for several decades. Recovery could depend upon final degradation of oil in intertidal habitats where harlequin ducks feed, if it can be assumed that continued injury is due to ingestion of oil contaminated food.

Marbled Murrelets

Injury: Approximately 612 marbled murrelets were recovered from beaches following the spill. Based on other carcass recovery studies, this suggested that between 8,000 and 12,000 birds may have been killed by the oil spill, which appears to be about 5 - 10% of the current population in the affected area. The available postspill data indicated that the marbled murrelets population has declined since the last census conducted in the middle 1980s. The oil spill probably increased the prespill rate of decline for this species in the spill area, although the incremental injury is difficult to estimate.

Recovery: Since the spill, surveys conducted in Prince William Sound have resulted in population estimates of 107,000 in 1989, 81,000 in 1990, and 106,000 in 1991. With such variation in postspill population estimates, it is not yet possible to determine a trend in marbled murrelet abundance in Prince William Sound. The data collected in the 1970s and 1980s indicate that the population was declining before the spill. Although there is uncertainty associated with the causes of this decline, scientists expect it to continue. There are several factors that could account for this decline including a diminished food supply, increased predation, reduced nesting habitat, or fishery interactions, but there are no conclusive data indicating if any or all of these factors affected the population.

Because of the population decline, the marbled murrelet population is not expected to return to prespill population levels. Estimates of when the population may stabilize vary widely among experts but may be more than a decade. Estimates of further decline range from 20% to 50%, but again there is much uncertainty.

Pigeon Guillemots

Injury: Because these birds forage nearshore and often congregate on rocky beaches, they were vulnerable to the spilled oil. Five hundred and sixteen guillemot carcasses were recovered after the spill. Total mortality is estimated to be between 1,500 to 3,000 individuals, and may be as much as 10 to 15% of the pigeon guillemot population in the Gulf of Alaska. The results of boat surveys in Prince William Sound indicate that the population of this species was 14,600 in 1973. After the spill, the populations were 4,000 in 1989; 3,000 in 1990; and 6,600 in 1991. The population in Prince William Sound was probably declining prior to the spill, but the survey data indicate that the decline in oiled areas was greater than in nonoiled areas. For the Naked Island group, results of postspill surveys indicated a 40% decline in abundance compared to the latest prespill surveys in the mid-1980s. The decline showed a correlation with degree of shoreline oiling. The oil spill probably increased the rate of decline for this species in the spill area, although the magnitude of incremental injury is difficult to estimate.

Recovery: Pigeon guillemots may not return to prespill population levels, as their population was probably declining prior to the spill. The reasons for the long-term decline are unknown which makes predictions of future population trends extremely difficult. The population is expected to stabilize sometime over the next several decades, but estimating the population size when it stabilizes is even more uncertain.

Other Birds

Numerous other birds were affected by the spill. The most direct evidence of injury comes from the carcasses of birds found on the beaches after the spill in 1989. A list of the species recovered during the spill can be found in Table 2-3. Some of the other species found dead included falcons, ducks, sandpipers, phalaropes, gulls, terns, auklets, puffins, various passerines, loons, grebes, shearwaters, petrels, cormorants, kittiwakes, and geese. In general, the number of dead birds recovered probably represents only 10 -15% of the total numbers of individuals killed. For most species, there are no reliable prespill data that will allow accurate assessment of the significance of estimated losses. Other important information comes from boat surveys carried out after the spill using similar techniques to those used in 1972-1973 and 1984-1985 surveys. Other birds that declined more in oiled than in nonoiled areas since the early 1972-1973 surveys include the Northwest crow and cormorant. A similar comparison based on the 1984-1985 surveys showed that cormorant, Arctic tern and tufted puffin declined more in oiled areas.

Recovery: There is a great deal of uncertainty about the recovery of populations of individual species because many were not studied.

FISH

Cutthroat Trout and Dolly Varden

Injury: Both Dolly Varden char and cutthroat trout feed extensively in the nearshore marine habitat and are particularly vulnerable to the effects of oil spills. Measurement of oil in the bile of Dolly Varden following the spill in 1989 showed that this species had the highest oil concentration of any fish species studied. Both species were captured at weirs on five stream after overwintering in 1989, 1990 and 1991 in an attempt to understand the effects of oiling. Studies of injury were not carried out in 1992.

While survival of Dolly Varden returning to oiled streams in 1990 was 32% less than those returning to nonoiled streams, and survival appeared to be 57% less for cutthroat trout returning to oiled streams in 1990, these differences are not statistically significant. There also are no prespill data with which to compare these results. However, it was determined that larger cutthroat trout grew significantly less in oiled areas in 1989, 1990 and 1991. Dolly Varden growth rates were also reduced between 1989 and 1990.

Recovery: Dolly Varden and cutthroat trout in oiled areas may have sustained a sublethal injury (slower growth in oiled areas). Scientists cannot estimate a recovery time without further study.

Pacific Herring

Injury: The extremely poor return of Prince William Sound herring in 1993 has residents very concerned. Because data were not collected from the 1993 herring run, and because herring populations naturally fluctuate greatly between years, it is difficult to understand the cause of the decline at this time. The following discussion describes injuries identified by damage assessment studies from 1989-1992.

The oil spill caused sublethal injuries to Pacific herring in Prince William Sound, but scientists do not know whether these injuries resulted in a population decline. Pacific herring spawned in intertidal and subtidal portions of Prince William Sound shortly after the spill. As much as 10% of the intertidal spawning habitat and 40% of the staging areas of herring in Prince William Sound may have been exposed to oil. Oiled spawning areas included portions of Naked and Montague islands.

Studies conducted in 1989 and 1990 showed a slight but statistically significant higher rate of egg mortality in oiled areas, compared to nonoiled areas. In 1989, rates of larval mortality, lethal and sublethal genetic damage, and physical deformities also were greater in oiled areas. There also is some evidence of differences in histopathological condition and reproductive success in oiled areas in 1989. However, all differences between oiled and unoled study sites

were less pronounced in 1990, and were not observed in 1991.

Three-year-old herring exposed as eggs or larvae in 1989 were under-represented in the 1992 and 1993 spawning migrations. Compared to Sitka Sound, which correlates closely with Prince William Sound in herring recruitment, the 1992 and 1993 returns of the 1989 year class were lower in Prince William Sound than expected. Data comparing herring biomass and age composition of Prince William Sound and Sitka Sound from 1969 to 1992 demonstrates a statistically significant correlation between the size and age structure of herring migrations in these two areas. There also was an outbreak of viral hemorrhagic septicemia (VHS) in herring returning to Prince William Sound in 1993, but it is not known if the disease is linked to the oil spill. Unusual oceanographic conditions, including poor plankton blooms in Prince William Sound, may have contributed to poor adult returns in 1993.

Recovery: More study of the factors affecting herring production is required in order to better predict the return of herring in Prince William Sound to pre-1989 conditions. The complex population dynamics of Pacific herring make it very difficult to predict the extent of injury or estimate natural recovery rates.

Pink Salmon

Injury: The oil spill caused sublethal injuries to wild populations of pink salmon, but there is some uncertainty about the extent of effects on population levels. Extremely low returns of hatchery-produced and wild fish to Prince William Sound in 1993 have focused attention on this issue.

Seventy-five percent of the wild pink salmon spawn intertidally at the mouth of streams in Prince William Sound. There was no apparent change in the use of this habitat in the summer of 1989, and many salmon deposited their eggs in the intertidal portion of oiled streams. In the autumn of 1989, egg mortality in oiled streams averaged about 15%, compared to about 9% in nonoiled streams. Since 1989, egg mortality has generally increased, until in 1991, there was an approximate 40 to 50% egg mortality in oiled streams, and 18% mortality in nonoiled streams. This trend continued in 1992.

Although the differences between egg mortality in oiled and nonoiled streams over the first two years are likely attributable to the effects of oil, the persistence of these differences four years after the spill was entirely unexpected and the exact reasons not understood. In this regard, natural factors that vary between oiled and nonoiled streams, e.g., the degree of wave exposure, have not been eliminated as possible causes of persistent differences. Also, the studies of pink salmon carried out after the spill have documented that adults released as fry from nearby hatcheries are wandering into streams and spawning with wild stocks. The potential effect of this phenomenon on egg survival has not been investigated. Some scientists suggest that the longer the differences in egg mortality persist, the less likely it will be that

oil is the cause or a contributing cause. However, if it assumed that differences between oiled and nonoiled streams is due to oil and that losses in eggs translate proportionately into adult loss, then this effect accounts for almost a 6% decrease in run strength since the spill.

Pink salmon fry released from hatcheries as well as wild pink salmon fry leaving their natal streams in the spring of 1989 were also exposed to oil in the open water. Both pink salmon and chum salmon juveniles were exposed to sufficient amounts of oil to induce enzymes that metabolize oil. In addition, tagged pink salmon fry released from the hatcheries and collected in oiled areas were smaller than those collected in nonoiled areas, even after accounting for the effects of food supply and temperature. The rate of return of pink salmon adults is dependent on conditions during the juvenile stage; and lower food supply, temperature and growth will likely result in a lower return of adults the following year. Based on oil-induced reductions in juvenile growth, the estimated effect of the spill on the 1990 return of wild stock pink salmon was a reduction of 1.86 million fish.

Despite the differences in egg mortality and juvenile growth, tagging data do not indicate whether pink salmon populations were affected by the oil spill. For example, fry that were tagged as they left their streams in 1990, and were recaptured as returning adults in 1992, did not show differences in survival between oiled and nonoiled streams. Larger sample sizes may have provided more definitive results. There is uncertainty whether or not the increased egg mortality seen in the oiled streams is affecting the adult populations. Unusual oceanographic conditions, including poor plankton blooms, may have contributed to poor adult returns in 1993.

Recovery: The most apparent injury to pink salmon is to egg survival. This difference in mortality rates between oiled and nonoiled streams persisted in 1992. For at least the first four years after the spill, the rate appears to be worsening, both in oiled and nonoiled areas. Some experts believe that the spill reduced the adult population and estimate that recovery will take more than a decade.

Rockfish

Injury: The oil spill may have caused sublethal injuries to rockfish, but it is unknown whether or not population declines also occurred. There is little prespill data on rockfish in the spill area. Many dead rockfish were reported to have been sighted after the spill, although only 20 adult yelloweye rockfish were recovered by biologists. Of these, only 5 were in good enough condition to chemically analyze. All 5 fish were determined to have died from oil ingestion. Samples collected from oiled areas in Prince William Sound and the outer Kenai coast indicated there was evidence of exposure to oil (in bile) in 1989, and higher than normal prevalences of organ lesions in 1989, 1990 and 1991, although there is some uncertainty associated with causes of these pathological changes. In 1990 and 1991, oil exposure was documented in fish collected from oiled but also nonoiled sites.

An additional unknown is the degree to which postspill increases in fishing pressure may be impacting rockfish. Partially due to numerous spill-related commercial fishing closures (salmon and herring) in 1989, commercial fishers increased their take of rockfish. Rockfish harvests in Prince William Sound increased from approximately 93,000 pounds in 1989 to over 489,000 pounds in 1990. While harvests decreased since 1990, harvests are still higher than the historic average. While population levels are unknown, concerns have arisen about possible overfishing. Rockfish are a slow growing species, produce relatively few young, and do not recover rapidly from overfishing.

Recovery: Because there is still considerable uncertainty that rockfish experienced significant direct mortality or sublethal effects, a natural recovery rate was not estimated.

Sockeye Salmon

Injury: Kenai River and Red Lake-Kodiak sockeye salmon stocks may have suffered population declines as well as sublethal injuries. This potential injury is unique, since it is due in part to a decision to close commercial fishing in 1989 in portions of Cook Inlet and in Kodiak waters. As a result, there were higher than usual returns (overescapement) of spawning fish to the Kenai and Red Lake systems in 1989, although this was the third consecutive year of overescapement to the Kenai River system.

For the Kenai system, more than 900,000 spawning fish returned each year from 1987 through 1989, when the system was managed for a return of only 500,000 fish a year. The cumulative effect of too many spawning adults in the Kenai River system has been a decline in smolt production. Although the exact mechanism by which this occurred is not clear, it is believed that availability of food (planktonic crustacea) are insufficient to meet the needs of the greater number of fry produced. Fewer fry surviving their first winter in rearing lakes result in fewer outmigrant smolt in the spring. Smolt production in the Kenai River system has declined as follows: 1989, 30 million; 1990, 6 million; 1991, 2.5 million; and 1992 and 1993, less than 1 million. Outmigrations of smolt from the system have been on the decline since 1990, and the forecasted returns in 1994, 1995 and 1996 are below escapement goals.

Recovery: There are no indications of recovery in the Kenai River. The Red Lake system may be recovering since the plankton have recovered and fry survival improved in 1993. Estimates of population recovery vary among experts but could exceed a decade to attain a 10-year population average similar to the prespill population levels. The Kenai River recovery could be prolonged if plankton populations do not recover to prespill population concentrations and salmon develop a cyclic pattern with large returns in some years followed by very small returns in others. Recovery could occur more quickly if plankton populations return to normal by 1993, and there is a normal adult escapement.

SHELLFISH

Crab, Shrimp, Sea Urchin and Oyster

Injury: While clams, mussels, crab, shrimp, sea urchins and oysters are all commonly referred to as shellfish, injuries to clams and mussels are addressed in the section on **Intertidal Communities**.

Dungeness crab and brown king crab studies ended early in 1989 due to the scarcity of these species in the spill area. Fishing pressure and natural predation may have reduced population levels prior to the spill. However, public comments from Kodiak Island and Alaska Peninsula communities identified several locations where high crab mortality (primarily Dungeness crabs) or declining crab populations have been noticed since 1989.

There also is little conclusive evidence to suggest that spot shrimp were injured by the oil spill. There were no studies on sea urchins, and oyster studies (on farmed oysters) ended after a legal interpretation indicated that the Natural Resource Damage Assessment Rules did not apply. However, since oil is known to have impacted subtidal sediments and communities, it is possible that undocumented exposure and injury occurred for several shellfish species not studied.

Recovery: Because it was not possible to establish that these species were injured by oil, no estimate of recovery was made.

INTERTIDAL COMMUNITIES

Injury: The intertidal zone is the area of beach between the low and high tide extremes. The oil spill caused population declines and sublethal injuries to the community of plants and animals living in the intertidal zone. Portions of 1500 miles of coastline were oiled (350 miles heavily oiled) resulting in significant impacts to intertidal habitats, particularly the upper intertidal zone. With tidal action, oil penetrated deeply into cobble and boulder beaches that are relatively common on the rocky islands of the spill area. Cleaning removed much of the oil from the intertidal zone, but subsurface oil persisted in many heavily oiled beaches, and in mussel beds, which were avoided during the cleanup.

Direct oiling killed many organisms, but beach cleaning, particularly high-pressure, hot-water washing, had a devastating effect on intertidal life. Several studies have documented the combined effects of oiling and cleanup on beaches and now track the course of recovery. Because of little or no prespill data, these studies have relied on comparisons of oiled and nonoiled sites. Because of our ability to measure effects on common organisms, these have been emphasized in the injury studies.

The most significant impacts occurred in the upper and middle intertidal zones on sheltered rocky shores, where the greatest amounts of oil stranded. In the upper and middle intertidal zones of rocky shores, the seaweed *Fucus gardneri* (rockweed or popweed), barnacles, limpets, periwinkles, clams, amphipods, isopods and marine worms were less abundant at oiled than nonoiled sites. Although there were increased densities of mussels in oiled area, they were significantly smaller than mussels in the nonoiled areas, and the total biomass was significantly lower. While the percentage of intertidal areas covered by *Fucus* was reduced following the spill, the coverage of opportunistic plants (ephemeral algae) that characteristically flourish in disturbed area was increased. The average size of *Fucus* plants was reduced, as was the reproductive potential of those plants surviving the initial oiling.

Clams. The magnitude of measured differences varied with degree of oiling and geographic area. On sheltered beaches, the data on abundance of clams in the lower intertidal zone strongly suggest that little neck clams and, to a lesser extent, butter clams were significantly affected by the spill. During the 1993 public meetings, people throughout the oil spill area, but especially in Kodiak and Alaska Peninsula communities, said they are still finding clam beds that are contaminated with oil. They are very concerned about the effects of the oiled clams on their subsistence lifestyles and on the overall ecosystem. Also, in 1990, comparisons of abundance of intertidal fishes indicated fewer fish in oiled areas, but such differences were not found in 1991.

Mussels. In 1991, relatively high concentrations of oil were found in mussels and in the dense underlying mat (byssal substrate) of certain oiled mussel beds. These beds were not cleaned or removed after the spill and are potential sources of fresh (unweathered) oil for harlequin duck, black oystercatchers, river otters, and juvenile sea otters, all of which feed on mussels and show signs of continuing injury. The extent and magnitude of oiled mussel beds are unknown and continue to be investigated.

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

Recovery in the upper intertidal appears to depend on the return of adult *Fucus* in large numbers to this zone. In the absence of a well-developed canopy of adult plants, eggs and developing propagules of *Fucus* lack sufficient moisture to survive. The reduced canopy of rockweed in the upper intertidal zone also appears to have made it easier for oystercatchers to prey on limpets. Accordingly, the recovery of limpets and other invertebrates is also linked to the recovery of rockweed. Existing adult plants will act as centers for the outward propagation of new plants, and it is estimated that recovery of *Fucus* may take a decade. Full recovery of the intertidal community may take more than a decade, since it may take several years for invertebrate species to return after *Fucus* has recolonized an area.

SUBTIDAL COMMUNITIES

Injury: The oil spill caused population declines and sublethal injuries in the communities of plants and animals found below low tide. Several kinds of subtidal environments were studied after the spill: eel grass beds, *Laminaria* (kelp) beds, fjords and the deep bottom (40 to 100 meters). All these studies relied on comparisons between oiled and nonoiled environments. Study sites also were matched for conditions (sediment grain size, depth, etc.) likely to affect the distribution and abundance of organisms.

The greatest differences were seen for small organisms living in the sandy sea bottom below eelgrass beds--they were less abundant in oiled environments. Among affected groups were amphipods, known from previous studies to be highly sensitive to oil. In addition, there were larger organisms that showed differences in abundance, most notably the crab *Telemesus* was less abundant in oiled areas. Two separate studies found that eelgrass in oiled areas did not bloom as well after the spill as in nonoiled areas. Other organisms, however, were more abundant in oiled areas--juvenile cod and some small mussels that live on eelgrass. Even greater differences were observed in the abundance of fauna at depths from 6-20 meters below the oiled eelgrass beds, where there were far fewer individuals in oiled areas.

The results of other subtidal studies were more equivocal. Chemical analyses show that *Exxon Valdez* oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases. Reduced abundances in fauna were encountered in several oiled bays at 100 m, but the causes of these differences are not clear. Some flatfish had elevated amounts of hydrocarbons in their bile in 1989 and 1990, and slightly elevated prevalences of gill damage.

Recovery: Analysis of invertebrates associated with eelgrass beds collected in 1991 indicated that differences noted in 1990 between oiled and nonoiled areas had started to converge. Another year of study in 1993 may indicate if this trend has continued. Because recovery has been observed in shallow (<20m) subtidal habitats, full recovery is expected in most cases within several years.

OTHER RESOURCES

Archaeological Resources

Injury: The oil spill area has been occupied by Native peoples for at least 11,000 years. The spill area also contains artifacts from the post-European contact era. It is estimated that the oil spill area contains between 2,600 and 3,137 historic properties, including 1,287 known sites that have been recorded in the Alaska Heritage Resources Survey.

Currently, 24 sites are known to have been adversely affected by clean-up activities, or looting

and vandalism linked to the oil spill. One hundred thirteen sites are estimated to have been similarly affected. Injuries attributed to looting and vandalism (linked to the oil spill) are still occurring.

Injuries to archaeological sites include theft of surface artifacts and masking of subtle clues that archaeologists depend upon to identify and classify sites. Key diagnostic artifacts have been illegally taken, ancient burials have been violated and potholes dug by looters have destroyed critical evidence contained in the layered sediments. Additionally, vegetation has been disturbed which has exposed sites to accelerated erosion. The effect of oil on the soil chemistry and organic remains may reduce or eliminate the utility of radiocarbon dating in some sites. Other injuries to archaeological sites have not yet been reported and the actual extent of damage will not be known for decades.

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

Recovery: Archaeological sites cannot recover in the same sense as biological species or organisms. They represent a category of finite, nonrenewable resources. Injury to this resource results not only in the loss of important scientific data, but in an irretrievable loss of Alaska's cultural heritage. Its importance was emphasized in over 100 comments received from the public throughout the state of Alaska. Restoration cannot regenerate what has been destroyed, but it can successfully prevent further degradation of both sites and the scientific information. Documentation of injured sites is necessary to preserve the artifacts and scientific data which remains in the vandalized sites.

Designated Wilderness Areas

Injury: Areas formally designated as wilderness within the spill area are: Katmai National Park, Becharof National Wildlife Refuge, and Kachemak Bay State Wilderness Park. Four federal areas are currently being formally considered for wilderness designation: Kenai Fjords National Park, Lake Clark National Park, Aniakchak National Monument and Preserve, and the Nellie Juan/College Fjord area of the Chugach National Forest. Federal wilderness areas are managed according to the 1964 Wilderness Act and the Alaska National Lands Conservation Act (ANILCA) of 1980. State wilderness areas are managed according to enabling legislation and subsequent management plans. Generally, the areas are managed to maintain their natural landscape, a sense of solitude, and their wild character. Evidence of human presence is generally limited to temporary uses. Various state and federal lands not legislatively designated as wilderness or wilderness study areas are managed according to each agencies' enabling legislation and subsequent regulations. These areas allow a broader range of uses and increased human development and thus have increased human presence.

The oil spill delivered oil in varying quantities to the adjoining waters of all designated

wilderness areas, and oil was deposited above the mean high tide line in many areas. During the intense clean-up seasons of 1989-1990, hundreds of workers and thousands of pieces of equipment were at work in the spill area. This activity was an unprecedented imposition of people, noise and activity on the area's undeveloped and normally sparsely occupied landscape.

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

SERVICES (HUMAN USES)

Commercial Fishing

Injury: During 1989, emergency commercial fishery closures were ordered in Prince William Sound, Cook Inlet, and the waters around Kodiak Island and the Alaska Peninsula. Harvests were closed or restricted for pink and sockeye salmon, herring, crab, shrimp, rockfish, smelt and sablefish. In 1990, portions of Prince William Sound were closed to shrimp and salmon fishing for the same reason. (See Table B-2.) All of the 1989 and 1990 closures were done to prevent harvest of oiled fish and were not triggered by population reductions in these species. As of December 1993, there are no spill-related commercial fishery closures in effect.

Significant impacts on fisheries may result from too many fish returning to the Kenai River system in 1989. During the 1989 commercial sockeye fishery closures, large numbers of fish escaped harvest to spawn. This resulted in an unusually large number of salmon fry moving into the lakes to feed. Sockeye fry spend up to two years feeding in fresh water before migrating to the ocean. Previous Kenai River overescapements in 1987 and 1988 compounded the problem. It is hypothesized that the salmon fry overgrazed the zooplankton available to them in the upper layers of the lakes. This reduced rates of growth and survival for the fry. Fry survival in the Kenai system was very poor for three years in a row. This will probably result in severely reduced adult returns to the Kenai system starting in 1994. Closure of Kenai River sockeye fisheries would have major impacts on many user groups.

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

rockfish harvest may overfish the population.

Public comment indicated concern that the oil spill had caused or could cause the following fishery impacts:

- (1) poor Prince William Sound pink salmon returns in 1992 and 1993;
- (2) potential reductions of sockeye returns in Chignik Lake due to 1989 sockeye overescapements;
- (3) poor Prince William Sound herring returns and disease problems in 1993; and
- (4) decreased Prince William Sound spot shrimp populations.

As of December 1993, biologists do not know whether these events were caused by the oil spill.

Recovery: Kenai River sockeye recovery will depend on recovery and availability of zooplankton populations in the lakes used by rearing fry. It is not yet known how many year classes of sockeye fry will be directly impacted by food shortages. However, the number of outmigrating Kenai River smolt was extremely low in 1991, 1992 and 1993, indicating that at least two consecutive year classes were impacted by overescapement. Kenai River smolt will return as adults in 1994, 1995 and 1996. The number of adults returning from these reduced outmigrations will almost certainly be lower than normal and may not be able to produce enough eggs to rebuild the runs within a single generation. If this turns out to be the case, adult returns to the Kenai in 1999, 2000 and 2001 may also be low. The Red Lake system also suffered overescapement in 1989 but may be recovering since plankton have recovered and fry survival improved in 1993.

Insufficient data exist to determine whether rockfish continue to be impacted by hydrocarbon contamination or if they are being harmed by overfishing. The lack of data could result in additional damage to the species. The long-term impacts of the injuries herring and pink salmon are uncertain.

COMMERCIAL FISHERY CLOSURES

TABLE B-2

Prince William Sound	
Pacific Herring	Gillnet and purse seine sac roe fisheries and pound and wild roe-on-kelp fisheries closed April 3, 1989.
Shrimp	Pot shrimp fishery closed while in progress on April 3, 1989. Trawl shrimp fishery closed on April 9, 1989. A small pot shrimp harvest area near Knight, Eleanor and Smith Islands was closed in 1990.
Sablefish (black cod)	Closed April 1, 1989. Reopened in inside waters only, in conjunction with the halibut opening on June 12, 1989.
Dungeness Crab	Closed April 30, 1989.
King Crab	Closed on October 1, 1989.
Groundfish	Closed April 30, 1989. Reopened with the June 12, halibut opening.
Miscellaneous Shellfish	On April 24, 1989 it was announced that no miscellaneous shellfish permits would be issued.
Pink and Sockeye Salmon	<p>Closures of commercial drift and set net fisheries in Eshamy District, Northern District (surrounding Naked and Perry Islands), parts of Culross Island Subdistrict, Southwestern District, and parts of Montague Island District.</p> <p>In 1990, two set net areas near Eshamy Bay were closed for four days and then reopened. In addition, portions of the northern and eastern shorelines of Latouche Island, and waters around Eleanor and Ingot Islands were closed to fishing.</p>

TABLE B-2 (cont.)
Upper Cook Inlet

Sockeye Salmon	With the exception of a very minor opening of a small portion of the Central District, the commercial drift gillnet season was closed because of oil. In addition, setnet fishing in the Upper Subdistrict south of the Kasilof River was closed for the 12 hour regular fishing period on July 7, 1989, due to the presence of oil on beaches.
Lower Cook Inlet	
Shrimp	Closed April 30, 1989. Reopened July 7, 1989.
Miscellaneous Shellfish	On April 24, 1989, it was announced that no miscellaneous shellfish permits would be issued to harvest these species in the Outer and Eastern Districts until the danger of oil contamination had passed.
Groundfish	The Outer and Eastern Districts were closed at noon, April 30, 1989. The fishery reopened to all species except sablefish, June 12 in conjunction with the 24-hour halibut opening.
Smelt	Smelt remained closed along with groundfish in the Outer and Eastern Districts on April 30, 1989. When groundfish reopened, smelt fishing remained closed.
Pacific Herring	The sac roe fishery in the Outer and Eastern Districts closed on April 15, 1989, prior to the anticipated opening date of April 20, 1989.
Pink Salmon	The seine fishery in the Kamishak District opened on June 1, 1989 and was closed by emergency order on June 8, 1989. Portions of Kamishak District north of Contact Point were opened after July 20 based on run strength. The Tutka Bay Subdistrict north of the HEA powerlines was closed to seining on July 10, and opened later the same day after further assessment showed the commercial fishery would not be impacted.

TABLE B-2 (cont.) Kodiak	
Pacific Herring	Approximately 34 of 56 management units were closed for the duration of the sac roe fishing season.
Sockeye and Pink Salmon	The commercial season was scheduled to begin June 9, 1989. The fisheries were postponed until June 19, when only the setnet fishery in the Alitak District opened; there were approximately 114 days fished in this setnet fishery by 87 fishermen. The only other commercial opening to occur during the 1989 salmon season was a two day seine opening in Karluk Lagoon, on the west side of Kodiak Island, in mid-September. The entire Kodiak Management Area closed to commercial salmon fishing at the conclusion of the Lagoon fishery.
Chignik	
Sockeye Salmon	The Chignik fishery opened on June 12, 1989. However, portions of the Eastern District were closed due to the presence or close proximity of oil in the Kilokak Rocks area, and in Imuya and Wide Bays. The ADF&G announced a 24-hour fishing period on June 26 for a portion of the Chignik Bay District. The area was limited to a small portion of this district due to the presence of oil in surrounding areas, and was later closed the same day due to the presence of mousse and sheen. Additional closures occurred on July 27 and August 5, 1989.

Passive Use

Injury: Passive uses of resources include the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other non-use values.

The areas of Alaska impacted by the oil spill supported a large diverse ecosystem that was valued by large numbers of the American public who did not visit the area. The spill killed substantial numbers of different bird species and marine mammals as well as oiling much of the coastline in the impacted areas. The spill also had substantial effects on the fish, bird, and wildlife populations. While some of these effects may be of relatively short duration, others such as recovery of various bird populations are likely to take decades.

A contingent valuation study of the American public done in 1991 found that approximately 95% were still aware of the *Exxon Valdez* oil spill, and that over 50% spontaneously named the spill as one of the worst environmental accidents to occur in the world during their lifetime. The median household was willing to pay \$31 to prevent a spill similar to the *Exxon Valdez* in the future. Multiplied by the number of U.S. households, this results in an estimate of spill damages of \$2.8 billion.

Recovery: The animals initially killed are irreplaceable. Fish and wildlife populations are recovering at different rates. Much of the oil in shoreline areas has been removed or has weathered to varying degrees. However, full recovery will not occur until the public also perceives that injured resources have recovered.

Recreation and Tourism

Injury: This statement of injury to recreation has been derived from reference material, public comment, and comment from agency managers. A comprehensive recreation injury assessment has not been conducted. Although this summary covers the entire spill area, most of the information is from Prince William Sound.

Recreation can be divided into two categories, commercial and non-commercial. Commercial recreation (tourism) includes uses by clients and operators of tourism services such as boat tours, fishing charters and flightseeing services. Non-commercial recreational users engage in many of the same activities as commercial users, but do not purchase or pay for the services of tourism businesses. Common recreational activities for all users include kayaking, camping, hiking, boating, sightseeing, photography, scuba diving, beachcombing, flying, sport fishing, hunting, gathering food, and investigating the history of an area.

Injuries to the natural resources as well as the oil spill clean up and other post-spill activities have caused injury to recreation and tourism. Injury is divided into five categories: (1)

quantity; (2) quality; (3) perception; (4) location; and (5) facilities.

Quantity. Some commercial recreation and tourism businesses were injured by the reduction in visitors and visitor spending as a result of the spill. Businesses relying on individual bookings rather than packaged tours, were hurt more by reduced bookings. Non-commercial recreation also decreased in some parts of the spill area.

Because oil fouled beaches, there was and still is a reduction of quality destinations available to some recreation users. There was a reduction in quantity and quality of wilderness based destinations because clean up activities brought people, noise and large motorized equipment throughout the spill area and disturbed the area's undeveloped and normally sparsely occupied landscape.

Public use cabin rentals and visitor use data from the State of Alaska, Chugach National Forest and Kenai Fjords National Park show fewer visits in some of the spill area in 1989 and 1990. Decreased use is an injury to those who would like to have used the area but avoided it because of the spill. While fewer people visited some areas, other areas experienced increased use. In some cases, increased use is causing additional resource damage and decreased enjoyment of overused areas.

There was a significant decline in sport fishing in the oil spill area following the oil spill. The loss to sport anglers in 1989 is estimated to be \$31 million. In 1992, cutthroat trout sport fishing in western Prince William Sound was closed due to low adult returns and in 1991 a restriction on the sport hunting of harlequin duck was imposed.

Quality. The quality of recreation experiences decreased as a result of the spill due to crowding, residual oil, and fewer fish and wildlife. During the cleanup efforts, thousands of additional people in the spill area reduced wilderness qualities. Some communities were directly affected by crowding. The degree of injury differs for different forms of recreation. For instance kayakers have been much more affected by this quality reduction than cruise ship passengers.

The injuries to fish and wildlife reduced the amount that were seen or caught by people visiting the area. In addition, seeing oil diminished the appreciation of the natural setting. More heavily oiled areas experienced more injury to the quality of recreation.

Perceptions. The oil spill caused injury to the way people perceive recreation opportunities in the spill area. According to public comment, changes in perceptions include: (1) increased sense of vulnerability of the ecosystem in regard to future oil spills; (2) erosion of wilderness character; (3) a sense of permanent change; (4) A sense of complete disruption of the ecosystem and contamination of the food chain; (5) a sense of unknown or unseen ecological effects; and (6) a sense of threat to archaeological resources.

These perceptions caused people to change destinations and trip plans, resulting in injuries to tourism, sport fishing, boating, recreation cabin bookings, and community businesses among others.

People who used the spill area before the oil spill occurred generally have greater perceptions of injury than first time recreation users of the spill area. Perceptions are changed more often for shore-based recreation users than those who remain on vessels.

Location. The location of recreation use was altered by changed use patterns and displaced use. Some recreation users were temporarily or permanently displaced from their customary or preferred sites due to spill-related changes such as crowding, presence of oil, or other factors. As a result of the oil spill, others changed the type or location of recreation use they historically engaged in.

Facilities. Some recreation facilities were injured by the spill, most from overuse or misuse during 1989 and 1990. For example, the Green Island public use cabin and Fleming Spit camp area near Cordova experienced over use, sanitation problems and resource degradation.

Recovery: Public comment shows persisting oil, crowding, diminished aesthetics, reduction of wilderness character, reduction of wildlife sightings, tainted food sources, disturbance of cultural sites, and evidence of clean up activities all to be continuing injuries to recreation. According to recent public comment, some displaced users are returning to parts of the spill area, while others still avoid the heavier oiled areas. Recovery of recreation is largely dependent on the recovery of the natural resources. As natural resources recover, recreational experiences will improve. The projected decrease in the Kenai River sockeye salmon returns could cause additional injury to recreation on the Kenai Peninsula. Use patterns continue to change in relation to the recovery of the resources, perceptions, and the effects of restoration projects.

Subsistence

Injury: Before the *Exxon Valdez* oil spill, the Alaska Department of Fish and Game's Subsistence Division documented 15 Native Alaskan communities (with about 2200 people) in Prince William Sound, Lower Cook Inlet, Kodiak and the Alaska Peninsula that relied heavily on subsistence resources. These resources included salmon, halibut, cod, rockfish and Dolly Varden; marine invertebrates such as clams, chitons, shrimp, crabs, and octopus; marine mammals (harbor seals and sea lions); land mammals such as deer (Prince William Sound and Kodiak Island), black bear and goats (Prince William Sound and Lower Kenai Peninsula); birds including ptarmigan, waterfowl, and gulls eggs; and wild plants. Many of these species were studied after the spill, and the results of these studies are summarized in this section. The mean number of resources used per household ranged from 10 to 25, and generally every household in these communities participated in subsistence harvests. The per capita

subsistence harvest ranged from nearly 200 pounds to over 600 pounds per year.

Table B-3 illustrates changes in harvest levels in the first year (April 1989 to March 1990) following the spill. Subsistence harvests of fish and wildlife in eleven of these villages (Chenega Bay, Tatitlek, Nanwalek (English Bay), Port Graham, Karluk, Old Harbor, Akhiok, Larsen Bay, Ouzinkie, Port Lions, and Chignik Lagoon) declined from 4% to 77%, compared to prespill harvest levels. The reasons for this decline varied among communities and households, but most dealt with the reduced availability of injured species and perceived consequences of the oil spill, especially the concern for potential health effects caused by consuming subsistence resources from the spill area.

Table B-3 does not reflect the injuries to subsistence use that occurred in Alaska Peninsula communities. After the spill, people in this area harvested fewer marine resources, but increased harvest levels of terrestrial species. Also, many people were and continue to be concerned about the safety of traditional foods and some families avoided using certain species.

Chemical analytical studies conducted in 1989-1991 measured levels of metabolites in the bile and petroleum hydrocarbons in edible tissues of subsistence foods. These studies found that most resources tested (fish, some species of shellfish, deer, ducks, marine mammals) contained no or very low levels of petroleum hydrocarbons, and that eating foods with those levels posed no health risk. Exposure to oil did not necessarily render organisms unsafe to eat since some exposed animals were found to have low or non-existent levels of hydrocarbons and their metabolites in their edible tissues. Some samples of shellfish, however, had unacceptably high levels of petroleum hydrocarbons. This prompted advisories, starting in 1989, that shellfish should not be collected from obviously oil-contaminated areas. This advice has not changed.

Recovery: Table B-3 summarizes changes in harvest levels in Native villages following the oil spill. The finding that subsistence harvests had partially recovered in 5 villages during the 1990-1991 timeframe suggested increased confidence in using some subsistence resources. However, the continued very low levels of harvest at Chenega Bay and Tatitlek, Nanwalek (English Bay) and Ouzinkie, and the continued concern in some households in many villages that some subsistence foods remained unsafe to eat, suggested that the injury persisted through the second year following the spill.

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

TABLE B-3. Subsistence Harvests Before and After the *Exxon Valdez* Oil Spill:

COMMUNITY	PRESPILL YEAR ONE (per capita harvest in pounds)	PRESPILL YEAR TWO (per capita harvest in pounds)	OIL SPILL YEAR (per capita harvest in pounds)	PERCENT CHANGE	POSTSPILL YEAR ONE (4/90 - 3/91) (per capita harvest in pounds)
<u>Prince William Sound</u>					
Chenega	308.8	374.2	148.1	-56.6 (e)	143.1
Tatitlek	351.7	643.5	214.8	-56.8 (e)	155.2
<u>Lower Cook Inlet</u>					
Nanwalek (English Bay)	288.8	(c)	140.6	-51.3 (b)	181.1
Port Graham	227.2	(c)	121.6	-46.5 (b)	213.5
<u>Kodiak Island</u>					
Akhiok	519.5	159.3	297.7	-12.3 (e)	(d)
Karluk	863.2	381.0	250.5	-59.7 (e)	395.2
Larsen Bay	403.5	200.9	209.9	-30.5 (e)	340.4
Old Harbor	491.1	419.3	271.1	-40.4 (e)	(d)
Ouzinkie	369.1	405.7	88.8	-77.1 (e)	204.9
Port Lions	279.8	328.3	146.4	-51.8 (e)	(d)
<u>Alaska Peninsula</u>					
Chignik Bay	187.9	(c)	208.6	+11.0 (b)	(d)
Chignik Lagoon	220.2	(c)	211.4	-4.0 (b)	(d)
Chignik Lake	279.0	(c)	447.6	+60.4 (b)	(d)
Ivanof Bay	455.6	(c)	489.8	+7.5 (b)	(d)
Perryville	391.2	(c)	394.2	+0.8 (b)	(d)

(a) Prespill study years are: Tatitlek 1987-88 and 1988-89; Chenega, 1984-85 and 1985-86; Nanwalek (English Bay) and Port Graham, 1987; Kodiak Island Borough, 1982-83 and 1986; Alaska Peninsula, 1984. The "spill year" is 1989 for all communities, except Chenega and Tatitlek, for which it is April 1989-March 1990.

(b) Compared to the most recent previous year.

(c) Only one previous measurement was taken.

(d) Not determined.

(e) Compared to the average of both prespill years.

Resources:
Summary of Results of Injury Assessment Studies

The tables in this part of the appendix summarize the results of the injury assessment studies for all natural resources and archaeology completed after the *Exxon Valdez* oil spill. Table B-4 shows whether there was initial mortality caused by the spill, whether the spill caused a measured population decline, and whether there is evidence of sublethal injury. For some resources, an estimate is available for the total number of animals initially killed by the spill. If available, that estimate is shown in parentheses under the initial mortality column. For many resources, the total number killed will never be known. For other resources, and archaeology, listed in Table B-5, information on injury is not quantitative.

The "Status of Recovery" columns show the best estimate of recovery using the most recent information. The columns show resources' progress toward recovery to the condition and population levels that scientists estimate would have occurred in the absence of the spill. The "Current Population Status" column shows a resource's progress from any "Decline in Population after the Spill." Similarly, the column labeled "Continuing Sublethal Effects" shows whether an sublethal injury is ongoing.

**TABLE B-4 Resources: Summary of Results of Injury Assessment Studies Done
After the *Exxon Valdez* Oil Spill**

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
MARINE MAMMALS										
Harbor Seals (d)	YES (300)	YES	YES	POSSIBLY STABLE, BUT NOT RECOVERING (b)	UNKNOWN	YES	YES (e)	UNKNOWN	UNKNOWN	Many seals were directly oiled. There was a greater decline in population indices in oiled areas compared to 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	(f)	(f)	(f)	(f)	(f)	(f)	Other than fewer animals being observed in Knight Island Passage in summer 1989, which did not persist in 1990, the oil spill did not have a measurable impact on the north Pacific population of humpback whales.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Killer Whales	Yes (13)	YES (h)	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 4 whales since 1990. Some experts think the loss of 13 whales in 1989, 1990 is unrelated oil spill.
Sea Lions (d)	UNKNOWN	YES (h)	NO	CONTINUING DECLINE	(f)	(f)	(f)	(f)	(f)	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.
Sea Otters	YES (3,500 TO 5,500)	YES	YES	STABLE, BUT NOT RECOVERING	YES, POSSIBLY	YES	YES	YES (e)	YES (e)	Postspill 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. Sea otters feed in the lower intertidal and subtidal areas and may still be exposed to hydrocarbons in the environment.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
TERRESTRIAL MAMMALS										
Brown Bear	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	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.
Black Bear	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	No field studies were done.
River Otters	YES (TOTAL NUMBER UNKNOWN)	NO	YES, POSSIBLY	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Exposure to hydrocarbons and possible sublethal effects were determined, but no effects were established on population. Sublethal 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	(f)	(f)	(f)	(f)	(f)	(f)	Elevated hydrocarbons were found in tissues some deer in 1989.
Mink	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Studies limited to laboratory toxicity studies.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
BIRDS										
Bald Eagles	YES (200 or more)	NO	YES	POSSIBLY RECOVERED	NO	YES	YES	YES (e)	YES(e)	Productivity in PWS was disrupted in 1989, returned to normal in 1990. Exposure to hydrocarbons and some sublethal effects were found in 1989, but no continuing effects were observed on populations.
Black-legged Kittiwakes	YES (NUMBER UNKNOWN)	NO	NO	NO CHANGE	NO	YES	YES (e)	YES (e)	YES (e)	Total reproductive success in oiled and unoiled areas of PWS has declined since 1989. 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 (120-150 ADULTS; UNKNOWN FOR CHICKS)	YES	YES	RECOVERING	YES	YES	YES (e)	YES (e)	YES (e)	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 postspill surveys in 1989, 1990 and 1991. Black oystercatchers feed in the intertidal areas and may be sti be exposed to hydrocarbons in the environme

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Common Murres	YES (170,000 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)	NO	NO	NO CHANGE	NO	YES (e)	YES (e)	YES (e)	YES (e)	While dead birds were recovered in 1989, there is no evidence of a population level impact when compared to historic (1972, 1973) population levels.
Harlequin Ducks	YES (APPROX. 1000)	YES	YES, POSSIBLY	UNKNOWN	YES	YES	YES (e)	YES (e)	YES (e)	Postspill samples showed hydrocarbon contamination. Surveys in 1990-1992 indicated population declines and possibly reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may still be exposed to hydrocarbons in the environment.
Marbled Murrelets (d)	YES (8,000 TO 12,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Measurable population effects were recorded 1989, 1990 and 1991. Marbled murrelet populations were declining prior to the spil..

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Peale's Peregrine Falcons	UNKNOWN	YES (h)	NO	(f)	(f)	(f)	(f)	(f)	(f)	When compared to 1985 surveys a reduction in population and lower than expected product was measured in 1989 in the PWS. Cause of these changes are unknown.
Pigeon Guillemots (d)	YES (1,500- TO 3,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found externally, on eggs.
Storm Petrels	YES (NUMBER UNKNOWN)	NO	NO	NO CHANGE	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	Few carcasses were recovered in 1989 although petrels ingested oil and transferred oil to their eggs. Reproduction was normal in 1989.
Other Seabirds	YES (number unknown)	VARIES BY SPECIES	UNKNOWN	VARIES BY SPECIES	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	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.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Other Sea Ducks	YES (875)	NO	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	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)	VARIES BY SPECIES	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Species collected dead in 1989 include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpipers; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.
Other Birds	YES (NUMBER UNKNOWN)	NO (NOT STUDIED)	UNKNOWN	UNKNOWN	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	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.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
FISH										
Cutthroat Trout	NO	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	NO	NO	NO	Differences in survival between anadromous adult populations in the oiled and unoiled areas were not statistically different; however, differences in growth between adult populations in the oiled and unoiled areas were found in 1989, 1990, and 1991.
Dolly Varden	NO	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	Differences in survival between anadromous adult populations in the oiled and unoiled areas were not statistically different. Growth rates between 1989 and 1990 were reduced.
Pacific Herring	YES, TO EGGS AND LARVAE	YES (h)	YES	SEE COMMENTS	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. Herring exposed as eggs or larvae in 1989 were under-represented in 1992 and 1993 returns. It is unknown whether 1993 disease outbreaks w due to the spill.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Pink Salmon (Wild) (d)	YES, TO EGGS	YES (h)	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial egg mortality in 1989. Egg mortality continued to be high in 1991 & 1992. Abnormal fry were observed in 1989. Reduced growth of juveniles was found in the marine environment, which can be correlated with reduced survival to adulthood. It is unknown whether poor returns in 1993 are linked to the spill.
Rockfish	YES (20) (g)	NO	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.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Sockeye Salmon	UNKNOWN	YES	YES	SEE COMMENTS	SEE COMMENTS	UNKNOWN	YES	YES	UNKNOWN	Fry survival continues to be poor in the Kenai River systems due to overescapements to the Kenai River in 1987, 1988, 1989. As a result, adult returns are expected to be low in 1990 and successive years. Trophic structures of Kenai and Skilak Lakes have been altered by overescapement. Red Lake may be recovering since plankton have recovered and fry survival improved in 1993.
SHELLFISH										
Clam	YES (NUMBER UNKNOWN)	YES	POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	Marginal declines in clam populations were noted in 1989. Native littleneck and butter clams were impacted by both oiling and cleanup, particularly high pressure, hot water washing. Littleneck clams transplanted to oiled areas in 1990 grew significantly less than those transplanted to unoiled sites. Reduced growth recorded at oiled sites in 1989 but not 1991.
Crab (Dungeness)	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Crabs collected from oil areas were not found to have accumulated petroleum hydrocarbons.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Oyster	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Although studies were initiated in 1989, they were not completed because they were determined to be of limited value.
Sea Urchin	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Studies limited to laboratory toxicity studies.
Shrimp	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	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 midintertidal is recovering. Some species (Fucus) in the upper intertidal zone have not recovered, and oil may persist in mussel beds.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
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 recover. Amphipods in eel grass beds recovered to prespill densities in 1991. Leather stars and helmet crabs show little sign of recovery through 1991.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

TABLE B-5 Other Natural Resources and Archaeology: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Resource	Description of Injury	Status of Recovery	Geographic Extent of Injury				Comments/Discussion
			(b)				
			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.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury	Status of Recovery	Geographic Extent of Injury (b)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
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) 1993 field reports are not yet finalized.
(b) There may have been an unequal distribution of injury within each region, see map for location of regions.
(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.
(d) Population may have been declining prior to the spill.
(e) Based on recovery of dead animals from this region of the spill zone.
(f) If no injury was detected or known, no assessment of recovery could be made.
(g) Total body count, not including carcasses not found.
(h) It is unknown if declines are due to the oil spill.

Services:
Summary of Results of Injury Assessment Studies

Table B-6 summarizes information concerning lost or reduced services damaged by the spill. Much of the injury to services and the information about those injuries is not quantitative. The table reflects the qualitative content of the information. The "Description of Reduction or Loss" column recounts the impacts of the spill on each service. The "Status of Recovery" shows the most recent information on recovery.

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

**TABLE B-6 Services: Summary of Results of Injury Assessment Studies Done
After the Exxon Valdez Oil Spill**

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Passive Use	The areas of Alaska impacted by the oil spill supported a large diverse ecosystem that was valued by large numbers of the American public who did not visit the area. The spill killed substantial numbers of different bird species and marine mammals as well as oiling much of the coastline in the impacted areas. The spill also had substantial effects on the fish, bird, and wildlife populations. While some of these effects may be of relatively short duration, others such as recovery of various bird populations are likely to take decades.	The animals initially killed are irreplaceable. Fish and wildlife populations are recovering at different rates. Much of the oil in shoreline areas has been removed or has weathered to varying degrees.	YES	YES	YES	YES	A contingent valuation study of the American public done in 1991 found that approximately 95% were still aware of the Exxon Valdez spill, and that over 50% spontaneously named the spill as one of the worst environmental accidents to occur in the world during their lifetime. The median household was willing to pay \$31 to prevent a spill similar to the Exxon Valdez in the future. Multiplied by the number of U.S. households, this results in an estimate of spill damages of \$2.8 billion.

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

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Recreation and Tourism (e.g., hunting, sportfishing, camping, kayaking, sailboating, motorboating, environmental education)	<p>The nature and extent of any reduction or loss of services varied by user group and by area.</p> <p>Some commercial recreation and tourism businesses were injured by the reduction in visitors and visitor spending as a result of the spill. Non-commercial recreation also decreased in some parts of the spill area. The quality of recreation experiences decreased as a result of the spill due to crowding, residual oil and fewer fish and wildlife. The oil spill caused injury to the way people perceive recreation opportunities in the spill area. The location of recreation use was altered by changed use patterns and displaced use. A few recreation facilities were impacted by the spill, most from overuse or misuse during 1989 and 1990.</p> <p>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.</p>	<p>Public comment shows persisting oil, crowding, diminished aesthetics, reduction of wilderness character, reduction of wildlife sightings, tainted food sources, disturbance of cultural sites, and evidence of clean-up activities all to be continuing injuries to recreation. Some displaced users are returning to parts of the spill area, while others still avoid the heavier oiled areas.</p> <p>Recovery of recreation, especially sport hunting and fishing, is largely dependent on the recovery of injured species. As species recover, recreational experiences will improve. The projected decrease in the Kenai River sockeye salmon returns could cause additional injury to recreation on the Kenai Peninsula. Use patterns continue to change in relation to the recovery of the resources, perceptions and restoration projects.</p>	YES	YES	YES	YES	Survey respondents also reported changes in their perception of recreation opportunity in terms of increased vulnerability to future 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.

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Commercial Fishing	<p>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).</p> <p>In 1990 portions of PWS were closed to shrimp and salmon fishing.</p>	<p>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.</p> <p>EVOS related sockeye over-escapement in the Kenai River system is anticipated to result in low adult returns in 1994 and beyond. Over-escapements may result in closure or harvest restrictions during these and perhaps in subsequent years.</p> <p>Returns of pink salmon and herring to Prince William Sound were very low in 1993. It is uncertain to what degree this is linked to the spill.</p>	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.

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

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Subsistence	<p>Subsistence harvests of fish and wildlife in 11 of 15 villages surveyed declined from 4 - 77% in 1989 when compared to prespill levels. At least 4 of the 11 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.</p> <p>In 1989-1991, chemical analysis indicated that most resources tested, including fish, marine mammals, deer, and ducks, were safe to eat. Starting in 1989, health advisories were issued indicating that shellfish from oiled beaches should not be eaten.</p>	<p>Many subsistence users believe that continued contamination to subsistence food sources is dangerous to their health.</p> <p>In addition, village residents believe that subsistence species continue to decline or have not recovered from the oil spill.</p> <p>Health advisories against eating clams from obviously oiled beaches are still in effect.</p>	YES	YES	YES	YES	For detailed information on village subsistence use, see Table B-3.

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

Appendix C

Areas Recommended by the Public for Purchase or Protection

During the public comment period in April and May of 1993, the public recommended many areas for purchase or protection. The list of recommended areas, by region, appears below.

Prince William Sound

Bainbridge Island
Chenega Island
Chugach National Forest
Cordova area private lands
Dangerous Passage
Eshamy/Jackpot Bay
Evans Bay
Fish Bay
Hawkins Island
Hinchinbrook Island
Icy Bay
Knight Island
Knowles Head
Latouche Island
Montague Island
Naked Island
Nelson Bay
Olsen Bay
Orca Bay/Narrows¹
Patton Bay
Port Fidalgo
Port Gravina (including Bear Trap Bay)
Red Head
Rude River
Sheep Bay
Simpson Bay
Two Moon Bay
Windy Bay

Kenai Area

Chrome Bay
Gull Island
Kamishak Bay
Kenai Fjords National Park
Kenai Peninsula
Port Chatham
Rocky Bay

Kodiak Area

Afognak Island
Fox/Red Fox Bay
Karluk River
Kodiak Island
Kodiak National Wildlife Refuge
Long Lagoon
Pauls & Laura Lake Chain
Shuyak Island/Strait
Sitkalidak Island
Sturgeon River

General

Tongass National Forest

1. Orca Narrows/Orca Bay was the only area that people specifically stated that they were opposed to acquiring.

Appendix D Planning Publications

The following publications have been produced by the *Exxon Valdez* Trustee Council's Restoration Planning Work Group in the development of this plan:

Restoration Following the *Exxon Valdez* Oil Spill: Proceedings of the Public Symposium, Anchorage, Alaska, July 1990.

Restoration Planning Following the *Exxon Valdez* Oil Spill: August 1990 Progress Report, Anchorage, Alaska, August 1990.

Restoration Framework, Anchorage, Alaska, April 1992.

Draft *Exxon Valdez* Oil Spill Restoration Plan: Summary of Alternatives for Public Comment, Anchorage, Alaska, April 1993.

Supplement to Draft *Exxon Valdez* Oil Spill Restoration Plan Summary of Alternatives for Public Comment, Anchorage, Alaska, June 1993.

Summary of Public Comment on Alternatives, Anchorage, Alaska, September 1993.

The following publications were produced by contractors for the *Exxon Valdez* Trustee Council's Restoration Planning Work Group.

Boland, J. M., Comprehensive Review and Critical Synthesis of the Literature on Recovery of Ecosystems Following Disturbances: Marine Invertebrate Communities, Pacific Estuarine Research Laboratory, California, October 1992.

Jones and Stokes Associates, Inc., Proceedings of the Workshop on Programs to Protect Marine Habitats, Bellevue, Washington, January 1992.

Jones and Stokes Associates, Inc., Summary Report on Programs to Protect and Manage Marine Habitats, Bellevue, Washington, January 1992.

The Nature Conservancy, Options for Identifying and Protecting Strategic Fish and Wildlife Habitats and Recreation Sites: A General Handbook, Anchorage, Alaska, December 1991.

Nevissi, A. E., T.H. Sibley, and C. Chang, Comprehensive Review and Critical Synthesis of the Literature on Recovery of Ecosystems Following Disturbance: Fish and Shellfish, University of Washington, Washington, September 1993.

Nur, N. and D.G. Ainley, Comprehensive Review and Critical Synthesis of the Literature on Recovery of Marine Bird Populations from Environmental Perturbations, Point Reyes Bird Observatory, California, March 1992.

Parametrix, Inc., ABA Consultants, and Goldstream Consulting, Monitoring Recovery Following the Exxon Valdez Oil Spill: A Conceptual Monitoring Plan, Kirkland, Washington, June 1993.

Stewart, B.S., P.K. Yochem, and J.R. Jehl Jr., Review and Critical Synthesis of the Literature on Recovery of Ecosystems Following Man-Induced and Natural-Phenomena-Related Disturbances: Harbor Seals and Killer Whales, Hubb-Sea World Research Institute, California, June 1992.

Versar, Inc., Restoration Planning Following the Exxon Valdez Oil Spill: Draft Technical Workshop Report, Columbia, Maryland, September 1990.

DRAFT 2
11/24/93

11.4.116
RECEIVED
NOV 30 1993

MISSION STATEMENT
OF THE
EXXON VALDEZ OIL SPILL SETTLEMENT TRUSTEE COUNCIL

EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

THE MISSION OF THE TRUSTEE COUNCIL AND ALL PARTICIPANTS IN COUNCIL EFFORTS IS TO EFFICIENTLY RESTORE THE ENVIRONMENT INJURED BY THE EXXON VALDEZ OIL SPILL TO A HEALTHY, PRODUCTIVE WORLD RENOWN ECOSYSTEM, WHILE TAKING INTO ACCOUNT THE IMPORTANCE OF QUALITY OF LIFE AND THE NEED FOR VIABLE OPPORTUNITIES TO ESTABLISH AND SUSTAIN A REASONABLE STANDARD OF LIVING.

THE RESTORATION WILL BE ACCOMPLISHED THROUGH THE DEVELOPMENT AND IMPLEMENTATION OF A COMPREHENSIVE INTERDISCIPLINARY RECOVERY AND REHABILITATION PROGRAM THAT INCLUDES:

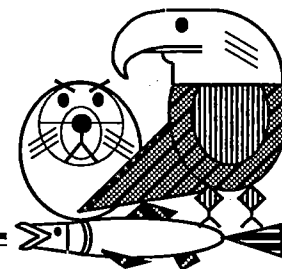
- * NATURAL RECOVERY
- * MONITORING AND RESEARCH
- * RESOURCE AND SERVICE RESTORATION
- * HABITAT ACQUISITION AND PROTECTION
- * RESOURCE AND SERVICE ENHANCEMENT
- * REPLACEMENT
- * MEANINGFUL PUBLIC PARTICIPATION
- * PROJECT EVALUATION
- * FISCAL ACCOUNTABILITY
- * EFFICIENT ADMINISTRATION

Exxon Valdez Oil Spill Trustee Council

Restoration Office

645 G Street, Suite 402, Anchorage, Alaska 99501

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



Mission Statement of the Exxon Valdez Oil Spill Trustee Council

The mission of the Trustee Council and all participants in council efforts is to efficiently restore the environment injured by the Exxon Valdez oil spill to a healthy, productive world renowned ecosystem, while taking into account the importance of quality of life and the need for viable opportunities to establish and sustain a reasonable standard of living.

The restoration will be accomplished through the development and implementation of a comprehensive interdisciplinary recovery and rehabilitation program that includes:

- Natural Recovery
- Monitoring and Research
- Resource and Service Restoration
- Habitat Acquisition and Protection
- Resource and Service Enhancement
- Replacement
- Meaningful Public Participation
- Project Evaluation
- Fiscal Accountability
- Efficient Administration

Adopted by the Trustee Council at their November 30, 1993 meeting.

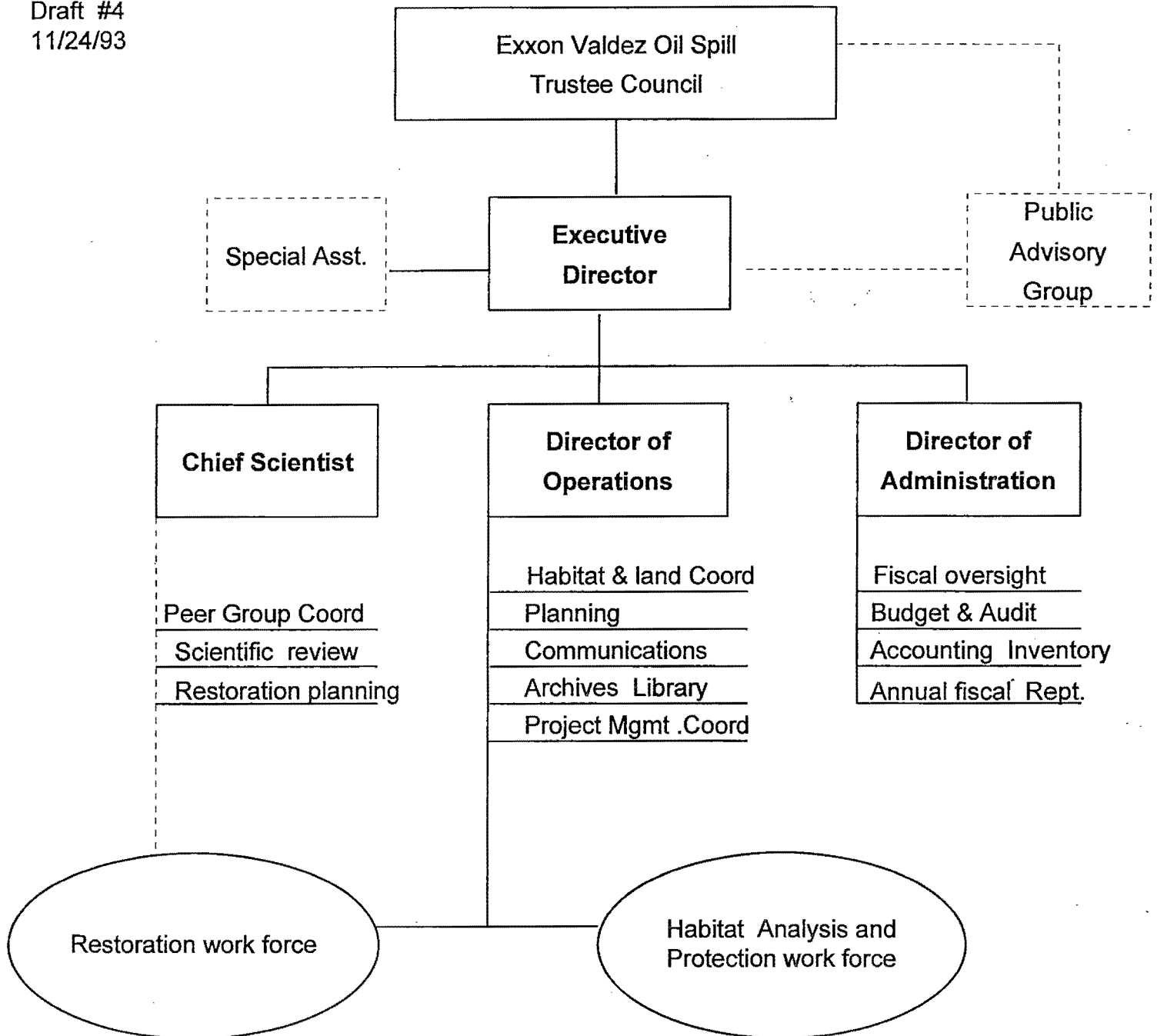
Trustee Agencies

State of Alaska: Departments of Fish & Game, Law, and Environmental Conservation

United States: National Oceanic and Atmospheric Administration, Departments of Agriculture and Interior

Exxon Valdez Oil Spill Trustee Council Organization Chart

Draft #4
11/24/93



- Notes:
1. This structure provides efficient management of the Council business at reduced costs.
 2. Secretarial and administrative staff will be developed as needed within the budget .
 3. There will be a transition period as we implement a formal management and tracking system.
 4. Items listed below directors are functions except Corrdinators and fiscal.

DRAFT

November 29, 1993

RECEIVED
NOV 30 1993**Administrative Funding Resolution**SERRA VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

Background - The Trustee Council has authorized funding for administrative/management of Council business and responsibilities, through December 31, 1993, for the Executive Director's Office, Restoration Team support (which includes the work groups), the Finance Committee, and the Public Advisory Group. Funding for the remaining nine months will be developed as soon as a new management structure is adopted by the Trustee Council. In the interim, a budget for administrative/management duties is needed for inclusion in the 1994 Draft Work Plan. Trustee Council authority is needed beginning January 1, 1994, to continue the administrative projects beyond that date.

Resolution - Because of time constraints on developing a new administrative budget, I recommend that the Council use the existing 12 month detailed budget for the Executive Director's Office, Restoration Team support, the Finance Committee, and the Public Advisory Group for inclusion in the draft Work Plan as the administrative/management budget. Appropriate explanation will be included with the budget to explain that the final amount authorized will be less than is shown in the draft Work Plan and reflect the new organization structure. Therefore, I request that the Council adopt the existing 12 month administration budgets (named above) with the understanding that a minimum 15% reduction will be made in the remaining nine month period, as we implement the new

structure and make the appropriate transfer of functions and costs.

Agencies should note that:

- 1) Agency Administrative FY94 budgets will be developed with the Executive Director immediately.
- 2) There should be no further administrative financial commitments for FY94 beyond February 1, 1994, without the expressed approval of the Executive Director, and vacancies will not be filled unless approved by the Executive Director.
- 3) A revised final detailed FY94 Administrative budget will be developed within the parameters set out by the new structure and the draft FY94 budget less at least 15%.
- 5) Previously established work groups will be dissolved or melded into the new management structure.
- 6) Each agency should designate a liaison/restoration work force person to work with the Executive Director in developing the FY94 Administrative budget respectively.

Table A-4 (cont'd)

HABITAT PROTECTION AND ACQUISITION PROJECTS: 1993

No.	Project Title	Project Description	Budget
93033	Harlequin Duck Restoration Monitoring Study in PWS, Kenai and Afognak	Study harlequin duck reproductive failure in western Prince William Sound; on outer Kenai coast and Afognak Island determine if there is reproductive failure and characterize their nesting habitat.	\$300,000
93034	Pigeon Guillemot Colony Survey	Identify and map pigeon guillemot colonies.	165,800
93051	Anadromous Streams and Marbled Murrelets	Assess marbled murrelet nesting habitat; survey anadromous fish streams on candidate lands for habitat protection.	1,222,300
93059	Habitat Identification Workshop	Identify parcels of nonpublic lands with habitat necessary for recovery of injured resources and services under imminent threat.	42,300
93060	Accelerated Data Acquisition	Collect and organize existing resource data needed to evaluate habitat protection and acquisition proposals.	43,900
93064	Imminent Threat Habitat Protection	Protect habitat under imminent threat. The amount budgeted for this project includes \$7.5 million toward the purchase of inholdings in Kachemak Bay State Park, and a downpayment of \$29,950,000 toward the purchase of uplands near Seal Bay on Afognak Island. The total purchase price for Seal Bay parcels will not exceed \$38.7 million. The rest of the allocation is for actions necessary to complete acquisitions, such as title search and appraisal.	37,850,000
Habitat Protection and Acquisition - Subtotal			\$39,666,600

Table A-4 (cont'd)

OTHER RESTORATION PROJECTS: 1993

No.	Project Title	Project Description	Budget
93003	Salmon Egg to Pre-emergent Fry Survival	Continue to monitor egg mortalities in the oiled and unoiled wild pink salmon streams.	\$686,000
93006	Site-Specific Archaeological Restoration	Assess injury at 24 sites and restore 19 of them.	260,100
93012	Genetic Stock Identification of Kenai River Sockeye Salmon	Develop a comprehensive database of sockeye salmon stocks in Cook Inlet.	300,600
93015	Kenai River Sockeye Salmon Restoration	Increased monitoring and management of the sockeye salmon stocks in the Kenai River and Upper Cook Inlet north of Anchor Point.	512,600
93016	Chenega Bay Chinook and Silver Salmon (NEPA Compliance)	NEPA compliance for the replacement of subsistence resources by permitted releases of chinook and coho salmon at designated sites near Chenega village from stocks of hatchery near Esther Island. The Trustee Council has deferred action on the decision whether to implement this project.	10,700
93017	Subsistence Food Safety Survey and Testing	Work with communities to identify and map areas and resources of continuing concern to subsistence users; sample subsistence foods from these areas.	307,100
93022	Monitor Murre Colony Recovery	Monitor the recovery of murre in the Barren Islands.	177,200
93024	Restoration of Coghill Lake Sockeye Salmon Stock	Restore natural productivity of Coghill Lake for sockeye salmon through use of lake fertilization techniques.	191,900
93035	Black Oystercatchers/Oiled Mussel Beds	Determine whether black oystercatchers breeding on shorelines with persistent oil contamination in Prince William Sound are affected by their use of these habitats.	107,900
93036	Oiled Mussel Beds	Document continued bioavailability of petroleum hydrocarbons to consumers of contaminated mussels and determine the rate of recovery of oiled mussel beds.	404,800

Table A-4 (cont'd)

OTHER RESTORATION PROJECTS: 1993 (cont'd)

No.	Project Title	Project Description	Budget
93038	Shoreline Assessment	Assess the shoreline hydrocarbon concentrations and, where appropriate, carry out necessary treatment using local work crews. Cost includes \$15,000 for U.S. Coast Guard transportation.	\$539,200
93039	Herring Bay Experimental and Monitoring	Determine what factors limit or facilitate recolonization of the intertidal by algae, especially <i>Fucus</i> , and invertebrates; and to provide controlled, long-term natural recovery monitoring of intertidal communities.	507,500
93041	Comprehensive Monitoring	Design the monitoring component of the Restoration Plan.	237,900
93042	Killer Whale Recovery	Obtain photographs of individual killer whales occurring in AB pod and document natural recovery.	127,100
93043	Sea Otter Demographics and Habitat	Restore sea otter populations by determining what is limiting their recovery and identifying important sea otter habitat in Prince William Sound for possible protection.	291,900
93045	Marine Bird / Sea Otter Surveys	Obtain annual estimates of the summer and winter populations of marine birds and sea otters in Prince William Sound to determine whether populations that had declined are recovering.	262,400
93046	Habitat Use, Behavior, and Monitoring of harbor Seals	Monitor the abundance and trends of harbor seals in oiled and unoled areas of Prince William Sound and characterize habitat use, hauling out and diving behavior.	233,500
93047	Subtidal Monitoring	Monitor recovery of sediments, hydrocarbon-degrading microorganisms, eelgrass beds, and shallow fish species in the subtidal environment.	1,000,800
93053	Hydrocarbon Database	Estimate the amount of Exxon Valdez oil that is present in environmental samples analyzed for hydrocarbons that are collected during restoration.	105,500

Table A-4 (cont'd)

OTHER RESTORATION PROJECTS: 1993 (cont'd)

No.	Project Title	Project Description	Budget
93057	Damage Assessment Geographic Information System	Complete statistical analysis and geographic information system mapping support for existing damage assessment studies and provide a database for restoration.	67,500
93062	Restoration Geographic Information System	Provide statistical and spatial analysis and geographic information system mapping support for approved restoration projects.	123,300
93063	Anadromous Stream Surveys	Develop proposals and designs for appropriate and cost-effective instream habitat and stock restoration projects.	59,400
93065	Prince William Sound Recreation Project	Develop a statement of injury, management goals, and proposals for restoration of recreation in Prince William Sound and identify and evaluate potential special designations that would benefit recreation and management of Prince William Sound. The estimated project cost is \$71,000. Unused funds will be used to fund other activities approved by the Trustee Council.	72,000
93067	Pink Salmon Coded-Wire Tag Recovery	Recover coded-wire tags from pink salmon in Prince William Sound to distinguish between wild stocks and hatchery stocks.	220,000
93068	Non-Pink Salmon Coded-Wire Tag Recovery	Recover coded-wire tags from fish other than pink salmon.	126,400
OTHER RESTORATION PROJECTS - Subtotal			\$6,932,300

Table A-5
1994 Work Plan

The Trustee Council approved interim funding of \$6,276,600 for the 1994 Work Plan, which began on 10/1/93. Many of the allocations were for the three-month period 10/1/93 to 12/31/93. Additional allocations will be made after the Restoration Plan is completed. The interim funding for administrative expenses includes certain 12-month costs, such as lease of office space. Once all allocations are made, administrative expenses are expected to be about five percent of the total.

ALLOCATIONS:1994

Purpose	Amount	Percent
Habitat Protection and Acquisition	\$558,500	9%
Other Restoration Projects	430,800	7%
Data Analysis and Report Preparation for 1993	3,273,000	52%
Administration	2,014,300	32%
Total	\$6,276,600	100%

The remainder of this table describes restoration projects approved in the 1994 Work Plan. It does not describe damage assessment or administration projects. Habitat protection and acquisition projects are listed separately from other restoration projects because of the high degree of interest shown in them.

Table A-5 (cont'd)

HABITAT PROTECTION AND ACQUISITION PROJECTS: 1994

No.	Project Title	Project Description	Budget
94110	Data Acquisition and Support	Provide logistical and technical support for habitat evaluation.	\$273,600
94126	Habitat Protection and Acquisition Fund	Facilitate purchase of habitat protection rights and develop post-acquisition management recommendations.	284,900
Habitat Protection and Acquisition - Subtotal			\$558,500

OTHER RESTORATION PROJECTS: 1994

No.	Project Title	Project Description	Budget
94064	Habitat Use, Behavior, and Monitoring of Harbor Seals in PWS	Monitor the abundance and trends of harbor seals in oiled and unoled areas of Prince William Sound.	\$2,500
94166	Herring Spawn Deposition and Reporductive Impairment	Improve the accuracy of the fisheries management of herring resources in Prince William Sound and determine if genetic damage ocured because of the spill.	37,100
94185	Coded-wire Tagging of Wild Pink Salmon in Prince William Sound	Provide marked fish of known origin for eventual recovery in either the commercial catch or the escapement.	34,800
94191	Investigating and Monitoring of Oil Related Egg and Alevin Mortalities	Continue to monitor egg mortalities in the oiled and unoled wild pink salmon streams.	85,400
94217	Prince William Sound Area Recreation Implementation Plan	Develop a prioritized list of recreation restoration projects, identify and describe potential special designations, identify real or perceived injury to the recreation resource and services in Prince William Sound, and develop management goals to restore recreation in Prince William Sound.	30,000

Table A-5 (cont'd)

OTHER RESTORATION PROJECTS: 1994 (cont'd)

No.	Project Title	Project Description	Budget
94258	Sockeye Salmon Overescapement	Continue to examine the effects of large 1989 overescapements.	141,000
94320	Ecosystem Monitoring	Develop an ecosystem monitoring plan.	100,000
OTHER RESTORATION PROJECTS - Subtotal			\$430,800

Appendix B Injury and Recovery

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BACKGROUND

The T/V *Exxon Valdez* struck Bligh Reef in March, just before the most biologically active season of the year. The resulting oil spill occurred during the seaward migration of salmon fry, major migrations of birds, and the primary breeding season of most species of birds, mammals, fish, and marine invertebrates in the spill's path. Many animals, such as sea otters and marine birds, were killed by the oil in open water. Approximately 1500 miles of southcentral Alaska's coastline were oiled (about 350 miles were heavily oiled), frequently with devastating impact to the upper intertidal zone. Direct oiling killed many organisms, and beach cleaning, particularly high-pressure, hot-water washing had a devastating effect on some intertidal communities. The spill also affected services (human uses), including subsistence, recreation, commercial fishing, and other uses. Some resources and services remain vulnerable to persistent oil in intertidal areas.

This appendix was originally presented in June of 1993 in the Supplement to the Summary of Alternatives. It has been updated to reflect new information gained from further analysis or completion of damage assessment studies. This appendix describes in detail the injuries sustained by individual resources and services, and what scientists and resource managers know about the present status of recovery. Table B-1 lists injured resources and lost or reduced services. Where possible, expectations for the progress of natural recovery are also projected. Information on injury and recovery is summarized in Tables B-4, B-5 and B-6.

INJURY TO NATURAL RESOURCES

Natural resource injuries from exposure to oil spilled by the T/V *Exxon Valdez* or due to the cleanup include:

- (1) **Mortality.** Death caused immediately or after a period of time by contact with oil, cleanup activities, reductions in critical food sources caused by the spill, or other causes.
- (2) **Sublethal Effects.** Injuries that effect the health and physical condition of organisms (including eggs and larvae), but do not result in the death of juvenile or adult organisms. However, injuries that initially appear to be sublethal can, over time, be fatal. Also, some sublethal effects, such as reproductive impairment, can eventually result in population reductions.
- (3) **Degradation of Habitat.** Alteration or contamination of flora, fauna, and the physical components of the habitat.

Due to the large geographical area, multiple habitat types and many species impacted by the spill, it is highly unlikely that all injuries to natural resources will be studied or fully documented.

Injuries Resulting in a Population Decline

The most serious injuries result in large population declines. In these cases, injury may persist for more than one generation. For example, the common murre was the most severely impacted bird species. Several large colonies in the Gulf of Alaska may have lost 35% to 70% of their breeding adults, a loss that may not be restored for many generations. Another example is in intertidal areas where populations of many species of plants and invertebrates declined as a result of oiling and cleanup.

If serious enough, mortality, sublethal injuries, or degradation of habitat may result in measurable population declines. For example, sublethal injuries that impair reproductive ability in a large portion of a population could result in a population decline.

Injuries Not Resulting in a Measurable Population Decline

There are several reasons why population declines were not measured in some species.

- (1) The injury may not have been severe enough to cause mortality or a population decline.
- (2) Spill-related population declines may have been impossible to distinguish from natural variations in population levels. Population census techniques are usually able to detect only relatively large population changes.
- (3) Population declines may have occurred initially but some species may have compensated by increasing productivity. The net effect would be no reduction in population.
- (4) Some species were not studied or were studied insufficiently to determine any injury, including population declines.

INJURY TO OTHER NATURAL RESOURCES

The cleanup increased public knowledge of archaeological site locations, which resulted in looting and vandalism of archaeological resources. Also, archaeological sites may have been damaged by oiling. Archaeological resources could be irretrievably lost if looting and vandalism continue. Since archaeological resources, such as sites and artifacts, are not living, renewable resources, they have no capacity to heal themselves.

The spilled oil also contaminated waters adjacent to designated Wilderness Areas, and was deposited above the high tide line in many cases. The intense cleanup resulted in an unprecedented disturbance of the area's undeveloped and normally uninhabited landscape. The massive intrusion of people and equipment associated with cleanup has ended, but direct injury to wilderness and intrinsic values lingers.

REDUCED OR LOST SERVICES

The oil spill impacted a wide range of services (human uses), including commercial fishing, subsistence (hunting, fishing, and gathering), passive use, recreation and tourism. Examples of recreation include sea kayaking, backcountry camping, sport fishing, and hunting.

Services were reduced or lost if the *Exxon Valdez* oil spill or cleanup:

- (1) reduced the physical or biological functions performed by natural resources that support services; or
- (2) reduced aesthetic and intrinsic values, or other indirect uses provided by natural resources; or
- (3) reduced the desire of people to use a natural resource or area.

DEFINING AND ESTIMATING RECOVERY

Many resources and services will recover without intervention. Other resources and services, especially those that were declining before the spill, may continue to decline if present trends continue. For many resources and services, there is no known restoration approach that will effectively accelerate recovery. However, in most cases, there are actions that can prevent further stress on resources.

To maximize the benefits of restoration expenditures, the Trustee Council will consider the rate and degree of natural recovery before investing restoration dollars. The Trustee Council has adopted the following definition of recovery for the purpose of restoration.

In general, resources and services will have recovered when they return to conditions that would have existed had the spill not occurred. Because it is difficult to predict conditions that would have existed in the absence of the spill, recovery is usually defined as a return to prespill conditions or to conditions comparable to those of nonoiled areas. For resources that were in decline before the spill, like marbled murrelets, recovery may consist of stabilization of the population at a lower level than before the spill. Factors to be considered when assessing recovery include reproductive success, growth and survival rates, and the age and sex composition of the injured population.

Full ecological recovery will have been achieved when the population of flora and fauna are again present at former or prespill abundances, healthy and productive, and there is a full complement of age classes at the level that would have been present had the spill not occurred. A recovered ecosystem provides the same functions and services as would have been provided had the spill not occurred.

It is extremely difficult to predict the amount of time needed for a species to recover. Scientists

often use models based on factors such as growth, mortality and reproductive rates. However, for many of the biological resources injured by the *Exxon Valdez* oil spill, the background information was not available to develop these predictive models. For those resources, peer reviewers and agency scientists based their estimates of recovery on the best available information from the damage assessment and restoration studies, the scientific literature and other sources.

Estimates of recovery provided in this section should be used with caution, but they are the best that can currently be provided. For some estimates, there is also substantial disagreement within the scientific community. The estimates are likely to change as recovery continues, more information is provided through monitoring, and more is learned about the species. Recovery estimates for services are not provided. Recovery of services is linked, in part, to the resources that support the service, but is also linked to changes in human perception of injury and can vary widely among user groups.

Table B-1 lists injured resources and lost or reduced services. The table breaks down biological resources into those that are recovering and not recovering, and those for which the recovery status is unknown. The table reflects the current understanding, but the recovery status of each resource and service will change over time. If new injuries are documented in the future, resources and services will be added to the list.

Table B-1 List of Injured Resources and Lost or Reduced Services

INJURED RESOURCES			LOST OR REDUCED SERVICES (Human Uses)
BIOLOGICAL	RESOURCES	OTHER	
Recovering Bald eagle Black oystercatcher Intertidal organisms (some) Killer whale Sockeye salmon (Red Lake) Subtidal organisms (some)	Not Recovering Common murre Harbor seal Harlequin duck Intertidal organisms (some) Marbled murrelet Pacific herring Pigeon guillemot Pink salmon Sea otter Sockeye salmon (Kenai River) Subtidal organisms (some)	Archaeological resources Designated Wilderness Areas	Commercial fishing Passive uses Recreation and Tourism including sport fishing, sport hunting, and other recreation uses Subsistence
Recovery Unknown Clams Cutthroat trout Dolly Varden River otter Rockfish			

A SUMMARY OF INJURY AND RECOVERY

MARINE MAMMALS

Harbor Seals

Injury: The oil spill caused population declines and sublethal injuries to harbor seals in Prince William Sound. Many were directly oiled and an estimated 300 died. The prespill population of harbor seals in Prince William Sound was estimated to be between 2,000 to 5,000 animals. While some dead seals were recovered from the Kenai Peninsula, the extent of injury outside Prince William Sound is unknown.

Many seals were exposed to oil in 1989. At 25 haul-out areas in Prince William Sound that have been regularly surveyed since 1984, 86% of the seals seen in the postspill spring (April) survey were extensively oiled and a further 10% were lightly oiled. This included many pups. By late May, 74% of the animals continued to be heavily oiled. Tissues from harbor seals in Prince William Sound contained many times the concentrations of aromatic hydrocarbons than did tissues from seals in the Gulf of Alaska. This trend persisted in 1990, when high concentrations of petroleum hydrocarbons again were found in the bile of surviving seals. In addition, pathology studies revealed damage to nerve cells in the thalamus of the brain, which is consistent with exposure to relatively high concentrations of low molecular weight aromatic (petroleum) hydrocarbons.

Recovery: Because harbor seal populations have declined precipitously since 1984, and the underlying causes of this decline are unknown, it is difficult to predict recovery from the oil spill. However, stable counts in 1990 to 1992 at haulouts within Prince William Sound may indicate an end to the ongoing decline within the Sound. There is evidence suggesting that the subsistence harvest has declined since the spill, which may contribute to the stabilization of the population. If the population has stabilized, normal production growth may soon begin to replace the estimated 300 seals killed during the spill. However, additional information on the rate of exchange between seal populations in Prince William Sound and the Gulf of Alaska, particularly with the large Copper River Delta population, as well as a better understanding of the causes of the prespill decline, would be required to improve predictions of the time needed for recovery.

Humpback Whales

Injury: The only apparent effect of the spill on humpback whales was a temporary displacement from preferred habitat in Lower Knight Island Passage during the summer of 1989. There is no evidence that any humpbacks were killed by the spill, nor has reproduction been affected. Photodocumentation studies confirmed that normal use of lower Knight Island Passage resumed in late 1989.

Recovery: Other than a temporary displacement, there is no evidence of injury. No estimate of recovery was made.

Killer Whales

Injury: Thirteen killer whales disappeared from one pod (extended family group) between 1988 and 1990, and are presumed to have died. Approximately 140 killer whales forming nine distinct pods regularly use Prince William Sound, and are considered resident pods. There are also transient pods and other resident pods with wider ranges that enter the Sound occasionally.

In the summer of 1989, there were more than 9 whales missing from resident pods. The AB pod, which had 36 individuals when last seen in the Sound in the fall of 1988, was missing 7 animals, for an unprecedented 19.4% mortality rate. In 1990, an additional 6 individuals were found missing from AB pod, resulting in an annual mortality rate of 20.7% (prespill mortality for the resident AB pod typically ranged from 3.1 to 9.1% from 1984 to 1988). The rate of natural mortality in killer whales in the North Pacific is about 2% per year. All of the missing whales were either females or immature animals, and in several cases calves were orphaned. No births were recorded in 1989 or 1990. Due to the fidelity of killer whales to the pod, and the strong bonds observed between mothers and calves, the missing whales are presumed to have died. However, no dead individuals were ever recovered.

The cause of death is uncertain. Some experts think that the circumstantial evidence points to the spill. Other experts acknowledge that something very unusual happened to AB pod in 1989 and 1990, but that based on current knowledge of whale biology, the circumstances of the spill and the toxicity of crude oil, these deaths may not be due to contact with oil spilled by the T/V *Exxon Valdez*.

Recovery: Despite the loss of a large number of reproductive females, AB pod is growing again. One birth was recorded in 1991; two births in 1992, and one in 1993. It is expected that AB pod may not recover to its prespill level of 32 to 36 individuals for more than a decade.

Sea Lions

Injury: Results from sea lion studies were inconclusive concerning the effects of the spill. Several sea lions were observed with oiled pelts, and oil was likely absorbed by some tissues.

Sea lions have experienced a severe decline over the last 30 years in the north Pacific Ocean--as great as 93%. This decline combined with seasonal movements, which are significant but not well understood, precluded determining if the sea lion population in the Gulf of Alaska

was affected by the spill. Sea lions were counted at eight haul-out sites, located mainly in the Gulf of Alaska. Some of these sites were oiled, although oiling was patchy and generally short-lived, but away from these sites sea lions were observed swimming through oil. Ten sea lions were found dead in oiled areas, mainly on rocky beaches, but it is not known how many of these deaths were attributable to natural mortality, or if any were due to oiling.

Recovery: Since there is no evidence that sea lions were injured by the oil spill, no estimate of recovery time was made.

Sea Otters

Injury: The oil spill caused declines in populations of sea otters in Prince William Sound and possibly in the Gulf of Alaska. Sea otters were the most abundant marine mammal in the path of the spreading oil slick and were particularly vulnerable to its effects. Their estimated population before the spill included as many as 10,000 sea otters in Prince William Sound and 20,000 in the Gulf of Alaska. It also is estimated that there are a total of 150,000 sea otters in Alaska.

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

Studies conducted throughout the spill area in 1990 and 1991 indicated that sea otters were still being affected by the spill. Carcasses found in these years included an unusually large proportion of prime-age adult otters, rather than mainly juvenile and old otters, as were found before the spill. A study of survival of recently weaned sea otters also showed a 22% higher death rate during the winter of 1990-1991 and spring of 1991 in areas affected by the spill. In 1992-1993 juvenile mortality rates had decreased dramatically, but were still higher in oiled than nonoiled areas.

Recovery: While little or no evidence of recovery has been detected, sea otters are expected to eventually recover to their prespill population. The rate of recovery will be dependent on the growth rate of the injured population. Under ideal conditions sea otters can expand their population at 9% per year. For sea otter populations already established in an area like Prince William Sound, the growth rate is usually closer to 2 -3% per year. Future rates of population increase are difficult to estimate. However, if stress remains negligible, recovery may take less than two decades.

TERRESTRIAL MAMMALS

Brown Bear

Injury: In the Kodiak Archipelago and on the Alaska Peninsula, brown bears forage in the intertidal zone, where clams are a favorite food. Brown bears also apparently scavenged the carcasses of sea otters and birds that washed ashore after the spill. Analyses of fecal material and samples of bile indicated that some brown bears had been exposed to oil. High concentrations of oil were found in the bile of one yearling brown bear found dead in 1989. The mortality rate for cubs is close to 50% for the first two years, and it is uncertain if this death was associated with oil exposure.

Recovery: Since there is no evidence that brown bears were injured by the spill, no estimate of recovery time was made.

Black Bear

Injury: There was an initial attempt to study the potential effects of the spill on black bears, but due to the difficulty of finding, tagging or observing this species in dense vegetation, the effort was quickly abandoned. No carcasses or other indications of oil spill-related injuries were ever reported.

Recovery: Since there is no evidence that black bears were injured by the spill, no estimate of recovery time was made.

River Otters

Injury: Following the oil spill, twelve river otter carcasses were found on beaches, representing some unknown fraction of the total number killed. The bile from two river otters collected from oiled areas in 1989 was analyzed and found to contain elevated concentrations of hydrocarbons. This indicates that surviving river otters could have ingested contaminated food.

There are indications that chronic oil exposure may affect river otters in Prince William Sound, although there is uncertainty about the evidence. First, river otters captured in oiled areas after the winter of 1989-1990 weighed less than those captured in unoiled areas, while they were of the same overall length. Since the oiled population is an island population (Knight Island) and the unoiled population is from a mainland location (Ester Passage), and there are no comparative prespill length and weight data from the two areas, it is difficult to determine whether this represents an effect of the spill. Second, chemical factors in the blood show slight differences between study areas: in the oiled population, haptoglobin

concentrations and some amino transferase enzyme activities are slightly elevated. These differences could be caused by disease, handling stress, parasites, oil exposure, or a combination of these factors.

A reduction in the number of prey species (but not in the quantity of food ingested) was noted in the diets of river otters in the oiled areas between 1989 and 1990; this reduction was not seen in the nonoiled study areas. This reduction was probably due to the severe impact of the spill on the intertidal and shallow subtidal fauna in the oiled portions of Knight Island. Also, on Knight Island the average size of territories of river otters was larger than on the mainland, potentially a result of having to forage over a larger area to find sufficient food. However, the significance of this size difference is uncertain because of the lack of prespill data and follow-up studies.

Finally, data from an analysis of river otter droppings in latrine sites was equivocal. The results of one analysis suggested that estimated populations sizes were not different between the study areas, and another suggested differences. Conclusions are problematic because of the relatively small sample sizes employed and the possibility that populations in the two study areas were different before the spill.

Recovery: Most of the evidence of injury to the river otters was gathered in 1989 and 1990, although some of the parameters that are designed to indicate continuing sublethal injury still showed differences in 1991, including length-weight differences. Without a reliable way to detect small changes in populations (it is probable that a small number of river otters were killed), it is difficult to predict when the population will recover. With a population density of approximately one otter for every two to three kilometers of shoreline in suitable habitats, the percentage of the population that requires replacement appears to be relatively small.

Sitka Black-tailed Deer

Injury: Deer often forage in the intertidal zone on seaweed. Since seaweeds were extensively contaminated on oiled shores, deer were probably exposed to oil. In fact, tissues from deer taken by subsistence hunters and chemically analyzed were found to contain, in some cases, indications of oil contamination. The deer were, however, determined to be safe to eat. No evidence was found that populations of Sitka black-tailed deer were injured by the spill. Most deer carcasses found in 1989 on islands in Prince William Sound were probably the result of winter kill.

Recovery: Since there was no evidence from the damage assessment studies that Sitka black-tailed deer were injured by the spill, no estimate of recovery time was made.

Mink

Injury: Mink forage in the intertidal zone and, therefore, could have been exposed to oil by contact or by ingestion of contaminated food. However, due to the lack of prespill information on population abundance and distribution and the difficulties of assessing population trends postspill, an assessment of injury to mink employing field studies was judged impractical. Instead, a laboratory study of mink was carried out to determine if oil-contaminated food affected reproduction. However, no reproductive effects were documented, even when high concentrations of weathered crude oil were added to their diet.

Recovery: Since there is no evidence that mink or other small mammals were injured by the spill, no estimate of recovery time is required.

BIRDS

Bald Eagles

Injury: There are estimated to be 27,000 adult bald eagles in Alaska. About 2,000 of these are in Prince William Sound and about 6,000 are found along the northern coast of the Gulf of Alaska. Bald eagles encountered floating oil while preying on fish and oil-contaminated carcasses, and heavy oiling of the plumage led to loss of flight and probably also loss of body heat. Preening also exposed eagles to oil ingestion.

There were 151 eagles found dead after the spill, an estimated 200 to 300 may have been killed. However, there is considerable uncertainty as to the total number of eagles killed by the spill. Seventy-four percent of radio-tagged eagles that died of natural causes in a postspill study were found in forests and other inland areas. If this carcass deposition pattern is representative of eagles dying from acute oil exposure, then total mortality based mainly on the recovery of carcasses during beach searches would be about 430 individuals. However, it seems unlikely that acutely oiled birds would die in similar locations as those that died of natural causes.

Most aerial surveys to estimate population size and productivity were conducted in Prince William Sound. Population estimates made in 1989, 1990 and 1991 indicate that there may have been an increase in the bald eagle population since the previous survey conducted in 1984, although considerable variability was associated with this data. Population estimates for the three postspill years were not significantly different from one another.

Estimates of productivity indicate that in 1989, 85% of nests in moderately and heavily oiled areas failed, compared to 55% in lightly oiled and nonoiled areas. In 1990, there was actually higher productivity in oiled than in nonoiled areas. It is estimated that the loss of production in 1989 was equivalent to 133 chicks.

Recovery: Since the number of eagles lost appears to be less than the change that can be detected by the aerial survey techniques, it may not be possible to follow recovery to prespill numbers. It also appears that the lost chick production in 1989 will not have a measurable impact on the population. Bald eagles are recovering, and may have already recovered from the effects of the spill.

Black Oystercatchers

Injury: The spill caused population declines and sublethal injuries to black oystercatchers. Nine black oystercatcher carcasses were recovered from beaches after the spill. It is unknown how many additional oystercatchers were killed by the spill but were not recovered. Prespill (1972-1973, 1984) and postspill population surveys suggest that within Prince William Sound, an estimated 120 - 150 black oystercatchers representing 12% to 15% of the total estimated population, died as a result of the spill. Mortality outside of Prince William Sound is unknown, but the total spill-area population is thought to be approximately 2,000 birds.

In addition to mortality caused directly by the spill, oiling also affected their reproductive success. Egg volume and the weight of chicks raised in oiled areas were lower compared to those raised in nonoiled areas; however, there are no prespill data, and it is not known if those conditions existed before the spill. Other measures such as hatching success, fledgling success, and chick production were not different between oiled and nonoiled areas. It is quite possible that in 1989 and 1990, disturbance associated with cleanup activities of oiled study areas, for example, Green Island, contributed to these differences.

Recovery: While black oystercatchers are recovering, an estimate of their recovery time is difficult to make. There is significant uncertainty associated with any estimate of recovery made because the population growth rate for black oystercatchers is unknown. However, if the growth rate is equal to Eurasian oystercatchers (6.25%) and there are no lingering sublethal injuries, the calculated estimate of recovery is several decades. Finally, the potential contribution of immigration from nonoiled areas on recovery is not easily estimated.

Murres

Injury: The oil spill caused population declines and sublethal injuries at murre colonies in the Gulf of Alaska. Including both common murres and thick-billed murres, there are about 12 million murres in Alaska, and 1.4 million in the Gulf of Alaska region. About 1.2 million of the total population in the Gulf of Alaska nest on the Semidi Islands, which were not directly impacted by the oil. Murres are particularly vulnerable to floating oil and have been killed in large numbers by oil spills elsewhere in the world.

At the major breeding colonies studied (Chiswell Islands, Barren Islands, Puale Bay, and the

Triplets), an estimated 120,000 to 134,000 adult breeders were killed by contact with oil. The oil arrived in early April just as birds were beginning to congregate at the colonies in anticipation of breeding. If the rate of mortality is adjusted for birds not counted on the colonies, but feeding at sea, it is estimated that 170,000 to 190,000 breeding birds were killed. In general, it is estimated that between 35% and 70% of the breeding adults at the above colonies were killed by the spill. It is not known where pre-breeding juveniles were at the time of the spill, or if many were killed.

The timing of reproduction was found to be different between oiled and unoiled areas after the spill. At the Barren Islands and at Puale Bay, egg laying was about a month late in 1989, 1990, and 1991, compared to the unoiled Semidi Islands. In 1992 there were some indications that breeding was returning to normal at places in the Barren Islands colony. At the Chiswell Islands, laying was not observed in 1989, and laying was late in 1990. Because fewer birds were occupying these colonies, it is likely that the rate of predation was much greater than normal, since these colonies rely on sheer numbers of birds to discourage predation by gulls and eagles. Furthermore, the delay in egg-laying (estimated to be one month) in the Barren Islands, Puale Bay and the Chiswell Islands since the spill, may result in an additional loss of chicks unable to survive the first autumn storms in the Gulf of Alaska. Conservatively, the estimate of lost production associated with delayed reproduction could exceed 300,000 chicks.

In February and March 1993, there was a major die off of murres around the Kenai Peninsula. Exact figures are not available but thousands of murres probably died during this time. Although lack of food has been implicated in this die off, other explanations have not been eliminated.

Recovery: The degree of recovery necessarily varies among the affected colonies. There are preliminary indications of recovery at the Barren Islands in 1991 and 1992, but it is not yet known when the timing of reproduction will return to normal. Agency scientists estimate that it could take many decades and perhaps a century before the injured murre populations return to their prespill levels. Variables affecting recovery time include the amount of disturbance near colonies and the rate of migration from healthy colonies.

Harlequin Ducks

Injury: The oil spill caused population declines and appears to have caused sublethal injuries in harlequin ducks. Of the six species of sea ducks studied, harlequin ducks feed highest in the intertidal zone where most of the stranded oil was initially deposited and in some cases still persists. An estimated 1000 harlequin ducks were killed by the spill. The resident prespill population of harlequin ducks in western Prince William Sound was estimated to be approximately 2000. Wintering migrants increase this population in the western Sound annually by 10,000. With few exceptions since 1989, neither breeding adults nor fledglings have been located in the heavily oiled areas of western Prince William Sound. Breeding

activity in the nonoiled eastern Prince William Sound appears to be normal.

Elevated concentrations of hydrocarbons and their metabolites were found in the bile of harlequin ducks collected in western Prince William Sound in 1989. If residual oil in the diet is affecting reproduction, then the effect should begin to diminish once the threshold for toxicity is reached and the levels of persistent oil decrease in the environment. Unfortunately, we have no information after 1989 that determined exposure levels in bile for harlequin ducks in western Sound. Also, there is so little known about how oil may affect reproduction and what physiological changes can be induced by feeding on oiled prey. For these reasons, the possible causes of breeding failure have not been established.

Recovery: There appears to be diminished reproduction in harlequin ducks in oiled areas of western Prince William Sound. There are no indications that recovery has occurred. Scientists disagree on the time it will take harlequin ducks to recover to their prespill levels, but estimates suggest that recovery may not occur for several decades. Recovery could depend upon final degradation of oil in intertidal habitats where harlequin ducks feed, if it can be assumed that continued injury is due to ingestion of oil contaminated food.

Marbled Murrelets

Injury: Approximately 612 marbled murrelets were recovered from beaches following the spill. Based on other carcass recovery studies, this suggested that between 8,000 and 12,000 birds may have been killed by the oil spill, which appears to be about 5 - 10% of the current population in the affected area. The available postspill data indicated that the marbled murrelets population has declined since the last census conducted in the middle 1980s. The oil spill probably increased the prespill rate of decline for this species in the spill area, although the incremental injury is difficult to estimate.

Recovery: Since the spill, surveys conducted in Prince William Sound have resulted in population estimates of 107,000 in 1989, 81,000 in 1990, and 106,000 in 1991. With such variation in postspill population estimates, it is not yet possible to determine a trend in marbled murrelet abundance in Prince William Sound. The data collected in the 1970s and 1980s indicate that the population was declining before the spill. Although there is uncertainty associated with the causes of this decline, scientists expect it to continue. There are several factors that could account for this decline including a diminished food supply, increased predation, reduced nesting habitat, or fishery interactions, but there are no conclusive data indicating if any or all of these factors affected the population.

Because of the population decline, the marbled murrelet population is not expected to return to prespill population levels. Estimates of when the population may stabilize vary widely among experts but may be more than a decade. Estimates of further decline range from 20% to 50%, but again there is much uncertainty.

Pigeon Guillemots

Injury: Because these birds forage nearshore and often congregate on rocky beaches, they were vulnerable to the spilled oil. Five hundred and sixteen guillemot carcasses were recovered after the spill. Total mortality is estimated to be between 1,500 to 3,000 individuals, and may be as much as 10 to 15% of the pigeon guillemot population in the Gulf of Alaska. The results of boat surveys in Prince William Sound indicate that the population of this species was 14,600 in 1973. After the spill, the populations were 4,000 in 1989; 3,000 in 1990; and 6,600 in 1991. The population in Prince William Sound was probably declining prior to the spill, but the survey data indicate that the decline in oiled areas was greater than in nonoiled areas. For the Naked Island group, results of postspill surveys indicated a 40% decline in abundance compared to the latest prespill surveys in the mid-1980s. The decline showed a correlation with degree of shoreline oiling. The oil spill probably increased the rate of decline for this species in the spill area, although the magnitude of incremental injury is difficult to estimate.

Recovery: Pigeon guillemots may not return to prespill population levels, as their population was probably declining prior to the spill. The reasons for the long-term decline are unknown which makes predictions of future population trends extremely difficult. The population is expected to stabilize sometime over the next several decades, but estimating the population size when it stabilizes is even more uncertain.

Other Birds

Numerous other birds were affected by the spill. The most direct evidence of injury comes from the carcasses of birds found on the beaches after the spill in 1989. A list of the species recovered during the spill can be found in Table 2-3. Some of the other species found dead included falcons, ducks, sandpipers, phalaropes, gulls, terns, auklets, puffins, various passerines, loons, grebes, shearwaters, petrels, cormorants, kittiwakes, and geese. In general, the number of dead birds recovered probably represents only 10 -15% of the total numbers of individuals killed. For most species, there are no reliable prespill data that will allow accurate assessment of the significance of estimated losses. Other important information comes from boat surveys carried out after the spill using similar techniques to those used in 1972-1973 and 1984-1985 surveys. Other birds that declined more in oiled than in nonoiled areas since the early 1972-1973 surveys include the Northwest crow and cormorant. A similar comparison based on the 1984-1985 surveys showed that cormorant, Arctic tern and tufted puffin declined more in oiled areas.

Recovery: There is a great deal of uncertainty about the recovery of populations of individual species because many were not studied.

FISH

Cutthroat Trout and Dolly Varden

Injury: Both Dolly Varden char and cutthroat trout feed extensively in the nearshore marine habitat and are particularly vulnerable to the effects of oil spills. Measurement of oil in the bile of Dolly Varden following the spill in 1989 showed that this species had the highest oil concentration of any fish species studied. Both species were captured at weirs on five stream after overwintering in 1989, 1990 and 1991 in an attempt to understand the effects of oiling. Studies of injury were not carried out in 1992.

While survival of Dolly Varden returning to oiled streams in 1990 was 32% less than those returning to nonoiled streams, and survival appeared to be 57% less for cutthroat trout returning to oiled streams in 1990, these differences are not statistically significant. There also are no prespill data with which to compare these results. However, it was determined that larger cutthroat trout grew significantly less in oiled areas in 1989, 1990 and 1991. Dolly Varden growth rates were also reduced between 1989 and 1990.

Recovery: Dolly Varden and cutthroat trout in oiled areas may have sustained a sublethal injury (slower growth in oiled areas). Scientists cannot estimate a recovery time without further study.

Pacific Herring

Injury: The extremely poor return of Prince William Sound herring in 1993 has residents very concerned. Because data were not collected from the 1993 herring run, and because herring populations naturally fluctuate greatly between years, it is difficult to understand the cause of the decline at this time. The following discussion describes injuries identified by damage assessment studies from 1989-1992.

The oil spill caused sublethal injuries to Pacific herring in Prince William Sound, but scientists do not know whether these injuries resulted in a population decline. Pacific herring spawned in intertidal and subtidal portions of Prince William Sound shortly after the spill. As much as 10% of the intertidal spawning habitat and 40% of the staging areas of herring in Prince William Sound may have been exposed to oil. Oiled spawning areas included portions of Naked and Montague islands.

Studies conducted in 1989 and 1990 showed a slight but statistically significant higher rate of egg mortality in oiled areas, compared to nonoiled areas. In 1989, rates of larval mortality, lethal and sublethal genetic damage, and physical deformities also were greater in oiled areas. There also is some evidence of differences in histopathological condition and reproductive success in oiled areas in 1989. However, all differences between oiled and unoled study sites

were less pronounced in 1990, and were not observed in 1991.

Three-year-old herring exposed as eggs or larvae in 1989 were under-represented in the 1992 and 1993 spawning migrations. Compared to Sitka Sound, which correlates closely with Prince William Sound in herring recruitment, the 1992 and 1993 returns of the 1989 year class were lower in Prince William Sound than expected. Data comparing herring biomass and age composition of Prince William Sound and Sitka Sound from 1969 to 1992 demonstrates a statistically significant correlation between the size and age structure of herring migrations in these two areas. There also was an outbreak of viral hemorrhagic septicemia (VHS) in herring returning to Prince William Sound in 1993, but it is not known if the disease is linked to the oil spill. Unusual oceanographic conditions, including poor plankton blooms in Prince William Sound, may have contributed to poor adult returns in 1993.

Recovery: More study of the factors affecting herring production is required in order to better predict the return of herring in Prince William Sound to pre-1989 conditions. The complex population dynamics of Pacific herring make it very difficult to predict the extent of injury or estimate natural recovery rates.

Pink Salmon

Injury: The oil spill caused sublethal injuries to wild populations of pink salmon, but there is some uncertainty about the extent of effects on population levels. Extremely low returns of hatchery-produced and wild fish to Prince William Sound in 1993 have focused attention on this issue.

Seventy-five percent of the wild pink salmon spawn intertidally at the mouth of streams in Prince William Sound. There was no apparent change in the use of this habitat in the summer of 1989, and many salmon deposited their eggs in the intertidal portion of oiled streams. In the autumn of 1989, egg mortality in oiled streams averaged about 15%, compared to about 9% in nonoiled streams. Since 1989, egg mortality has generally increased, until in 1991, there was an approximate 40 to 50% egg mortality in oiled streams, and 18% mortality in nonoiled streams. This trend continued in 1992.

Although the differences between egg mortality in oiled and nonoiled streams over the first two years are likely attributable to the effects of oil, the persistence of these differences four years after the spill was entirely unexpected and the exact reasons not understood. In this regard, natural factors that vary between oiled and nonoiled streams, e.g., the degree of wave exposure, have not been eliminated as possible causes of persistent differences. Also, the studies of pink salmon carried out after the spill have documented that adults released as fry from nearby hatcheries are wandering into streams and spawning with wild stocks. The potential effect of this phenomenon on egg survival has not been investigated. Some scientists suggest that the longer the differences in egg mortality persist, the less likely it will be that

oil is the cause or a contributing cause. However, if it assumed that differences between oiled and nonoiled streams is due to oil and that losses in eggs translate proportionately into adult loss, then this effect accounts for almost a 6% decrease in run strength since the spill.

Pink salmon fry released from hatcheries as well as wild pink salmon fry leaving their natal streams in the spring of 1989 were also exposed to oil in the open water. Both pink salmon and chum salmon juveniles were exposed to sufficient amounts of oil to induce enzymes that metabolize oil. In addition, tagged pink salmon fry released from the hatcheries and collected in oiled areas were smaller than those collected in nonoiled areas, even after accounting for the effects of food supply and temperature. The rate of return of pink salmon adults is dependent on conditions during the juvenile stage; and lower food supply, temperature and growth will likely result in a lower return of adults the following year. Based on oil-induced reductions in juvenile growth, the estimated effect of the spill on the 1990 return of wild stock pink salmon was a reduction of 1.86 million fish.

Despite the differences in egg mortality and juvenile growth, tagging data do not indicate whether pink salmon populations were affected by the oil spill. For example, fry that were tagged as they left their streams in 1990, and were recaptured as returning adults in 1992, did not show differences in survival between oiled and nonoiled streams. Larger sample sizes may have provided more definitive results. There is uncertainty whether or not the increased egg mortality seen in the oiled streams is affecting the adult populations. Unusual oceanographic conditions, including poor plankton blooms, may have contributed to poor adult returns in 1993.

Recovery: The most apparent injury to pink salmon is to egg survival. This difference in mortality rates between oiled and nonoiled streams persisted in 1992. For at least the first four years after the spill, the rate appears to be worsening, both in oiled and nonoiled areas. Some experts believe that the spill reduced the adult population and estimate that recovery will take more than a decade.

Rockfish

Injury: The oil spill may have caused sublethal injuries to rockfish, but it is unknown whether or not population declines also occurred. There is little prespill data on rockfish in the spill area. Many dead rockfish were reported to have been sighted after the spill, although only 20 adult yelloweye rockfish were recovered by biologists. Of these, only 5 were in good enough condition to chemically analyze. All 5 fish were determined to have died from oil ingestion. Samples collected from oiled areas in Prince William Sound and the outer Kenai coast indicated there was evidence of exposure to oil (in bile) in 1989, and higher than normal prevalences of organ lesions in 1989, 1990 and 1991, although there is some uncertainty associated with causes of these pathological changes. In 1990 and 1991, oil exposure was documented in fish collected from oiled but also nonoiled sites.

An additional unknown is the degree to which postspill increases in fishing pressure may be impacting rockfish. Partially due to numerous spill-related commercial fishing closures (salmon and herring) in 1989, commercial fishers increased their take of rockfish. Rockfish harvests in Prince William Sound increased from approximately 93,000 pounds in 1989 to over 489,000 pounds in 1990. While harvests decreased since 1990, harvests are still higher than the historic average. While population levels are unknown, concerns have arisen about possible overfishing. Rockfish are a slow growing species, produce relatively few young, and do not recover rapidly from overfishing.

Recovery: Because there is still considerable uncertainty that rockfish experienced significant direct mortality or sublethal effects, a natural recovery rate was not estimated.

Sockeye Salmon

Injury: Kenai River and Red Lake-Kodiak sockeye salmon stocks may have suffered population declines as well as sublethal injuries. This potential injury is unique, since it is due in part to a decision to close commercial fishing in 1989 in portions of Cook Inlet and in Kodiak waters. As a result, there were higher than usual returns (overescapement) of spawning fish to the Kenai and Red Lake systems in 1989, although this was the third consecutive year of overescapement to the Kenai River system.

For the Kenai system, more than 900,000 spawning fish returned each year from 1987 through 1989, when the system was managed for a return of only 500,000 fish a year. The cumulative effect of too many spawning adults in the Kenai River system has been a decline in smolt production. Although the exact mechanism by which this occurred is not clear, it is believed that availability of food (planktonic crustacea) are insufficient to meet the needs of the greater number of fry produced. Fewer fry surviving their first winter in rearing lakes result in fewer outmigrant smolt in the spring. Smolt production in the Kenai River system has declined as follows: 1989, 30 million; 1990, 6 million; 1991, 2.5 million; and 1992 and 1993, less than 1 million. Outmigrations of smolt from the system have been on the decline since 1990, and the forecasted returns in 1994, 1995 and 1996 are below escapement goals.

Recovery: There are no indications of recovery in the Kenai River. The Red Lake system may be recovering since the plankton have recovered and fry survival improved in 1993. Estimates of population recovery vary among experts but could exceed a decade to attain a 10-year population average similar to the prespill population levels. The Kenai River recovery could be prolonged if plankton populations do not recover to prespill population concentrations and salmon develop a cyclic pattern with large returns in some years followed by very small returns in others. Recovery could occur more quickly if plankton populations return to normal by 1993, and there is a normal adult escapement.

SHELLFISH

Crab, Shrimp, Sea Urchin and Oyster

Injury: While clams, mussels, crab, shrimp, sea urchins and oysters are all commonly referred to as shellfish, injuries to clams and mussels are addressed in the section on **Intertidal Communities**.

Dungeness crab and brown king crab studies ended early in 1989 due to the scarcity of these species in the spill area. Fishing pressure and natural predation may have reduced population levels prior to the spill. However, public comments from Kodiak Island and Alaska Peninsula communities identified several locations where high crab mortality (primarily Dungeness crabs) or declining crab populations have been noticed since 1989.

There also is little conclusive evidence to suggest that spot shrimp were injured by the oil spill. There were no studies on sea urchins, and oyster studies (on farmed oysters) ended after a legal interpretation indicated that the Natural Resource Damage Assessment Rules did not apply. However, since oil is known to have impacted subtidal sediments and communities, it is possible that undocumented exposure and injury occurred for several shellfish species not studied.

Recovery: Because it was not possible to establish that these species were injured by oil, no estimate of recovery was made.

INTERTIDAL COMMUNITIES

Injury: The intertidal zone is the area of beach between the low and high tide extremes. The oil spill caused population declines and sublethal injuries to the community of plants and animals living in the intertidal zone. Portions of 1500 miles of coastline were oiled (350 miles heavily oiled) resulting in significant impacts to intertidal habitats, particularly the upper intertidal zone. With tidal action, oil penetrated deeply into cobble and boulder beaches that are relatively common on the rocky islands of the spill area. Cleaning removed much of the oil from the intertidal zone, but subsurface oil persisted in many heavily oiled beaches, and in mussel beds, which were avoided during the cleanup.

Direct oiling killed many organisms, but beach cleaning, particularly high-pressure, hot-water washing, had a devastating effect on intertidal life. Several studies have documented the combined effects of oiling and cleanup on beaches and now track the course of recovery. Because of little or no prespill data, these studies have relied on comparisons of oiled and nonoiled sites. Because of our ability to measure effects on common organisms, these have been emphasized in the injury studies.

The most significant impacts occurred in the upper and middle intertidal zones on sheltered rocky shores, where the greatest amounts of oil stranded. In the upper and middle intertidal zones of rocky shores, the seaweed *Fucus gardneri* (rockweed or popweed), barnacles, limpets, periwinkles, clams, amphipods, isopods and marine worms were less abundant at oiled than nonoiled sites. Although there were increased densities of mussels in oiled area, they were significantly smaller than mussels in the nonoiled areas, and the total biomass was significantly lower. While the percentage of intertidal areas covered by *Fucus* was reduced following the spill, the coverage of opportunistic plants (ephemeral algae) that characteristically flourish in disturbed area was increased. The average size of *Fucus* plants was reduced, as was the reproductive potential of those plants surviving the initial oiling.

Clams. The magnitude of measured differences varied with degree of oiling and geographic area. On sheltered beaches, the data on abundance of clams in the lower intertidal zone strongly suggest that little neck clams and, to a lesser extent, butter clams were significantly affected by the spill. During the 1993 public meetings, people throughout the oil spill area, but especially in Kodiak and Alaska Peninsula communities, said they are still finding clam beds that are contaminated with oil. They are very concerned about the effects of the oiled clams on their subsistence lifestyles and on the overall ecosystem. Also, in 1990, comparisons of abundance of intertidal fishes indicated fewer fish in oiled areas, but such differences were not found in 1991.

Mussels. In 1991, relatively high concentrations of oil were found in mussels and in the dense underlying mat (byssal substrate) of certain oiled mussel beds. These beds were not cleaned or removed after the spill and are potential sources of fresh (unweathered) oil for harlequin duck, black oystercatchers, river otters, and juvenile sea otters, all of which feed on mussels and show signs of continuing injury. The extent and magnitude of oiled mussel beds are unknown and continue to be investigated.

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

Recovery in the upper intertidal appears to depend on the return of adult *Fucus* in large numbers to this zone. In the absence of a well-developed canopy of adult plants, eggs and developing propagules of *Fucus* lack sufficient moisture to survive. The reduced canopy of rockweed in the upper intertidal zone also appears to have made it easier for oystercatchers to prey on limpets. Accordingly, the recovery of limpets and other invertebrates is also linked to the recovery of rockweed. Existing adult plants will act as centers for the outward propagation of new plants, and it is estimated that recovery of *Fucus* may take a decade. Full recovery of the intertidal community may take more than a decade, since it may take several years for invertebrate species to return after *Fucus* has recolonized an area.

SUBTIDAL COMMUNITIES

Injury: The oil spill caused population declines and sublethal injuries in the communities of plants and animals found below low tide. Several kinds of subtidal environments were studied after the spill: eel grass beds, *Laminaria* (kelp) beds, fjords and the deep bottom (40 to 100 meters). All these studies relied on comparisons between oiled and nonoiled environments. Study sites also were matched for conditions (sediment grain size, depth, etc.) likely to affect the distribution and abundance of organisms.

The greatest differences were seen for small organisms living in the sandy sea bottom below eelgrass beds--they were less abundant in oiled environments. Among affected groups were amphipods, known from previous studies to be highly sensitive to oil. In addition, there were larger organisms that showed differences in abundance, most notably the crab *Telemesus* was less abundant in oiled areas. Two separate studies found that eelgrass in oiled areas did not bloom as well after the spill as in nonoiled areas. Other organisms, however, were more abundant in oiled areas--juvenile cod and some small mussels that live on eelgrass. Even greater differences were observed in the abundance of fauna at depths from 6-20 meters below the oiled eelgrass beds, where there were far fewer individuals in oiled areas.

The results of other subtidal studies were more equivocal. Chemical analyses show that *Exxon Valdez* oil apparently did not reach deeper than 20 to 40 meters, although elevated activities of hydrocarbon-degrading bacteria were seen somewhat deeper in some cases. Reduced abundances in fauna were encountered in several oiled bays at 100 m, but the causes of these differences are not clear. Some flatfish had elevated amounts of hydrocarbons in their bile in 1989 and 1990, and slightly elevated prevalences of gill damage.

Recovery: Analysis of invertebrates associated with eelgrass beds collected in 1991 indicated that differences noted in 1990 between oiled and nonoiled areas had started to converge. Another year of study in 1993 may indicate if this trend has continued. Because recovery has been observed in shallow (<20m) subtidal habitats, full recovery is expected in most cases within several years.

OTHER RESOURCES

Archaeological Resources

Injury: The oil spill area has been occupied by Native peoples for at least 11,000 years. The spill area also contains artifacts from the post-European contact era. It is estimated that the oil spill area contains between 2,600 and 3,137 historic properties, including 1,287 known sites that have been recorded in the Alaska Heritage Resources Survey.

Currently, 24 sites are known to have been adversely affected by clean-up activities, or looting

and vandalism linked to the oil spill. One hundred thirteen sites are estimated to have been similarly affected. Injuries attributed to looting and vandalism (linked to the oil spill) are still occurring.

Injuries to archaeological sites include theft of surface artifacts and masking of subtle clues that archaeologists depend upon to identify and classify sites. Key diagnostic artifacts have been illegally taken, ancient burials have been violated and potholes dug by looters have destroyed critical evidence contained in the layered sediments. Additionally, vegetation has been disturbed which has exposed sites to accelerated erosion. The effect of oil on the soil chemistry and organic remains may reduce or eliminate the utility of radiocarbon dating in some sites. Other injuries to archaeological sites have not yet been reported and the actual extent of damage will not be known for decades.

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

Recovery: Archaeological sites cannot recover in the same sense as biological species or organisms. They represent a category of finite, nonrenewable resources. Injury to this resource results not only in the loss of important scientific data, but in an irretrievable loss of Alaska's cultural heritage. Its importance was emphasized in over 100 comments received from the public throughout the state of Alaska. Restoration cannot regenerate what has been destroyed, but it can successfully prevent further degradation of both sites and the scientific information. Documentation of injured sites is necessary to preserve the artifacts and scientific data which remains in the vandalized sites.

Designated Wilderness Areas

Injury: Areas formally designated as wilderness within the spill area are: Katmai National Park, Becharof National Wildlife Refuge, and Kachemak Bay State Wilderness Park. Four federal areas are currently being formally considered for wilderness designation: Kenai Fjords National Park, Lake Clark National Park, Aniakchak National Monument and Preserve, and the Nellie Juan/College Fjord area of the Chugach National Forest. Federal wilderness areas are managed according to the 1964 Wilderness Act and the Alaska National Lands Conservation Act (ANILCA) of 1980. State wilderness areas are managed according to enabling legislation and subsequent management plans. Generally, the areas are managed to maintain their natural landscape, a sense of solitude, and their wild character. Evidence of human presence is generally limited to temporary uses. Various state and federal lands not legislatively designated as wilderness or wilderness study areas are managed according to each agencies' enabling legislation and subsequent regulations. These areas allow a broader range of uses and increased human development and thus have increased human presence.

The oil spill delivered oil in varying quantities to the adjoining waters of all designated

wilderness areas, and oil was deposited above the mean high tide line in many areas. During the intense clean-up seasons of 1989-1990, hundreds of workers and thousands of pieces of equipment were at work in the spill area. This activity was an unprecedented imposition of people, noise and activity on the area's undeveloped and normally sparsely occupied landscape.

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

SERVICES (HUMAN USES)

Commercial Fishing

Injury: During 1989, emergency commercial fishery closures were ordered in Prince William Sound, Cook Inlet, and the waters around Kodiak Island and the Alaska Peninsula. Harvests were closed or restricted for pink and sockeye salmon, herring, crab, shrimp, rockfish, smelt and sablefish. In 1990, portions of Prince William Sound were closed to shrimp and salmon fishing for the same reason. (See Table B-2.) All of the 1989 and 1990 closures were done to prevent harvest of oiled fish and were not triggered by population reductions in these species. As of December 1993, there are no spill-related commercial fishery closures in effect.

Significant impacts on fisheries may result from too many fish returning to the Kenai River system in 1989. During the 1989 commercial sockeye fishery closures, large numbers of fish escaped harvest to spawn. This resulted in an unusually large number of salmon fry moving into the lakes to feed. Sockeye fry spend up to two years feeding in fresh water before migrating to the ocean. Previous Kenai River overescapements in 1987 and 1988 compounded the problem. It is hypothesized that the salmon fry overgrazed the zooplankton available to them in the upper layers of the lakes. This reduced rates of growth and survival for the fry. Fry survival in the Kenai system was very poor for three years in a row. This will probably result in severely reduced adult returns to the Kenai system starting in 1994. Closure of Kenai River sockeye fisheries would have major impacts on many user groups.

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

rockfish harvest may overfish the population.

Public comment indicated concern that the oil spill had caused or could cause the following fishery impacts:

- (1) poor Prince William Sound pink salmon returns in 1992 and 1993;
- (2) potential reductions of sockeye returns in Chignik Lake due to 1989 sockeye overescapements;
- (3) poor Prince William Sound herring returns and disease problems in 1993; and
- (4) decreased Prince William Sound spot shrimp populations.

As of December 1993, biologists do not know whether these events were caused by the oil spill.

Recovery: Kenai River sockeye recovery will depend on recovery and availability of zooplankton populations in the lakes used by rearing fry. It is not yet known how many year classes of sockeye fry will be directly impacted by food shortages. However, the number of outmigrating Kenai River smolt was extremely low in 1991, 1992 and 1993, indicating that at least two consecutive year classes were impacted by overescapement. Kenai River smolt will return as adults in 1994, 1995 and 1996. The number of adults returning from these reduced outmigrations will almost certainly be lower than normal and may not be able to produce enough eggs to rebuild the runs within a single generation. If this turns out to be the case, adult returns to the Kenai in 1999, 2000 and 2001 may also be low. The Red Lake system also suffered overescapement in 1989 but may be recovering since plankton have recovered and fry survival improved in 1993.

Insufficient data exist to determine whether rockfish continue to be impacted by hydrocarbon contamination or if they are being harmed by overfishing. The lack of data could result in additional damage to the species. The long-term impacts of the injuries herring and pink salmon are uncertain.

COMMERCIAL FISHERY CLOSURES

TABLE B-2

Prince William Sound

Pacific Herring	Gillnet and purse seine sac roe fisheries and pound and wild roe-on-kelp fisheries closed April 3, 1989.
Shrimp	Pot shrimp fishery closed while in progress on April 3, 1989. Trawl shrimp fishery closed on April 9, 1989. A small pot shrimp harvest area near Knight, Eleanor and Smith Islands was closed in 1990.
Sablefish (black cod)	Closed April 1, 1989. Reopened in inside waters only, in conjunction with the halibut opening on June 12, 1989.
Dungeness Crab	Closed April 30, 1989.
King Crab	Closed on October 1, 1989.
Groundfish	Closed April 30, 1989. Reopened with the June 12, halibut opening.
Miscellaneous Shellfish	On April 24, 1989 it was announced that no miscellaneous shellfish permits would be issued.
Pink and Sockeye Salmon	<p>Closures of commercial drift and set net fisheries in Eshamy District, Northern District (surrounding Naked and Perry Islands), parts of Culross Island Subdistrict, Southwestern District, and parts of Montague Island District.</p> <p>In 1990, two set net areas near Eshamy Bay were closed for four days and then reopened. In addition, portions of the northern and eastern shorelines of Latouche Island, and waters around Eleanor and Ingot Islands were closed to fishing.</p>

TABLE B-2 (cont.)

Upper Cook Inlet

Sockeye Salmon

With the exception of a very minor opening of a small portion of the Central District, the commercial drift gillnet season was closed because of oil. In addition, setnet fishing in the Upper Subdistrict south of the Kasilof River was closed for the 12 hour regular fishing period on July 7, 1989, due to the presence of oil on beaches.

Lower Cook Inlet

Shrimp

Closed April 30, 1989. Reopened July 7, 1989.

Miscellaneous Shellfish

On April 24, 1989, it was announced that no miscellaneous shellfish permits would be issued to harvest these species in the Outer and Eastern Districts until the danger of oil contamination had passed.

Groundfish

The Outer and Eastern Districts were closed at noon, April 30, 1989. The fishery reopened to all species except sablefish, June 12 in conjunction with the 24-hour halibut opening.

Smelt

Smelt remained closed along with groundfish in the Outer and Eastern Districts on April 30, 1989. When groundfish reopened, smelt fishing remained closed.

Pacific Herring

The sac roe fishery in the Outer and Eastern Districts closed on April 15, 1989, prior to the anticipated opening date of April 20, 1989.

Pink Salmon

The seine fishery in the Kamishak District opened on June 1, 1989 and was closed by emergency order on June 8, 1989. Portions of Kamishak District north of Contact Point were opened after July 20 based on run strength. The Tutka Bay Subdistrict north of the HEA powerlines was closed to seining on July 10, and opened later the same day after further assessment showed the commercial fishery would not be impacted.

TABLE B-2 (cont.)

Kodiak

Pacific Herring	Approximately 34 of 56 management units were closed for the duration of the sac roe fishing season.
Sockeye and Pink Salmon	The commercial season was scheduled to begin June 9, 1989. The fisheries were postponed until June 19, when only the setnet fishery in the Alitak District opened; there were approximately 114 days fished in this setnet fishery by 87 fishermen. The only other commercial opening to occur during the 1989 salmon season was a two day seine opening in Karluk Lagoon, on the west side of Kodiak Island, in mid-September. The entire Kodiak Management Area closed to commercial salmon fishing at the conclusion of the Lagoon fishery.

Chignik

Sockeye Salmon	The Chignik fishery opened on June 12, 1989. However, portions of the Eastern District were closed due to the presence or close proximity of oil in the Kilokak Rocks area, and in Imuya and Wide Bays. The ADF&G announced a 24-hour fishing period on June 26 for a portion of the Chignik Bay District. The area was limited to a small portion of this district due to the presence of oil in surrounding areas, and was later closed the same day due to the presence of mousse and sheen. Additional closures occurred on July 27 and August 5, 1989.
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Passive Use

Injury: Passive uses of resources include the appreciation of the aesthetic and intrinsic values of undisturbed areas, the value derived from simply knowing that a resource exists, and other non-use values.

The areas of Alaska impacted by the oil spill supported a large diverse ecosystem that was valued by large numbers of the American public who did not visit the area. The spill killed substantial numbers of different bird species and marine mammals as well as oiling much of the coastline in the impacted areas. The spill also had substantial effects on the fish, bird, and wildlife populations. While some of these effects may be of relatively short duration, others such as recovery of various bird populations are likely to take decades.

A contingent valuation study of the American public done in 1991 found that approximately 95% were still aware of the *Exxon Valdez* oil spill, and that over 50% spontaneously named the spill as one of the worst environmental accidents to occur in the world during their lifetime. The median household was willing to pay \$31 to prevent a spill similar to the *Exxon Valdez* in the future. Multiplied by the number of U.S. households, this results in an estimate of spill damages of \$2.8 billion.

Recovery: The animals initially killed are irreplaceable. Fish and wildlife populations are recovering at different rates. Much of the oil in shoreline areas has been removed or has weathered to varying degrees. However, full recovery will not occur until the public also perceives that injured resources have recovered.

Recreation and Tourism

Injury: This statement of injury to recreation has been derived from reference material, public comment, and comment from agency managers. A comprehensive recreation injury assessment has not been conducted. Although this summary covers the entire spill area, most of the information is from Prince William Sound.

Recreation can be divided into two categories, commercial and non-commercial. Commercial recreation (tourism) includes uses by clients and operators of tourism services such as boat tours, fishing charters and flightseeing services. Non-commercial recreational users engage in many of the same activities as commercial users, but do not purchase or pay for the services of tourism businesses. Common recreational activities for all users include kayaking, camping, hiking, boating, sightseeing, photography, scuba diving, beachcombing, flying, sport fishing, hunting, gathering food, and investigating the history of an area.

Injuries to the natural resources as well as the oil spill clean up and other post-spill activities have caused injury to recreation and tourism. Injury is divided into five categories: (1)

quantity; (2) quality; (3) perception; (4) location; and (5) facilities.

Quantity. Some commercial recreation and tourism businesses were injured by the reduction in visitors and visitor spending as a result of the spill. Businesses relying on individual bookings rather than packaged tours, were hurt more by reduced bookings. Non-commercial recreation also decreased in some parts of the spill area.

Because oil fouled beaches, there was and still is a reduction of quality destinations available to some recreation users. There was a reduction in quantity and quality of wilderness based destinations because clean up activities brought people, noise and large motorized equipment throughout the spill area and disturbed the area's undeveloped and normally sparsely occupied landscape.

Public use cabin rentals and visitor use data from the State of Alaska, Chugach National Forest and Kenai Fjords National Park show fewer visits in some of the spill area in 1989 and 1990. Decreased use is an injury to those who would like to have used the area but avoided it because of the spill. While fewer people visited some areas, other areas experienced increased use. In some cases, increased use is causing additional resource damage and decreased enjoyment of overused areas.

There was a significant decline in sport fishing in the oil spill area following the oil spill. The loss to sport anglers in 1989 is estimated to be \$31 million. In 1992, cutthroat trout sport fishing in western Prince William Sound was closed due to low adult returns and in 1991 a restriction on the sport hunting of harlequin duck was imposed.

Quality. The quality of recreation experiences decreased as a result of the spill due to crowding, residual oil, and fewer fish and wildlife. During the cleanup efforts, thousands of additional people in the spill area reduced wilderness qualities. Some communities were directly affected by crowding. The degree of injury differs for different forms of recreation. For instance kayakers have been much more affected by this quality reduction than cruise ship passengers.

The injuries to fish and wildlife reduced the amount that were seen or caught by people visiting the area. In addition, seeing oil diminished the appreciation of the natural setting. More heavily oiled areas experienced more injury to the quality of recreation.

Perceptions. The oil spill caused injury to the way people perceive recreation opportunities in the spill area. According to public comment, changes in perceptions include: (1) increased sense of vulnerability of the ecosystem in regard to future oil spills; (2) erosion of wilderness character; (3) a sense of permanent change; (4) A sense of complete disruption of the ecosystem and contamination of the food chain; (5) a sense of unknown or unseen ecological effects; and (6) a sense of threat to archaeological resources.

These perceptions caused people to change destinations and trip plans, resulting in injuries to tourism, sport fishing, boating, recreation cabin bookings, and community businesses among others.

People who used the spill area before the oil spill occurred generally have greater perceptions of injury than first time recreation users of the spill area. Perceptions are changed more often for shore-based recreation users than those who remain on vessels.

Location. The location of recreation use was altered by changed use patterns and displaced use. Some recreation users were temporarily or permanently displaced from their customary or preferred sites due to spill-related changes such as crowding, presence of oil, or other factors. As a result of the oil spill, others changed the type or location of recreation use they historically engaged in.

Facilities. Some recreation facilities were injured by the spill, most from overuse or misuse during 1989 and 1990. For example, the Green Island public use cabin and Fleming Spit camp area near Cordova experienced over use, sanitation problems and resource degradation.

Recovery: Public comment shows persisting oil, crowding, diminished aesthetics, reduction of wilderness character, reduction of wildlife sightings, tainted food sources, disturbance of cultural sites, and evidence of clean up activities all to be continuing injuries to recreation. According to recent public comment, some displaced users are returning to parts of the spill area, while others still avoid the heavier oiled areas. Recovery of recreation is largely dependent on the recovery of the natural resources. As natural resources recover, recreational experiences will improve. The projected decrease in the Kenai River sockeye salmon returns could cause additional injury to recreation on the Kenai Peninsula. Use patterns continue to change in relation to the recovery of the resources, perceptions, and the effects of restoration projects.

Subsistence

Injury: Before the *Exxon Valdez* oil spill, the Alaska Department of Fish and Game's Subsistence Division documented 15 Native Alaskan communities (with about 2200 people) in Prince William Sound, Lower Cook Inlet, Kodiak and the Alaska Peninsula that relied heavily on subsistence resources. These resources included salmon, halibut, cod, rockfish and Dolly Varden; marine invertebrates such as clams, chitons, shrimp, crabs, and octopus; marine mammals (harbor seals and sea lions); land mammals such as deer (Prince William Sound and Kodiak Island), black bear and goats (Prince William Sound and Lower Kenai Peninsula); birds including ptarmigan, waterfowl, and gulls eggs; and wild plants. Many of these species were studied after the spill, and the results of these studies are summarized in this section. The mean number of resources used per household ranged from 10 to 25, and generally every household in these communities participated in subsistence harvests. The per capita

subsistence harvest ranged from nearly 200 pounds to over 600 pounds per year.

Table B-3 illustrates changes in harvest levels in the first year (April 1989 to March 1990) following the spill. Subsistence harvests of fish and wildlife in eleven of these villages (Chenega Bay, Tatitlek, Nanwalek (English Bay), Port Graham, Karluk, Old Harbor, Akhiok, Larsen Bay, Ouzinkie, Port Lions, and Chignik Lagoon) declined from 4% to 77%, compared to prespill harvest levels. The reasons for this decline varied among communities and households, but most dealt with the reduced availability of injured species and perceived consequences of the oil spill, especially the concern for potential health effects caused by consuming subsistence resources from the spill area.

Table B-3 does not reflect the injuries to subsistence use that occurred in Alaska Peninsula communities. After the spill, people in this area harvested fewer marine resources, but increased harvest levels of terrestrial species. Also, many people were and continue to be concerned about the safety of traditional foods and some families avoided using certain species.

Chemical analytical studies conducted in 1989-1991 measured levels of metabolites in the bile and petroleum hydrocarbons in edible tissues of subsistence foods. These studies found that most resources tested (fish, some species of shellfish, deer, ducks, marine mammals) contained no or very low levels of petroleum hydrocarbons, and that eating foods with those levels posed no health risk. Exposure to oil did not necessarily render organisms unsafe to eat since some exposed animals were found to have low or non-existent levels of hydrocarbons and their metabolites in their edible tissues. Some samples of shellfish, however, had unacceptably high levels of petroleum hydrocarbons. This prompted advisories, starting in 1989, that shellfish should not be collected from obviously oil-contaminated areas. This advice has not changed.

Recovery: Table B-3 summarizes changes in harvest levels in Native villages following the oil spill. The finding that subsistence harvests had partially recovered in 5 villages during the 1990-1991 timeframe suggested increased confidence in using some subsistence resources. However, the continued very low levels of harvest at Chenega Bay and Tatitlek, Nanwalek (English Bay) and Ouzinkie, and the continued concern in some households in many villages that some subsistence foods remained unsafe to eat, suggested that the injury persisted through the second year following the spill.

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

TABLE B-3. 'Subsistence Harvests Before and After the *Exxon Valdez* Oil Spill:

COMMUNITY	PRESPILL YEAR ONE (per capita harvest in pounds)	PRESPILL YEAR TWO (per capita harvest in pounds)	OIL SPILL YEAR (per capita harvest in pounds)	PERCENT CHANGE	POSTSPILL YEAR ONE (4/90 - 3/91) (per capita harvest in pounds)
<u>Prince William Sound</u>					
Chenega	308.8	374.2	148.1	-56.6 (e)	143.1
Tatitlek	351.7	643.5	214.8	-56.8 (e)	155.2
<u>Lower Cook Inlet</u>					
Nanwalek (English Bay)	288.8	(c)	140.6	-51.3 (b)	181.1
Port Graham	227.2	(c)	121.6	-46.5 (b)	213.5
<u>Kodiak Island</u>					
Akhiok	519.5	159.3	297.7	-12.3 (e)	(d)
Karluk	863.2	381.0	250.5	-59.7 (e)	395.2
Larsen Bay	403.5	200.9	209.9	-30.5 (e)	340.4
Old Harbor	491.1	419.3	271.1	-40.4 (e)	(d)
Ouzinkie	369.1	405.7	88.8	-77.1 (e)	204.9
Port Lions	279.8	328.3	146.4	-51.8 (e)	(d)
<u>Alaska Peninsula</u>					
Chignik Bay	187.9	(c)	208.6	+11.0 (b)	(d)
Chignik Lagoon	220.2	(c)	211.4	-4.0 (b)	(d)
Chignik Lake	279.0	(c)	447.6	+60.4 (b)	(d)
Ivanof Bay	455.6	(c)	489.8	+7.5 (b)	(d)
Perryville	391.2	(c)	394.2	+0.8 (b)	(d)

(a) Prespill study years are: Tatitlek 1987-88 and 1988-89; Chenega, 1984-85 and 1985-86; Nanwalek (English Bay) and Port Graham, 1987; Kodiak Island Borough, 1982-83 and 1986; Alaska Peninsula, 1984. The "spill year" is 1989 for all communities, except Chenega and Tatitlek, for which it is April 1989-March 1990.

(b) Compared to the most recent previous year.

(c) Only one previous measurement was taken.

(d) Not determined.

(e) Compared to the average of both prespill years.

Resources:
Summary of Results of Injury Assessment Studies

The tables in this part of the appendix summarize the results of the injury assessment studies for all natural resources and archaeology completed after the *Exxon Valdez* oil spill. Table B-4 shows whether there was initial mortality caused by the spill, whether the spill caused a measured population decline, and whether there is evidence of sublethal injury. For some resources, an estimate is available for the total number of animals initially killed by the spill. If available, that estimate is shown in parentheses under the initial mortality column. For many resources, the total number killed will never be known. For other resources, and archaeology, listed in Table B-5, information on injury is not quantitative.

The "Status of Recovery" columns show the best estimate of recovery using the most recent information. The columns show resources' progress toward recovery to the condition and population levels that scientists estimate would have occurred in the absence of the spill. The "Current Population Status" column shows a resource's progress from any "Decline in Population after the Spill." Similarly, the column labeled "Continuing Sublethal Effects" shows whether an sublethal injury is ongoing.

**TABLE B-4 Resources: Summary of Results of Injury Assessment Studies Done
After the *Exxon Valdez* Oil Spill**

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
MARINE MAMMALS										
Harbor Seals (d)	YES (300)	YES	YES	POSSIBLY STABLE, BUT NOT RECOVERING (b)	UNKNOWN	YES	YES (e)	UNKNOWN	UNKNOWN	Many seals were directly oiled. There was a greater decline in population indices in oiled areas compared to 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	(f)	(f)	(f)	(f)	(f)	(f)	Other than fewer animals being observed in Knight Island Passage in summer 1989, which did not persist in 1990, the oil spill did not have a measurable impact on the north Pacific population of humpback whales.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Killer Whales	Yes (13)	YES (h)	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 4 whales since 1990. Some experts think that loss of 13 whales in 1989, 1990 is unrelated to oil spill.
Sea Lions (d)	UNKNOWN	YES (h)	NO	CONTINUING DECLINE	(f)	(f)	(f)	(f)	(f)	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.
Sea Otters	YES (3,500 TO 5,500)	YES	YES	STABLE, BUT NOT RECOVERING	YES, POSSIBLY	YES	YES	YES (e)	YES (e)	Postspill 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. Sea otters feed in the lower intertidal and subtidal areas and may still be exposed to hydrocarbons in the environment.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
TERRESTRIAL MAMMALS										
Brown Bear	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	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.
Black Bear	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	No field studies were done.
River Otters	YES (TOTAL NUMBER UNKNOWN)	NO	YES, POSSIBLY	UNKNOWN	UNKNOWN	YES	UNKNOWN	UNKNOWN	UNKNOWN	Exposure to hydrocarbons and possible sublethal effects were determined, but no effects were established on population. Sublethal 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	(f)	(f)	(f)	(f)	(f)	(f)	Elevated hydrocarbons were found in tissues some deer in 1989.
Mink	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Studies limited to laboratory toxicity studies.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
BIRDS										
Bald Eagles	YES (200 or more)	NO	YES	POSSIBLY RECOVERED	NO	YES	YES	YES (e)	YES(e)	Productivity in PWS was disrupted in 1989, returned to normal in 1990. Exposure to hydrocarbons and some sublethal effects were found in 1989, but no continuing effects were observed on populations.
Black-legged Kittiwakes	YES (NUMBER UNKNOWN)	NO	NO	NO CHANGE	NO	YES	YES (e)	YES (e)	YES (e)	Total reproductive success in oiled and unoiled areas of PWS has declined since 1989. 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 (120-150 ADULTS; UNKNOWN FOR CHICKS	YES	YES	RECOVERING	YES	YES	YES (e)	YES (e)	YES (e)	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 postspill surveys in 1989, 1990 and 1991. Black oystercatchers feed in the intertidal areas and may be still be exposed to hydrocarbons in the environment.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Common Murres	YES (170,000 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)	NO	NO	NO CHANGE	NO	YES (e)	YES (e)	YES (e)	YES (e)	While dead birds were recovered in 1989, there is no evidence of a population level impact when compared to historic (1972, 1973) population levels.
Harlequin Ducks	YES (APPROX. 1000)	YES	YES, POSSIBLY	UNKNOWN	YES	YES	YES (e)	YES (e)	YES (e)	Postspill samples showed hydrocarbon contamination. Surveys in 1990-1992 indicated population declines and possibly reproductive failure. Harlequin ducks feed in the intertidal and shallow subtidal areas and may still be exposed to hydrocarbons in the environment.
Marbled Murrelets (d)	YES (8,000 TO 12,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Measurable population effects were recorded in 1989, 1990 and 1991. Marbled murrelet populations were declining prior to the spill.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Peale's Peregrine Falcons	UNKNOWN	YES (h)	NO	(f)	(f)	(f)	(f)	(f)	(f)	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 (d)	YES (1,500 TO 3,000)	YES	NO	STABLE OR CONTINUING DECLINE	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Pigeon guillemot populations were declining prior to the spill. Hydrocarbon contamination was found externally, on eggs.
Storm Petrels	YES (NUMBER UNKNOWN)	NO	NO	NO CHANGE	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	Few carcasses were recovered in 1989 although petrels ingested oil and transferred oil to their eggs. Reproduction was normal in 1989.
Other Seabirds	YES (number unknown)	VARIES BY SPECIES	UNKNOWN	VARIES BY SPECIES	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	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.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Other Sea Ducks	YES (875)	NO	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	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)	VARIES BY SPECIES	UNKNOWN	UNKNOWN	UNKNOWN	YES	YES (e)	YES (e)	YES (e)	Species collected dead in 1989 include golden plover; lesser yellowlegs; semipalmated, western, least and Baird's sandpipers; surfbird; short-billed dowitcher; common snipe; red and red-necked phalarope.
Other Birds	YES (NUMBER UNKNOWN)	NO (NOT STUDIED)	UNKNOWN	UNKNOWN	UNKNOWN	YES (e)	YES (e)	YES (e)	YES (e)	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.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
FISH										
Cutthroat Trout	NO	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	NO	NO	NO	Differences in survival between anadromous adult populations in the oiled and unoiled areas were not statistically different; however, differences in growth between adult populations in the oiled and unoiled areas were found in 1989, 1990, and 1991.
Dolly Varden	NO	NO	YES	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	Differences in survival between anadromous adult populations in the oiled and unoiled areas were not statistically different. Growth rates between 1989 and 1990 were reduced.
Pacific Herring	YES, TO EGGS AND LARVAE	YES (h)	YES	SEE COMMENTS	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. Herring exposed as eggs or larvae in 1989 were under-represented in 1992 and 1993 returns. It is unknown whether 1993 disease outbreaks were due to the spill.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Pink Salmon (Wild) (d)	YES, TO EGGS	YES (h)	YES	SEE COMMENTS	YES	YES	UNKNOWN	UNKNOWN	UNKNOWN	There was initial egg mortality in 1989. Egg mortality continued to be high in 1991 & 1992. Abnormal fry were observed in 1989. Reduced growth of juveniles was found in the marine environment, which can be correlated with reduced survival to adulthood. It is unknown whether poor returns in 1993 are linked to the spill.
Rockfish	YES (20) (g)	NO	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.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Sockeye Salmon	UNKNOWN	YES	YES	SEE COMMENTS	SEE COMMENTS	UNKNOWN	YES	YES	UNKNOWN	Fry survival continues to be poor in the Kenai River systems due to overescapements to the Kenai River in 1987, 1988, 1989. As a result, adult returns are expected to be low in 1990 and successive years. Trophic structures of Kenai and Skilak Lakes have been altered by overescapement. Red Lake may be recovering since plankton have recovered and fry survival improved in 1993.
SHELLFISH										
Clam	YES (NUMBER UNKNOWN)	YES	POSSIBLY, FINAL ANALYSES PENDING	UNKNOWN	UNKNOWN	YES	YES	YES	YES	Marginal declines in clam populations were noted in 1989. Native littleneck and butter clams were impacted by both oiling and cleanup, particularly high pressure, hot water washing. Littleneck clams transplanted to oiled areas in 1990 grew significantly less than those transplanted to unoiled sites. Reduced growth recorded at oiled sites in 1989 but not 1991.
Crab (Dungeness)	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Crabs collected from oil areas were not found to have accumulated petroleum hydrocarbons.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
Oyster	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Although studies were initiated in 1989, they were not completed because they were determined to be of limited value.
Sea Urchin	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	Studies limited to laboratory toxicity studies.
Shrimp	NO	NO	NO	(f)	(f)	(f)	(f)	(f)	(f)	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 midintertidal is recovering. Some species (Fucus) in the upper intertidal zone have not recovered, and oil may persist in mussel beds.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury			Status of Recovery (a)		Geographic Extent of Injury (b)				Comments/Discussion
	Oil Spill Mortality (total mortality estimate)(c)	Measured Decline in Population after the spill	Sublethal or Chronic Effects	Current Population Status	Continuing Sublethal or Chronic Effects	PWS	Kenai	Kodiak	Alaska Penin.	
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 prespill densities in 1991. Leather stars and helmet crabs show little sign of recovery through 1991.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

TABLE B-5 Other Natural Resources and Archaeology: Summary of Results of Injury Assessment Studies Done After the *Exxon Valdez* Oil Spill

Resource	Description of Injury	Status of Recovery	Geographic Extent of Injury (b)				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 fractions 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.

(a) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Resource	Description of Injury	Status of Recovery	Geographic Extent of Injury				Comments/Discussion
			(b)	PWS	Kenai	Kodiak	Alaska Penin.
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) 1993 field reports are not yet finalized.

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

(c) Adjusted for carcasses not found, not reported, scavenged, or otherwise lost.

(d) Population may have been declining prior to the spill.

(e) Based on recovery of dead animals from this region of the spill zone.

(f) If no injury was detected or known, no assessment of recovery could be made.

(g) Total body count, not including carcasses not found.

(h) It is unknown if declines are due to the oil spill.

Services:
Summary of Results of Injury Assessment Studies

Table B-6 summarizes information concerning lost or reduced services damaged by the spill. Much of the injury to services and the information about those injuries is not quantitative. The table reflects the qualitative content of the information. The "Description of Reduction or Loss" column recounts the impacts of the spill on each service. The "Status of Recovery" shows the most recent information on recovery.

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

**TABLE B-6 Services: Summary of Results of Injury Assessment Studies Done
After the Exxon Valdez Oil Spill**

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Passive Use	The areas of Alaska impacted by the oil spill supported a large diverse ecosystem that was valued by large numbers of the American public who did not visit the area. The spill killed substantial numbers of different bird species and marine mammals as well as oiling much of the coastline in the impacted areas. The spill also had substantial effects on the fish, bird, and wildlife populations. While some of these effects may be of relatively short duration, others such as recovery of various bird populations are likely to take decades.	The animals initially killed are irreplaceable. Fish and wildlife populations are recovering at different rates. Much of the oil in shoreline areas has been removed or has weathered to varying degrees.	YES	YES	YES	YES	A contingent valuation study of the American public done in 1991 found that approximately 95% were still aware of the Exxon Valdez oil spill, and that over 50% spontaneously named the spill as one of the worst environmental accidents to occur in the world during their lifetime. The median household was willing to pay \$31 to prevent a spill similar to the Exxon Valdez in the future. Multiplied by the number of U.S. households, this results in an estimate of spill damages of \$2.8 billion.

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

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Recreation and Tourism (e.g., hunting, sportfishing, camping, kayaking, sailboating, motorboating, environmental education)	<p>The nature and extent of any reduction or loss of services varied by user group and by area.</p> <p>Some commercial recreation and tourism businesses were injured by the reduction in visitors and visitor spending as a result of the spill. Non-commercial recreation also decreased in some parts of the spill area. The quality of recreation experiences decreased as a result of the spill due to crowding, residual oil and fewer fish and wildlife. The oil spill caused injury to the way people perceive recreation opportunities in the spill area. The location of recreation use was altered by changed use patterns and displaced use. A few recreation facilities were impacted by the spill, most from overuse or misuse during 1989 and 1990.</p> <p>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.</p>	<p>Public comment shows persisting oil, crowding, diminished aesthetics, reduction of wilderness character, reduction of wildlife sightings, tainted food sources, disturbance of cultural sites, and evidence of clean-up activities all to be continuing injuries to recreation. Some displaced users are returning to parts of the spill area, while others still avoid the heavier oiled areas.</p> <p>Recovery of recreation, especially sport hunting and fishing, is largely dependent on the recovery of injured species. As species recover, recreational experiences will improve. The projected decrease in the Kenai River sockeye salmon returns could cause additional injury to recreation on the Kenai Peninsula. Use patterns continue to change in relation to the recovery of the resources, perceptions and restoration projects.</p>	YES	YES	YES	YES	Survey respondents also reported changes in their perception of recreation opportunity in terms of increased vulnerability to future 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.

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury (a)				Comments/Discussion
			PWS	Kenai	Kodiak	Alaska Penin.	
Commercial Fishing	<p>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).</p> <p>In 1990 portions of PWS were closed to shrimp and salmon fishing.</p>	<p>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.</p> <p>EVOS related sockeye over-escapement in the Kenai River system is anticipated to result in low adult returns in 1994 and beyond. Over-escapements may result in closure or harvest restrictions during these and perhaps in subsequent years.</p> <p>Returns of pink salmon and herring to Prince William Sound were very low in 1993. It is uncertain to what degree this is linked to the spill.</p>	YES	YES	YES	YES	<p>Injuries and recovery status of rockfish, pink salmon, shellfish and herring are uncertain. Therefore, future impacts on these fisheries is unknown.</p>

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

Service	Description of Reduction or Loss	Status of Recovery	Geographic Extent of Injury				Comments/Discussion
			(a)	PWS	Kenai	Kodiak	Alaska Penin.
Subsistence	<p>Subsistence harvests of fish and wildlife in 11 of 15 villages surveyed declined from 4 - 77% in 1989 when compared to prespill levels. At least 4 of the 11 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.</p> <p>In 1989-1991, chemical analysis indicated that most resources tested, including fish, marine mammals, deer, and ducks, were safe to eat. Starting in 1989, health advisories were issued indicating that shellfish from oiled beaches should not be eaten.</p>	<p>Many subsistence users believe that continued contamination to subsistence food sources is dangerous to their health.</p> <p>In addition, village residents believe that subsistence species continue to decline or have not recovered from the oil spill.</p> <p>Health advisories against eating clams from obviously oiled beaches are still in effect.</p>	YES	YES	YES	YES	For detailed information on village subsistence use, see Table B-3.

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



Appendix C

Areas Recommended by the Public for Purchase or Protection

During the public comment period in April and May of 1993, the public recommended many areas for purchase or protection. The list of recommended areas, by region, appears below.

Prince William Sound

Bainbridge Island
Chenega Island
Chugach National Forest
Cordova area private lands
Dangerous Passage
Eshamy/Jackpot Bay
Evans Bay
Fish Bay
Hawkins Island
Hinchinbrook Island
Icy Bay
Knight Island
Knowles Head
Latouche Island
Montague Island
Naked Island
Nelson Bay
Olsen Bay
Orca Bay/Narrows¹
Patton Bay
Port Fidalgo
Port Gravina (including Bear Trap Bay)
Red Head
Rude River
Sheep Bay
Simpson Bay
Two Moon Bay
Windy Bay

Kenai Area

Chrome Bay
Gull Island
Kamishak Bay
Kenai Fjords National Park
Kenai Peninsula
Port Chatham
Rocky Bay

Kodiak Area

Afognak Island
Fox/Red Fox Bay
Karluk River
Kodiak Island
Kodiak National Wildlife Refuge
Long Lagoon
Pauls & Laura Lake Chain
Shuyak Island/Strait
Sitkalidak Island
Sturgeon River

General

Tongass National Forest

1. Orca Narrows/Orca Bay was the only area that people specifically stated that they were opposed to acquiring.



Appendix D Planning Publications

The following publications have been produced by the *Exxon Valdez* Trustee Council's Restoration Planning Work Group in the development of this plan:

Restoration Following the *Exxon Valdez* Oil Spill: Proceedings of the Public Symposium, Anchorage, Alaska, July 1990.

Restoration Planning Following the *Exxon Valdez* Oil Spill: August 1990 Progress Report, Anchorage, Alaska, August 1990.

Restoration Framework, Anchorage, Alaska, April 1992.

Draft *Exxon Valdez* Oil Spill Restoration Plan: Summary of Alternatives for Public Comment, Anchorage, Alaska, April 1993.

Supplement to Draft *Exxon Valdez* Oil Spill Restoration Plan Summary of Alternatives for Public Comment, Anchorage, Alaska, June 1993.

Summary of Public Comment on Alternatives, Anchorage, Alaska, September 1993.

The following publications were produced by contractors for the *Exxon Valdez* Trustee Council's Restoration Planning Work Group.

Boland, J. M., Comprehensive Review and Critical Synthesis of the Literature on Recovery of Ecosystems Following Disturbances: Marine Invertebrate Communities, Pacific Estuarine Research Laboratory, California, October 1992.

Jones and Stokes Associates, Inc., Proceedings of the Workshop on Programs to Protect Marine Habitats, Bellevue, Washington, January 1992.

Jones and Stokes Associates, Inc., Summary Report on Programs to Protect and Manage Marine Habitats, Bellevue, Washington, January 1992.

The Nature Conservancy, Options for Identifying and Protecting Strategic Fish and Wildlife Habitats and Recreation Sites: A General Handbook, Anchorage, Alaska, December 1991.

Nevissi, A. E., T.H. Sibley, and C. Chang, Comprehensive Review and Critical Synthesis of the Literature on Recovery of Ecosystems Following Disturbance: Fish and Shellfish, University of Washington, Washington, September 1993.

Nur, N. and D.G. Ainley, Comprehensive Review and Critical Synthesis of the Literature on Recovery of Marine Bird Populations from Environmental Perturbations, Point Reyes Bird Observatory, California, March 1992.

Parametrix, Inc., ABA Consultants, and Goldstream Consulting, Monitoring Recovery Following the Exxon Valdez Oil Spill: A Conceptual Monitoring Plan, Kirkland, Washington, June 1993.

Stewart, B.S., P.K. Yochem, and J.R. Jehl Jr., Review and Critical Synthesis of the Literature on Recovery of Ecosystems Following Man-Induced and Natural-Phenomena-Related Disturbances: Harbor Seals and Killer Whales, Hubb-Sea World Research Institute, California, June 1992.

Versar, Inc., Restoration Planning Following the Exxon Valdez Oil Spill: Draft Technical Workshop Report, Columbia, Maryland, September 1990.