12.06.04 1 of 5

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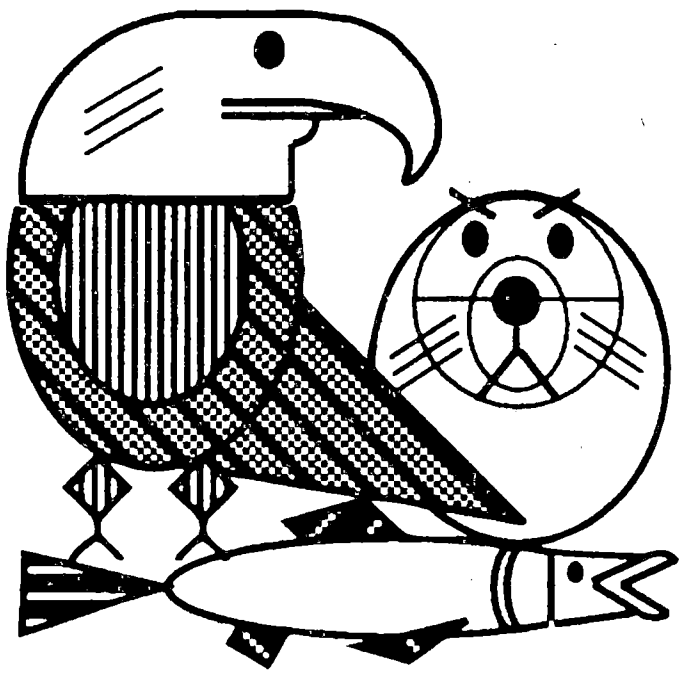
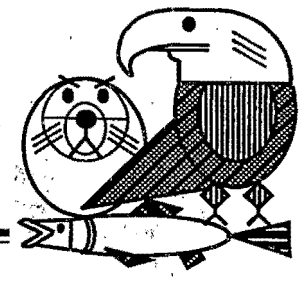
Preliminary Review Draft

FY95 Work Plan
Brief Project Descriptions
June 1994



Exxon Valdez **Oil Spill**
Trustee Council
645 G Street, Suite 401
Anchorage, AK 99501
907/278-8012

Exxon Valdez Oil Spill Trustee Council
Restoration Office
645 G Street, Suite 401, Anchorage, Alaska 99501-3451
Phone: (907) 278-8012 Fax: (907) 276-7178



June 23, 1994

Dear Reviewer,

The attached *Preliminary Review Draft FY 95 Brief Project Descriptions* includes Brief Project Descriptions (BPDs) received in response to the *Invitation to Submit Restoration Projects for Fiscal Year 1995.* A summary of the projects submitted in this *Preliminary Review Draft* is provided in Tables 1 through 5 attached to this letter.

The BPDs are printed in order of their 5-digit Project Number. Each BPD is assigned a Project Number starting with "95" (for fiscal year 95) followed by three additional digits. If the proposed project is a project continued from FY 94, the 3-digit number from last year was retained. If a project has multiple related parts or sub-projects, those are identified by a letter at the end of the Project Number (e.g., 95007A, 95007B, ... etc.). If a project is a "closeout" from FY 94, "CLO" follows the Project Number. In addition to being given a project number, each project is assigned to a "lead agency" for purposes of follow-up and management. (Note: All projects, regardless of who proposed them, were assigned to a lead Trustee Council agency for purposes of administration.)

Additionally, projects were identified as "continuation" or "new" projects (one project was categorized as a "carry forward" of funds from FY 94), and placed into one of the following six categories:

- General Restoration
- Monitoring
- Research
- Habitat Protection
- Administration
- Restoration Reserve

In some cases, project proposals included multiple elements. The assignment of a project to a particular category (e.g., research vs. monitoring) was based on a brief review and is for initial organizational purposes only.

In addition to the BPDs, three additional documents are included at the end of the *Preliminary Review Draft* for your review.

Broad Agency Announcement (BAA) — A copy of the BAA, referenced in the *Invitation to Submit Restoration Projects for Fiscal Year 1995,* as issued by the National Oceanic and Atmospheric Administration is included for your review. This BAA describes the research area of interest (i.e., food limitation on recovery of injured resources) for which proposals are still being accepted until June 30, 1994. Proposals submitted in response to the BAA will be transmitted to the Interim Science Review Board as soon as possible after June 30.

Comments by LGL Alaska Research Associates, Inc. (LGL) — In addition to providing information concerning LGL's capabilities to undertake restoration projects, these comments provide several specific "restoration project concepts."

Comments by Cook Inlet Seiners Association — Comments from the Cook Inlet Seiners Association in response to the *Invitation to Submit Restoration Projects for Fiscal Year 1995* also include recommendations concerning several restoration project ideas.

SUMMARY

A total of 155 project proposals have been submitted as summarized below:

Project Category	# Projects	FY 95 Cost ($000s)
General Restoration	47	$ 22,757.3
Monitoring	28	$ 6,896.1
Research	68	$ 18,954.0
Habitat Protection	7	$ 2,399.9
Administration	4	$ 4,092.0
Restoration Reserve	1	$ 12,000.0
TOTAL	155	$ 67,099.3

GENERAL RESTORATION PROJECTS (Table 1)

Table 1 presents a summary of General Restoration project proposals submitted for FY 95. General Restoration is a term applied to all restoration activities other than Monitoring, Research and Habitat Protection. General Restoration Projects intended to help an injured *resource* recover will increase the rate of recovery, the degree of recovery or protection for an injured resource. General Restoration projects intended to help an injured *service* recover must have a sufficient relationship to an injured resource and benefit the same user group that was injured.

A total of 47 General Restoration projects were proposed for FY 95 with a total of approximately $22 million in costs (about half of which was attributable to proposed Project 95003 - Area E Commercial Salmon Permit Buyback Program). In FY 94, $5.4 million was allocated to General Restoration projects.

Twenty-seven of the proposed General Restoration projects are new this year. Table 1 lists General Restoration projects by the primary resource or service they would address.

MONITORING PROJECTS (Table 2)

Table 2 presents a summary of Monitoring project proposals submitted for FY 95. As with the other tables, Table 2 shows the location and project type (i.e., continued, new) and cost for FY 95 and FY 96 (if known). This table does not show total project cost because many of the monitoring programs have an undetermined end date. A total of 28 proposed monitoring projects were submitted for a total of $6.9 million in FY 95. In FY 94, a total of $12.1 million was allocated for Monitoring and Research projects combined.

Table 2 also shows the monitoring projects that were submitted compared to the preliminary monitoring recommendations that are included in the *Invitation to Submit Restoration Projects for Fiscal Year 1995*. (See Chapter 3 of the *Invitation*.) While monitoring recommendations contained in the *Invitation* are preliminary and will be subject to further peer review, legal analysis, and policy evaluation, they give an indication of what was anticipated in FY 95 submissions.

RESEARCH PROJECTS (Table 3)

Table 3 presents a summary of Research project proposals submitted for FY 95. Several different groups of projects were submitted as integrated research proposals, including:

— the continued PWS System Investigation (PWSSC/UAF/ADFG)(1);
— a study directed at Processes Structuring Recovery of Injured Nearshore Vertebrate Predators in PWS (NBS)(2);
— a Marine Mammal Ecosystem Study package(3);
— Nearshore Ecosystem Studies (UAF); and
— a collection of Pelagic Ecosystem Studies.

(1) an overview of this collection of projects is provided as Attachment A
(2) an overview of this collection of projects is provided as Attachment B
(3) an overview of this collection of projects is provided as Attachment C

Table 3 is organized to reflect these groupings of project proposals as well as other project proposals that address similar or related issues. It is recognized that many of the research proposals address varied topics and do not fit easily into any one category. The categories in Table 3 are for initial organization only and will undoubtedly be revised.

A total of 68 research projects have been proposed for FY 95, including 21 projects that are proposed to be continued from FY 94, 46 new project proposals, and 1 closeout project.

HABITAT PROTECTION (Table 4)

Table 4 presents a summary of Habitat Protection project proposals submitted for FY 95, including 7 proposed projects for a total of $2.4 million. (These projects do not provide funding for actual purchase or acquisition of parcels from private landowners.)

ADMINISTRATION (Table 5)

Table 5 presents a summary of Administration project proposals submitted for FY 95 including 4 projects for a total of $4.1 million.

RESTORATION RESERVE (Table 6)

Table 6 reflects the proposal to add another $12 million to the Restoration Reserve in FY 95 to add to the $12 million already set aside in FY 94.

* * * * *

Your review and comment on the *Preliminary Review Draft FY 95 Brief Project Descriptions* is greatly appreciated as the Trustee Council works toward the formulation of a work plan for FY 95. If you have questions, please let me know or contact Bob Loeffler or Eric Myers in the Anchorage Restoration Office.

Sincerely,

Molly McCammon

Molly McCammon, Director of Operations

attachments

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Total Cost: $67,099

Total Number of Projects: 155

Note 1: Brief Project Descriptions are not available for these projects.

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Table 1 GENERAL RESTORATION

Proj No.	Title	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs.
Archaeological Resources										
95007-CLO	Closeout: Site-specific Archaeological Restoration	ADNR	All	Closeout	94007	$599.5	$191.7	$0.0	$191.7	1
95007B	Archaeological Site Restoration (Site SEW-488)	USFS	PWS	Cont'd	94007	$599.5	$185.2	$0.0	$185.2	
95007C	Crafton Island Site Restoration	USFS	PWS	Cont'd	94007	$600.0	$27.7	$5.0	$32.7	
Birds - General										
95038	Symposium on Seabird Restoration	DOI	ALL	NEW			$77.0	$0.0	$77.0	2
95098	Identification of Seabird Feeding Areas from Remotely Sensed Data	DOI	ALL	NEW			$74.0	Unk	Unk	4
Birds - Murrelets										
95099	Murrelet Vocalization in Conjunction with Artificial Nests: A Possible Means of Attraction to Habitat	DOI	ALL	NEW			$77.0	Unk	Unk	4
Birds - Murres										
95096	Restoration of Murres by Way of Social Attraction and Predator Removal	DOI	ALL	NEW			$167.0	Unk	Unk	4
95097	Restoration of Murres by Way of Transplantation of Chicks: A Feasibility Study	DOI	ALL	NEW			$176.0	Unk	Unk	4
Birds - Predator Removal										
95041A-CLO	Closeout: Introduced Predator Removal from Islands	DOI	OUT	Closeout	94041	$84.0	$20.4	$0.0	$20.4	1
95041B-CLO	Introduced Predator Removal from Islands: Follow-up Surveys	DOI	OUT	Closeout	94041	$84.0	$50.9	$0.0	$50.9	2
95042	Five-year Plan to Remove Predators from Seabird Colonies	DOI	OUT	NEW			$75.0	$0.0	$75.0	2
Fish - Cutthroat/Dolly Varden										
95043B	Cutthroat and Dolly Varden Rehabilitation in Western PWS	USFS	PWS	Cont'd	94043		$137.4	Unk	Unk	

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Table 1 GENERAL RESTORATION

Proj.No.	Title	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs.
Fish - Herring										
95051	Large Scale Coded Wire Tagging of PWS Herring	ADFG	PWS	NEW			$190.6	$512.5	$846.2	4
95165	PWS Herring Stock Genetic Stock Identification	ADFG	PWS	Cont'd	94165	$62.0	$94.0	$97.0	Unk	3
Fish - Pink Salmon										
95024	Enhancement of Wild Pink Salmon Stocks	ADFG	PWS	NEW			$350.0	$685.5	Unk	
95079	Pink Salmon Restoration through Small-Scale Hatcheries	ADFG	PWS	NEW			$150.0	$75.0	$425.0	6
95320C	Otolith Thermal Mass Marking of Hatchery Reared Pink Salmon in PWS	ADFG	PWS	Cont'd	94320C	$53.9	$649.0	$292.7	$1,436.2	
Fish - Rockfish										
95111	Sustainable Rockfish Yield	ADFG	PWS	NEW			$204.4	$318.0	$797.2	3
95112	Rockfish Restoration Objective	ADFG	PWS	NEW			$69.0	Unk	Unk	Unk
Fish - Salmon										
95137	Prince William Sound Salmon Stock Identification and Monitoring Studies	ADFG	PWS	Cont'd	94137	$261.6	$273.4	$0.0	$273.4	2
95139B	Spawning Channel-Port Dick Creek	ADFG	KEN	Cont'd			$127.5	Unk	Unk	5
95139C	Salmon Habitat and Stock Restoration-Pink Creek and Horse Marine Barrier Bypass Development	ADFG	KOD	Cont'd			$45.7	Unk	$203.7	5
Fish - Sockeye Salmon										
95255	Kenai River Sockeye Restoration	ADFG	KEN	Cont'd	94255	$406.1	TBD	TBD	TBD	
Multiple Resources										
95052	Community Involvement and Use of Traditional Knowledge	ADNR	ALL	NEW			$230.6	$300.0	Unk	5
95417	Carry-over of 1994 funds for Project 94417, Waste Oil Disposal Facilities	ADEC	All	Carry fwd	94417	$232.0	$0.0	$0.0	$0.0	
Persistence of Oil										
95047	Seal Contamination	ADNR	PWS	NEW			Unk	Unk	Unk	Unk
95266-CLO	Shoreline Assessment and Oil Removal	ADEC	ALL	Closeout	94266	$365.0	$93.8	$0.0	$93.8	

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Table 1 GENERAL RESTORATION

Proj No.	Title	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs
Services - Commercial Fishing										
95003	Area E Commercial Salmon Permit Buyback Program	ADFG	PWS	NEW			$11,735.0	$0.0	$11,735.0	Unk
95006	Paint River Pink Salmon Development	ADFG	KEN	NEW			$173.9	$215.0	$568.9	4
95088	Salmon Instream Restoration: Pink Creek and Horse Marine Bypass	ADFG	KOD	NEW			$52.7	Unk	$210.7	
95093	PWSAC: Restoration of Pink Salmon Resources and Services	ADFG	PWS	NEW	94320L		$2,219.1	$2,241.2	Unk	Unk
95259	Restoration of Coghill Lake Sockeye	ADFG	PWS	Cont'd	94259	$354.1	$324.6	$324.6	$973.8	
95320B	PWS Pink Salmon Stock Identification and Monitoring (CWT)	ADFG	PWS	Cont'd	94320b	$244.4	$260.5	$248.6	Unk	Unk
Services - Recreation and Tourism										
95002	Leave No Trace Education Program	USFS	PWS	NEW		$0.0	$177.7	$166.8	$294.5	2
95016	A Tribute to Prince William Sound	USFS	PWS	NEW			$161.0	$0.0	$161.0	1
95053	Cordova's Mini Imaginarium	ADNR	PWS	NEW			$62.6	$62.6	$125.2	2
95067	Overescapement Information Brochure	USFS	KEN	NEW			$23.4	$0.0	$23.4	1
95080	Fleming Spit Recreation Area Enhancements	ADNR	PWS	NEW			$1,365.0	$0.0	$1,365.0	Unk
95082	"Mor-Pac Hill" Campground Improvements	ADNR	PWS	NEW			$360.0	$0.0	$360.0	
95084	Odiak Camper Park Expansion	ADNR	PWS	NEW			$266.0	$0.0	$266.0	Unk
95085	Cordova Historical Marine Park	ADNR	PWS	NEW			$196.5	$0.0	$196.5	Unk
Services - Subsistence										
95017	Port Graham Coho Salmon Subsistence Fishery Restoration Project	ADFG	KEN	NEW			$587.9	$0.0	$587.9	1
95069	Restoration of Salmon Stocks of Special Importance to Native Cultures	ADFG	PWS KEN	NEW			$672.6	Unk	Unk	
95244	Seal and Sea Otter Coop Subsistence Harvest Assistance	ADFG	PWS KEN	Cont'd	94244	$55.0	$54.5	Unk	Unk	Unk
95272	Chenega Chinook Release Program	ADFG	PWS	Cont'd	94272	$57.4	$38.7	$39.1	$77.8	2
95279	Subsistence Food Safety Testing	ADFG	ALL	Cont'd	94279	$379.2	$207.3	$0.0	$207.3	
95428-CLO	Closeout: Subsistence Planning	ADFG	ALL	Closeout	94428		$81.0	$0.0	Unk	1
						TOTAL:	$22,757.3			
						Number of Projects:	47			

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Table 2 MONITORING

Proj. No.	Title	Lead Proposer	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96
Mammals									
Harbor Seals; (trend counts)	Part of research Project 95064: Monitoring Habitat Use, Trophic Interactions of Harbor Seals in Prince William Sound								
Killer Whales; (photo-id)									
95013	Killer Whale Monitoring in PWS		NOAA	PWS	NEW	94092		$105.0	Unk
95092	Recovery Monitoring of PWS Killer Whales	NOAA	NOAA	PWS	NEW	94092		$99.5	$29.0
Sea Otters (aerialsurveys, carcass collection)	Part of research project 9505B: Sea Otter Abundance and Distribution; See also Boat Surveys, Project 95159								
River Otters (latrine surveys)									
95062	River Otter Recovery Monitoring	ADFG	ADFG	PWS	NEW			TBD	TBD
Birds									
Bald Eagles (productivity survey; population survey)									
95029	Population Survey of Bald Eagles in PWS	DOI	DOI	PWS	NEW			$48.3	$0.0
95030	Productivity Survey of Bald Eagles in PWS	DOI	DOI	PWS	NEW			$81.9	$0.0
Black Oystercatchers (none in 1995)									
95159	Surveys to Determine Additional Oil Spill Effects and Recovery of Marine Bird and Sea Otter Populations in PWS	DOI	DOI	PWS	Cont'd	94159	$107.0	$391.0	$41.0
Common Murres (productivity survey; population survey)									
95039	Common Murre Productivity Monitoring	DOI	DOI	KEN	Cont'd	94039		$163.7	$138.5
Harlequin Ducks (productivity survey, population survey)									
95005	Harlequin Duck Abundance and Productivity in Western Cook Inlet	DOI	DOI	KEN	NEW			$40.2	Unk
95427	Harlequin Duck Recovery Monitoring	ADFG	ADFG	PWS	Cont'd	94427	$40.4	$221.8	Unk
Marbled Murrelets (none in 1995)	See Project 95159 (Black Oystercatchers)								
Pigeon Guillemots (none in 1995)	See Project 95159 (Black Oystercatchers)								
Fish and Shellfish									
Cuttrhoat and Dolly Varden (growth rates)	No project submitted								
Pacific Herring (health & spawning biomass counts)									
95166	Herring Natal Habitats	ADFG	ADFG	PWS	Cont'd	94166	$466.3	$493.3	$493.3

Description in parenthesis is the monitoring projects expected from the Invitation to Submit Restoration Projects. "Harbor Seals (trend counts)" shows that a project to monitor trend count was referenced in the Invitation for 1995.

Table 2 MONITORING

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Proj No.	Title	Proposer	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96
Pink Salmon (egg mortality and returns per spawner)									
	Part of research project 95191B: Oil Related Egg and Alevin Mortality; and general restoration project 95320B Pink Salmon Stock ID and monitoring (Coded Wire Tag)								
Sockeye Salmon (smolt outmigration for Kenai, Red Lake, and Akalura systems; Fry abundance for Kenai)									
95048	Historical Analysis of Sockeye Salmon Growth		ADFG	ALL	NEW			$85.0	$11.0
95258	Sockeye Salmon Overescapement See also general restoration project 95255, Kenai River Restoration	ADFG	ADFG	KEN	Cont'd	94258	$854.9	$983.3	$0.0
Other Resources									
Archaelogy(index and crosscheck sites)									
95007A	Archaeological Site Restoration - Index Site Monitoring	ADNR	ADNR	ALL	Cont'd	94007	$599.5	$190.9	$190.0
Intertidal Organisms (PWS sites and Herring Bay)									
95094	Recovery of Intertidal Clams in PWS	ADFG	ADFG	PWS	NEW			$229.2	Unk
95045	Green Island Intertidal Restoration Monitoring		USFS	PWS	NEW			$113.4	$113.0
95086A	Coastal Habitat Intertidal Monitoring and		ADFG	PWS	Cont'd		$729.4	$829.4	Unk
95086C	Herring Bay Monitoring and Restoration Studies		ADFG	PWS	Cont'd	94086	$729.4	$549.1	Unk
95106	Subtidal Monitoring: Eelgrass Communities		ADFG	PWS	NEW			$399.9	$0.0
95107	Subtidal Site Verification		ADFG	PWS	NEW			$84.0	$0.0
Persistence of Oil (Kodiak & Ak Penin shoreline assessment; mussel beds; and subtidal bile)									
95027	Kodiak and Alaska Peninsula Comprehensive Shoreline Assessment: Monitoring Surface and Subsurface Oil	ADEC	ADEC	KOD AKP	NEW			$759.5	$113.6
95090	Mussel Bed Restoration and Monitoring in PWS and Gulf of Alaska	NOAA	NOAA	PWS KEN	Cont'd	94090	$676.1	$261.8	$270.0
95290	Hydrocarbon Data Analysis, Interpretation, and Database Maintenance for Restoration and NRDA Environmental Samples Associated with the Exxon Valdez Oil Spill	NOAA	NOAA	ALL	Cont'd	94290	$130.2	$72.2	Unk
95026	Hydrocarbon Monitoring: Integration of Microbial and Chemical Sediment Data		ADEC	All	NEW			$84.4	Unk

Descri ··· in parenthesis is the monitoring projects expected from the Invitation ··· ·mit Restoration Projects. "Harbor Seals (trend counts)" shows that a ı to monit(d count was referenced in the Invitation for 1995.

Table 2 MONITORING

Proj.No.	Title	Proposer	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96
Services									
Commercial fishing (none; see individual resources for monitoring)									
	No project submitted								
Desginated Wilderness areas (none; see persistence of oil)									
	No project submitted								
Passive use (none; see specific resources for monitoring)									
	No project submitted								
Recreation and Tourism (beach use and customer surveys)									
95056	Monitoring Visual Sensitivity in PWS	USFS	USFS	PWS	NEW			$264.7	$159.8
Closeout Monitoring Projects									
95039CLO	Closeout: Common Murre Population Monitoring	DOI	DOI	KEN	Closeout	94039	$227.2	$30.5	$0.0
95090CLO	Mussel Bed Restoration and Monitoring	ADEC	ADEC	PWS	Closeout	94090	$518.0	$154.4	$0.0
95173CLO	Closeout: Pigeon Guillemot Recovery Monitoring	DOI	DOI	PWS	Closeout	94173	$201.1	$55.0	$0.0
95285CLO	Closeout: Subtidal Sediment Recovery Monitoring	NOAA	NOAA	KEN	Closeout	95285	$629.2	$104.7	$0.0
							TOTAL	$6,896.1	
							No. of Projects =	28	

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Description in parenthesis is the monitoring projects expected from the Invitation to Submit Restoration Projects. "Harbor Seals (trend counts)" shows that a project to monitor trend count was referenced in the Invitation for 1995.

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Table 3 **RESEARCH**

Proj No	Title	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs
PWS System Investigation (PWSSC/UAF/ADFG)										
95320A	Salmon Growth and Mortality	ADFG	PWS	Cont'd	94320A	$263.4	$378.6	$378.6	$757.2	4
95320D	PWS Pink Salmon Genetics	ADFG	PWS	Cont'd	94320d	$171.2	$218.2	$130.0	$348.2	
95320E	Juvenile Salmon and Herring Integration	ADFG	PWS	Cont'd	94320e	$907.1	$1,492.0	$1,492.0	$4,476.0	
95320G	Phytoplankton and Nutrients	ADFG	PWS	Cont'd	94320g	$141.5	$297.3	$0.0	$297.3	
95320H	Role of Zooplankton in the PWS Ecosystem	ADFG	PWS	Cont'd	94320h	$300.1	$380.1	Unk	Unk	2-5
95320I(2)	Isotope Tracers-Food Webs of Fish	ADFG	PWS	Cont'd	94320I		$196.1	$160.0	Unk	2-5
95320I(3)	Purchase of Isotope Radio Mass Spectrometer	ADFG	PWS	NEW	94320I		$257.4	$0.0	$257.4	1
95320J	Information Systems and Model Development	ADFG	PWS	Cont'd	94320j	$756.5	$1,575.1	$1,430.9	Unk	Unk
95320K	PWSAC: Experimental Fry Release	ADFG	PWS	Cont'd	94320k	$46.6	$48.1	$48.6	Unk	Unk
95320M	Observational Physical Oceanography in PWS and the Gulf of Alaska	ADFG	PWS	Cont'd	94320m	$773.1	$824.4	$0.0	$824.4	1
95320N	Nearshore Fish	ADFG	PWS	Cont'd	94320N	$666.9	$1,192.4	$707.4	Unk	Unk
95320P	Planning and Communication	ADFG	PWS	Cont'd	94320P	$51.8	$176.5	$169.6	$346.1	2
95320Q	Avian Predation on Herring Spawn	ADFG	PWS	Cont'd	94320q	$84.8	$124.8	$427.1	Unk	
95320S	Place-holder for ADF&G Multi-step Sealed Proposal (Disease Impacts on PWS Herring Populations)	ADFG	PWS	Cont'd	94320S	$97.0			TBD	
95320T	Juvenile Herring Growth and Habitat Partitioning	ADFG	PWS	NEW			$456.8	$500.0	Unk	3-5
95320U	Somatic and Spawning Energetics of Herring and Pollock	ADFG	ALL	NEW			$97.2	$102.3	$324.6	
95320V	Herring Predation by Humpback Whales in PWS	ADFG	PWS	NEW			$181.6	$171.6	$363.2	2
95320Y	Variation in Local Predation Rates on Hatchery-Released Fry	ADFG	PWS	NEW			$118.9	$85.2	Unk	2+

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Table 3 **RESEARCH**

Proj No	Title	Lead Agency	Loc	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs
Marine Mammal Ecosystem Research (ADFG/UAF/NOAA)										
95001	Condition and Health of Harbor Seals	ADFG	PWS	NEW			$153.8	$131.4	$375.8	
95064	Monitoring, Habitat Use, and Trophic Interactions of Harbor Seals in PWS	ADFG	PWS	Cont'd	94064	$272.2	$309.4	$302.0	$710.0	
95073	Impact of Killer Whale Predation on Harbor Seals in PWS	NOAA	PWS	NEW			$99.5	$229.5	$493.0	
95163	Abundance and Distribution of Forage Fish and their Influence on Recovery of Injured Species	NOAA	PWS KEN	Cont'd	94163		$1,203.7	$1,000.0	Unk	
95320I(1)	Istotope Tracers - Food Webs of Marine Mammals and Birds	ADFG	PWS	Cont'd	94320I	$60.5	$100.1	Unk	Unk	2-5
Other Marine Mammal Research										
95014	Predation by Killer Whales in PWS. Feeding Behavior and Distribution of Predators and Prey	NOAA	PWS	NEW			$156.9	$148.8	Unk	3
Nearshore Ecosystem/Community Structure Research (UAF)										
95009A	Trophics and Community Structure in the Intertidal and Shallow Subtidal	USFS	PWS	NEW			$455.4	Unk	Unk	2-5
95009B	Primary Productivity as a Factor in the Recovery of Injured Resources in Prince William Sound	USFS	PWS	NEW			$218.9	$291.3	$723.1	3
95009C	Trophic Dynamics and Energy Flow: Impacts of Herring Spawn and Sea Otter Predation on Nearshore Benthic Community Structure	USFS	PWS	NEW			$217.3	Unk	Unk	3-5
95009D	Survey and Experimental Enhancement of Octopuses in Intertidal Habitats	USFS	PWS	NEW			$159.5	$157.5	Unk	2-5
95009E	Community Structure of Mobile Foragers Using the Nearshore	USFS	PWS	NEW			$280.5	$227.0	Unk	2-5

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Table 3 **RESEARCH**

Proj No.	Title	Lead Agency	Loc	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs.
Recovery of Nearshore Predators (NBS)										
95025A	Factors Affecting Recovery of Sea Ducks and their Prey	DOI	PWS	NEW			$393.7	$298.0	$1,290.0	5
95025B	Sea Otter Abundance and Distribution, Food Habits and Population Assessment	DOI	PWS	NEW			$162.7	$82.8	$274.7	3
95025C	Pigeon Guillemots and River Otters	DOI	PWS	NEW			$179.6	$179.9	$539.6	4
95025D	Settlement Rates of Nearshore Invertebrates, Oceanic Processes and Population Recovery, Are They Linked?	DOI	PWS	NEW			$435.7	$405.0	$1,190.0	5
95025E	Algal Competition Limiting Recovery in the Intertidal	DOI	PWS	NEW			$222.5	$222.5	$525.0	3
95025F	Availability and Utilization of Musculus spp. as Food for Sea Ducks and Sea Otters	DOI	PWS	NEW			$4.6	$4.6	$9.2	2
95025G	Recruitment Patterns of Nearshore Clam Populations in PWS	DOI	PWS	NEW			$121.3	$121.3	$522.7	5
95025H	Effects of Predatory Invertebrates on Nearshore Clam Populations in PWS	DOI	PWS	NEW			$118.4	$100.0	$256.7	3
95025J	Primary Productivity as a Factor in the Recovery of Injured Resources in PWS	DOI	PWS	NEW			$397.0	$310.0	$1,017.0	3

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Table 3 **RESEARCH**

Proj No.	Title	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs.
Other Nearshore/Intertidal Research										
95075	Population Structure of Blue Mussels in Relation to Levels of Oiling and Densities of Vertebrate Predators	NOAA	PWS	NEW			$197.5	$317.7	$314.1	3
95010	Inertidal Fauna and Flora Species Composition, Abundance and Variability Relative to Physical Habitat Controls	DOI	KEN	NEW			$73.5	Unk	Unk	2
95018	Partitioning of Primary Production Between Pelagic and Benthic Communities	ADFG	PWS	NEW			$197.1	$0.0	$197.1	1
95086B	Population Dynamics of Eelgrass and Associated Fauna	ADFG	PWS	Cont'd	94086	$729.4	$64.8	$35.0	$99.8	2
95087	Sea Urchin Population Dynamics: Changes in Population Density and Availability as Prey of Sea Otters	ADFG	PWS	NEW			$65.4	$0.0	$65.4	
Pelagic Ecosystem Research (NBS)										
95019	Distribution of Forage Fish as Indicated by Puffin Diet Sampling	DOI	PWS KEN	NEW			$284.4	$204.2	$692.8	4
95021	Seasonal Movement and Pelagic Habitat Use by Common Murres from the Barren Islands	DOI	KEN	NEW			$251.1	$212.5	$463.6	3
95022	Foraging Efficiencies at Temporary Food Patches	DOI	PWS	NEW			$183.1	$147.2	$230.3	2
95023	Food Web Relationships of Pelagic Species Exhibiting Long-term Decline	DOI	PWS	NEW			$168.0	$170.0	$483.0	4
Other Pelagic Research										
95033	Kittiwakes as Indicators of Forage Fish Availability	DOI	PWS KEN	NEW			$198.5	Unk	Unk	5
95173	Factors Affecting Recovery of PWS Pigeon Guillemot Populations	DOI	PWS	Cont'd	94173	$201.1	$353.7	Unk	Unk	5

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Table 3 RESEARCH

Proj.No.	Title	Lead Agency	Loc	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs.
Upland/Riparian Ecosystem Research										
95043A	Cordova Cutthroat Trout Habitat	USFS	PWS	Con't	94043		$22.7	$0.0	$22.7	1
95046	Long-term Record in Tree Rings of Climatic Features	NOAA	ALL	NEW			$153.6	$166.3	$494.5	3
95050	A Test of Sonar Accuracy in Estimating Escapement of Sockeye Salmon	ADFG	KEN, OUT	NEW			$79.3	$78.0	$235.4	4
95054	Montague Riparian Rehabilitation	USFS	PWS	NEW			$42.7	$0.0	$42.7	
95060	Spruce Bark Beetle Infestation Impacts on Injured Fish	ADFG	PWS KEN	NEW			TBD	TBD	TBD	
95105	Kenai River Ecosystem Restoration Pilot Enclosure Study	ADFG	KEN	NEW			$361.2	Unk	Unk	
Ecotoxicology Research										
95044	In Situ Formation and Ecotoxicity of Hydrocarbon Degradation Products Produced by Ultramicrobacteria	NOAA	PWS	NEW			$118.5	Unk	Unk	5
95071	Monitoring Nearshore Fish Species for Persistence of Oil Exposure and Ecotoxicological Effects	NOAA	PWS KEN AKP	NEW			$225.0	$185.0	Unk	
95074	Herring Reproductive Impairment	NOAA	PWS	NEW			$234.8	Unk	Unk	
95076	Effects of Oiled Incubation Substrate on Survival and Straying of Wild Pink Salmon	NOAA	ALL	NEW			$179.9	$310.9	$1,380.4	5
95191A	Investigating and Monitoring Oil Related Egg and Alevin Mortalities	ADFG	PWS	Cont'd	94191	$782.9	$681.5	Unk	Unk	5
95191B	Injury to Salmon Eggs and Pre-emergent Fry Incubated in Oiled Gravel (Laboratory Study)		ALL	Cont'd	94191	$784.0	$165.6	$324.0	$489.5	2

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Table 3 **RESEARCH**

Proj No.	Title	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs.
Other Research										
95031	Reproductive Success as a Factor Affecting Recovery of Murrelets in PWS	DOI	PWS	NEW			$398.0	Unk	Unk	2
95055	Prehistoric Ecological Baseline for PWS	USFS	PWS	NEW			$149.6	$91.7	$241.3	
95057	Movement of Larval and Juvenile Fishes within PWS	NOAA	PWS	NEW			$300.0	Unk	Unk	3
95065	PWSAC Pink Salmon Fry Mortality	ADFG	PWS	NEW			$52.5	$0.0	$52.5	1
95077	Recreation Impacts in PWS; Human Impacts as a Factor Constraining Long Term Ecosystem Recovery	ADNR	PWS	NEW			$117.0	$117.0	$376.9	
95078	Culture, History, and Ecosystems: An Assessment of Cultural/Historical Strategies to Building Long-term Understanding of Ecosystem Dynamics in the Exxon Valdez Oil Spill Area	DOI	ALL	NEW			$166.7	$0.0	$166.7	
95102-CLO	Closcout: Murrelet Prey and Foraging Habitat in Prince William Sound	DOI	PWS	Closeout	94102	$231.5	$62.3	$0.0	$62.3	1
						TOTAL:	$18,954.0			
						Number of Projects:	68			

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Table 4 **HABITAT PROTECTION**

Proj.No.	Title	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs.
95058	Restoration Assistance to Private Landowners	ADFG	ALL	NEW			$415.7	$0.0	$415.7	1
95095	Quantification of Stream Habitat for Harlequin Ducks and Anadromous Fish Species from Remote Sensed Data	ADNR	ALL	NEW			$88.0	Unk	Unk	4
95110-CLO	Closeout: Habitat Protection and Data Acquisition	ADNR	All	Closeout	95110	$678.7	$60.0	$0.0	$60.0	1
95126	Habitat Protection and Acquisition Support	ADNR	ALL	Cont'd	94120	$1,160.3	$1,403.3	$0.0	$1,403.3	
95200	Public Access	ADNR	PWS	NEW			$154.7	$247.5	$897.2	
95505A	Channel Type Habitat Relationships	USFS	PWS	Cont'd	94505	$406.1	$261.0	$69.3	$330.3	
95505B	Data Analysis for Stream Habitat	USFS	All	Cont'd	94505	$406.1	$17.2	$0.0	$17.2	
						TOTAL:	$2,399.9			
						Number of Projects:	7			

Table 5 ADMINISTRATION AND PUBLIC INFORMATION

Proj No	Title	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs.
95049	Independent Review of Restoration and Monitoring Projects	ADFG	ALL	NEW			$31.9	$0.0	$31.9	1
95089	Information Management System	All	ALL	Cont'd			$540.1	Unk	Unk	Unk
95100	Administration Budget	All	ALL	Cont'd			$3,500.0		$3,500.0	Unk
95422-CLO	Restoration Plan EIS/Record of Decision	USFS	ALL	Closeout	94422	$343.4	$20.0	$0.0	$20.0	
						TOTAL:	$4,092.0			
						Number of Projects:	4			

Table 6 RESTORATION RESERVE

Proj No.	Title	Lead Agency	Loc.	Proj Type	FY 94 Proj #	Cost FY 94	Cost FY 95	Cost FY 96	Total Cost	Yrs.
95424	Restoration Reserve	All	All	Cont'd	94424	$12,000.0	$12,000.0	$12,000.0	Unk	Unk

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Attachment A: Overview of Prince William Sound Systems Investigation

Project number: 95320

Study type: Research/Monitoring

Name of study leader(s): Dr. Ted Cooney, University of Alaska Fairbanks

Lead agency: Alaska Department of Fish & Game (ADF&G)

Cooperating agencies:
U.S. Forest Service (USFS)
National Biological Survey (NBS)
National Oceanic and Atmospheric Administration (NOAA)
University of Alaska Fairbanks (UAF)
Prince William Sound Science Center (PWSSC)
Prince William Sound Aquaculture Corporation (PWSAC)
North Gulf Oceanic Society (NGOS)

Start-up/Completion Dates: Ongoing; for FY95 October 1, 1994 - September 30, 1995

Duration: 5-10 years, beginning with FY1994

Geographic area of study: Prince William Sound, North Gulf of Alaska

Contact:
Dr. Ted Cooney
SEA Chief Scientist
IMS, UAF
Fairbanks, AK 99775
Tel: (907) 474-7407

- or -

Dr. David Scheel
SEA Scientific Management
PWS Science Center
Cordova, AK 99574
Tel: (907) 424-5800

B: INTRODUCTION

Sound Ecosystem Assessment (SEA) is a comprehensive and integrated study of natural and anthropogenic-induced variability in pink salmon and pacific herring production in Prince William Sound. SEA research focuses on understanding processes constraining the production of these species as the principal means to affect appropriate recovery strategies. SEA for FY95 is a continuation of research begun in FY94 (11 projects), expanded to include new core studies (6 projects), primarily of Pacific herring and herring predators. Most budgets reflect increases associated with the anticipated 12 month fiscal year.

Research sponsored by the *Exxon Valdez* Oil Spill (EVOS) Trustee Council since 1989 has documented that some species damaged by the spill are not recovering. The list of injured/not recovering species includes invertebrates, fish, birds, and mammals. When such species are economically important (as are pink salmon and herring), their status is highlighted by poor harvests and hardships in communities depending upon the resources. Unexpectedly low pink salmon returns in 1992-1993 and Pacific herring spawning returns in 1993-1994 have placed the future course of the fishing industry in Prince William Sound in grave doubt.

SEA has been developed as an integrated study from its inception, characterized by hierarchical structure, and attention to ecological boundaries and integrity. Emphasis is on data collection and monitoring, interagency cooperation, and a recognition of human needs and values in the ecosystem. Hierarchical structure means that SEA seeks connections between levels, not only in the ecosystem, but also in composition (federal, state and local representation) and logistics (research projects share platforms, equipment, and data management). Attention to ecological boundaries and integrity means that SEA follows a life-history pathway approach for pink salmon and herring to focus research efforts and to insure that connections to other species of prey, competitors, and predators are studied. SEA's emphasis on data collection, analysis, and monitoring acknowledges the need for more and better information, as well as for an integrated understanding placed in the context of past events. The recognition of human needs and values means that SEA has been developed with extensive public input, and will continue to take direction from the needs of human residents in the ecosystem.

The initial funding of SEA has allowed the program to begin field operations and collect valuable data about conditions in Prince William Sound during 1994. A preliminary analysis of the 1994 data is underway and initial results will be available for presentation at a Fall 1994 program review. The proposals presented here describe the work SEA intends to undertake during FY95, the first full year of funding.

C: NEED FOR THE PROGRAM

Pink salmon and herring are injured species, are not recovering, and are crucial to the economies of local communities and to the well-being and lifestyles of Prince William Sound residents. An historical data base and a set of experimental tools are provided for both species by commercial records, past research, and management/enhancement activities. Herring and pink salmon life histories have in common features allowing parallel conceptualization of research problems. For example, both species migrate inshore to spawn in locations subject to significant oceanographic and meteorological influences (wave action, floods) on survival. Their life histories are never-the-less distinct enough that studying each provides added insight to the ecosystem structure and function. For example, herring have a planktonic stage, pink salmon do not; herring spawn year after year, pink salmon die after spawning. Finally, both species are important and conspicuous elements of the marine ecosystem in Prince William Sound, serving as an energy source for a diverse assemblage of marine and terrestrial consumers. For this reason, SEA includes research focused on an array of associated species, especially where biological or conceptual links to pink salmon and herring are particularly strong.

D: PROJECT DESIGN

1.1 Multi-year objectives:

The SEA research program has been conceived as a 5-10 year effort in response to recommendations by a peer scientific review of the proposal in the December 1993 Cordova workshop. The primary goal of the core SEA study is to test a series of hypotheses concerning ecosystem function.

Cumulatively, the SEA hypotheses reflect our understanding of marine, freshwater, and climatological processes constraining populations in Prince William Sound. Revision of the hypotheses will likely occur as data accumulates, and SEA makes progress toward three goals. These are, first, to acquire an ecosystem-level understanding of processes constraining levels pink salmon and herring abundance and production in Prince William Sound; second, to use this new understanding to more accurately forecast pink salmon and herring responses to both natural and anthropogenic ecosystem disturbance, including their response to management, enhancement, and mandated restoration activities; and third, to establish a data base describing the status of the Prince William Sound ecosystem relative to pink salmon and herring as an information source for improving the effectiveness of management, enhancement, and mandated restoration activities for these key species.

These goals, and the hypothesis below provide continuity and focus for the duration of SEA. The hypotheses are initially based on previous studies of the oceanography and food-web dynamics of the area. Each of the hypotheses is examined in greater detail in individual project descriptions, but are presented here in summary:

1) Survival of pink salmon and herring embryos and alevins in natal habitats is largely established by density-independent physical factors.

2) Losses of larval and juvenile pink salmon and herring to predation are modulated by prey-switching. The diets of predators (fishes, birds and mammals) on 0-class fishes (including pink salmon and herring) are modulated by amounts of macrozooplankton present each year. When macrozooplankton is abundant, predators are strongly planktivorous. In contrast, when macrozooplankton populations are weak, predators are more piscivorous and predation on the smallest fish is substantial. Ocean temperature influences growth and feeding rates of both predators and prey.

3) Biomass of macrozooplankton (food for planktivores including birds, mammals and fishes) is established by physical transport processes that both seed the Sound from the adjacent Gulf of Alaska in the summer and flush surface populations from the region in the spring. The production of macrozooplankton is further modified by local levels of primary productivity.

4) Overwintering survival of Pacific herring to breeding age (at least two winters) is determined by the physiological condition of juveniles entering winter, and by food, temperature, and predators encountered from October through April.

These hypotheses are referred to here and in individual proposals as 1) natal habitats; 2) predator-prey relationships; 3) lake/river processes; and 4) herring overwintering.

1.2 Milestones for FY95

As conceived, SEA is designed as a multi-year investigation to exploit natural variation to create tests for each hypothesis. Sufficient variability is likely to occur over a five to ten year period. However, progress will be made in each year toward our long-term goals. Specific milestones for each project are given in each of the brief project descriptions. The following describes more general milestones that will likely be achieved by SEA in FY95.

1) Design and implementation of continuing joint oceanographic and acoustic/net sampling based on results of the 1994 field work, including appropriate location, scale and timing of sampling.

2) Continuation of data collection and data base growth. This information, and systems designed to store and provide access to it, will begin to form the basis to more accurately forecast animal production and to predict population responses to disturbance, including their response to management, enhancement, and restoration activities.

3) Description of physical processes within the Sound, and the resulting influence on distributions and production of plankton, fish, birds, and mammals influencing salmon and herring production. Initial model of physical transport to provide testable predictions.

4) Description of variation in diet of juvenile salmon and fish predators, and the distribution of these fishes, occurring along the salmon migratory pathway, including extent of evidence for prey-switching. Initiate a model of prey switching to provide testable predictions.

5) Initiate herring studies tracking larvae from spawning beaches to juvenile overwintering areas, including preliminary assessments of fish, bird, and mammal winter predation on these schools, and identify possible important factors in overwintering condition.

6) Continue ecotoxicological and disease studies of herring initiated in FY94.

2. Schedule (FY95 - SEA):

Nov. 1 Begin FY95 field season. Preliminary observations for herring overwintering program. Census of deep overwintering and surface zooplankton populations. Winter oceanographic observations. Order equipment and supplies.

Jan 1 Complete equipment and supplies acquisition. Bid vessels for FY95 spring/summer studies.

Feb 15 Select vessel charters. Begin staging for spring/summer field work in Cordova.

Mar 15 Begin spring oceanographic, phytoplankton, zooplankton, and predator studies.

May 1 All other field studies in place.

Aug 1 Majority of field work completed.

Oct 1 Formal review of FY95 season.

4. Technical support: See individual brief project descriptions.

5. Location: Prince William Sound

E. PROJECT IMPLEMENTATION

The SEA program is being implemented cooperatively by Alaska Department of Fish & Game, PWS Science Center, University of Alaska Fairbanks, PWS Aquaculture, as well as U.S. Forest Service, National Biological Survey, U.S. Fish & Wildlife Service, and National Oceanic and Atmospheric Administration. The interaction of scientists in these organizations to conduct the SEA program occurs within the PWS Fisheries Ecosystem Planning Group, an ad hoc organization with a mission to develop and advocate the best ecosystem science for the restoration and management of pink salmon and herring in Prince William Sound.

F: COORDINATION OF INTEGRATED RESEARCH EFFORT

1. Major programs:

SEA is organized under six major programs. Four correspond to the hypotheses named above and the fifth is responsible for the integrative data base and modeling efforts. A new program in ecotoxicology and disease is defined for FY95 as the result of core and related projects in the field. Each program coordinates research on one or a few related hypothesis and involves researchers from all projects contributing to the testing of those hypotheses (Table 1). The programs are themselves linked to shared logistics, data management and by the goal of developing predictive models of productivity.

The *Natal Habitat Program* studies factors determining survival in spawning redds and herring intertidal and subtidal spawning areas. The purpose of this program is to improve prediction of the number of fry and larval herring emerging from natal habitats and to understand the natural and anthropogenic factors influencing survival.

The *Predator-Prey Program* involves identifying factors determining predator diet, and hence prey-switching. This program will characterize major fish, bird, and mammal predators on herring larvae, salmon fry, and juveniles of both species. The goal of this program is to predict feeding intensity of predators as a function of predator abundance, alternative prey, and energetic constraints. Attention is given in this program to interactions of hatchery fry and pink salmon predators.

The *Lake/River Program* focuses on physical and biological factors constraining the production of zooplankton forage for fish, birds, and mammals in Prince William Sound. This program will

evaluate oceanographic patterns, the seeding of the Sound with zooplankton, the role of flushing in limiting zooplankton standing stock, and the availability of zooplankton as winter forage for herring.

The *Herring Overwintering Program* examines factors determining winter growth, survival, and condition of herring. The goal of this program is to determine factors regulating the survival of juvenile herring and the condition of adults as they enter the spring breeding season. This Program also examines causes and effects of disease in herring as viral hemorrhagic septicemia (VHS) apparently influences spawning condition.

The *Ecotoxicology and Disease Program* focus on oil and pathogenic causes of herring and salmon mortality in both early and late stages of life history.

The *Database & Modeling Program* provides the tools for building improved predictive capabilities. Information from all studies will be archived in Cordova and distributed as needed to investigators, the agencies, and the Trustee Council. SEA projects are adopting a centralized data bank, common to all projects and addressable for data synthesis and integration activities. Individual projects will contribute data and insight to the data base and modeling project, and each project will benefit from data services provided by this project. The modeling effort will draw on shared data and the expertise of project investigators to simulate important aspects of the system under study. Modeling will be one of the principal tools for testing the SEA hypotheses and providing improved predictive capabilities.

2. Field logistics:

To the greatest extent possible, projects share field platforms, transport, equipment, sampling schedules and personnel. SEA vessels will include a mid-water trawler, two seiners, an acoustic skiff, a fry skiff and support boat, a vessel for oceanography, and two support vessels (one for work in natal habitats, one in support of other nearshore sampling). The trawler and each seiner-skiff pair support sampling of oceanographic, phyto- and zooplankton, acoustic, and net data as well as some marine bird and mammal observations. Logistics for natal habitats are coordinated with ADF&G surveys of spawn sites.

Scientific crews aboard these boats coordinate sampling schedules and share responsibilities for data collection and ship-board processing. Resulting information is shared daily in the field, and changes are made to sampling protocols as necessary to maintain efficiency and cooperation, and to optimize the power of the investigation.

3. Planning and Communications:

Scientific planning and communications assist coordination between projects, and build community interaction with ongoing science. Planning activities allow the SEA program to keep abreast of other Trustee-funded research programs and to evaluate possible future directions as SEA evolves. Communications activities are designed to keep individual researchers aware of SEA activity outside their own projects, to facilitate coordination among SEA researchers and

between SEA and other Trustee research and to actively maintain community involvement in setting direction for SEA research in the future.

G: PUBLIC PROCESS

SEA was originally designed and implemented with extensive public involvement through the PWS Fisheries Ecosystem Planning Group (FERPG), and this group remains an important avenue for SEA scientists to interact with the public. SEA was reviewed at the December 1993 Cordova workshop. Additionally, the SEA project for Planning and Communication actively seeks public input and involvement in research from PWS communities.

Table 1. Project relationships to SEA programs for FY95 Prince William Sound System Investigations including SEA and cooperating studies.

		NH	P/P	L/R	HO	ETD	D&M
A.	**Continuing SEA core projects**						
320-A	Salmon growth and mortality		X	X			X
320-E	Juv. salmon and herring predators		X		X		X
320-G	Phytoplankton and nutrients			X	X		X
320-H	Role of zooplankton		X	X	X		X
320-J	Information systems and modeling	X	X	X	X	X	X
320-K	Experimental fry releases		X				X
320-M	Physical oceanography			X	X		X
320-N	Nearshore fish/Acoustics		X	X	X		X
320-P	Planning and communications	X	X	X	X	X	X
320-Q	Avian predation on herring spawn	X	X				X
320-W	Fish food webs/stable isotopes		X		X		X
B.	**New SEA core projects**						
320-0	Hatchery fry predators		X				X
320-R	Herring disease and ecotox.	X			X	X	X
320-S	Herring natal habitats	X					X
320-T	Juv. herring growth	X	X		X	X	X
320-U	Bio-energetics of herring & pollock		X		X	X	X
320-V	Whale predation on herring		X		X		X
320-X	UAF admin. charges						
C.	**Other PWS System Investigations cooperating studies**						
94320-B	CWT recovery of PWS pink salmon						X
94320-C	Otolith mass marking						X
94320-D	Pink salmon genetics	X					X
94320-F	Trophic interactions of harbor seals		X				X
94320-I	Mammal food webs/stable isotopes		X				X
	ADF&G Pink salmon alevin census	X					X
	Larval & juvenile herring in PWS	X		X	X		
94191	Oil related egg & alevin mortalities	X				X	X
	Bald eagle diet		X				X

NH = Natal habitats; P/P = Predator-prey; L/R = Lake/River; HO = Herring overwintering; ETD = Ecotoxicology & disease; D&M = Database & modeling.

Attchment B: Overview of Processes structuring recovery of injured nearshore vertebrate predators in Prince William Sound

Project Number: 95025

Project leader: Leslie Holland-Bartels

Lead agency: National Biological Survey

Cooperating agencies: University of Alaska, Fairbanks
University of Alaska, Juneau
Prince William Sound Science Center
Purdue University
U.S. Fish and Wildlife Service
University of Washington

Cost of project: 2,120.5K

Project start up date: October 1, 1994

Project Completion Date: September 30, 1999

Project duration: 5 YEARS (variable by project)

Geographic area: Prince William Sound

Contact person: Leslie Holland-Bartels
Branch Chief, Marine Mammals/Fisheries
National Biological Survey
Alaska Science Center
1011 East Tudor Road
Anchorage, Alaska 99503
(907) 786-3312, FAX 786-3636

B. INTRODUCTION

The nearshore marine ecosystem of Prince William Sound (PWS) may be functionally distinct from the pelagic ecosystem by spatial, energetic, and structural considerations. The nearshore ecosystem is constrained by bathymetry to relatively shallow water where space is limiting, receives a larger proportion of primary production from sessile macroalgae, and is composed largely of sessile benthic invertebrates that provide the predominate prey for a variety of vertebrate predators whose distributions are limited to the nearshore ecosystem. Because of shorelines and coastal physiography the nearshore ecosystem served as a repository for much of the oil spilled by the T/V Exxon Valdez. As a result most of the observed injured resources may be considered components of the nearshore system. EVOS injured wildlife resources include several warm blooded vertebrate predators that reside in the nearshore ecosystem.

Species include sea otters, harlequin ducks, bald eagles and black oystercatchers. Other recognized nearshore vertebrate predators include other shorebirds, river otter, mink and fish. Estimates of distribution and abundance of non-recovering, as well as other nearshore predators, suggest that densities vary among areas in western PWS. Recovery of injured resources is usually defined relative to pre-spill distribution and abundance, however, such data are lacking or incomplete. A large number of nearshore invertebrate populations were likely damaged as a result of the spill. It is also quite likely that changes in the species composition and abundance of both nearshore invertebrates and vertebrates because of the spill resulted in modifications in processes (ie., competition, predation, and recruitment) that are recognized as important in structuring nearshore marine invertebrate populations. In order to understand how injured resources are recovering, we must understand the processes that are responsible for structuring those communities.

We suggest potential mechanisms to answer the question of what is limiting recovery or why do vertebrate predator densities differ among areas in PWS, these include concerns in toxicology, physical processes, population dynamics and trophic interactions/prey abundance. These are based on a wide variety of coordinated meetings and will be assessed for the potential of limiting recovery of damaged resources.

The EVOS induced changes in populations of dominant competitors and resident predators in the nearshore region are limiting recovery of benthic communities.

Recovery of nearshore resources damaged by EVOS is limited by recruitment processes.

EVOS induced changes in populations of benthic prey species have influenced the recovery of benthic foraging predators.

EVOS induced changes in top predators have influenced the recovery of EVOS injured benthic prey populations.

Initial and/or residual oil in benthic habitats has a toxicological effect limiting the recovery of benthic communities.

Initial and/or residual oil in benthic habitats and in or on benthic prey organisms has had a limiting effect on the recovery of benthic foraging predators.

Physical processes limit the recovery of nearshore ecosystems.

C. NEED FOR THE PROJECT:

This project will potentially provide the data needed to identify what processes are limiting the recovery of not only injured vertebrate resources, but injured invertebrate resources as well. The project can potentially identify those mechanisms responsible for limiting recovery, which should provide rationale and justification for direct restoration decisions. Additionally, data

from this project may aid in defining the status of an injured resource relative to recovery and integrates both process oriented research and monitoring. Because baseline data on abundance are limiting other measures of the status of populations may be necessary to define a recovery endpoint.

D. PROJECT DESIGN:

Thirteen areas of study have been identified to address the issue of restoration of injured resources in the nearshore ecosystem. Through several meetings and close coordination, nine projects are submitted under this proposal. Two associated studies are being submitted by other lead agencies and two areas of needed research are identified, but no principal investigators have been identified. Each is an independent, yet integrated effort to evaluate each of the proposed mechanisms relative to recovery of injured resources. Each of the studies incorporate the spatial variability in predator densities relative to oil effects to evaluate each of the hypotheses in relation to restoration of a healthy and productive nearshore marine ecosystem in PWS. Each provides data to the core hypotheses related to restoration of vertebrate predators, and for the invertebrate subproposals, they concurrently address specific issues of restoration at those lower trophic levels.

NBS proposals: Following are brief descriptions of the purpose, objectives, methods and principal investigator(s) (where identified) of each project. We are aware of several other efforts that may relate to the nearshore ecosystem, but time constraints did not allow further discussion. After initial project review, however, further integration may be appropriate. These include efforts by Dr. Ray Highsmith, University of Alaska, Dr. David Scheel, Prince William Sound Science Center and Dr. Mary Anne Bishop, Copper River Delta Institute.

Subproject # 1: **Factors Affecting Recovery of Sea Ducks and their Prey**

Principal Investigators: **D. Essler (National Biological Survey) and K. Laing (U.S. Fish and Wildlife Service)**

Sea ducks are an important avian component of the nearshore ecosystem of Prince William Sound, particularly in winter. During March 1972 - 1991, sea ducks constituted 36% of birds observed by boat survey. Study of sea duck wintering ecology and ecosystem interactions serves to elucidate factors that limit populations and recovery of injured species and systems. This study is comprised of two related components: survival and movements, and foraging ecology of wintering sea ducks. Food habits and over winter survival of harlequin and goldeneye ducks will be estimated within the oil spill area. Stomach contents will estimate diet and radio telemetry will facilitate estimating survival in each species.

Subproject #2: **Sea otter abundance and distribution, food habits and population assessment project**

Principal Investigators: **B. Ballachey and J. Bodkin (National Biological Survey)**

Co-Investigator: **A. Rebar (Purdue University)**

This project will define seasonal patterns of sea otter habitat use relative to shoreline oiling and sea otter densities. Diets will be determined by visual observation at sites within density blocks. Reproduction will be estimated by pup to non-pup ratios and population assessment will be made through evaluation of physiological and morphological measures. Comparisons of prey distributions may provide a measure of the state of recovery in areas where mortality was known to be nearly complete. If prey populations are significantly different in abundance or size it may be concluded that predation forces are not equivocal among areas of different predator densities, possibly as a result of a persistent oil effect, suggesting a lack of recovery. Conversely, if prey populations are similar among areas which varied relative to oil exposure, it may be assumed that predation is similar among those areas and densities of vertebrate predators are limited by prey and recovery may be considered. In addition, blood measures will be examined as indicators of population recovery.

Subproject #3: **Pigeon guillemots and river otters as bioindicators of nearshore ecosystem health in Prince William Sound.**

Principal Investigator: **Daniel D. Roby (National Biological Survey: Alaska Cooperative Fish & Wildlife Research Unit, University of Alaska-Fairbanks)**

Co-Investigators: **Lawrence K. Duffy (Chair, Department of Chemistry University of Alaska-Fairbanks) and R. Terry Bowyer (Professor Institute of Arctic Biology, University of Alaska-Fairbanks**

This study is designed to develop a better understanding of how petroleum hydrocarbon pollution affects the nearshore marine environment. Results will allow us to test biostatistical models that predict ecosystem health and environmental deterioration. Our primary focus is the pigeon guillemot (*Cepphus columba*) as an indicator of environmental stress. The guillemot model will be used as an upper trophic level sentinel of bioavailable contaminants and as a surrogate to estimate the potential exposure and risk to other organisms that are components of the PWS nearshore ecosystem. River otters will also be examined since they inhabit marine environments, make extensive use of, and concentrate their activities in intertidal and subtidal zones. River otters are extremely sensitive to aquatic pollutants, yet continued to reside within the area of oil-contaminated shorelines in Prince William Sound following the *Exxon Valdez* oil spill. The study will identify guillemot nest sites and river otter latrine sites; more accurately assess the effects of oil exposure. It is our intent to collect blood from guillemots in several areas of PWS to establish control areas; use blood samples from the guillemot population to determine levels of acute phase blood proteins, indicative of exposure and tissue damage. We also will measure cytokines; supplement our molecular work by cellular studies such as red cell volume, hematocrits and immune functions; generate risk-assessments based on these biomarkers; and measure trophic level using stable isotope analysis of guillemot samples and plants and scats from river otter latrine sites.

Subproject #4: **Settlement Rates of Nearshore Invertebrates, Oceanographic Processes and Population Recovery: Are They Linked?**

Principal Investigator: **Gail V. Irvine (National Biological Survey) and David Salmon (Prince William Sound Science Center)**

This project addresses the hypothesis that offshore physical forcing functions (oceanographic) control settlement of planktonic larvae into nearshore environments, affecting the ability of the adult populations to recover. Settlement and recruitment rates of key intertidal organisms affected by the spill and important to the diets of other consumers, will be examined and related to larval abundance in the plankton and physical oceanography of the nearshore. Intensive site-specific manipulations, such as being performed at Herring Bay, provide data on locally operating mechanisms, but this study is designed to address variability in the contributions from the plankton on a broader scale. Thus, the project also examines whether the distribution and abundance of larvae can be used as indicators of mesoscale circulation of marine waters, linking transport phenomena with characteristics of which habitats may be more resilient to disturbance.

Subproject #5. **Algal Competition Limiting Recovery in the Intertidal**

Principal Investigators: **Michael S. Stekoll (University of Alaska, Juneau) and Gail V. Irvine (National Biological Survey)**

This effort proposes to investigate a documented shift in algal composition in the lower intertidal of sheltered rocky habitats in the Cook Inlet-Kenai Peninsula area (CIK) that has the

potential to be long-term and ecologically significant. Alaria, an annual kelp, normally dominates the lower intertidal during the summer season, but since the spill, Alaria has declined in abundance and the perennials, Fucus gardneri and members of the Gigartinaceae, have increased. If these perennials are able to successfully inhibit the recolonization and growth of Alaria, then this shift may become long lasting, and has implications for trophic and habitat relationships. This project will address the recovery of this community and investigate mechanisms responsible for the shift and that could affect recovery.

Subproject #6. **The availability and utilization of Musculus spp. as food for sea ducks and sea otters**

Principal Investigators: **Thomas A. Dean (Coastal Resources Associates, Inc.) and Stephen Jewett (University of Alaska, Fairbanks). Submitted through National Biological Survey**

This project will examine the utilization of *Musculus* by sea ducks and sea otters in Prince William Sound. Large numbers of *Musculus* recruit to selected eelgrass beds within the Sound each spring and the vast majority of the mussels disappear over the winter. *Musculus* provide an important potential food source for sea ducks and otters. Evidence for the utilization of *Musculus*, which are generally more abundant at oiled sites, may help rule out prey availability as a factor limiting otter or sea duck recovery. The objectives of the study are to determine if *Musculus* are utilized a food by either otters or sea ducks, and determine changes to *Musculus* densities that may result from predation by otters or ducks.

Subproject #7: **Recruitment patterns of nearshore clam populations in Prince William Sound**

Principal Investigator: **Glenn R. VanBlaricom (National Biological Survey, Washington Cooperative Fish and Wildlife Research Unit)**

This project will describe patterns of recruitment in nearshore clam populations known to be significant prey for sea otters in Prince William Sound (PWS). Nearshore clam populations were injured by the Exxon Valdez oil spill (EVOS), but their recovery patterns are unknown. Since clams are an important food resource for sea otters in PWS, it is possible that damage to clam populations has contributed to the failure of sea otter populations to recover from the EVOS. Age structure of clam populations will be used to determine the frequency and intensity of successful recruitment events in years recently past. Present rates of recruitment will be measured and correlated with environmental variables such as current pattern, water temperature, and primary production in the water column. The results will be used to evaluate the hypotheses that 1) low rates of clam recruitment are contributing to lack of recovery from EVOS damage in clam and sea otter populations in PWS, and 2) recent fluctuations in clam populations, and consequent effects on predators such as sea otters, are largely independent of EVOS damage.

Subproject #8: **Effects of predatory invertebrates on nearshore clam populations in Prince William Sound.**

Principal Investigator: **Glenn R. VanBlaricom (National Biological Survey, Washington Cooperative Fish and Wildlife Research Unit)**

Nearshore clam populations in Prince William Sound (PWS) are a biological resource injured by the *Exxon Valdez* oil spill (EVOS), but patterns of recovery are unknown. Clams are an important food resource for sea otters in PWS, also a biological resource also injured by the EVOS. Sea otters in PWS have not recovered from the oil spill. It is possible that damage to clam populations has contributed to the failure of sea otter populations to recover from the EVOS. Dynamics of clam populations often are influenced substantially by patterns of predation by invertebrates such as sea stars, crabs, and snails. This project will describe patterns of predation by such invertebrates on nearshore clam populations known to be significant prey for sea otters in PWS. Data on diet, activity, and density of predators will be used to estimate rates of clam mortality as a result of invertebrate predation. The results ill be used to examine the hypothesis that high rates of clam mortality are contributing to lack of recovery from EVOS damage in clam and sea otter populations in PWS. Objectives are to assemble, synthesize, and evaluate published literature on patterns of predation on bivalves by predatory invertebrate species known to occur with reasonable abundance in Prince William Sound. Incorporate relevant unpublished information available in the public domain and through contacts with other investigators of benthic ecosystems in PW; determine the diets of potentially important invertebrates in nearshore habitats of PWS; determine activity-time budgets of predatory invertebrates that forage on bivalves in PWS; determine patterns of

density for predatory invertebrates; and determine by experimental removal the effects of predation by invertebrates on mortality, population density, and size structure of clam populations.

Subproject #9: **Primary productivity as a factor in the recovery of injured resources in Prince William Sound**

Principal Investigator: **Dr. Michael S. Stekoll (University of Alaska)**

This project will investigate the production and flow of fixed carbon in the nearshore ecosystem of Prince William Sound and will determine the importance of benthic primary productivity in the recovery of injured intertidal and subtidal species. Results from this project would lay the foundation for understanding how fixed carbon is moved through the Prince William Sound nearshore system, and how this carbon flow is altered by seasonal events. The study will determine the relative importance of carbon input from phytoplankton, benthic production, terrestrial plants, and episodic transport (e.g., herring spawn). Understanding the flow of carbon will increase our understanding of factors that limit recovery of nearshore organisms.

Other Agency Proposals for Information Only: The following proposals are being submitted through other lead agencies, but have been closely coordinated and data will be integrated in the future. Their summaries are provided for information and proposals attached in the appendix.
identified:

Sea urchin population dynamics: changes in population density and availability as prey of sea otters. This effort is being submitted through ADF&G, but is closely coordinated with this proposed NBS package.

Principal Investigators: **Stephen Jewett (University of Alaska-Fairbanks) and Thomas A. Dean (Coastal Resources Associates, Inc). Submitted through ADF&G. Included for information only.**

This project will examine changes in the distribution and abundance of sea urchins, and will examine the availability of sea urchins as food for injured sea otter resources. Sea urchins, a favored food of otters, consume large amounts of algae (especially kelps) and can profoundly affect the structure of nearshore ecosystems. Prior to the spill there were few urchins in Prince William Sound, presumably because of predation by otters. It was predicted that a decrease in otter populations as a result of the *Exxon Valdez* oil spill, may lead to increases in urchin densities and subsequent decreases in kelps. However, urchin populations are increasing within the Sound. This project will address if urchin population densities are increasing in the Sound, if this increase is related to the lack of predation by otters, and if the increasing urchin population is a potential food source for recovering otter populations.

Population structure of blue mussels in relation to levels of oiling and densities of vertebrate

predators: This effort is being submitted through NOAA/NMFS, but is closely coordinated with this proposed NBS package.

Principal Investigator: **Charles E. O'Clair (NOAA/NMFS). Submitted through NMFS. Provided for information only.**

Contaminated mussels are suspected of being one of the factors limiting the recovery of vertebrate predators. Sea otters, harlequin ducks, and black oytercatchers are known to prey on mussels. Although black oystercatchers are considered to be recovering from EVOS, sea otters and harlequin ducks are not. This project is designed to support research of the vertebrate predator subgroup and will measure abundance, distribution and growth of *Mytilus* in oiled and unoiled locations and will measure hydrocarbon loads in mussel tissue. The project will also integrate the mussel bed cleaning project with the needs of the predator group.

Needed Research: The following subject areas are identified as research needs for which no Principal Investigator has been identified:

Black oystercatcher density, diet and reproductive success

Principal Investigators: to be determined, data need identified

This project will synthesize available black oystercatcher data, estimate dietary composition and reproductive success relative to oystercatcher density at three sites in western PWS. Densities will be estimated from available NRDA data. Dietary composition will be estimated from visual observations and collections of shell materials returned to nest sites. Reproductive success will be estimated from egg production and hatching and fledgling rates. Growth rates of chicks will be estimated from each density blocking.

Limpet/littorine study

Principal Investigators: to be determined, data need identified

The question of interest is whether effects on limpet and littorine populations by the EVOS are affecting the recovery of their vertebrate and invertebrate predators. Types of information needed include: comparisons of density, age and size structure of the populations in oiled and unoiled habitats, recruitment into those populations, and importance of the various limpet and littorine species to predators. Additionally, links need to be made with Herring Bay studies examining the effects of loss of Fucus on injury to and recovery of limpets and littorines.

D. PROJECT DESIGN

Elements of the project designs of the specific components of this study are included within each of the subproject proposals. Please refer to attachments. Project site selection will be coordinated to ensure a cohesive ecosystem approach, allow increased efficiency and cost effectiveness of data collection, and ensure that data can be properly shared to address the overall project hypotheses related to restoration of injured vertebrates. Data will be stored in a common format for easy exchange within the team and among other complimentary efforts. Individual subproject reports as well as a comprehensive analysis across subprojects will be conducted.

E. PROJECT IMPLEMENTATION

Many of the principal investigators included in this proposal have been conducting injury assessment studies in Prince William Sound since 1989. Others have an extensive research history in estuarine/marine waters of the Sound and elsewhere throughout Alaska. This array of scientists represents a highly experienced, well published group that can accomplished the objectives set forth in the proposal in an efficient and scientifically defendable manner. Please see the individual subproposals for individual credentials.

F. COORDINATION OF INTEGRATED RESEARCH EFFORTS

This effort is the product of numerous coordination efforts over the last six weeks. Each subproject proposal addresses specific coordination. However, the entire package is intended to ensure a synthesis of data across trophic levels. Each project depends on elements of the others. In addition, data from the SEA Project (physical and biological oceanography) and efforts by ADF&G, NOAA, and the Prince William Sound Science Center will continue to coordinated with and integral to this effort.

G. PUBLIC PROCESS

Investigators have taken part in public participation workshops sponsored by the Trustee Council. Scoping meetings conducted by the National Biological Survey were based on open invitation to a wide array of scientists throughout the federal, state, university, and private communities.

H. PERSONNEL QUALIFICATIONS

Each subproposal outlines the qualifications of the Principal Investigators. In addition, Dr. Leslie Holland-Bartels will act as project coordinator. Dr. Holland-Bartels is a senior scientist with the Alaska Science Center, National Biological Survey with 14 years experience in aquatic ecology. She has over 25 publications in national scientific journals on subjects ranging from contaminants, ecology of invertebrates, fisheries, water quality and aquatic ecology. She presently supervises the NBS Marine Mammal and Fisheries Branch of the Alaska Science Center.

F. BUDGET

Subproject	Title	Agency	FY 95 Cost
Project 1:	Factors Affecting Recovery of Sea Ducks and their Prey	NBS/USFWS	393.7K
Project 2:	Sea otter abundance and distribution, food habits and population assessment project	NBS	162.7K
Project 3	Pigeon guillemots and river otters as bioindicators of nearshore ecosystem health in Prince William Sound.	NBS, UAF	179.6K
Project 4	Settlement Rates of Nearshore Invertebrates, Oceanographic Processes and Population Recovery: Are They Linked?	NBS, PWSSC	435.7K
Project 5	Algal Competition Limiting Recovery in the Intertidal	UAF, NBS	222.5K
Project 6	The availability and utilization of Musculus spp. as food for sea ducks and sea otters	Private, UAF through NBS	4.6K
Project 7	Recruitment patterns of nearshore clam populations in Prince William Sound	NBS/U. Wash	121.3K
Project 8	Effects of predatory invertebrates on nearshore clam populations in Prince William Sound.	NBS/U. Wash	118.4K
Project 9	Primary productivity as a factor in the recovery of injured resources in Prince William Sound	UAF-Juneau	397.0K
	Project coordination/data synthesis/database management/FY 95 report	NBS	85.0K
		Σ	2120.5K

Attachment C

overview: Marine Mammal Studies

STATE OF ALASKA

WALTER J. HICKEL, GOVERNOR

DEPARTMENT OF FISH AND GAME

~~P.O. BOX 669~~ 1300 College Rd
~~CORDOVA, ALASKA 99574-0669~~ Fairbanks
PHONE: (907) ~~424-3212~~ 456-5156
FAX: (907) ~~424-3235~~ 452-6410

June 10, 1994

Molly McCammon, Director of Operations
Exxon Valdez Oil Spill Trustee Council
Restoration Office
645 G Street, Suite 401
Anchorage, AK 99501-3451

Dear Molly:

Enclosed is a group of proposed Exxon Valdez Oil Spill (EVOS) Restoration studies that are being submitted as part of an integrated MARINE MAMMAL ECOSYSTEM package. The package is designed to bring together a small group of naturally affiliated studies that will lend themselves well to a cooperative and integrated approach. The focus has been narrowed to a marine mammal ecosystem approach, rather than including all pelagic predators, because the investigators believed that would produce a better research product. Furthermore, communication and synthesis of results among this relatively small group of investigators can be realistically achieved without the need for a separate coordination component. The five investigators and their respective organizations (ADF&G, NOAA, and UAF) have been or are currently working together on other cooperative research efforts and are accustomed to sharing research platforms, ideas, and data. We are confident that the cooperation and communication required to synthesize this group of projects into a MARINE MAMMAL ECOSYSTEM study will be easily and efficiently accomplished.

By focusing on marine mammals, their predators, and their prey, we are not implying that marine mammals should be considered separately from the rest of the PWS ecosystem. All of the investigators proposing studies as part of this package are currently providing information to and cooperating with SEA plan and/or proposed seabird studies. Prey species for stable isotope and fatty acid analyses are being chosen in coordination with seabird researchers to make sure that species of broad trophic importance are selected. Meetings have already taken place to discuss coordination of sampling sites for bird, mammal, fish, and oceanographic studies. Incorporation of data from oceanographic and other SEA plan studies will be essential to meaningful synthesis of our research findings.

Each of the Brief Project Descriptions submitted as part of the MARINE MAMMAL ECOSYSTEM package have also been submitted separately by the investigators through their standard organizational

Attachment C

overview: Marine Mammal stud

channels. This was done to accommodate individual agency requirements and the fact that some projects are ongoing and others are being proposed for the first time. The electronic copies of each project description have been submitted through organizational channels.

Three of these brief project descriptions are for continuing projects. During FY94, harbor seal studies were conducted under 94064 (monitoring and habitat use) and 94320-F (a small trophics component that was included as part of SEA). Stable isotope studies were funded in FY94 as SEA project 94320-I and forage fish studies as project 94163.

If you have any questions or need additional information, please contact me or any of the individual investigators at the following phone or fax numbers:

Kathy Frost, ADF&G, Fairbanks - Phone 456-5156 Fax 452-6410
Mike Castellini, UAF, Fairbanks - Phone 474-6825 Fax 474-7204
Don Schell, UAF, Fairbanks - Phone 474-7115 Fax 474-5836
Marilyn Dahlheim, NMML/NOAA - Phone 206 526-4020 Fax 526-6615
Bruce Wright, NOAA - Phone 789-6600 Fax 789-6608

We found the package "Invitation to Submit Restoration Projects for FY 1995" to be very informative, and it provided useful guidelines for developing project descriptions. The emphasis on an ecosystem approach to research, and on interdisciplinary and multi-agency projects, should result in a research effort that will answer some of the significant, long-term questions about the health of Prince William Sound.

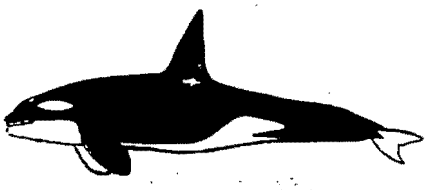
Sincerely,

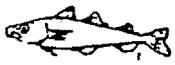
Kathy Frost

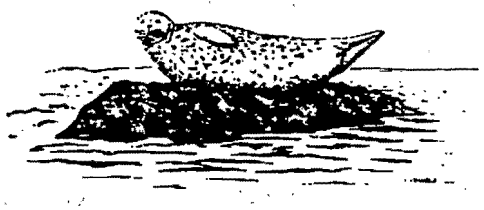
Kathryn J. Frost
Marine Mammals Biologist

Attachment C

overview: Marine Mammal Studie







FY95 MARINE MAMMAL ECOSYSTEM Studies

The MARINE MAMMAL ECOSYSTEM package for FY95 contains five major projects that provide an ecosystem approach to studying marine mammals and their environment in Prince William Sound (PWS). The primary focus is on harbor seals and killer whales, species that were injured by the Exxon Valdez oil spill (EVOS). A central goal of the studies is to understand why harbor seals in PWS have declined almost 60% since 1984, and why they are not recovering from impacts of the EVOS. This package incorporates projects that directly address harbor seals, as well as studies of their predators and prey. The status of harbor seals affects subsistence users who depend on harbor seals for food, commercial fishermen who may be affected by regulations necessary to protect marine mammals, and recreational users and tourists who view and photograph marine mammals.

The studies in this package directly address the question **"What is causing the long-term decline in some marine mammals and sea birds"**, which was identified as one of five high priority ecosystem issues to be addressed by restoration research. The studies do so by addressing a suite of broad questions, including:

Is it food, competition, or predation?
Is it human impact?
Is it disease?
Is it habitat?

The EVOS Damage Assessment and Restoration Science Programs have previously funded studies of harbor seals and killer whales in PWS. Those studies have documented injury, monitored for recovery, and gathered some information on biology and ecological relationships. The FY95 MARINE MAMMAL ECOSYSTEM package will continue some parts of the harbor seal and killer whale studies, while reorienting them toward a more integrated and ecosystem-based approach. The addition of new studies dealing with harbor seal physiology, stable isotopes in food webs, and forage fish biology will result in an integrated program of research with a strong ecosystem emphasis. The overall package includes investigations of diet and trophic interactions of harbor seals; movements, feeding areas, and haulout use; diving and feeding behavior; health and disease; availability of prey species; impact of killer whale predation; and effects of human-caused mortality. These are all identified as important issues under the recovery monitoring strategy for harbor seals.

In addition, studies in this package will obtain information that addresses a second high priority ecosystem question **"What is causing the failure of PWS herring and pink salmon runs?"**. Investigators will provide data to SEA Plan projects regarding seal and killer whale predation on herring and pink salmon; the significance of salmon and herring in seal and whale diets; and the locations of marine mammal concentration and feeding areas.

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Overview: Marine Mammal St.

Components of the MARINE MAMMAL ECOSYSTEM Project

Harbor Seal Monitoring, Habitat Use, and Trophic Interactions

Project Leader: Kathryn J. Frost, ADF&G

This project will gather data on the distribution, abundance, behavior, food habits, and genetic relationships of harbor seals in PWS. Monitoring will be done at trend count sites during pupping and molting to determine whether there is recovery following the EVOS, or whether the ongoing decline is continuing. Seals will be instrumented with satellite tags to investigate habitat use, movements, and diving and haulout behavior. Fatty acids in blood and blubber of harbor seals and in prey species will be analyzed to provide information on diet and food web relationships in PWS. These data will be integrated with results from stable isotope analyses to provide better resolution of trophic status. The effects of killer whale predation, subsistence harvest, and other mortality on the harbor seal population in PWS will be modeled to evaluate how those factors may be influencing recovery. Blood samples will be analyzed for phocine distemper, herpes virus, and other diseases that could cause health problems in the seal population. Skin samples will be analyzed to determine the genetic relationships of harbor seals within PWS, and of PWS harbor seals to seals in other areas. This study will address hypotheses that food limitation, killer whale predation, disease, or human impacts may be limiting recovery and/or causing seal numbers to decline.

Harbor Seal Condition and Health Status

Project Leader: Michael Castellini, UAF

This project will analyze body morphometrics to assess the condition of harbor seals, and will analyze blood to examine their disease and health status. Ratios of length to girth and estimates of body fat and density will be compared for harbor seals collected before and after the EVOS, and within and outside of PWS. This will allow an assessment of whether PWS seals are underweight (malnourished) or "normal". Blood will be analyzed for indicators of health, including anemia, dehydration, organ function, tissue damage, oxygen carrying capacity, hormonal balance, and stress-induced protein levels. If harbor seals in PWS are malnourished or unhealthy, that would support hypotheses that food or disease have caused the decline and are limiting recovery. If seals are healthy, other causes must be sought for the ongoing decline. Samples for this project will be obtained from seals caught during satellite tagging operations and from archived collections of serum. Historical data on seal morphometrics will be made available from ADF&G.

Attachment C

Overview: Marine Mammal Stu

Effects of Killer Whale Predation on Recovery Rates of Injured Resources

Project Leader: Marilyn Dahlheim, NMML/NMFS

This project will investigate the potential impact of killer whale predation on PWS harbor seals, and also on other injured resources such as herring and pink salmon. Skin and blubber biopsy samples will be examined through stable isotope and fatty acid analyses to determine the importance of marine mammals versus fish in the diet of the PWS killer whales. The combination of stable isotope and fatty acid analyses provides a complementary approach that will increase the resolution in prey determination and evaluation of trophic interactions. These data will be integrated with information on killer whale distribution and abundance, foraging strategies, and population energetics, and will be used in a collaborative effort with ADF&G to model the impact of killer whale predation on PWS harbor seals.

Confirming Food Web Dependencies in the PWS Ecosystem using Stable Isotope Tracers

Project Leader: Donald M. Schell, UAF

The objective of this project is to use the predictable shifts in stable isotope ratios of carbon and nitrogen that occur with increasing trophic level to describe trophic status and food web dependencies of harbor seals in PWS. Stable isotope ratio analyses will be performed on samples from harbor seals and their key prey species. Predators acquire stable isotopes in proportion to the amount of food derived from each source, and thus tissues such as claws or whiskers can provide a temporal record of foods consumed. Such information is especially useful where it is difficult to determine diets from direct observations of feeding or stomach contents. It is possible to trace energy supply between trophic levels (phytoplankton and zooplankton to fishes to top consumers) using carbon isotopes, and to construct food webs and assign trophic status using nitrogen isotopes which are enriched at each trophic step. Through the temporal record provided by seal whiskers, it should be possible to identify major shifts in prey base and trophic status over the life of individual seals. These techniques have been successfully used in studies of Steller sea lions, bowhead whales, and other species. Samples will be obtained in conjunction with harbor seal and forage fish studies.

Abundance and Distribution of Forage Fish and their Influence on Recovery of Injured Species

Project Leader: Bruce Wright, NOAA

The objectives of this project are to determine temporal and spatial distribution, abundance, and availability of important prey

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Overview: marine mammal st

species (forage fishes, squid, and macrozooplankton), and to determine what biotic and abiotic factors affect short-term and long-term distribution and abundance. These data will be integrated with information about predator distribution, abundance, and foraging behavior to evaluate the hypothesis that food limitation is responsible for ongoing declines and the failure of injured species (harbor seals, sea birds, salmon) to recover following the EVOS. Data about forage species are essential for understanding food web relationships and for evaluating whether food may be limiting. However, this is not an easy topic to address. Multiple years of integrated studies which combine traditional and new technology will be required to gather data sufficient to answer this question.

Recovery of Harbor Seals from EVOS: Condition and health status

PROJECT NUMBER: 95001

PRINCIPAL INVESTIGATORS: Dr. Michael Castellini

DURATION: 3 Years

PROPOSED START DATE: Jan 1, 1995 to Dec 31, 1997

AMOUNT REQUESTED: $375,778

B. INTRODUCTION

Overview:

This proposal is written in collaboration with the inter-disciplinary and integrative MARINE MAMMAL ECOSYSTEMS program submission to EVOS. As outlined under the broad program direction, the goals of the combined collaborative projects are to investigate ecosystem wide questions addressing the recovery of marine mammal injured species, specifically, harbor seals. These issues include the direct impact of oil spills, human interactions, food, competition, climatic factors, disease and habitat loss.

Under these guidelines, the enclosed proposal deals with the issues of body condition and health status of harbor seals with the resulting data applying directly to issues of disease, food limitation and the impact of oil.

Project description:

In collaboration with other field teams, 30-40 harbor seals will be captured and temporarily held at sampling sites within and outside the EVOS area. Complete body morphometrics (to assess body condition) and samples of blood (to examine disease/health status) will be collected. Seals will be returned unharmed to the capture site and blood samples will be taken to the University of Alaska in Fairbanks for analysis.

BODY MORPHOMETRICS. Using a large temporal and geographic data base currently held at UAF, the body morphometrics of the harbor seals will be analyzed and fit to models of body condition. For example, we have excellent data relating the length and girth of seals to their body mass. By fitting harbor seals to these curves, we can assess whether the animals are underweight (malnourished) or "normal". Additional factors, such as estimates of total body fat and body density are included in these assessments of condition. It is proposed that by comparing values for body condition from harbor seals collected before and after the EVOS event and by comparing data collected from animals inside and outside of the EVOS area, we can provide information as to whether this species, which is not recovering, appears to be physically sound.

BLOOD CHEMISTRY: Samples of blood will be analyzed for over 30 indicators of "health". These tests will examine, among others, potential anemia, dehydration, organ function, tissue damage and oxygen carrying capacity. In addition, assays for hormonal balance and stress protein levels that are extremely sensitive to alterations in health status will be conducted.

These data will be compared, on a temporal basis with samples collected before EVOS and on a geographic basis with control animals that were not impacted.

C. NEED FOR PROJECT

As a component of the MARINE MAMMAL ECOSYSTEMS proposal, this project deals with the health status/disease/body condition segment of harbor seal biology. To move towards the restoration of marine mammals, a multi-disciplinary, integrative approach is critical given the scope of the problem. Thus, certain components of the MARINE MAMMAL ECOSYSTEMS group will focus on habitat use and trophic level interactions, others on population studies and others on food resources. Any one agency cannot handle all components of such an intense approach. The University can provide the services and research for the health component through the Institute of Marine Science marine mammal physiology group. To move towards restoration, interactive projects, such as the one proposed here, must be carried out in collaboration with monitoring programs. That is, limited field programs that only contained a monitoring component or conversely only looked at individual animals would not be the most appropriate way to understand the impact of the EVOS event on injured species.

The premises and hypotheses of this project are simple: Either the EVOS impacted animals are different in their health status compared to non-EVOS animals, or they are not. If the species are compromised, then we will know some of the directions that would have to be followed towards potential restoration. If they are not compromised, then we will be able to focus our attention into other areas that may better explain their current recovery status.

D. PROJECT DESIGN

1. OBJECTIVES:

A. Capture 30-40 harbor seals at locations throughout PWS at 2-3 different times per year. This work will be in direct field collaboration with ADF&G.

B. Hold animals for 1-4 hours during which time complete body measurements and blood samples will be collected.

C. Analyze body measurements via computer modeling and assay blood samples for health indicators.

2. METHODS:

A. Captures: This will involve procedures tested in the field and routinely utilized by ADF&G. Basically, the seals are approached from sea on small boats while the animals are hauled out on beaches. A net is set across the beach and the animals move from the beach into to water when they see the boats. Animals are caught in the nets, moved onto the beach, tranquilized to facilitate the measurements and held until all sampling, attachment of diving recorders and recovery from anaesthesia are completed.

B. Body measurements: Linear and curvilinear length, girth at 7 locations and mass are collected from each animal. These are quickly and easily carried out in the field. Back at UAF,

the data are fit into models of how length, girth and mass are related for harbor seals and animals are quickly placed above or below their predicted weight for size. In addition, estimates of total body fat will be collected from measurements of total body impedance (BIA). This method utilizes a quick assessment of body fat by measuring resistance across a set of electrodes placed at the head and tail of the body. Further estimates of body fat are taken from ultrasound measurements of blubber depth at half a dozen sites across the body. From all of these values, estimates of body density (ie, relative fatness) can be evaluated.

C. Blood chemistry: Blood samples are measured in the field to assess the number of red cells in the blood (hematocrit), visualized under microscopes to examine the types of blood cells and then prepared for return to the lab. At Fairbanks, the samples are sent to a veterinary laboratory for assessment of "standard" health indices (such as cholesterol level, salts, and enzymes characteristic of tissue damage) and also analyzed at UAF for indicators of dehydration (water content), malnutrition (BUN, ketones), stress (haptoglobin), hormone imbalance (Angiotensin, ANP) and stress proteins (samples sent to collaborators at Stanford Research Institute). These data can then be compared to cataloged values for healthy seals to assess the status of the PWS seals.

It should be emphasized that the above methods are routine for the marine mammal group at UAF and that we conduct similar assays hundreds of times/year on seal and sea lion species from around the world. Thus, we have the expertise, the data bases and the consistency to best analyze these samples from the PWS animals.

3. SCHEDULE:

A. Capture dates: It is anticipated that captures of harbor seals will occur in the spring (April), summer (July) and fall (October) for both calendar years 1995 and 1996.

B. Analysis dates: Blood samples will be analyzed after each capture. Some of the assays are rapid and can be done within days for all samples, others take much longer. Body morphometric analysis is rapid and animals can be quickly assessed.

C. Report dates: The last predicted field season will be in the fall of 1996 and the final section of support will be to allow completion of analyses and publish reports. A final report will be submitted on 12/31/97.

4. TECHNICAL SUPPORT:

A. Veterinary samples will be sent on a service agreement to veterinary facilities in Fairbanks.

B. Stress protein samples will be sent to Stanford Research Institute for analysis.

C. All other analytical processes will be carried out by UAF personnel.

D. Boat and direct field support will be through our ongoing collaboration with ADF&G.

5. LOCATION:

Captures: Harbor seals will be captured in the EVOS event area in central and southwest PWS.

E. IMPLEMENTATION and
F. COORDINATION

As noted above, this project on the health of harbor seals, is submitted jointly as part of the MARINE MAMMAL ECOSYSTEMS program. This component is being run by the marine mammal physiology group at UAF. Other state agencies, federal agencies and universities will be in charge of other components of the project. UAF, ADF&G and NOAA currently collaborate with each other on marine mammal biology projects in and around Alaska. This project expands and builds on that collaboration and extends the depth of the project to focus on the EVOS event.

G. PUBLIC PROCESS

Through the process of public seminars and documents produced by the University, data from this work will be made available to the general public.

H. PERSONNEL QUALIFICATIONS

The principal investigator (Dr. Castellini) has worked in the field of marine mammal physiology since 1975 and has headed the seal physiology group at UAF since 1989. He has published extensively in this area and presented findings around the world on work from his lab. An abbreviated CV is attached.

The two PhD graduate students involved in this project will be in charge of field operations and laboratory analysis. B. Fadely is the primary field support person presently involved in collaborative harbor seal work with ADF&G and is the modeler for the body condition indices. Mr. Fadely currently holds a MS degree in marine biology. T. Zenteno will be responsible for all assays related to stress proteins, hormonal balance and haptoglobin levels. Ms. Zenteno currently holds a MS degree in zoology and biochemistry.

Field collaborators will be personnel from ADF&G in Fairbanks: K. Frost and L. Lowry have been excellent collaborators on field work with PWS harbor seals and their continued support and expertise is critical to this project.

I. BUDGET

Justification:

A) Salaries as per UAF approved levels with 5% increases in wages/year for three years.

B) Travel involves three field trips/year for the two PhD students in years 1 and 2 with 1 field trip scheduled in the last year. 1 field trip /year for PI and research associate. 2 trips/year for PI to Anchorage for EVOS workshops as required by EVOS. Year 1 also includes travel for 2 students to Scientific meeting to present results. Per diem for each city taken from current UAF allowances. Field costs estimated based on past trips.

C) Services include sending samples to veterinary labs in Fairbanks and samples to Stanford Research Institute. Phone, postage and cargo shipping based on average yearly costs/project for our laboratory.

D) Commodities include all collecting supplies, expendables and analytical supplies needed for assays. Freezer inventory supplies include freezing vials and costs of liquid nitrogen. Computer supplies include database software upgrades, media and memory upgrades. Field gear includes foul weather gear and shipping containers.

E) Equipment:

1. Microscope (Thomas Scientific # 6552-V25) for field determinations of blood cells.
2. Sample liquid nitrogen dry shipper and case (Cole-Parmer # G-44330-02 with G-44330-62)
3. Moisture analyzer (Arizona Instruments MAX-2000) for analysis of water in blood samples.
4. Speedvac sample preparation for hormonal assays (Savant # AES1000 with RH72-12 rotor as per Forma Scientific).
5. Ultracold freezer (REVCO Elite # ULT-1875-5 as per VWR # 55702-270) for storage of samples.
6. Data base computer (Pentium with 1 gb storage and tape backup). Vendor Per UAF purchasing.

F) Student aid.

As per costs for tuition waivers and fees for graduate students at UAF.

G) Indirect costs. 20% as per agreement with UA and EVOS Council.

APPENDIX: Castellini CV

NAME: Michael Angelo Castellini
PLACE OF BIRTH: Upland, California, January 22, 1953
EDUCATION:

B.A. Biology	1975	University of California, San Diego
PhD. Marine Biology	1981	Scripps Institution of Oceanography

EMPLOYMENT RECORD:

1976-80	Research assistant, University of California, San Diego
1981	Postdoctoral research fellow, Scripps Institution of Oceanography
1982	NATO postdoctoral fellow, Univ. of British Columbia, Vancouver
1983-86	NIH postdoctoral fellow, University of British Columbia, Vancouver
1986-87	Visiting assistant research physiologist, UC San Diego
1987	Adjunct lecturer, Department of Biology, UC San Diego
1987-89	Assistant research biologist, University of California, Santa Cruz
1990-92	Research associate in Marine Sciences, Univ Calif Santa Cruz
1989-93	Assistant professor marine biology, Univ. of Alaska, Fairbanks
1993-	Associate professor marine biology, Univ. of Alaska, Fairbanks

Publications relevant to proposal

Castellini, M.A., D.P. Costa and A.C. Huntley. Fatty acid metabolism in fasting elephant seal pups. Journal of Comparative Physiology B. 157(4):445-449. 1987.

Castellini, M.A., R.W. Davis and G.L. Kooyman. Blood chemistry regulation during repetitive diving in Weddell seals. Physiological Zoology. 61(5):379-386. 1988.

Castellini, J.M., Castellini, M.A. and M.B. Kretzmann. Circulatory water balance in suckling and fasting northern elephant seal pups. Journal of Comparative Physiology B. 160(5):537-542. 1990.

Castellini, M.A. and D.P. Costa. Relationships between plasma ketones and fasting duration in neonatal elephant seals. American Journal of Physiology. 259:R1089-R1090. 1990.

Davis, R.W., M.A. Castellini, T.M. Williams and G.L. Kooyman. Fuel homeostasis in the harbor seal during submerged swimming. Journal of Comparative Physiology B. 160:627-635. 1991.

Castellini, M.A. The biology of diving: biochemical, physiological and behavioral limits. In: Advances in Comparative and Environmental Physiology. Vol 8. R. Gilles, ed. Springer-Verlag, Berlin. pp 105-134. 1991.

Castellini, M.A., G.L. Kooyman and P.J. Ponganis. Metabolic rates of freely diving Weddell seals: Correlations with oxygen stores, swim velocity and diving duration. Journal of Experimental Biology. 165: 181-194. 1992.

Castellini, M.A., J.M. Castellini and V.L. Kirby. Blood glucose handling methods can compromise analytical results: Evidence from marine mammals. Journal of the American Veterinary Association. 201(1): 145-148. 1992.

Castellini, M.A., D.P. Costa and J.M. Castellini. Blood glucose distribution, brain size and diving in small odontocetes. Marine Mammal Science. 8(3): 294-298. 1992.

Castellini, M.A. and L.D. Rea. The biochemistry of natural fasting at its limits. Experientia. 48: 575-582. 1992.

Castellini, M. and D. Calkins. Mass estimates using body morphology in Steller sea lions. Marine Mammal Science. 9: 48-54. 1993.

Castellini, M.A., R.W. Davis, T.R. Loughlin and T.M. Williams. Blood chemistries and body condition of Steller sea lion pups at Marmot Island, Alaska. Marine Mammal Science. 2: 202-208. 1993.

Year 1; Jan 1, 1995 to Dec 31, 1995

Wages				
Personnel	Time	Amount		
M. Castellini	3 months	14199		
J.M. Castellini	3 months	7155		
B. Fadely	6 months	7308		
T. Zenteno	6 months	7308		
Total Wages			35970	
Leave				
M. Castellini		2853		
J.M. Castellini		1530		
Total leave			4383	
Benefits				
M. Castellini		4995		
J.M. Castellini		3534		
Total benefits			8529	
TOTAL SALARIES				48882
Travel				
3 RT airfare/year FBKS/Anchorage				
Fadely				
Zenteno				
M. Castellini				
1 RT airfare/year FBKS/Anchorage				
J.M. Castellini				
Total 10 RT airfares @ $350			3500	
Per Diem				
Field days				
80 person days @ $50/day			4000	
EVOS workshop per diem/Anchorage				
Castellini 14 days @ $170			2380	

1 RT airfare FBKS/Orlando			
Marine Mammal meetings			
Fadely			
Zenteno			
Total 2 RT airfares @ $700	1400		
Per Diem			
12 person days @ $94	1128		
TOTAL TRAVEL		12408	
Services			
Vet lab analysis	3900		
Phone	500		
Postage	200		
Cargo shipping	1000		
TOTAL SERVICES		5600	
Commodities			
Blood metabolites	7600		
Hormone assays	9500		
Freezer inventory supplies	500		
Computer supplies	3000		
Field gear	1000		
TOTAL COMMODITIES		21600	
Equipment			
Microscope	1376		
Shipper	1000		
Speedvac	8000		
Moisture analyzer	8200		
Freezer	7000		
Data base computer	3000		
Shipping costs for above items	1000		
TOTAL EQUIPMENT		29576	
Student aid			
Fadely 2 semesters	5060		
Zenteno 2 semesters	5060		
TOTAL STUDENT AID		10120	
TOTAL DIRECT		128186	
INDIRECT (20%)		25637	
TOTAL REQUESTED			153823

Year 2; Jan 1, 1996 to Dec 31, 1996

All wages taken as Year 1 values * 1.05)

Personnel	Time	Amount		
M. Castellini	3 months	14909		
J.M. Castellini	3 months	7513		
B. Fadely	6 months	7673		
T. Zenteno	6 months	7673		
Total Wages			37769	
Leave				
M. Castellini		2997		
J.M. Castellini		1608		
Total leave			4604	
Benefits				
M. Castellini		5246		
J.M. Castellini		3712		
Total benefits			8958	
TOTAL SALARIES				51331
Travel				
3 RT airfare/year FBKS/Anchorage				
Fadely				
Zenteno				
M. Castellini				
1 RT airfare/year FBKS/Anchorage				
J.M. Castellini				
Total 10 RT airfares @ $375			3750	
Per Diem				
Field days				
80 person days @ $50/day			4000	
EVOS workshop per diem/Anchorage				
M. Castellini 14 days@ 170			2380	
TOTAL TRAVEL				10130
Services (YEar 1 *1.06)				
Vet lab analysis			4134	
Phone			530	
Postage			212	
Cargo shipping			1060	
TOTAL SERVICES				5936
Commodities	(Year 1 * 1.06)			
Blood metabolites			8056	
Hormone assays			10070	
Freezer inventory supplies			530	
Computer supplies			2120	
Field gear			1060	
TOTAL COMMODITIES				31956
Equipment				
No equipment planned				
TOTAL EQUIPMENT				0
Student aid				
Fadely 2 semesters			5060	
Zenteno 2 semesters			5060	
TOTAL STUDENT AID				10120

TOTAL DIRECT	109473	
INDIRECT (20%)	21895	
TOTAL REQUESTED		131368

Year 3; Jan 1, 1997 to Dec 31, 1997

All wages taken as Year 2 values * 1.05)

Personnel	Time	Amount		
M. Castellini	3 months	15654		
J.M. Castellini	3 months	7513		
B. Fadely	6 months	7673		
T. Zenteno	6 months	7673		
Total Wages			38514	
Leave				
M. Castellini		3147		
J.M. Castellini		1608		
Total leave			4754	
Benefits				
M. Castellini		5509		
J.M. Castellini		3712		
Total benefits			9221	
TOTAL SALARIES				52489
Travel				
1 RT airfare/year FBKS/Anchorage				
Fadely				
Zenteno				
2 RT airfare/year FBKS/Anchorage				
M. Castellini				
Total 4 RT airfares @ $400			1600	
Per Diem				
Field days				
20 person days @ $50/day			1000	
Per diem EVOS workshop Anchorage				
M. Castellini 14 days @$170			2380	
TOTAL TRAVEL				4980
Services				
Vet lab analysis			500	
Phone			600	
Postage			300	
Publication costs			1000	
TOTAL SERVICES				2400
Commodities				
Blood assays			1000	
Hormone assays			2000	
Computer supplies			2500	
TOTAL COMMODITIES				5500
Equipment				
No equipment planned				
TOTAL EQUIPMENT				0
Student aid				
Fadely 2 semesters			5060	
Zenteno 2 semesters			5060	
TOTAL STUDENT AID				10120

TOTAL DIRECT	75489	
INDIRECT (20%)	15098	
TOTAL REQUESTED		90587

TOTAL COSTS

Personnel				
Wages				
M. Castellini	44762			
J.M. Castellini	22181			
B. Fadely	22655			
T. Zenteno	22655			
Total wages		112253		
Leave				
M. Castellini	8996			
J.M. Castellini	4745			
Total leave		13742		
Benefits				
M. Castellini	15750			
J.M. Castellini	10958			
Total benefits		26708		
Total salaries			152702	
Travel				
Airfares	10250			
Per diem	17268			
Total travel			27518	
Services			13936	
Commodities			59056	
Equipment			29576	
Student aid			30360	
TOTAL DIRECT			313148	
INDIRECT (20%)			62630	
TOTAL REQUESTED				375778

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Leave No Trace Educational Program: Reducing Human Impact to Assist Long Term Ecosystem Recovery

Project number: 95002

Lead Agency: USDA Forest Service

Cooperating Agencies: ADNR

Contact: The National Outdoor Leadership School (NOLS)

Don Ford
NOLS Alaska Director
Box 981
Palmer, AK 99645
907-745-4047

Rich Brame
NOLS Outreach & Training
288 Main Street
Lander, WY 82520
307-332-8800

Geographic Area: Prince William Sound

Project Startup Date: 1/95

Cost of Project FY'95: $158.7 K

Cost of Project FY'96: $95.6 K

Duration: Two Years

INTRODUCTION: Through a Memorandum of Understanding signed in the spring of 1993, the National Outdoor Leadership School (NOLS) has become a partner with the U.S. Forest Service, National Park Service, and Bureau of Land Management in the national Leave No Trace (LNT) program. Leave No Trace is an educational program designed to give users the best minimum-impact techniques and ethics available for their recreational use of America's wildlands. NOLS, as the leader in backcountry education and leadership, has committed to develop and distribute LNT curriculum and educational materials for all major backcountry recreational environments nation-wide.

NOLS seeks funding from the Trustees, through a contract with the USDA Forest Service, for a three phase Leave No Trace educational project. The phases can be funded and conducted as a whole or as separate and distinct projects. The three proposed phases also address a comprehensive variety of target audiences and learning styles while keeping to NOLS' traditional strength and philosophy: hands-on education works.

By educating the users of PWS, the Leave No Trace program will help reduce the human impacts detrimental to long term ecosystem recovery.

PROJECT DESCRIPTION

1. **Resources and/or Associate Services:** The three phases of the Leave No Trace program for Prince William Sound serve to minimize the impacts caused by kayakers, tour groups, hunters, and other recreationist. This is particularly important on the Sound where the EVOS has changed the natural character and resilience of many beaches and bays. Changes in the traditional recreation patterns and locations caused by the spill mean that formerly pristine or infrequently used areas are now receiving heavier use. Additionally, with increase notoriety as a result of the spill, more people are coming to the Sound. The effect of this increased and concentrated recreational use can be mitigated through education using common themes and valid research.

2. **Objectives:**

   A. Through education, reduce impacts of recreation users on recovering resources and in areas that are experiencing increased or new use resulting from changed use patterns.

   B. Educate a wide array of user groups in PWS on minimum-impact techniques and ethics.

   C. Create a contingent of educators in Alaska who can train others in minimum-impact techniques.

3. **Methods:** The methods used to educate recreation users of Prince William Sound on minimum-impact techniques and ethics is accomplished in three phases.

Phase I:

During the summer of 1995, NOLS will reproduce and distribute 10,000 Leave No Trace Outdoor Skills & Ethics Temperate Coastal Zones booklets which present the principles, ethics, and techniques of minimum-impact sea kayaking in southern Alaska. Guides, outfitters, hunters, tour group operators and user groups will be targeted for this written information.

During the early spring of 1995, NOLS staff will adapt the existing LNT Outdoor Skills & Ethics: Temperate Coastal booklet into a shorter pamphlet format designed for casual users such as tour participants, clients and interested travelers to the area. NOLS will work with the Forest Service, AK Department of Natural Resources, and organized user groups to distribute 50,000 copies of the LNT Coastal pamphlet during the 1995 and 1996 recreational seasons.

Phase II:

Over a two-season period, NOLS will train 100 grant-funded user group representatives as Masters of Leave No Trace. The LNT Masters program is a six-day field course which thoroughly covers the techniques and ethics of minimum impact use for a given environment and also teaches the Masters how to present LNT to others. This proven curriculum and pyramid-style of intensive training has the goal of improving the use and preservation on recreational lands and coasts.

Targeted participants will have strong boating or kayaking background, be interested in education, and will be in positions where they can teach others such as the public, youths, or clients. Chugach National Forest and AK Department of Natural Resources should enact measures requiring certain types of commercial permit holders and employees to go through this course.

Phase III:

In order to educate recreationists well before they actually enter Prince William Sound in 1996, NOLS will create a brief (20 minute) educational video of Leave No Trace techniques and ethics in Prince William Sound and other similar temperate coastal environments. Two hundred fifty videos will be provided at no cost to education programs, user groups, youth organizations, federal and state agencies, oil spill response agencies, Alaska Native corporations, outfitters and tour operators in PWS and in the communities of Valdez, Whittier, Tatitlek, Chenega and Cordova. Additional videos will be provided for sale to the public through NOLS and the Forest Service. This video will utilize a professional production company and use the existing NOLS productions of Soft Paths and Canyon Soft Paths as basic models.

4. **Location:** This project will focus on Prince William Sound. The lands and communities used by recreationist in Prince William Sound will benefit by this educational program. The principles of leave no trace may also carry to areas outside of PWS and the program could be expanded, with additional funding, to cover the entire spill affected area.

5. **Technical Support:** None Needed.

6. **Contracts:** Because the education materials and programs were developed by NOLS staff, they are the logical entity to implement this program. This project will be completed by NOLS through a Chugach National Forest contract. Chugach National Forest will administer the contract and assure that objectives are met.

SCHEDULES:

1/95	Contract between NOLS and Chugach National Forest
4/95	Create short pamphlet on LNT Outdoor Skills and Ethics
	Identify target participants ;for the LNT Masters
5/95 - 9/95	Distribute short pamphlet on LNT Outdoor Skills and Ethics
5/95 - 8/95	Conduct five LNT Masters Training Session in PWS.
11/95	Progress Report submitted.
12/95	Develop Challenge Cost Share Agreement with Forest Service
	for video production.
3/96	Video script and storyboards completed.
4/96 - 9/96	Filming for video.
5/96 - 9/96	Continue distribution of pamphlet and booklet.
5/956- 8/96	Conduct five more LNT Masters Training Session in PWS.
11/96	Video completed and distributed.
12/96	Final project report due.

EXISTING AGENCY PROGRAM:

The LNT Trace program developed by NOLS is an important program that supports the management of the USDA Forest Service and the State of Alaska Department of Natural Resources.

ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

This project is categorically excluded from formal documentation in an environmental assessment or environmental impact statement under Forest Service regulations [FSH 1909.15.1a(3)]. No other permits are required. No ground disturbing activity is proposed. Project is for public information and training.

PERFORMANCE MONITORING

This project will be coordinate by the Forest Service and a project leader from NOLS. The final products will be distribution of the Leave No Trace Outdoor Skills & Ethics: Temperate Coastal Zones booklets and pamphlets, the creation and distribution of the LNT Video, 100 people educated in the LNT Masters program, and progress and final reports. Project monitoring and coordination with the Trustees will be done through the recreation staff and the Supervisors Office of Chugach National Forest. Contract compliance will be completed by the same.

FY95 BUDGET ($K)

FY 1995	**USFS**	**ADNR**	**TOTAL**
Personnel	10.0	5.0	15.0
Travel	1.5	0.0	1.5
Contractual	139.2	0.0	139.2
Commodities	0.0	0.0	0.0
Equipment	0.0	0.0	0.0
Capital Outlay	0.0	0.0	0.0
Sub-Total	150.7	5.0	155.7
General Administration	21.6	0.4	22.0
Project Total	$172.3	$5.4	$177.7
NEPA Compliance	0.0		

FY 1996	**USFS**	**ADNR**	**TOTAL**
Personnel	10.0	5.0	15.0
Travel	1.5	0.0	1.5
Contractual	85.2	0.0	85.2
Commodities	0.0	0.0	0.0
Equipment	0.0	0.0	0.0
Capital Outlay	0.0	0.0	0.0
Sub-Total	96.7	5.0	101.7
General Administration	14.7	0.4	15.1
Project Total	$111.4	$5.4	$116.8
NEPA Compliance	0.0		

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Project #95003

Doc.#9506l3003

6/10/94

Cover Page For Invitation To Submit Restoration Projects For Fiscal Year 1995

1. Area E Commercial Salmon Permit Buyback Program

2. Project leader to be determined at a later time

3. State of Alaska, Commercial Fisheries Entry Commission
   8800 Glacier Hwy, #109
   Juneau, Ak 99801

4. Estimated cost of project, $11,735,000.00

5. 1/1/95, Completion date unknown

6. Until 25% of permits are retired and not to be reissued

7. Prince William Sound

8. James L. Mykland
   P.O. Box 1241
   Cordova, AK 99574
   907-424-7115

B. Introduction:

Commercial Salmon Fishing was injured by the EVOS. 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 and work.

Prince William Sound is the only area in the oil spill impacted area that is experiencing major salmon run failures.

Prince William Sound Acqualture Corporation, which relies on pink salmon stocks to generate cost recovery funds, have been experiencing low pink salmon survival rates during the past three years. Conversely PWSAC's board of directors have voted to increase the cost recovery rate to 40% of total hatchery produced salmon stocks. This will put an additional burden on the common property fishery which is already reeling from run failures plus low prices.

C. Need for Project:

As long as Commercial Fishing and Pink Salmon are listed as a non-recovering resources the restoration of Prince William Sound will not be completed.

The genetic damage done to pink salmon stocks may take as long as ten to twenty years to be resolved.

If the commercial salmon fishing fleet is reduced then the social economic viliability of the rest of the fleet may be preserved until Prince William Sound is restored to pre-spill conditions.

This buyback program will help restore and contribute to the recovery of the Commercial Fishing Fleet in Prince William Sound.

D. Project Design:

The objective of this buyback program would be to purchase and retire 25% of the Salmon Purse Seine, Drift Gillnet, and Set Gillnet in Area E (PWS) of the State of Alaska Commercial Fisheries Registration Area.

The permits would be bought back at current market value.

The retirement of these permits would have to be done in conjuncture and regulation with the Commercial Fisheries Entry Commission

E. Project Implementation

The State of Alaska CFEC would be the state agency that implements this program.

G. Public Process

The majority of limited entry salmon permit holders from Area E are willing to support such a program.

Summary and Conclusions:

Poor returns of salmon stocks to Prince William Sound have caused severe impacts to commercial fisheries. The economic viability for the commercial fishermen in Prince William Sound is almost nil. There are not enough salmon stocks to support the commercial fishing fleet in its present state.

Commercial Fishermen are a resouce that is non-recovering. As long as salmon run failures continue to occur more commercial fishermen will be facing economic hardships unparalleled in the commercial fishing history of Prince William Sound.

Salmon stock recovery could take Ten to Twenty years. At least 25% of commercial fishermen in Area E will not be able to survive this recovery duration.

A commercial fishing permit buyback program will help the commercial fishing resource to recover and hopefully survive until the complete restoration of Prince William Sound has been done.

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Harlequin Duck Abundance and Productivity in Western Lower Cook Inlet

Project Number: 95005

Project Leader: Alan J. Bennett

Lead Agency: National Park Service- Lake Clark National Park and Preserve

Cost of Project: $40,185./FY95

Start/Completion: 3-1-95/9-30-97

Project Duration: 3 years

Geographic Area: Western Lower Cook Inlet from Redoubt Point to Sea Otter Point, including Tuxedni & Chinitna Bay

Contact Person: Alan J. Bennett
Wildlife Biologist
National Park Service
Lake Clark National Park and Preserve
General Delivery
Port Alsworth, AK 99653
(907) 781-2267 or 781-2218

INTRODUCTION:

The purpose of this project is to establish baseline population parameters for harlequin ducks (Histrionicus histrionicus) in Western Lower Cook Inlet. This project will provide information on harlequin duck distribution, abundance, productivity, and habitat use that will assist in restoring harlequin duck populations in the Gulf of Alaska.

NEED FOR THE PROJECT:

There is no existing information concerning harlequin ducks in Western Cook Inlet. Random observations made during routine coastal patrols and reconnaissance surveys following the 1989 Exxon Valdez oil spill suggest that this region supports a substantial breeding population of harlequin ducks. Although the project site occurs within the Exxon Valdez Spill Area, it has been assumed that harlequin duck populations and habitat were not impacted.

Knowledge of breeding harlequin duck numbers and reproductive performance on the northwestern edge of the spill zone will provide a useful reference against which recovery rates in Western Prince William Sound can be measured. Full restoration of this species may require knowledge of how populations are preforming in undisturbed breeding habitats (Crowley 1991).

In addition, results of this project can be used to direct management actions that protect or

maintain harlequin duck populations within Western Lower Cook Inlet. Some coastal and riparian habitats within this region could be adversely impacted by logging, mining and residential development on private inholdings (National Park Service 1994, Alaska Dept. Fish & Game 1993). Information on harlequin duck distribution and habitat requirements is necessary to guide land acquisition or protection efforts within riparian corridors.

PROJECT DESIGN:

1. **Objectives**-Determine distribution, abundance, productivity, and habitat use of harlequin ducks (population parameters will be expressed as breeding adults and juveniles/linear mile of coastline)

2. **Methods**- Numbers of adult harlequin ducks will be estimated bi-weekly from 1 May to 15 June in tidal estuaries and coastal waters before they ascend the rivers to breed (Crowley 1991). From 15 July to 30 September bi-weekly surveys for adults and broods will be used to measure production. Population/production surveys will systematically sample coastal and intertidal habitats between Redoubt Point and Sea Otter Point, and large near-coastal lakes such as Crescent and Hickerson. Coastal harlequin population/production surveys will be conducted from a 22 foot aluminum skiff powered by twin 50 hp outboards. A skiff operator will pilot the vessel near the coastline, islands and off-shore rocks, and in intertidal estuaries. One or more observers will use 8-10X binoculars to determine numbers, sex, and age of all birds sighted. Habitat descriptions of breeding streams,including vegetative, hydrologic, and topographic characteristics as described by Patten (1990), will be made from 1:12,000 scale aerial photographs obtained in 1993 and selective ground surveys.

3. **Schedule**-Early (May-June) and late summer (July-September) surveys will be used to measure reproductive effort and performance of resident harlequin ducks. Habitat descriptions will be made during July and August. Data analysis and report preparation will be completed in November.

4. **Technical Support**-Computer services and other technical support will be provided by Lake Clark National Park.

5. **Location**-The project will include near-coastal waters, rivers and lakes between Redoubt Point and Sea Otter Point in Western Lower Cook Inlet. No communities will be affected by the project.

PROJECT IMPLEMENTATION:

The Lake Clark National Park field headquarters at Port Alsworth would implement 100% of the this project. Park biologists have the technical expertise and logistical support to conduct this project in the most timely and cost-effective fashion. Local knowledge of the coastline, field work conditions, and the seasonal use patterns of harlequin ducks is pivotal to the success

of the project.

COORDINATION OF INTEGRATED RESEARCH EFFORT:

The Alaska Department of Fish & Game, Division of Wildlife Conservation and U.S. Fish & Wildlife Service will collaborate in this project. Survey dates and procedures will conform to those used by the U.S. Fish & Wildlife Service and Alaska Department of Fish & Game to assure direct comparison of results with other study sites. Because site-specific variations may occur in the chronology of harlequin breeding (K. Laing, USFWS pers. comm.), survey dates in this project span a broader period than those used in Prince William Sound.

PUBLIC PROCESS:

Efforts will be made to seek the support and participation of private and corporate landowners within and adjacent to the project site.

PERSONNEL QUALIFICATIONS:

Alan J. Bennett, Project Leader/Principal Investigator. B.S., M.S. in wildlife ecology, Twenty years experience including 12 years conducting waterfowl research & surveys in coastal habitats of Cook Inlet & the Gulf of Alaska.

BUDGET (1995):

Personnel			$12,000.
Technician salary (0.3 FTE) ($3,000./mo X 4 months)			
Travel			$ 8,475.
Fixed-wing charter (Port Alsworth to Coast) $500./RT X 12 trips	$ 6,000.		
Port Alsworth to Anchorage ($450/RT X 2 trips)	$ 900.		
Per diem in Anchorage ($225./day X 7 days)		$ 1,575.	
Contractual Services			$13,000.
Skiff charter ($400./day X 20 days)	$ 8,000.		
Field camp rental ($200./day X 25 days)	$ 5,000.		
General Administration ($12,000. X 15%, $13,000 X 7%)		$ 2,710.	
Equipment			$ 2,000.

Report Preparation	$ 2,000.
Total for FY95:	$40.185.

LITERATURE CITED

Alaska Department of Fish & Game, 1993. Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Draft Management Plan, ADF&G, Anchorage 114 pgs.

Crowley, D.W. 1991. Preliminary status report of the harlequin duck restoration project in PWS, Alaska Dept. of Fish & Game, Anchorage. 34 pgs.

National Park Service, 1994 Unpubl. Lake Clark National Park & Preserve Resources Management Plan. Port Alsworth, AK, 187 pgs.

Patten, S.M. 1990. Prince William Sound harlequin duck breeding habitat analysis. Bird study no.11. Alaska Dept. of Fish & Game. Anchorage, AK. 23 pgs.

Project 95006

TITLE: PAINT RIVER PINK SALMON DEVELOPMENT PROJECT

PROJECT LEADER: Thomas E. Mears

LEAD AGENCY: Cook Inlet Aquaculture Association

COST OF PROJECT:

FY 95	$ 173,943
FY 96	215,000
FY 97	150,000
FY 98	30,000

PROJECT START-UP/ COMPLETION DATES:

June 1995 through August 1998

PROJECT DURATION: 4 years

GEOGRAPHIC AREA: Kamishak Bay in Lower Cook Inlet

CONTACT PERSON:

Thomas E. Mears
Cook Inlet Aquaculture Association
HC 2, Box 849
Soldotna, Alaska 99669
(907) 283-5761

INTRODUCTION

In 1989 oil from the Exxon Valdez spill fouled Kamishak Bay waters sufficiently to preclude customary commercial salmon fishing activities.

Paint River runs into the Kamishak Bay of Lower Cook Inlet about 100 miles WSW of Homer, Alaska.

Paint River watershed is contained within the expanded McNeil River State Game Sanctuary and newly created McNeil River State Game Refuge. Paint River did not previously produce salmon; a tidewater falls prevented fish access.

This project will aid restoration by developing a significant run of pink salmon at Paint River. The run, once developed, will be sustained through natural spawning.

Alaska Department of Fish and Game (ADF&G) and Cook Inlet Aquaculture Association (CIAA) have jointly determined the feasibility and desirability of establishing Paint River salmon populations. Paint River is believed capable of producing annual returns of more than 1.7 million adult salmon including up to 900,000 pink salmon.

NEED FOR THE PROJECT

This project will restore damaged pink salmon resources through development of a new naturally reproducing run.

PROJECT DESIGN

Objectives:

- Collect 8 million pink salmon eggs from Bruin Bay River for two consecutive years.

  Transport collected eggs to Tutka Hatchery for incubation.

  Transport about 6.8 million pink salmon fry from Tutka Hatchery for Paint River release.

- Construct crew cabin at Paint River intertidal fish ladder.

- Finish covering the fish ladder with bear proof grating.

- Monitor adult return as fish ascend the intertidal fish ladder for two consecutive years.

- Aerially survey Paint River watershed to determine distribution of spawning fish for 2 consecutive years.

Methods:

Pink salmon egg collections will occur at a weir erected above the intertidal zone in Bruin Bay River. Broodstock will be ripened in the River and spawned using delayed fertilization techniques. Broodstock carcasses will be returned to the River.

Iced containers of eggs and milt will be transported to Tutka Hatchery via floatplane. At the hatchery eggs will be fertilized, sanitized and loaded into NOPAD incubators. Standard incubation procedures will be utilized.

In the spring emergent fry will be transported from Tutka Hatchery to Paint River for immediate release several miles above the intertidal falls. Transport will be accomplished using an oxygenated tank slung from a helicopter.

A cabin about 18'x24' will be constructed adjacent to the Paint River intertidal fish ladder to house personnel necessary to operate the fish ladder. A bear proof fence (7' high cyclone fence with metal posts, fencing extending 4'below ground level, topped with multiple strands of barbed wire and electrified) will enclose the crew cabin.

As originally designed and constructed, about 2/3 of the upper surface of the fish ladder was fitted with grating to protect against intentional or accidental entry by bears. The remaining third was intended to be protected by fencing. The fencing appears to be inadequate and will be removed. The remaining portion of the fish ladder fitted with grating.

Adult pink salmon returns will be counted, weighed and sexed as fish ascend the intertidal fish ladder. Operating personnel will regulate ladder flows as required to afford fish passage.

As adult pink salmon migrate into the Paint River watershed, weekly aerial surveys will be conducted in order to determine the distribution of spawning fish.

Schedule:

CIAA would plan to construct the crew cabin and bear-proof fence and install grating on the fish ladder in June, 1995.

The pink salmon egg collections would occur in August of 1995 and 1996. Fry releases would occur in late May to early June, 1996 and 1997.

Ladder operation and adult return monitoring would occur through July and August of 1997 and 1998.

Technical Support:

CIAA operates Tutka Hatchery under a contract with ADF&G.

Location:

Paint River is a tributary of Kamishak Bay on the westside of Lower Cook Inlet about 100 miles from Homer, Alaska. Paint River watershed is contained within the expanded McNeil River State Game Sanctuary and the McNeil State Game Refuge.

PROJECT IMPLEMENTATION-

This project should be implemented by CIAA under auspices of ADF&G.

COORDINATION OF INTEGRATED RESEARCH EFFORT-

As fish are allowed into the Paint River watershed, ADF&G biologists will attempt to determine the effects on bear distribution or behavior.

PUBLIC PROCESS-

Through the 15-year history of the Paint River project there have been several workshops and public meetings, public involvement through the Legislative process which expanded McNeil Sanctuary and created the McNeil Refuge, public notice and review through the construction permitting process, public notice through the Alaska Board of Game process and one court action attempting unsuccessfully to prevent fish ladder construction.

Additional public and agency review would occur as State of Alaska fish transport permits and Tutka Hatchery management plan alterations are sought.

PERSONNEL QUALIFICATIONS-

Thomas E. Mears has B.S. and M.S. degrees in Fisheries Science from Michigan State University. Mr. Mears taught fisheries technician training courses at Alpena (Michigan) Community College for 10 years. Mr. Mears has been employed by CIAA as Biologist and as Executive Director since 1979 and is intimately familiar with the Cook Inlet drainage and all relevant salmon enhancement techniques.

PROJECT 95006

BUDGET- Fiscal Year 1995 Budget Summary

Construct Crew Cabin and Fence, Install Grating

Personnel	
Construction Labor	$ 3,800
Travel	0
Contractual Services	
Backhoe and Small Equipment Rental	2,000
Barge Charter	9,750
Boat Charter	750
Commodities	
Cabin Materials	6,800
Miscellaneous	1,000
Bolts and Brackets	1,500
Food	750
Equipment	
Grating (inc. shipping to Anc.)	30,750
Cabin Stove, Lights, Communications, ets	2,500
Fence Materials	12,000
Capital Outlay	0
General Administration (10%)	7,160
Subtotal	$78,760

Pink Salmon Egg Collection

Personnel	
Field Personnel	$21,484
Principal Investigator	11,640
Travel	
Field Personnel	2,021
Principal Investigator	650
Contractual Services	
Air Charter	30,323
Equipment Rentals	1,202
Egg Incubation (in kind donation)	0
Commodities	6,153
Equipment	13,049
Capital Outlay	0
General Administration (10%)	8,652
Subtotal	$95,174

FY 1995 Total $173,934

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Archaeological Site Restoration- Index Site Monitoring

Project Number: 950007-A

Principal Investigator: Douglas R. Reger

Lead Agency: Alaska Department of Natural Resources

Cooperating Agencies: U.S. Forest Service
U.S. National Park Service
U.S. Fish and Wildlife Service

Project Cost: FY95 $190.9; FY96 $190.0K

Project Startup: January 1, 1995; Completion: January 1, 1996

Project Duration: 5 years(estimated)

Geographic Area: Oil Spill Area Wide

Contact Person: Judith E. Bittner/ Douglas R. Reger
Office of History and Archaeology
Alaska Division of Parks and Outdoor Recreation
Anchorage, AK 99510-7001
(907) 762-2622

B. Introduction

Damage to archaeological sites as a result of cleanup activities after the Exxon Valdez Oil Spill has been amply documented in damage assessment studies performed since the spill. Sites vandalized since the spill have been monitored and plans developed to restore the damages at the studied sites. Monitoring of damaged sites as a gauge of vandal activities in the spill area was identified as a primary strategy for site restoration during fiscal year 1995 (FY95). The monitoring will continue and extend beyond the documentation of vandalized sites investigated under project 94007, Site Specific Archaeological Restoration

C. Need for the Project

Evidence of vandalism dropped dramatically after 1989, probably reflecting the more effective archaeological constraint system that had been put into place by the participating agencies, with the cooperation of Exxon Corp., by the late summer of 1989. This apparent reduction in vandalism was unexpected and at first suggested that continued vandalism related to the *Exxon Valdez* spill event might not be a significant future concern. However, based on what we know about the behaviour patterns of archaeological looters, the activity focus of vandals may have shifted (or will shift) from general prospecting to a more focused pattern during the initial "prospecting" phase, or simply observed by more discrete potential looters

engaged in cleanup operations in the post-1989 era. Artifact hunters are most likely to act on the opportunities presented by this knowledge in the next 15 years while their memories remain fresh; thereafter, the threat should gradually drop as the information loses "immediacy" and specificity.

D. Project Design

1. Objectives

Archaeological monitoring of archaeological sites injured by the spill or spill related activities will target a small number of sites which are determined to represent those that are most vulnerable to looting. Those sites will serve as a gauge for levels of vandalism in the spill area.

2. Methods

A strategy was identified during a 1994 restoration workshop of designating 3 or 4 index sites or sites critically vulnerable to looting which will be monitored on an annual basis. A second group of 4 sites will be selected for monitoring biannually as a check over a broader area. The second group of sites may vary over time in order to maintain flexible response to new information such as fresh reports of vandlism or new findings on patterns of looting. The second group of sites provides a cross-check to monitoring data collected at the index sites. Focusing annual monitoring on 4 index sites and using a 2-year monitoring schedule on the additional 4 sites, expenditures will be significantly reduced while maintaining continuity of tracking levels of vandalism over the years. Vulnerability to looting will be the primary criteria of selection with managerial jurisdiction a secondary concern. One or two of these sites will also be selected for continued hydrocarbon monitoring so the behavior and effect of oiling can be observed over the long term in archaeological deposits.

3. Schedule

Project proposal reviewed in Public Review Document..... August, 1994

Trustee Project Approval..... November, 1994

Detailed Work Plans submitted..... January 1, 1995

Fieldwork..... May-August, 1995

Draft Report..... October 1, 1995

Final Report..... January 1, 1996

4. Technical Support

The only technical support will be provided by commercial radiocarbon laboratory and a lab capable of conducting the required chemical testing.

5. Location

The sites will be located throughout the spill area.

E. Project Implementation

This project will be implemented by agency archaeologists meeting the professional qualifications specified under the Secretary of the Interior's Guidelines for Archaeology and Historic Preservation.

F. Coordination of Integrated Research

This project will be coordinated with the Traditional Knowledge Transfer Project proposed for Trustee funding in FY95. It will not mesh well with other projects although logistic arrangements will be coordinated with projects within each agency.

G. Public Process

Public involvement will occur with the public review of this brief project description and through consultation with knowledgeable local people under the Traditional Knowledge Transfer Project.

H. Personnel Qualifications

Personnel used by the agencies for this project will meet the professional qualifications standards specified under the Secretary of the Interior's Guidelines for Archaeology and Historic Preservation.

I. FY95 Budget(($K)

Personnel	95.9
Travel	38.0
Contractual	34.1
Commodities	7.8
Equipment	0.0
Capital Outlay	0.0
SubTotal	175.8
General Administration	15.1
Total	190.9

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Site SEW-488 Archeological Site Restoration

Project Number: 95007-B

Project Type: Restoration management actions, archeology

Project Leader(s): Linda Finn Yarborough
U.S. Department of Agriculture, Forest Service

Lead Agency: Alaska State Department of Natural Resources

Cooperating Agencies: U.S. Department of Agriculture, Forest Service

Project Cost: $182,200

Start Date: May24, 1995

Finish Date: May30, 1996

Geographic Area of Project: Prince William sound

Project Leader Signature:

Project Manager: Name:

Signature:

A. Introduction

The Louis Bay Lamp Site, SEW-488, was discovered during the Exxon Valdez Oil Spill Cleanup Program. Injury to the site consists of oiling during high pressure water treatment and unmonitored cleanup activities (Jesperson & Grffin 1992; McAllister 1992). Erosional disturbance of the site will result in a significant loss of scientifically and culturally valuable information and items (Dekin 1992) unless restoration actions are taken during the 1995 field season. Stabilization of the bank following archeological excavations will slow or halt further erosion and preserve the site. This site has yielded dates for human occupation ranging from 600 BP to 3,400 BP.

B . Pro ject Description

1. Resources and/or Services: The intent of this project is to conduct site specific restoration activities at an archeological site on Knight Island in Prince William Sound. Impacts to the site require mitigation through data collection as well as site stabilization.

2. Objectives: The objectives of the project are to ameliorate and halt the deterioration and destruction of the site in order to protect and preserve the remaining cultural deposits. Scientific and cultural knowledge will be gained through the project which will add significantly to the understanding of the prehistory of the Prince William Sound. The results of the project will include separate reports geared appropriately for professional archeologists and for members of the general public.

3. Methods: The site is about 75 meters long by 30 meters wide, with a depth exceeding one meter. Excavation of about 10 cubic meters along the eroding site edge is proposed, with 6 subsequent 5 0 cm tests to more accurately define the boundaries of the site. Additional excavation of eight 1meter squares in the main body of the site would provide an adequate sample of the site to augment preliminary testing already accomplished.

The research design and field arrangements will be coordinated by a GS-11 (or equivalent) archeologist/principle investigator (Pl). The field crew will consist of the Pl, one GS-9 (or equivalent) archeologist and two GS-7 (or equivalent) archeologists. The GS-11 archeologist will coordinate analysis and report production. Reports will be in formats designed for both professional and public audiences.

4. Alternatives: The project follows the procedures set forth in laws, regulations, and guidelines which delineate what can and cannot be done with historical properties; other than no action, no alternative exists.

5. Location: The project site is located on knight Island in Prince William Sound. See Figure 1.

6. Benefits: Preliminary testing indicates the site has the potential to reveal an extensive sequence of occupational layers interspersed by beach deposits (Dekin 1992) . This project will enhance the scientific and cultural understanding of early occupants of the Sound as well as ensure the preservation of the site for further investigation or protection. It must be assumed that this is the only site that can provide the kind of information already documented to exist there; without its preservation through halting further impacts, that information (and the cultural values it embodies) will be irretrievably lost. Without stabilization of the deposits from further deterioration, the exposed cultural materials provide a lure for site destruction through vandalism. The stabilization will therefore help protect the site from human as well as natural impacts. Data collection and analysis will allow

C. Schedules and Planning

1. May 24,1995 -- Start of consultation under the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act and preparation of work plans and research designs. Continuation of logistical and personnel planning.

2. July 5,1995 -- Start of field work of site restoration work.

3. September 30,1995 -- Completion of interim field report to U.S.D.A. Forest Service

4. December 31, 1995 -- Completion of draft final report to U . S. D. A. Forest Service

5. April 30, 1995 -- Completion of review by U.S.D.A. Forest Service and delivery to the State of Alaska Department of Natural Resources.

D . Environm ental Com pliancelPerm it/Coordination Status

The Chugach National Forest will comply with the requirements of the National Environmental Protection Act and provide the results to the lead agency-. The restoration actions at SEW-48~ will also comply with the provisions of the Archeological Resources Protection Act.

E. Performance Monitoring

A checklist of milestone dates will be kept by the Principle Investigator and the Forest Archeologist for the Chugach National Forest. The quality and timeliness of field work, analysis, and report production will be monitored by the Forest Archeologist.

F. Personnel a ua lifications

Personnel will meet or exceed the qualifications for archeologists as presented in appropriate Forest Service policies and will comply with the requirements established by the National Historic Preservation Act and the Archeological Resources Protection Act.

G. Budget

Personnel	$56.2
Travel	2.0
C ontractual	95.1
Commodities	10.8
Equipment	5.8
Capital Outlay	0.0
Subtotal	$169.9
General Administration	15.3
Project Total	$185.2
Flll Time Equivalents (FTE)	1.3

Site Specific Archaeological Restoration: Crafton Island

Project Number: 95007-C

Project Leader: John L. Mattson, USDA Forest Service, Chugach National Forest

Project Cost: $32.8K

Direct Costs: Fiscal Year 1995: **$23.5;** Fiscal Year 1996: **$5.0.**

Total Direct Cost: $28.5K **Total Indirect Cost: $4.2K**

Start Date: May 1, 1995 **Completion Date:** May, 1996

Project Duration: One year

Lead agency: Department of Agriculture, Forest Service

Geographic area: Field Work: Crafton Island, Prince William Sound
Analysis: Anchorage

Contact Person: Linda Finn Yarborough
USDA Forest Service
Chugach National Forest
3301 C Street, Suite 300
Anchorage, Alaska 99503-3998
(907) 271-2511

B. Introduction

This project is intended to conduct site specific restoration activities at an archeological site on Crafton Island in Prince William Sound. Impacts to the site require mitigation through data collection as well as site stabilization.

The Crafton Island Cave Site, SEW-004, was vandalized during the course of the Exxon Valdez Oil Spill in 1989, and continued to be vandalized as late as 1992. The site's location and size were known from visits by Bureau of Indian Affairs, ANCSA Office, archeologists during the 14(h)(1) selection process and Exxon archeologists during the oil spill cleanup program, which resulted in surface measurements and maps. However, its exact extent and nature have not been established. Monitoring visits to the site have documented continuing vandalism, both during the Oil Spill Cleanup effort and afterwards. Stone and wood artifacts lying on the surface as a result of vandals' activities were collected and subsequently curated at the Anchorage Museum of History and Art. No tests were made. However, the site appears to be about 1.5 to 2 meters deep and appears to have excellent preservation of both bone and fibrous material within the drip-line.

C. Need for the Project

This site is in imminent danger of further vandalism resulting from increased general knowledge of the site's location and contents following the EVOS and subsequent cleanup activities. The project is needed to mitigate the damage already done to the site and to obtain as much information as possible about the remaining deposits before they are further disrupted. The project is also needed to assure the appropriate and respectful treatment of any human remains still intact in the site. *The project is two-fold: to mitigate the damages to the archaeological resources and to protect human remains from additional desecration.*

It must be assumed that this is the only site that can provide the kind of information already documented to exist there. Without mitigative excavation and data collection, and halting further impacts, that information (and the cultural values it embodies) will be irretrievably lost. Without stabilization of the deposits from further deterioration, the exposed cultural materials will continue to provide a lure for site destruction through vandalism. Stabilization after excavation will therefore help protect the site from human as well as natural impacts. This project will enhance the scientific and cultural understanding of the prehistoric occupants of the Prince William Sound as well as ensure the preservation of the site for further investigation or protection. The resulting information will provide significant insights into the prehistoric habitation of Prince William Sound for subsequent interpretation and education programs.

D. Project Design

1. Objectives: The objectives of the project are to ameliorate and halt the deterioration and destruction of the site in order to protect and preserve the remaining cultural deposits. Scientific and cultural knowledge will be gained through the project which will add significantly to the understanding of the prehistory of the Prince William Sound. The results of the project will include separate reports geared appropriately for professional archeologists and for members of the general public. *Specifically, the work will (1) define the site's depth and extent, and the degree to which it has been disturbed, (2) address research questions concerning this site in particular and Prince William Sound prehistory in general, including site location determinants, age, cultural affinities, and nature and season of occupations, and (3) provide for appropriate and respectful treatment of any encountered human remains.*

2. Methods: The field work will be conducted in two phases. The first will involve testing to determine the depth of the site and to gather additional information on the general nature of its deposits. The second phase will overlap with the first phase and will involve non-random data recovery based on the results of the initial testing. It will emphasize recovering material from intact deposits, to maximize knowledge of the significance of the site and enable the research questions to be addressed. Full and accurate records will be kept of all field observations and operations.

A two meter by two meter grid will lay over the site, its orientation established from a base line shot by Forest Service surveyors and tied to fixed points by satellite telemetry. Excavation will

be in arbitrary 10 cm levels in disturbed matrices and will continue in natural stratigraphic layers if intact deposits are identifiable. The provenience of *in situ* artifacts and fauna will be individually measured, and associations with cultural features will be noted. All cultural material, except for fire-cracked rock, will be collected for analysis. Fire-cracked rock will be weighed and discarded. Matrices removed from excavation squares will be screened through 1/16 inch wire mesh, and bulk samples will be taken from each square for laboratory analysis of macrobotanical remains and soil chemistry. Charcoal samples for radiocarbon dating will be taken whenever possible. Because flotation will not be possible in the field, samples will be floated later in a laboratory situation to recover charred plant material, especially from clearly defined hearths or storage pits. Pollen and phytolith samples will also be taken from different locations in the site. Individual level maps will be made as work proceeds, and wall profiles will be drawn from each unit. Full video and still camera photography documentation will be continuous throughout the excavations.

No human remains are currently present on the surface of the site. However, if human remains are discovered, they will be examined on site to determine ethnic and cultural affiliation. If such remains appear within the continuum of the prehistoric Alaskan Native population, then work will proceed in accordance with prior agreements with the appropriate Native organization, as stipulated in the Native American Graves Protection and Repatriation Act.

The current size estimates for the site suggest that there may be as much as 330 m^3 of cultural deposit present. It is estimated that two archeologists and three on-the-job trainees will be able to sample approximately 7 m^3 , an approximately 2% sample of the site, in the four weeks allotted for work at the site.

Types of analysis depend upon information recovered during excavations. These include, but are not restricted to: studies of artifacts and their distribution; C-14 dating; analysis of human, faunal, and floral remains; studies of soils and stratigraphy; and investigation of the environmental factors that influenced settlement at the site. Artifacts, faunal material, and human remains collected during earlier work at the site will be analyzed and included in the final report.

The final report on the project will be prepared according to the Secretary of the Interior's Standards and Guidelines. This report will summarize information gathered during the literature review, present the research design, detail the actual procedures used during the field work, and give the results of the research. It will also include a discussion of the research topics and an evaluation of how the project met the goals outlined in the data recovery plan.

Following the procedures set forth in pertinent legislation and guidelines, the project will mitigate the damage to the archeological site through data gathering and physical restoration/stabilization. Final physical restoration will include backfilling, stabilization and/or revegetation of affected areas and archeological tests

3. Schedule:

1. May 15, 1995 -- Start of consultation under the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act, preparation of community involvement, and preparation of work plans and research designs. Continuation of logistical and personnel planning.

2. July 5, 1995 -- Start of field work of site restoration work.

3. September 30, 1995 -- Completion of interim field report to U.S.D.A. Forest Service

4. December 31, 1995 -- Completion of draft final report to U.S.D.A. Forest Service and EVOS Trustee Council

5. April 15, 1996 -- Completion of review by U.S.D.A. Forest Service and EVOS Trustee Council, and delivery of copy to the State Historic Preservation Officer.

4. Technical Support: The project requires qualified field and laboratory personnel, C-14 dating, analysis of soils, faunal remains, artifacts and other remains, and permanent curation of collected material.

5. Location: This project is intended to conduct site specific restoration activities at an archeological site on Crafton Island in Prince William Sound.

E. Project Implementation: *All or parts of the project will be contracted out through the Forest Service. Sole source contracts for the work may be allowed if suitable "8A" contractors (certified under the Small Business Act) submit proposals.* If no 8A contractor is so employed, contracting will be through established competitive means as established in Forest Service regulations, policy and guidelines, and in cooperation with the EVOS Restoration Office.

The Chugach National Forest program is oriented towards specific projects and inventory, however the Forest does not have an on-going field program dedicated to archaeological site restoration in the oil spill area. Archaeological activities in the spill area are undertaken on a specific, short-term basis relative to the specific needs.

F. Coordination of Integrated Research Effort: Due to internal regulations, the Chugach National Forest is developing its own Environmental Assessment (EA) for this project. The draft EA will be completed by May 15, 1995. Any mitigation measures identified through National Environmental Policy Act (NEPA) compliance will become part of the project.

The proposed project is subject to the provisions of the National Historic Preservation Act (NHPA), the Archaeological Resources Protection Act (ARPA), and the Native American

Graves and Repatriation Act (NAGPRA). The project will be carried out in conformance with the consultative processes and standards demanded by these legislative mandates. Coordination between agencies, and consultation and/or coordination with Native village and regional organizations will be done throughout the project. *The efforts of local communities, the Trustee Council and the Chugach National Forest have formed links with local communities to help assure local involvement. The project will be coordinated with other EVOS funded archaeological/cultural projects as well as biologically based projects to share information and efficient logistical support.*

The proposed action complies with the Endangered Species Act, the Marine Mammals Protection Act, and Executive Orders 11988 and 11990. There will be no restriction of subsistence activities as documented by the Alaska National Interest Lands Conservation Act, Title VIII, Section 810(a) Summary of Evaluation and Findings.

G. **Public Process:** The public will be involved in the project as required by NEPA, NHPA, and NAGPRA, and will have an opportunity for involvement during the draft review phase. Site specific restoration activities are subject to site location restrictions as required by ARPA. *The Chugach National Forest will proactively involve local communities and the academic community along with the EVOS researchers* to ensure active information sharing and participation in the project from its inception to completion of the final report.

H. Personnel Qualifications

John L. Mattson, Ph.D.
- Forest Archaeologist, Chugach National Forest

Linda Finn Yarborough, M.S.
- Assistant Forest Archaeologist, Chugach National Forest
- Ph.D. Candidate, University of Wisconsin, Madison

I. Budget

All Personnel, Travel, Commodities, and equipment will be contracted out at **$28.5.** Administration costs of $4.2 will be for Forest Service oversight of the project.

Total Cost of Project: $32.8

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Project Title: Trophics and Community Structure in the Intertidal and Shallow Subtidal.

Project Number: 95009a

Study Type: Research/Monitoring

Name of Study Leader(s): Dr. Ray Highsmith, University of Alaska
Dr. Mike Stekoll, University of Alaska

Lead Agency: U.S. Forest Service, Pacific Northwest Research Station

Cooperating Agencies: University of Alaska Fairbanks (UAF)
Prince William Sound Science Center (PWSSC)
Alaska Department of Fish & Game (ADF&G)

Cost of Project: **FY95:** $455,418
FY95 Report Writing: $14,698

Start-up/Completion Dates: FY95: October 1, 1994 - September 30, 1995

Duration: 2-5 years

Geographic area of study: Prince William Sound

Contact: Dr. Raymond Highsmith, Director
West Coast National Undersea Research Center
School of Fisheries & Ocean Sciences
210A O'Neill
University of Alaska, Fairbanks
Fairbanks, AK 99775-1080
Tel: (907) 474-5804

B. INTRODUCTION

Injury to the biological resources of Prince William Sound resulted from the 1989 *Exxon Valdez* oil spill (EVOS), and may be continuing. While some species are known to be recovering, the status of many others remain unknown or are known to be deteriorating. The list of injured biological resources not recovering includes birds, fish, and mammals, as well as both intertidal and subtidal organisms. Injured services include commercial, sport, and subsistence harvests of these non-recovering resources.

The disruption and recovery of community structure is the most pressing issue for research in the nearshore. Most of the non-recovering injured species are predators on nearshore marine organisms. Nearshore resources also provide important breeding or spawning habitat for many injured species. The April 1994 EVOS workshop on research priorities identified seven major

hypotheses about processes limiting recovery of nearshore groups of injured resources. Of these seven hypotheses, five were directly related to the trophic structure of nearshore systems. Although the specifics vary, nearshore trophic hypotheses were considered a research priority for nearly all injured/non-recovering resources. The set of research projects proposed here are designed to address these hypotheses by examining variation in, and mechanisms affecting, trophic relationships in the nearshore ecosystem.

Trophic relationships between organisms determine energy flow through a system. These projects therefore share a common focus on major energy pathways. They are designed to examine the regulation of energy pathways in nearshore systems by first, focussing on a large, seasonal and short-lived input of energy into a restricted nearshore area (herring spawn deposition), and second, by examining variation connected to the presence or absence of a dominant predator (sea otters). Each condition is provided by a natural experiment in Prince William Sound. Large, local variation in energy input is provided by spawning runs of Pacific herring. During spawning, a large biomass of herring accumulates along sections of shoreline. Herring defecate and spawn, depositing nutrients and energy into the nearshore area where spawning occurs. Variation in predation is associated with sea otter use of an area, and with herring spawn deposition, as the abundance of food attracts numerous predators on herring and herring eggs, as well as secondary predators on animals attracted by the opportunity to prey upon herring. Herring spawn thus provides a local, intense and repeated disturbance to the system that may be used to trace the roles of nutrient and energy availability, competition, predation, and prey availability in limiting or structuring nearshore dynamics. Local variation in area use by sea otters provides an additional opportunity to examine the role of predation.

These projects examine how ocean circulation, environmental richness (e.g. primary productivity, influx of nutrients, food availability), and predator-prey relationships (e.g. food availability, patch use, grazing pressure, predation risk) interact to limit or structure communities. Regular spawning beaches of Pacific herring receive large, temporally discreet input of nutrients and energy in the form of herring eggs, feces and carcasses, as well as avian and mammalian feces from foragers attracted to the site. Three possibilities are considered for how utilization of such natural localized variation in nutrient and energy supply (e.g. herring spawn) may/may not limit populations in the nearshore. First, abundant localized energy, nutrient, and prey may increase nearshore productivity and diversity through local nutrient enrichment and increased food availability. Alternatively, an abundant supply of nutrients, energy, and food may decrease nearshore productivity and diversity through locally increased predation rates or over-nutrification. Finally, the short-term abundance of nutrients and energy may have limited or no persistent effect because trophic structure is constrained by events not related to local and seasonal super-abundance of energy, nor by the short-term intensity of predation. For example, productivity may be regulated by temperature, or trophic dynamics may determined by the severity of winter weather.

The results of this research will allow an evaluation of the strength of trophic hypotheses in explaining patterns and predicting recovery in the nearshore. Should the data continue to support trophic structure as an important factor in nearshore communities, results from this

work should clearly point to specific interactions that are most important, thereby providing information for decisions about the most appropriate restoration activities in nearshore communities. Resource users (e.g. subsistence harvesters) may gain a better understanding of energy limitation, predation, and patterns in the nearshore through the results of this research. With this improved knowledge, they may be better able and more willing to adapt to the fluctuations in nearshore communities, as populations in this habitat continue their recovery from the oil spill and respond to natural fluctuations in the environment.

C. NEED FOR THE PROJECT

This research is designed to examine how community structure in the nearshore is (or is not) limited by trophic interactions, particularly focused on seasonal energy limitation and the impact of predation. Recovery of the nearshore is no longer believed to be greatly impeded by continued hydrocarbon exposure or toxicity. Rather, ecosystem processes now determine the course of recovery, and the future structure of communities.

The EVOS Trustee Council has identified the disruption and recovery of community structure as the most pressing issue for research in the nearshore. Of hypotheses identified by nearshore researchers at the EVOS Research Priorities workshop (April 1994), most related recovery in the nearshore to trophic issues about community structure. The need has been identified for more information to understand how prey availability, competition, predation, and physical processes influence nearshore organisms. This study uses natural variation in energy and predator abundance in the nearshore to address these information needs.

D. PROJECT DESIGN

1.1. General Objectives

These projects examine how ocean circulation, environmental richness (e.g. primary productivity, influx of nutrients, food availability), and predator-prey relationships (e.g. food availability, patch use, grazing pressure, predation risk) interact to limit or structure communities. Three general hypotheses will be examined, utilizing natural localized variation in nutrient and energy supply (herring spawn) to examine processes limiting nearshore populations. At regular spawning beaches of Pacific herring, the re-current, large, short-lived input of nutrients and energy (in the form of herring feces, eggs and carcasses and feces of predators attracted by the herring) may:

(1) Increase nearshore productivity, standing biomass, and diversity through local nutrient enrichment and increased food availability;

(2) Decrease nearshore productivity, standing biomass, and diversity through locally increased predation rates or over-nutrification, or;

(3) Have limited or no persistent effect on local communities because trophic structure is constrained by events not related to local and seasonal super-abundance of energy, nor

by the short-term intensity of predation (e.g. productivity may be regulated by currents; trophic structure may be constrained by seasonal energy shortages in winter).

This set of interrelated studies will examine these specific hypotheses about the impact of energy influx and predator abundance as a means of addressing three more general hypotheses formulated at the EVOS Research Priorities workshop (April 1994). These three are (numbered as in J. Bodkin, 'Report on results of nearshore working groups...') #1, Competition/predation, #4, Limited prey, and #5, Predation. Two other trophic-related hypotheses (#2, recruitment, and #6, indirect toxicity) are not specifically addressed here, but depend upon trophic relationships in the nearshore. Hence, information collected by these studies should be of use in evaluating these hypotheses.

It will not be possible to evaluate these hypotheses related to herring spawn based on a single year of data. For this reason, a 3-5 year study is proposed. A preliminary evaluation of the first hypothesis is scheduled to be available in the first year. Preliminary results for the second and third hypotheses will be available only in later years.

1.2. Objectives for 1995

The following specific objectives will be achieved for 1995:

1) Identify specific sampling sites based on site visits and criteria listed below (Methods).

2) Design interdisciplinary nested sampling schedules to examine site characteristics at several scales.

3) Within each focal study site, and following the nested sampling design, seasonally measure (FY95 spring and summer) local availability of substrate types, sunlight, nutrients, primary productivity, and detrital influx. We will also attempt to coordinate with SEA and forage-fish oceanography studies to obtain local measures of oceanographic patterns.

4) Within each focal study site, and following the nested sampling design, seasonally measure (FY95 spring and summer) abundance and distribution of specific intertidal and shallow subtidal organisms including dominant algae, sea grasses, invertebrates, and vertebrate foragers, and nearshore plankton.

5) Use measures in objectives 3-4, in conjunction with ADF&G and SEA program measurements of herring spawn abundance, biomass, distribution, and duration to begin a preliminary evaluation of the hypotheses above.

2. Methods

Specific methods for each study are given in the project descriptions. However, a general approach to study sites and sampling designs common to all projects is laid out here.

Study sites will be stratified by the presence/absence of use by herring or sea otters, and by sampling scale. Sites will be matched by location in the Sound, exposure, and general characteristics. Two pairs of sites will differ in historical use by herring for spawn deposition. Candidates for these two pairs are northern Montegue Island paired with northern Green Island; and Bidarki Point paired with southern Bligh Island. Northern Montegue and Bidarki Point are the most consistent sites of herring spawn deposition over the past ten years. Nearby Green Island and Bligh Island beaches have received little or no spawn during the same period (E. Brown, pers. comm.). Bidarki Point and Bligh Island are located near the village of Tatitlik. We will explore opportunities at these sites for sampling designed around subsistence users and issues (e.g. factors influencing the abundance of octopus). A fifth site with low sea otter density (Herring Bay) will be matched with northern Montegue/Green Islands, which currently have a high otter density (J. Bodkin, pers. comm.). Herring Bay, Green Island and northern Montegue Island also have been the site of past and ongoing EVOS research. Substantial background data is therefore available for these sites.

Foragers in the nearshore range from sessile filter feeders to deposit feeders and grazers to highly mobile predators. These organisms move over daily or seasonal feeding ranges that vary in size by many orders of magnitude. It is therefore necessary to explicitly consider scale and foraging range when examining the nearshore system. We recognize two general classes of feeders: sessile organisms (e.g. filter feeders, some grazers and detritivores) that move slowly or not at all and feed over a small area (a few cubic centimeters to a few square meters); and mobile organisms (e.g. seastars, crabs, octopus, otters, birds) that may forage over areas from hundreds of square meters to many square kilometers. While this particular distinction is artificial, it recognizes a real difference in the scale at which organisms relate to their environment, and provides a biologically relevant framework for a spatially-nested sampling design. Further detail on spatial nesting of design are provided in the individual project descriptions.

3. Schedule

Scheduled milestones for projects are included in each project description. In general, all projects will hold to the following schedule:

Winter '95: Personnel selection and equipment procurement. Site visits and site selection, sampling design, preliminary tests of experimental protocols.

Spring '95: Preparation of proposals for FY96. On-site sampling at all sites; intensive work at herring spawn sites.

Summer '95: On-site sampling at all sites; preliminary examination of data.

4. Technical Support

See individual project descriptions for details on technical support.

5. Location

This work will be conducted in Prince William Sound. Specific focal sites under consideration are northern Montegue Island, northern Green Island, Bidarki Point, southern Bligh Island, and Herring Bay. Reasons for this choice of study sites were presented under Methods.

E. PROJECT IMPLEMENTATION

This project should be implemented by the U.S. Forest Service through the various cooperating agencies.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project involves the coordination of several research studies under this umbrella proposal. The projects are coordinated by common themes, techniques, sampling sites, and logistics. Coordination to date has been achieved through periodic workshops, and will continue both on sampling sites and via further face-to-face interactions.

We will also be coordinating data sharing with SEA and possibly forage fish/pelagic predators research projects. Collaboration with SEA will involve at least oceanography (D. Salmon, P.I.), herring projects (J. Wilcock, E. Brown, P.I.s) nearshore fish (G. Thomas, P.I.), and avian predation on herring spawn (M.A. Bishop, P.I.).

G. PUBLIC PROCESS

Public input to date has been received via the EVOS Trustee Research Priorities workshop (April 1994) and conversations about subsistence use of the nearshore with Jody Seitz and Martha Vlasoff. We welcome further public input, and anticipate opportunities to talk with members of the public at EVOS-sponsored workshops and community visits (communities near sampling sites only).

H. PERSONNEL QUALIFICATIONS

Mike Stekoll, Professor, UAF/SFOS, Juneau
Ray Highsmith, Professor, Director West Coast National Undersea Research Center, UAF/SFOS. Invertebrate biology, intertidal ecology, benthic ecology. Highsmith has supervised and participated in nearshore EVOS studies since 1989.
David Scheel, Ph.D. Associate Scientist, Prince William Sound Science Center. Predator-prey relations, foraging behavior, resource-use modeling.
Tania Vincent, Ph.D. candidate, Prince William Sound Science Center. Community ecology, resource-use modeling.
Mary Anne Bishop, Ph.D. Research Avian Ecologist, Copper River Delta Institute, US Forest Service, & Center for Streamside Studies, University of Washington. Bishop has conducted

avian research in Prince William Sound and on the Copper River Delta since 1990 on shorebirds and trumpeter swan migration ecology and on avian predation on herring spawn.

I. FY95 BUDGET($K)

A budget is attached here providing for logistical and vessel support common to all projects. Individual project budgets are contained within each project description.

FY95

Personnel	$21.3
Travel	$12.3
Services	$335.0
Commodities	$1.0
Equipment	$10.0
Total	$379.6
Overhead (@20%)	$75.9
Total Requested	$455.5
FY95 Report Writing	$14.7

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Primary Productivity as a Factor in the Recovery of Injured Resources in Prince William Sound

This study is a component of the interdisciplinary nearshore ecosystem program described in the umbrella proposal, "Trophics and Community Structure in the Intertidal and Shallow Subtidal".

Project Number: 95009-B

Project Leader: Dr. Michael S. Stekoll
University of Alaska

Lead Agency: U.S. Forest Service, Pacific Northwest Research Station

Cooperating agencies: University of Alaska Fairbanks (UAF)
Prince William Sound Science Center (PWSSC)
Alaska Department of Fish and Game (ADF&G)

Cost of Project: FY 95 $218,850
FY 96 $213,000
FY 97 $213,000

FY95 report:$78,329

Project Start Date: Oct 1, 1994

Project Duration: 3 years

Geographic Area: Prince William Sound

Contact Person: Michael S. Stekoll
JCSFOS
University of Alaska
11120 Glacier Hw
Juneau, AK 99801
(907) 465-6279
(907) 465-6447 FAX

B. Introduction

This project will investigate the production and flow of fixed carbon in the nearshore ecosystem of Prince William Sound and will determine the importance of benthic primary productivity in the recovery of injured intertidal and subtidal species. Results from this project would lay the foundation for understanding how fixed carbon is moved through the Prince William Sound nearshore system, and how this carbon flow is altered by seasonal events. The study will determine the relative importance of carbon input from phytoplankton, benthic production, terrestrial plants, and episodic transport (eg herring spawn). Understanding the flow of carbon

will increase our understanding of factors that limit recovery of nearshore organisms.

The results of the study will give information on the relative importance of the various sources of carbon that are introduced into the nearshore system. Importance is measured by the relative abundance of each source of carbon present in the higher trophic organisms. Information will also be generated on how these proportions change seasonally and how they are affected by physical and chemical processes.

From the above information it may be possible to estimate the relative importance of the various plant communities in supplying the nearshore invertebrate community with carbon. Further, a model could be created to predict the disturbance to a community if there are changes in the normal flow of carbon into the system. Such disturbances could be effected by oil spill treatment, El Nino events, winter storms, etc.

As a component of the multidisciplinary nearshore ecosystem study, "Trophics and community structure in the intertidal and shallow subtidal", this study will provide information on the availability and stable isotope values of various primary producers within the nearshore ecoystem. This proposal will provide the foundation for collaborative studies of higher trophic levels, such as the role of invertebrates in community structure and the role of mobile predators in the nearshore environment.

B. Need for the Project

Injury to the biological resources of Prince William Sound as a result of the Exxon Valdez (EVOS) oil spill have been documented since 1989. Although recovery has occurred for many species and is progressing for others, many injured resources have been listed as not recovering. The range of such injured and not recovering species includes bird, marine mammals, fish, and both intertidal and subtidal organisms.

One hypothesis for the lack of recovery for injured species is that recovery is limited by food/prey availability. Most of the injured species from the higher trophic levels (birds, fish, mammals) are predators on nearshore, marine organisms. These nearshore organisms make their living as predators themselves, as scavengers, as grazers, and/or as suspension/deposit feeders. The ultimate source of carbon/energy for all of these organisms is from primary production. In the nearshore there are four possible sources for carbon: the first three are primary production from terrestrial plants, benthic marine plants and phytoplankton, and the fourth is episodic transport of carbon. Benthic plants (seaweeds and marine grasses) provide carbon for grazers, such as littorines, urchins, and limpets. These organisms in turn serve as food for higher trophic level organisms. Populations of many of these grazers have been altered by the EVOS. Phytoplankton and organic detritus (along with zooplankton) provide carbon for suspension and deposit feeders, such as barnacles, mussels, and clams. The relative importance of these forms of carbon depend on the organisms and area of concern, but contributions from both phytoplankton and benthic plants may be important. Carbon production provided by terrestrial plants will be important in nearshore areas in the vicinity of

streams and rivers. Episodic transport could bring in carbon from areas outside of the nearshore system. Two examples of this type of transport are the annual Pacific herring spawnings in the spring and the salmon runs in the summer and fall.

A decline in primary productivity in PWS as a direct or indirect effect of the oil spill could explain the lack of recovery of some injured resources. For example, sea otters may have less prey, which feed on seaweeds, available in an area where benthic production has been depressed as a result of the spill.

This project proposes to look at primary production as one aspect of an ecosystem approach to understanding recovery of the biological resources. The general approach is to determine the relative contributions of the various sources of production into the nearshore system and also to determine whether this pattern has been altered in areas affected by the oil spill and treatment.

C. Project Design

Objectives

1. To determine the productivity and standing biomass of benthic marine plants in the nearshore.

2. To determine the productivity and biomass of phytoplankton in the nearshore.

3. To determine the organic input to the nearshore from terrestrial sources

4. To determine the relative contribution of these sources of carbon to the carbon budget of higher trophic level organisms.

5. To determine what factors may limit primary productivity in the nearshore.

Methods

Site selection. About four to six sheltered rocky sites in PWS will be selected based on intertidal and subtidal vegetation and associated communities. Areas of use by higher trophic level organisms such as sea otters, herring and birds will be targeted, if possible. Site selection will be coordinated with the nearshore study groups of the National Bioilogical Survey (NBS) and University of Alaska (UAF).

Primary productivity will be measured by C-14 fixation in situ. Productivity will be normalized both by chlorophyll content and by biomass. Determinations will be made during the period of algal blooms for phytoplankton and at quarterly intervals for benthic algae and eel grasses. Extrapolations will be made to determine the total productivity for the system on an annual basis. Water chemistry for the determination of nutrients will be performed on samples taken in and near to the selected sites. Light irradiance data will be collected as often as feasible for

correlation with productivity rates

Streams that flow into the nearshore area will be sampled for total organic carbon four times during the year. Stream flow rates and capacities will be estimated in order to estimate the total carbon input from this source.

Stable carbon isotope ratios can be used to determine the source of primary productivity used by various organisms (Duggins et al . 1989). Nitrogen isotopes can be used to look at differences in trophic feeding. Isotope ratios will be determined for the sources of carbon including phytoplankton, benthic seaweeds, detritus, particulate and dissolved organic matter and herring eggs. Additionally, stable isotope ratios (C and N) will be determined for several different organisms which use different feeding strategies. Such organisms will include a grazer, suspension feeder, detritus feeder and predator. Isotope ratios will be compared to those from the sources of carbon. The isotope ratio will be determined throughout the year in order to determine seasonal variation in feeding strategies and relative importance of carbon sources. This aspect of the study will be closely coordinated with the invertebrate and mobile predator trophic interaction studies proposed by NBS and UAF.

Schedule

Spring/95. Site selection.

June/95-June 97. Sampling for photosynthesis, nutrients, light levels and isotope ratios. These will be done four times a year at quarterly intervals. One sampling date will coincide with the spring algal bloom in March.

Data compilation and analysis will be on-going through the year. There should be a minimum of two years of sampling for estimation of year to year variation. Annual reports will be submitted by April of each year.

Technical Support

Laboratory analysis of stable isotope samples and CHN samples will be required.

Location

Field work will take place near and at selected sheltered rocky sites in Prince William Sound. Laboratory analyses will be done at the University of Alaska, both at Fairbanks and at the Juneau Center, School of Fisheries and Ocean Sciences.

E. Project Implementation

This project should be implemented by the U.S. Forest Service through the various cooperating agencies.

F. Coordination of Integrated Research Effort

This project is designed to be closely coordinated with nearshore food web studies of University of Alaska Fairbanks and the Prince William Sound Science Center, and with the nearshore trophic studies proposed by the National Biological Survey. Collaboration will occur with the SEA study through oceanography, herring projects, nearshore fish and avian predation. This study will provide information to other studies concerning how fixed carbon is routed to the nearshore organisms.

G. Public Process

Public input has been received via the EVOS Trustee Research Priorities Workshop held in April 1994 and from reviews of publications and reports from previous projects completed for the EVOS damage assessment and monitoring studies (Herring Bay monitoring and Coastal Habitat Injury Assessment studies).

H. Personnel Qualifications

Michael Stekoll. Professor of Chemistry and Biochemistry at the University of Alaska Southeast and UAF/SFOS. He has expertise in plant biochemistry, phycology and pollution biology. He has been involved since 1989 as a co-PI with Coastal Habitat Injury Assessment, Herring Bay Restoration and Monitoring and in the subtidal injury assessment projects. He has published on oil pollution effects and on nearshore ecology since 1980.

I. Budget

FY95

Personnel:	$141,000
Travel:	$ 11,400
Contractual services:	$ 7,200
Commodities:	$ 16,300
Equipment:	$ 6,500
Capital outlay:	$ 0
General administration:	$ 36,475
Total:	$218,850
Report Completion:	$78,329
Total Budget for one year with final report:	$299,179

Trophic Dynamics and Energy Flow: Impacts of Herring Spawn and Sea Otter Predation on Nearshore Benthic Community Structure

This study is a component of the interdisciplinary nearshore ecosystem program described in the umbrella proposal, "Trophics and Community Structure in the Intertidal and Shallow Subtidal".

Project Number: 95009-C

Project Leader: Raymond C. Highsmith
Institute of Marine Science
School of Fisheries & Ocean Sciences
University of Alaska Fairbanks
Fairbanks, AK 99775-7220

Lead Agency: U.S. Forest Service, Pacific Northwest Research Station

Cooperating Agencies: University of Alaska Fairbanks (UAF)
Prince William Sound Science Center (PWSSC)
Alaska Department of Fish & Game (ADF&G)

Cost of Project: FY 95: $ 217,260
Report Writing FY 95: $ 74510

Project Start Date: 1 October 1994

Project Duration: 3-5 years

Geographic Area: Prince William Sound

Contact Person: Raymond C. Highsmith, Professor
Institute of Marine Science
School of Fisheries & Ocean Sciences
University of Alaska Fairbanks
Fairbanks, AK 99775-7220

B. INTRODUCTION

Nearshore foodwebs are only partially understood and undoubtedly vary from site to site, especially with regard to source and magnitude of energy flow. The presence or absence of certain species or web connections, and the relative strengths of interactions common to most sites, are likely dependent upon source and magnitude parameters. Nearshore energy inputs are typically a mixture of local production, e.g. kelps, seagrasses and resident phytoplankton, and imported production, usually in the form of phytoplankton distributed by the overall current regime of the region.

Each spring, schools of Pacific herring enter Prince William Sound to deposit eggs on rocks, kelps and seagrasses in intertidal and shallow subtidal habitats. The herring, as well as some intertidal and subtidal organisms, have been identified as EVOS injured resources. The arrival of the herring at spawning sites marks the onset of a major, imported energy pulse at those sites. Not only are the eggs an energy source, but so are fish carcasses and fecal material as well as fecal inputs from mammalian and avian predators that track the herring. Herring densities and spawn deposits have been reduced since the EVOS and intertidal and subtidal communities have only partially recovered.

We propose to investigate the impact of herring spawning activities on intertidal and shallow subtidal foodwebs by comparing regular spawning sites with non-spawning sites. Each year, the Alaska Dept. of Fish and Game monitors the herring migration, spawning sites and the amount of spawn produced. We will cooperate with the ADF&G (E. Brown) in selection of two study sites based upon dependability of herring return and estimated magnitude of energy contribution. A non-herring site in the vicinity of each herring site will be carefully chosen for comparison. Candidates for the two pairs are northern Montegue Island paired with northern Green Island and Bidarki Point paired with southern Bligh Island. Northern Montegue and Bidarki Point are the most consistent sites of herring spawn deposition over the past ten years, while there has been little or no spawning activity at the other two sites during the same period.

In addition to the herring energy input work (bottom-up), we will investigate the impact of a dominant predator, the sea otter, on intertidal and shallow subtidal communities (top-down). Otters tend to be patchily distributed in the nearshore zone (pers. obs.). Thus, some areas are heavily utilized for foraging and others are not. Because sea otters do not have an insulating blubber layer, they depend upon their fur coat and a high metabolic rate to maintain body temperature. Consequently, daily consumption of benthic organisms by otters typically amounts to 20-30% of their own body weight. While sea otter impact on specific prey species can be locally devastating, other components of the community are likely affected also. For example, prey species such as butter clams are also utilized by the sunflower star *Pycnopodia helianthoides*. As butter clam densities are reduced, the seastar population may decline also. Sea otters are also known to prey on benthic predators such as seastars and octopus, and on sea urchins which are usually considered grazers but also scavenge and are sometimes predatory. Thus, otters impact nearshore communities at different trophic levels. In order to gain an understanding of sea otter influence on overall community structure, a heavily utilized region will be compared with Herring Bay, where otter densities are low and we have considerable information on the intertidal community. The sea otter utilization sites will be chosen in consultation with researchers working on sea otters. Initial indications (J. Bodkin, pers. comm.) are that regions on the north sides of Montegue and Green Islands being considered for the herring work (see above and multi-disciplinary umbrella proposal) will also be suitable sea otter utilization sites, possibly resulting in considerable savings.

This proposal specifically addresses the contribution of marine invertebrates to foodweb complexity (both as predators and as prey), energy transfer and community structure at matched sites as a component of the multi-disciplinary nearshore ecosystem study, "Trophics and

Community Structure in the Intertidal and Shallow Subtidal". Other components of the collaborative study will investigate nutrient supply, primary production and ecology of benthic plants, and the role of highly mobile (vertebrate) predators in the nearshore environment.

C. NEED FOR THE PROJECT

Pacific herring, intertidal organisms (some), subtidal organisms (some) and sea otters are considered to be not recovering from the EVOS (Table 1, ISRP-FY95). These groups are the main focus of this research proposal. Determining the course of energy flow through a community should reveal important structuring mechanisms. Understanding structuring mechanisms is necessary to distinguish between spill-related and natural changes in communities and to predict recovery rates and acceptable end-points. In cases of non-recovery, this knowledge may be critical. For example, normal mass spawning of herring probably swamps out local predators on both fish and eggs. With a greatly reduced spawning population, the relationship may be reversed, with fish, eggs and larvae so heavily preyed upon by the concentration of predators that recovery is further inhibited. Determining the effect of the herring-related energy pulse on the nearshore community should provide insights into how the source (type) and magnitude of energy inputs impact community structure and dynamics. Do kelp recruitment success and growth rates increase due to the enhanced nutrient (feces, carcasses, failed eggs) supply, resulting in damped onshore water motion and reduced food supply for filter feeders such as mussels and barnacles (Estes & Palmisano 1974), and reduced larval supply for recruitment of intertidal organisms (Gaines & Roughgarden 1987). If primary production is enhanced, will local grazer densities increase and will grazers such as sea urchins switch to herring eggs when available? Numerous other examples could be given. The herring-based energy pulse in local habitats may serve as a tracer, revealing important aspects of herring biology and nearshore community ecology.

With regard to sea otters, do they so broadly depress invertebrate prey populations that nearshore benthic communities are recruitment driven? Is the distribution of sea otters dependent upon the availability of certain prey species? Were densities of key members of the prey-species list reduced by the oil spill? Does the presence of otters invariably result in alternate communities (e.g. kelp vs no kelp via predation on sea urchins) as suggested in the literature (Estes and Palmisario 1974, Duggins 1989). Do non-prey species increase in abundance when prey populations are depressed? For example, do infaunal polychaete worm populations increase when butter and steamer clam densities are substantially reduced? And can the worms prevent recolonization by clams through predation on newly settled clam larvae or juveniles? To what extent can varying concentrations of sea otters be sustained by the nearshore benthic community? Again, there are many important questions surrounding the role of sea otters in the nearshore environment and tracking energy flow should provide a framework for investigating non-recovery of both the otters and impacted components of the intertidal and subtidal communities.

Literature Cited

Duggins, D.O.,C.A. Simenstad, and J.A. Estes. 1989. Magnification of Secondary Production by Kelp Detritus in Coastal Marine Ecosystems. Science 245:170-173.

Estes, J.A., and J.F. Palmisano. 1974. Sea otters: their role in structuring nearshore communities. Science 185:1058-1060.

Gaines, S.D., and J. Roughgarden. 1987. Fish in Offshore Kelp Forests Affect Recruitment to Intertidal Barnacle Populations. Science 235:479-481.

D. PROJECT DESIGN

The general objectives of the herring spawn deposition study are given in the over-arching proposal, Trophics and Community Structure in the Intertidal and Shallow Subtidal. Briefly, three major hypotheses are presented: 1) localized energy inputs related to the spawn deposition increase productivity, standing crop and diversity; 2) mobile predators initially attracted by the spawn activities reduce standing crop and diversity by preying on less mobile resident species; and 3) the herring-related energy inputs have no lasting effect on the community. The objectives of the study relative to sea otter site utilization are to examine the impact of sea otter predation on benthic community structure, including changes in the food web and major energy pathways.

Objectives

Specific objectives for 1995 include:

1. Establish study sites based on visits to candidate sites by the interdisciplinary team. See umbrella proposal for discussion of criteria.

2. Design interdisciplinary nested sampling schedules to examine site characteristics at several scales.

3. Within each focal site, measure abundance and distribution of specific intertidal and shallow subtidal invertebrates, particularly those preying on herring eggs, preyed upon by sea otters or having a major role in energy transfer or community structure.

4. Conduct stable isotope analyses (C, N and possibly S) on tissue samples of invertebrates as part of the overall effort to develop foodweb models at the study sites. Criteria for selecting species will be same as in No. 3.

5. Determine which invertebrates prey on herring eggs.

6. Determine which invertebrates prey on invertebrates in No. 5. Do the species change with habitat type?

7. Determine if benthic secondary productivity is enhanced by fecal inputs from herring and predators drawn to the spawn site.

8. Determine if mobile predators drawn to the spawn sites have a negative effect on the local invertebrate community. Rather than benefitting from the energy pulse, resident invertebrates may be subjected to unusually intense predation by the concentration of mobile predators. For example, groups of gulls have been observed vigorously attacking the large seastar, *Pycnopodia helianthoides*, during low tides (E. Brown, pers. comm.). Seastars are ripe in the spring, making them an energetically rewarding prey item.

Objectives 1 and 2 will be completed in 1995. Studies will be initiated in FY95 to address the other objectives but will extend into FY96 and FY97 before completion.

Methods

As indicated in the objectives section, sites will be selected jointly by the principal investigators after visiting the candidate sites and consultation with other researchers working on herring spawning activities and sea otters.

Densities of herring egg predators, sea otter prey species and species having a significant role in energy flow at the study sites will be determined using a nested sampling design integrated with other components of the study. To the extent possible, densities of target species will be determined in the field. Distributions will be related to substrate and habitat type, particularly with regard to those utilized by herring for egg deposition and otters for foraging.

Tissue samples of the species of interest will be collected and analyzed for carbon and nitrogen stable isotope ratios to investigate energy flow pathways and relative strength of foodweb linkages. Stable isotope data on herring eggs will be provided by E. Brown (ADF&G). In addition, direct observations of feeding activities will be made and quantified where possible. Gut contents or fecal material of freshly collected invertebrate predators, including suspected herring egg predators, will be examined (undigested material and hard parts can often be identified and our laboratory has considerable experience with this type of work). Feeding experiments will be conducted at the University's Kasitsna Bay Laboratory to determine prey choice of certain invertebrate predators, particularly potential herring egg predators such as *Strongylocentrotus droebachiensis* (green urchin), *Pycnopodia helianthoides* (sunflower seastar), *Leptasterias hexactis* (seastar), *Fusitriton oregonensis* (hairy triton), *Nucella* spp. (whelks), and the common crabs *Cancer oregonensis* and *Telmessus cheiragonus*. For example, feeding experiments will be conducted with amphipods. Preliminary examination of benthic quadrat samples collected by ADF&G at herring spawn sites indicates that amphipods (6 families) are abundant, including lysianassids which are well known predators and scavengers. *Leptasterias hexactis* and juvenile *P. helianthoides* also occurred in the quadrat samples. Field manipulations (transplants, enclosures, exclosures, etc.) will not be attempted in 1995 but may

be included in study plans for subsequent years based upon 1995 results.

Densities and size-frequency distributions of major sea otter prey species (*Saxidomus giganteus, Protothaca staminea, Mya truncata, M. arenaria, Macoma spp., Telmessus cheiragonus* and mussels) will be determined at the low and high otter usage sites.

At soft-bottom herring spawn sites, sediment samples will be collected for CHN analyses in comparison with samples from non-spawn sites. Collections before, during and after the spawning activity should reveal whether there is organic enrichment through transport of herring and herring predator fecal material. Densities of infaunal organisms will also be compared between sites.

Schedule

Winter, 1995: Personnel selection, purchase supplies and materials, team planning workshop

Spring, 1995: Site visits and site selection, preliminary tests of experimental protocols, initiate study (especially at herring spawn sites), begin feeding studies and isotope analyses

Summer, 1995: Data collection and sampling at study sites, feeding studies, isotope analyses, preliminary examination of data

Sampling will be conducted quarterly. Report writing will be ongoing throughout the year with annual report submission in April of each year.

Technical Support

Stable isotope and CHN analyses will be conducted at the Institute of Marine Science, UAF. We are experienced at conducting these analyses. Sufficient replicate samples will be analyzed to meet statistical requirements. Computer services and data management will be provided by IMS.

Location

The work will be conducted in Prince William Sound. Study sites under consideration are northern Montegue Island, northern Green Island, Bidarki Point, southern Bligh Island and Herring Bay. Reasons for considering these sites were presented in the Methods section.

E. PROJECT IMPLEMENTATION

This project should be implemented by the U.S. Forest Service through the various cooperating agencies.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is part of a coordinated study (see umbrella proposal entitled "Trophics and Community Structure in the Intertidal and Shallow Subtidal") to be conducted by scientists from the University of Alaska, Prince William Sound Science Center and the U.S. Forest Service. The herring related work will be done in close collaboration with ADF&G (E. Brown), including some data sharing and sample collecting. The work will also be coordinated with vertebrate predator studies in the NBS program. Collaboration will also occur with the SEA study through physical oceanography, herring, nearshore fish and avian predation studies.

G. PUBLIC PROCESS

Public input has been received via the EVOS Trustee Research Priorities Workshop held in April 1994 and from reviews of publications and reports from previous projects completed for the EVOS damage assessment and monitoring studies (Herring Bay Experimental and Monitoring Study and Coastal Habitat Study No. 1).

H. PERSONNEL QUALIFICATIONS

Dr. Highsmith is a Professor of Marine Science at the Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, and teaches graduate courses in marine biology and on the biology and ecology of marine invertebrates. Dr. Highsmith has conducted studies on marine invertebrates since 1970 and has been involved in EVOS studies, both experimental and monitoring, since 1989. Project personnel include S. Saupe, who has a M.S. degree in stable isotope studies, and T. Rucker who has a M.S. degree in marine invertebrate ecology. Rucker has been involved in EVOS studies since 1989 and Saupe since 1990. Other technical staff have been involved in EVOS studies since 1990.

I. Budget

FY95

Personnel	$ 123,558
Travel	$ 10,168
Services	$ 20,000
Commodities	$ 6,500
Equipment	$ 15,000
Student Aid	$ 4,824
Total	$ 181,050
Overhead (@20%)	$ 36,210
Total Requested	$ 217,260
FY95 Report Writing	$ 74,510

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Survey and Experimental Enhancement of Octopuses in Intertidal Habitats

This study is a component of the interdisciplinary nearshore ecosystem program described in the umbrella proposal, "Trophics and Community Structure in the Intertidal and Shallow Subtidal".

Project Number: 95009-D

Project type: Research/Monitoring

Name of project leader(s): Dr. David Scheel, Prince William Sound Science Center
Dr. Raymond Highsmith, West Coast National Undersea Research Center

Lead agency: U.S. Forest Service, Pacific Northwest Research Station

Cooperating agencies: University of Alaska Fairbanks
Prince William Sound Science Center
Alaska Department of Fish & Game

Cost of Project: **FY95:** $154.8K

Start-up/Completion Dates: FY95 October 1, 1994 - September 30, 1995

Duration: 2-5 years

Geographic area of project: Prince William Sound

Contact:

Dr. David Scheel
PWS Science Center
P.O. Box 705
Cordova, AK 99574
Tel: (907) 424-5800

- or -

Dr. Raymond Highsmith, Director
West Coast National Undersea Research Center
School of Fisheries & Ocean Sciences
210A O'Neill
University of Alaska, Fairbanks
Fairbanks, AK 99775-7220
Tel: (907) 474-7836

B: INTRODUCTION

Nearly 90% of the residents of Tatitlek, Chenega Bay, and Cordova used marine invertebrate subsistence resources prior to the *Exxon Valdez* oil spill (Seitz, unpublished MS; data on individual species were not presented). Some portion of these marine invertebrates are octopus, traditionally harvested from their dens in the intertidal zones by subsistence users. Subsistence users in Prince William Sound have noted apparent declines in octopus and other species (e.g. gumboot chiton) since 1989. Although no connection to damage by oil has been established, the decline of these mollusks following EVOS further reduces subsistence resources available for residents in the EVOS affected area. This proposal is for funds to survey intertidal octopus and gumboot chiton densities at several sites, provide information on habitat use and distribution for these species, and explore the potential of artificial dens as a cost-

effective survey technique and as a way to enhance local octopus density.

Oil from the *Exxon Valdez* had a large impact on organisms in intertidal areas. As populations in these areas respond to this disturbance, the composition of intertidal communities may change dramatically. This will affect all species using the intertidal, not only those documented as injured by exposure to the oil. Changes in the abundance of many species are to be expected in these circumstances. In addition to mollusk declines, noted changes include, among many others, local declines in sea otter abundances (Garrott, et al. 1993) and increases in opportunistic algae.

Octopuses and chitons are both important prey of sea otters in areas where high otter density has persisted over several years (Reidman & Estes, 1988). Declines in octopuses may therefore be a result of changes in sea otter density over recent decades. Alternatively, if octopuses were adversely affected by *Exxon Valdez* oil, their decline may result in less food for recovering otter populations. Octopuses are also efficient predators on other invertebrates and small fish in the intertidal, and may be an important element in the intertidal trophic structure.

The extent, severity, and cause of octopus declines are not known. Nor is it known if changes in the abundance of these mollusks will adversely affect the recovery of other intertidal species. Without information of this type, the course of recovery of octopus in the intertidal cannot be predicted, nor can this resource be managed as effectively as possible.

C. NEED FOR THE PROJECT

Octopuses and chitons are included as injured, non-recovering species under the general headings of Subtidal Organisms and Intertidal Organisms. Subsistence use of these resources in Prince William Sound has resulted in the knowledge that these species have declined in apparent abundance. The extent, severity, and cause of these declines are unknown, but comprise a part of the decline in subsistence services.

This project proposes a survey of these species to initially assess the extent of declines, as well as a test of potential monitoring and restoration of octopus through artificial den construction. Information from this study will be conveyed to subsistence users.

D. PROJECT DESIGN

1.1. General Objectives

The overall purpose of this project is to assess site-to-site variability in octopus density as indicated by use of natural intertidal dens, to measure habitat associations of octopus in the intertidal, and to test artificial den placement as a means of 1) surveying octopus densities and 2) enhancing octopus densities. As a secondary goal, we will survey chiton density during octopus surveys.

1.2. Objectives for 1995

For 1995, sampling will be focused at the sites of the 'Trophics and community structure in the intertidal and shallow subtidal' (TCSISS) projects, in order to share costs with those projects. An additional survey site will be identified that has been harvested in recent years. Once successful techniques are developed from the 1995 work, sites designed to monitor octopus in other subsistence areas may be added.

1) Consult with subsistence users in Tatitlek to improve study design, identify a suitable survey site with a history of harvest, and recruit collaborators. Tatitlek is chosen here because of its proximity to TCSISS sites identified for sampling.

2) Conduct seasonal surveys of octopus use of natural dens in intertidal areas during low tides. Measure distribution and density of gumboot chiton in the same areas.

3) Test short-term placement of artificial octopus dens as a technique to survey local octopus density.

4) Test long-term placement of artificial octopus dens as a technique to enhance local octopus density.

5) Examine octopus distribution and density in light of results from this and other TCSISS projects to formulate specific hypotheses about factors constraining octopus abundance at sampling sites.

2.1 Methods

1) In collaboration with Jody Seitz (SEA Planning and Communications), involvement of subsistence users of octopus will be solicited for the goals stated above.

2) At low tide, foot surveys will be conducted along transects for occupied intertidal octopus dens. Potential and occupied den locations along a survey will be noted to estimate the proportion of den sites that appear to be occupied. Surveys will be stratified according to habitat types identified in the 'Mobile Foragers' and other TCSISS projects. At each location, local octopus density will be assumed constant over a period of a few days, and repeated surveys will be used to estimate variance in the sampling technique.

3) Octopus are known to use artificial structures as temporary den sites (e.g. Reidman & Estes 1988). We will design artificial dens and place them in the intertidal and shallow subtidal to evaluate the placement of artificial dens as an octopus survey technique. Octopus should use the dens, and artificial den occupancy will then serve as an indicator of local octopus density, much as a trapping grid can indicate rodent density in a grassland.

4) If suitable den sites are limiting to octopus, the addition of permanent dens to areas with few octopus should enhance octopus density. We will artificially increase den availability in restricted areas and evaluate the cost-effectiveness of this technique to locally increase octopus density.

5) If dens are known to be utilized, yet do not increase octopus density over time, this strongly suggests that octopus density is limited by prey availability or recruitment, and not by den availability or predation. Results from this survey and other TCSISS projects will be used to develop testable hypotheses about the cause of apparent declines in octopus and/or gumboot chiton.

Den selection as a survey tool presents several challenges to the researcher. First, artificial dens must be designed to be suitable, or octopuses will not utilize them. However, it is relatively simple to design artificial dens that octopuses will inhabit, the requirements being that the den be opaque and have an enclosed space with a narrow opening. In addition, because sea otters will prey on octopuses denning in containers such as aluminum soda cans, we will make artificial dens which resist attack by sea otter. Second, if artificial dens are preferred to natural dens, octopus may abandon traditional dens to use artificial ones. In the extreme, this may mean that we find 100% occupancy of artificial dens over a wide range of local octopus densities. However, this effect will be clearly discernable from the survey results, and experimental design can be manipulated (design and density of artificial dens) to minimize it. Further, experiments with artificial den placement along census transects will be used to estimate octopus preference for artificial over naturally-occurring dens. Finally, if additional dens successfully enhance octopus densities, we must evaluate den placement as a survey technique in light of the knowledge that den placement increases octopus use of the area. When using dens to estimate local octopus density, this effect will be minimized by the limiting the duration that dens are in the water. Over the short term, artificial dens are likely be occupied by octopus already in the area, indicating local density.

Artificial dens may enhance local octopus density under two conditions: first, if den availability limits recruitment of juvenile octopus to an area; and second, if predation limits octopus densities and den availability limits predation rates on octopus. Dens will fail to enhance octopus density if den availability does not limit recruitment, does not limit predation rates or if neither recruitment nor predation rates limit octopus densities. Hence, results of experimental den enhancement will guide the formulation of specific hypotheses about octopus declines.

2.2 References

Garrott, R. A., L. L. Eberhardt, and D. M. Burn. 1993. Mortality of sea otters in Prince William Sound following the Exxon Valdez oil spill. Marine Mammal Science 9(4):343-359.

Reidman, M. L., and J. A. Estes. 1988. A review of the history, distributions and foraging ecology of sea otters. Pages 4-21 in: G. R. VanBlaricom and J. A. Estes, editors. Ecological Studies, 65: The community ecology of sea otters. Springer-Verlag, New York.

Seitz, J. L. Unpublished ms. Subsistence production in Prince William Sound.

3. Schedule

Winter '95: Personnel selection and equipment procurement. Site visits and site selection, laboratory design of artificial dens, preliminary tests of experimental protocols. Initiate visits and collaboration with subsistence users of octopus and chiton.

Spring '95: Foot and artificial den surveys; habitat mapping. Experimental assessment of den preference.

Summer '95: Foot and artificial den surveys; habitat mapping. Experimental assessment of den preference. Experimental test of artificial dens as octopus enhancement tool. Preliminary examination of data.

Sept-Oct '95: Additional surveys

Nov 30 1995: Draft report

Jan 30 1996: Final report

4. Technical Support

In order to meet the stated goals, this project will need access to community knowledge of local harvest sites and site history. This will most likely be solicited from Tatitlek.

5. Location

This work will be conducted in Prince William Sound. Specific focal sites under consideration are northern Montegue Island, northern Green Island, Bidarki Point, southern Bligh Island, and Herring Bay. Reasons for this choice of study sites are presented in a cover document 'Trophics and community structure in the intertidal and shallow subtidal'.

E. PROJECT IMPLEMENTATION

This project should be inplemented by the U.S. Forest Service through the various cooperating agencies.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is part of the "Trophics and Community structure in the intertidal and shallow subtidal" (TCSISS) program and will share logistics, personnel and study sites with other TCSISS projects. Data and results will be shared among these projects. Each project therefore benefits from additional knowledge of a sampling site that would not otherwise have been collected.

This project shares a goal, that of understanding factors constraining a predator's use of habitats, with the project 'Community structure of mobile foragers using the nearshore'. Both projects will share a PI (D. Scheel) and both will rely upon the same logistics for sampling.

Air and boat transportation necessary to get researchers to remote locations in PWS will

be shared with other projects having similar needs.

G. PUBLIC PROCESS

This proposal is a direct result of public input received via the EVOS Trustee Research Priorities workshop (April 1994) and conversations about subsistence use of the nearshore with Jody Seitz (currently ADF&G Subsistence) and Martha Vlasoff. The project is designed to solicit and support collaboration with subsistence users to sample a study site with a historical harvest of octopus. We welcome further public input, and anticipate opportunities to talk with members of the public at EVOS-sponsored workshops and community visits (communities near sampling sites only).

H. PERSONNEL QUALIFICATIONS

David Scheel, Ph.D. Associate Scientist, Prince William Sound Science Center. Predator-prey relations, foraging behavior, resource-use modeling and habitat selection.
Ray Highsmith, Professor, Director West Coast National Undersea Research Center, UAF/SFOS. Invertebrate biology, intertidal ecology, benthic ecology. Highsmith has supervised and participated in nearshore EVOS studies since 1989.

I. FY95 BUDGET($K)

	FY95 PWSSC	UAF	FY96 PWSSC	UAF
Personnel	$79.0	$6.6	$79.0	$6.6
Travel	$15.3	$3.3	$15.3	$3.3
Contractual	$10.9	$0.0	$10.9	$0.0
Commodities	$10.7	$0.0	$9.0	$0.0
Equipment	$7.1	$0.0	$7.1	$0.0
Total direct costs	$123.0	$9.9	$121.3	$9.9
Indirect costs (20%)	$24.6	$2.0	$24.3	$2.0
sub-totals	$147.6	$11.9	$145.6	$11.9
Project Total		$159.5		$157.5

Community Structure of Mobile Foragers using the Nearshore.

This study is a component of the interdisciplinary nearshore ecosystem program described in the umbrella proposal, "Trophics and Community Structure in the Intertidal and Shallow Subtidal".

Project ID number: 95009--E

Project type: Research/Monitoring

Name of project leader(s): Dr. Mary Anne Bishop, Copper River Delta Institute, US Forest Service & Univ. Washington;
Tania Vincent, Prince William Sound Science Center
David Scheel, Prince William Sound Science Center

Lead agency: U.S. Forest Service, Pacific Northwest Research Station

Cooperating agencies: Prince William Sound Science Center
University of Alaska Fairbanks (UAF)
Alaska Department of Fish & Game (ADF&G)

Cost of Project: **FY95:** $280.5 K

Start-up/Completion Dates: FY95 October 1, 1994 - September 30, 1995

Duration: 2-5 years

Geographic area of project: Prince William Sound

Contact:
Tania Vincent
PWS Science Center
P.O. Box 705
Cordova, AK 99574
Tel: (907) 424-7437
Tel: (907) 424-5800 msg.

-or-

Dr. Mary Anne Bishop
Copper River Delta Institute
U.S. Forest Service
P.O. Box 1460
Cordova, AK 99574
Tel: (907) 424-7212

B: INTRODUCTION

Intertidal and shallow subtidal habitats provide important resources to many species and services injured in the *Exxon Valdez* oil spill (EVOS). At higher trophic levels, species using these habitats depend on nearshore marine organisms as prey resources. For example, juvenile fish, sea otters, harlequin ducks, and humans all feed on resources in the nearshore. Understanding changes in nearshore communities and the trophic structure of these communities has been identified as a research priority by the EVOS Restoration Office and is the focus of five hypotheses developed by the Nearshore Working Group.

This study is a component of the proposed program "Trophics and community structure in the intertidal and shallow subtidal (TCSISS)". It specifically addresses TCSISS hypotheses regarding the role and intensity of predation by mobile foragers in trophic food webs. The community of mobile nearshore predators includes birds, mammals, fish, and some invertebrates such as crabs and octopus. Three questions will be addressed in this context: First, what characteristics of the nearshore environment provide suitable foraging habitats for mobile intertidal foragers? Second, how effectively do foragers use these habitats? That is, what are the relative foraging efficiencies of mobile foragers, particularly birds. Third, what is the intensity of habitat patch use by these foragers and how are variations in habitat use reflected in the community structure, productivity or abundance of their prey?

This study is focused on avian and mammal foragers in the nearshore. Some work on invertebrates will be conducted in conjunction with the TCSISS projects "Survey of octopuses" (Scheel & Highsmith) and "Trophic dynamics and energy flow" (Highsmith) where techniques in this project are applicable. Fish will not be not considered here because the techniques we plan to use are not suitable to also sample fish habitat use.

Mobile foragers in the nearshore may have a large effect on distribution and abundance of their prey (VanBlaricom & Estes 1988; Kvitek & Oliver 1988). High predation intensity can deplete the abundance of preferred prey, sometimes resulting in dramatic changes in primary and secondary production, trophic structure, and predator populations in the nearshore ecosystem (VanBlaricom & Estes 1988; Duggins, et al. 1989). Dramatic changes in the availability, distribution or density of prey can also impact predator populations. Predator response can include prey switching (that may in turn adversely effect alternative prey), changes in habitat or patch use, and changes in population size or growth rates.

Hence, understanding the patterns of foraging and habitat use of intertidal mobile foragers is necessary to predicting and facilitating the recovery from EVOS injury of these foragers and of their intertidal and subtidal prey. This project will provide information on the relative intensity of habitat use, and provide insight to the factors influencing use of the intertidal and shallow subtidal by an important group of nearshore foragers.

C. NEED FOR THE PROJECT

This project is designed to examine how community structure in the nearshore is (or is not) impacted by the community of mobile predators that forage in intertidal and shallow subtidal areas. This group of predators includes several injured species (harlequin ducks, marbled murrelet, sea otters, black oystercatchers, bald eagles, and river otters) that feed on other injured resources (pacific herring, intertidal and subtidal organisms). This community of predators and prey contribute to injured services including commercial fishing, tourism, subsistence and passive use.

Seven major hypotheses about processes limiting recovery of nearshore groups of injured resources that were identified at the EVOS research priorities workshop. Five hypotheses are directly related to the trophic structure of nearshore systems. Of these five, three (competition/

predation, limited prey, predation) hypothesize that predator-prey relationships, as described by prey choice, patch or habitat use, and population regulation, may limit recovery of resources in the nearshore. This study will provide information designed to begin to test these and related hypotheses about community processes in the nearshore.

D. PROJECT DESIGN

1.1. General Objectives

This project is designed with three objectives: first, to identify critical habitat components for the community of mobile foragers in the intertidal ecosystem (primarily birds and some mammals); second, to measure the relative foraging efficiencies of species feeding in mixed-species aggregations; and third, to measure intensity of patch use at the study sites and estimate the general impact of these species on intertidal habitats.

These objectives relate directly to testing the three TCSISS hypotheses. Identifying critical components of habitat for foragers in the nearshore will be necessary to evaluate how the hypothesized increase in productivity from energy and nutrient input (herring spawn) affects mobile forager diversity. Relative foraging efficiencies can be used to indicate the importance of competitive versus predation effects on communities. Finally, patch use intensity and the general impact of predation must be known to examine the hypothesis that local intense predation limits nearshore recovery.

1.2. Milestones for 1995

Critical habitat components:

1) Record characteristics of habitat patches, including location, substrate type, and dominant sessile organisms (e.g. sea grasses, algae, mussels) at chosen study sites.

Relative foraging efficiencies:

2) Sampling seasonally within each site, record size and composition of foraging aggregations observed in nearshore habitats. For aggregations persisting less than several hours, record arrival and departure sequence of foragers. Within aggregations, sample behavior to measure capture rates for avian diving foragers that regularly bring prey to the surface (for sea otters, foraging behavior will be assessed in another project in "Processes structuring recovery of injured nearshore vertebrate predators in Prince William Sound").

3) Test experimental feeding trays as a method to measure relative efficiencies, costs, and risks associated with foraging.

Survey patch use:

4) Within each study site, seasonally survey the abundance and distribution of specific birds and mammals using intertidal and shallow subtidal habitats.

5) Examine data collected under Milestones 1-4 to provide a preliminary characterization of

important habitat components, foraging efficiencies and intensity of habitat use.

It will not be possible to fully characterize use of nearshore habitats by the community of mobile predators based on a single year of data. For this reason, a 2-5 year study is proposed. A preliminary evaluation of the data will be available following the first year.

2.1 Methods

1) Characteristics of habitat patches: Broad category shoreline sensitivity indices will be obtained from an existing GIS data base. In combination with sampling efforts of other TCSISS projects, shoreline habitats at each study site will be mapped by boat and (where appropriate) foot surveys at low tide. Substrate, physical features, and dominant plant and sessile animal populations will be noted.

2) Size and composition of foraging aggregations: Foraging aggregations will be observed from a small boat, or from shore. All foragers present (including potential secondary predators on foragers) will be counted and identified to species if possible, or to species group, and foraging behaviors noted. Some aggregations will also be videotaped for later counting to check on-site estimates and to allow focal-animal sampling of feeding behaviors. Repeated counts throughout the observation period will be used to record arrival and departure sequence.

3) Feeding trays: Feeding trays containing sieved substrate and a known amount of food items will be placed at sampling stations. Three trays will be used at each station, placed in a line perpendicular to the shoreline, at fixed distances from shoreline cover. Trays will be left in place for approximately one-half tidal cycle (from the retreat of the tide at the lowest tray until its return at that site). Presence and species of foragers visiting each tray will be recorded from tracks in the tray. Tray contents will be sieved at the end of each trial. Remaining food items will be recovered and weighed. Similar techniques have been successfully used to measure bird (e.g. Lima 1988) and mammal (e.g. Brown 1988) feeding efficiencies, but this technique has not yet been tested on intertidal foragers.

4) Survey: The relative abundance and species composition of birds and marine mammals foraging in the nearshore will be documented using shoreline transects. Nearshore boat transect surveys will be conducted both at low and high tide along a 15-km length of shoreline. Transect width will extend from the shoreline seaward to 120m. Shorelines will be divided into transects based on habitat types (see #1 above) and natural landmarks. Data collected will include: location, number and species (or genus), shoreline type, foraging behavior, and habitat (land, water, or air). Transects will be surveyed using methodologies as in 94320-Q SEA: Avian Predation on Herring Spawn (adapted from USF&WS marine bird and mammal surveys, 1993).

2.2 References

Brown, J. S. 1988. Patch use as an indicator of habitat preference, predation risk, and competition. Behavioral Ecology and Sociobiology 22:37-47.

Duggins, D. O., C. A. Simenstad, and J. A. Estes. 1989. Magnification of secondary production by kelp detritus in coastal marine ecosystems. Science 245:170-173.

Kvitek, R. G., and J. S. Oliver. 1988. Sea otter foraging habits and effects on prey populations and communities in soft-bottom environments. Pages 4-21 in: G. R.

VanBlaricom and J. A. Estes, editors. Ecological Studies, 65: The community ecology of sea otters. Springer-Verlag, New York.

Lima, S.L. 1988. Initiation and termination of daily feeding in dark-eyed juncos: influences of predation risk and energy reserves.

Reidman, M. L., and J. A. Estes. 1988. A review of the history, distributions and foraging ecology of sea otters. Pages 4-21 in: G. R. VanBlaricom and J. A. Estes, editors. Ecological Studies, 65: The community ecology of sea otters. Springer-Verlag, New York.

U.S. Fish and Wildlife Service. 1993. Observer manual for boat surveys for marine birds. Migratory Bird Management, Anchorage, Alaska.

VanBlaricom, G. R. and J. A. Estes, editors. Ecological Studies, 65: The community ecology of sea otters. Springer-Verlag, New York.

3. Schedule

Nov-Dec 94: Personnel selection and equipment procurement. Preliminary site visits if feasible depending on funding date.

Winter 95: Site visits and site selection, preliminary tests of experimental protocols. Initial field sampling.

Spring 95: Preparation of proposals for FY96. On-site sampling at each site; intensive foraging observations and transect surveys. Feeding tray experiments at each site.

Summer 95: On-site sampling at all sites; preliminary examination of data.

Fall 95: Continued sampling at all sites; data analysis and write-up begins.

4. Technical Support: None

5. Location

This work will be conducted in Prince William Sound. Specific focal sites under consideration are northern Montegue Island, northern Green Island, Bidarki Point, southern Bligh Island, and Herring Bay. Reasons for this choice of study sites are presented in a cover document "Trophics and community structure in the intertidal and shallow subtidal".

E. PROJECT IMPLEMENTATION

This project should be implemented by the U.S. Forest Service and should be conducted by the Copper River Delta Institute (CRDI) and Prince William Sound Science Center. This project is closely related to and builds on work conducted by Mary Anne Bishop at CRDI (94320Q SEA: Avian Predation on Herring Spawn). The theoretical basis for work proposed here developed from Science Center staff's (D. Scheel, PI and T. Vincent, PI) past work and interaction with colleagues (e.g. Vincent, Scheel, Brown & Vincent. In prep. Tradeoffs and coexistence in consumer-resource models: it all depends on what you eat.).

This work will utilize data from work proposed under both the SEA program and Pelagic Predator project. Close interaction and access to SEA researchers and data make the Copper River Delta Institute and the PWS Science Center an appropriate choice.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is part of the Trophics and community structure in the intertidal and shallow subtidal (TCSISS) integrated study program. It also is designed with input from the SEA program, and the Pelagic Predators work group and complements research proposed within those groups. Both PIs of the proposed work has been and will continue to be active participant in SEA and EVOS Trustee meetings to integrate research.

G. PUBLIC PROCESS

Public input to date has been received via the EVOS Trustee Research Priorities workshop (April 1994). We welcome further public input, and anticipate opportunities to talk with members of the public at EVOS-sponsored workshops and community visits (communities near sampling sites).

H. PERSONNEL QUALIFICATIONS

Mary Anne Bishop, Ph.D. Research Avian Ecologist, Copper River Delta Institute, US Forest Service, & Center for Streamside Studies, University of Washington. Bishop has conducted avian research in Prince William Sound and on the Copper River Delta since 1990 on shorebirds and trumpeter swan migration ecology and on avian predation on herring spawn.

Tania Vincent, Ph.D. candidate, Prince William Sound Science Center. Community ecology, resource-use modeling.

David Scheel, Ph.D. Associate Scientist, Prince William Sound Science Center. Predator-prey relations, foraging behavior, resource-use modeling.

I. BUDGET (Amounts shown in thousands).

	FY95 USFS	PWSSC	FY96 USFS	PWSSC
Personnel	$80.4	$78.4	$83.0	$78.4
Travel	$3.5	$4.6	$3.5	$4.6
Contractual	$1.5	$8.7	$1.5	$8.7
Commodities	$10.9	$11.1	$7.4	$7.3
Equipment	$26.0	$18.9	$0.2	$0.0
Total direct costs	$122.3	$121.7	$95.6	$99.0
Indirect costs (20%)	$12.2	$24.3	$12.6	$19.8
sub-totals	$134.5	$146.0	$108.2	$118.8
Project Total		$280.5		$227.0

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Intertidal Fauna and Flora Species Composition, Abundance and Variability Relative to Physical Habitat Controls

Project #: 95010

Principal Investigator:
Dr. Megan N. Dethier
University of Washington
Friday Harbor Labs
Friday Harbor, WA. 98250
Tel: 206-378-2165
Fax: 206-543-1273
Internet: megand@fhl.washington.edu

Estimated Project Costs for Fiscal Year 1995: $75,000

Proposed Project Startup Date: October 1, 1994

Proposed Completion Date (including report writing): November 30, 1995

Proposed Geographic Area: Katmai National Park and Preserve

Contact Person:
Carl Schoch
Oregon State University
College of Oceanic and Atmospheric Science
Corvallis, OR 97331
Tel: 503-737-3504
Fax: 503-737-2064
Internet: cschoch@oce.orst.edu

Introduction

In April, 1989, the National Park Service contracted intertidal ecologists to conduct pre-assessments of park shorelines that seemed to be in the path of the oncoming EXXON Valdez oil spill. The task was daunting since the shoreline was tremendously variable in biological assemblages and it was uncertain where the oil would contact shore. The intertidal algae and fauna were surveyed at 16 sites for potential baseline information on the pre-oiled intertidal communities. With little knowledge of the shoreline, the sites were picked arbitrarily based on accessibility, substrate type, relocation, and replication along exposure gradients (strictly for the purposes of determining pre-oiled conditions) (Duggins, and Miller, 1990). The oil, however, only stranded sporadically along the Kenai Fjords and Katmai coasts, and none of the surveyed beaches was contaminated. Thus, although important information was gathered on a coast with virtually no baseline data, the objective of establishing a pre-oiled condition was not accomplished because no method existed to compare the surveyed sites to the oiled sites.

In the years since the spill, we have developed a procedure to link specific intertidal fauna/flora communities to physical habitats. This has significant application to the coast of Alaska, which has sparse biological transect data but, in some areas, considerable

geomorphological information. With comprehensive geomorphological data now available for much of the spill area, statistical inference can be made from a limited series of biological transects to a broader area. The results of the study outlined by this proposal will:

1. Provide information to quantify habitat disruption.

2. Define the spatial extent and spatial relationships of disrupted and of recovering intertidal communities.

3. Provide information to determine the rate of recovery and to aid in the determination of when recovery is complete.

4. Provide information on the mechanisms responsible for variations in recruitment, growth, condition and survival of intertidal communities.

5. Fill the gaps in current knowledge about the spatial distribution of intertidal communities, the seasonal variation of abundance, and how to monitor the long term productivity level of intertidal lands.

This proposal provides a systematic methodology for using available information to determine key relationships in the ecosystem that are important for injury and restoration assessment. Under the research strategies outlined by the Oil Spill Trustee Council in the Invitation to Submit Restoration Projects for Fiscal Year 1995, this proposal addresses the priority ecosystem issue of "Disruption of Nearshore Community Structure". This study will first identify fauna/flora assemblages within specific habitat types (as defined by geomorphology) in each of three intertidal zones for geomorphologically homogenous beach segments. The proposed procedure has evolved from 4 years of field work in Cook Inlet and the Gulf of Alaska on National Park shorelines. The methodology was refined and tested in Puget Sound during the spring of 1994 (Schoch et al, in review), and in the summer of 1994 will be applied to the Cook Inlet shorelines of Lake Clark National Park. The proposed study will incorporate rigorous statistical analyses to aid in defining community linkages to beach types in healthy habitats. The results of these analyses can be used to compare community structure of healthy beaches with injured beaches, ultimately for the purpose of determining recovery rates and the point of complete restoration. With a better understanding of intertidal community structure and the variability of these communities with varying physical constraints, the mechanisms controlling recovery can be examined including the effects of predation, physical habitat type, recruitment, etc.

Need For The Project

Research to date in Alaska on population level injury for intertidal communities has been patchy and inconclusive due in large part to the huge spatial variation in communities. This project will begin to quantify that variation. The results can be used to determine the extent of damage, the degree of this disruption, and the degree of recovery over broad spatial

scales. Intertidal community structure is difficult to determine quantitatively because of the tremendous spatial variability of intertidal organisms and the logistical complications of multiple replicates. Past and proposed restoration projects have used Fucus spp. as an indicator/proxy of intertidal community health and recovery. However, the recovery of intertidal communities must be based not on the abundance of one species such as Fucus spp. as proposed, but rather on abundance and spatial distribution of the entire community. Further, each intertidal zone should be analyzed for recovery and this cannot be done using an indicator species generally restricted to the upper intertidal zones of semi-protected shores, such as Fucus spp. Therefore, a systematic methodology for determining the distribution and abundance of intertidal organisms on a large spatial scale is needed to answer questions related to recovery. Although research issues concerning habitat are not considered a high priority for fiscal year 1995 funding, we believe that natural resources (community structure) issues cannot be divorced from the habitats that support them. Therefore, in order to address questions of natural resource recovery and community structure, basic relationships with habitat must be determined first. The extent of disruption to community structure and the recovery of this structure can then be analyzed for determining the extent of injury and recovery rates. As indicated in the Invitation to Submit Restoration Projects, the determination of disruption to intertidal community structure is a high priority due to the direct linkage to sea otters, salmon, and other high trophic level organisms. The basis of the proposed work is a detailed, 32 parameter, vertical (i.e. separated into each intertidal zone) and horizontal description of shoreline geomorphology for each homogenous beach segment (i.e. geomorphologically the same in the horizontal dimensions). This shoreline model was developed over the past 4 years for habitat sensitivity and stranded oil persistence analyses, and has been applied to the shorelines of Kenai Fjords, Katmai, Aniakchak, and Lake Clark National Park Units (Schoch, 1994). We propose to develop statistical linkages between beach types defined by this model and a broader vision of natural resources (i.e. community structures) determined by existing transect data (augmented if necessary by additional fauna/flora surveys) so that inference for abundance and distribution can be made to broader geographic regions. These statistical inferences can then be used to track the recovery of injured beaches in comparison to healthy beaches, as well as to establish a database relating habitat sensitivity to intertidal community structure. With large scale information on the abundance and distribution of intertidal organisms, important questions regarding injury, recovery and the effects of intertidal resources on higher trophic level organisms can be addressed.

Project Design

Objectives:

1. Identify intertidal natural resources and community structures for specific beach types, including species composition, abundance, and variability.
2. Identify the spatial distribution, both vertical and horizontal, of beach types within a specified project area.
3. Identify the degree of disruption of resources and their services by statistical comparison of healthy beach communities (species composition, abundance, and variability) to the communities of injured and recovering beaches.

Methods:

1. Identify project area.
   There are several possibilities depending on the priorities of the restoration committee. The field work for Katmai National Park, Aniakchak National Monument, and Lake Clark National Park is 70 % complete, and for Kenai Fjords National Park the field work is about 20% complete (all data available from the National Park Service, Coastal Programs Office). Significantly more work is required for the remainder of the spill area where only partial horizontal descriptions have been completed (available from ADEC). Therefore, although the Alaska Peninsula is not a high priority restoration area, this would be the most economical place for this study since the work is significantly more complete. Other areas, such as Prince William Sound would require additional geomorphological field work to augment existing information, although this could be accomplished if deemed desirable by the Oil Spill Trustee Council (the schedule and proposed budget would have to be adjusted for this additional and/or alternative work). Assuming the selection of the Katmai shoreline for the first year effort, this work is the closest to completion and only 6 weeks of additional geomorphological field work are anticipated to complete the coverage of the 400 mile shoreline. Biological transects may require additional time with consideration of the spring tide cycles.
2. Map project shoreline.
   Using digitized low altitude aerial photography (available from the National Park Service and Walker Associates) for basemaps, the homogenous shoreline segment information (32 parameters for each shoreline segment defining each horizontal and vertical unit) will be entered into a relational database.
3. Statistical analysis of beach segments.
   Beach segments will be clustered into groups with similar geomorphological and physical characteristics.
4. Develop linkages between fauna/flora communities and beach types.
   Using existing fauna/flora transect data (available from the National Park Service, ADEC, and EXXON) and augmenting this information with additional transect work on randomly selected beach segments, natural resources will be related to habitat types using analysis of variance (ANOVA) or multi-variate correlation

(CANOCO).

5. Analysis of intertidal resources disruption.
ANOVA comparisons between healthy beach communities and injured or recovering beach communities will indicate the extent of current disruption. Replicate analyses will indicate the rate of recovery.

Schedule

October 1, 1994 - May 1, 1995

The compilation of the geomorphological and physical parameters into a relational database can begin immediately (i.e. October 1, 1994). Digitizing the aerial photography and compiling the digital base map can also begin immediately. Statistical analyses of beach segments and group clustering of homogenous units can be completed before the 1995 field season.

June 1, 1995 - August 31, 1995

The field season will be used to complete missing geomorphological information, and to complete missing fauna/flora transect information. The total number of field days will be determined by the extent of the missing information (anticipated not to exceed 90 days).

September 1, 1995 - November 30, 1995

This period will be dedicated to data analysis and report writing.

Technical Support

Digital database development will be conducted at Oregon State University using ERDAS and a relational database software such as Paradox or Oracle. Field work will require vessel support, however the size and sophistication will depend on funding, ranging from kayaks and shore camping to a full support facility. Laboratory analysis of field samples (if any) will be conducted at the Friday Harbor Laboratories, WA. Data transfer and archiving procedures are negotiable.

Location

Other project locations can be considered, based on funding level, restoration priorities, and logistical considerations.

Project Implementation

By design, this proposal is intended to be implemented by the principal investigator with the assistance of state and federal agencies such as the National Park Service Regional Office, Katmai National Park and Preserve, National Biological Service, Alaska Department of Natural Resources, Alaska Department of Environmental Conservation, etc.

Coordination of Integrated Research Effort

A lot of data has been gathered since the 1989 spill by state, federal and private entities. The first step is to aggregate existing information from the National Park Service, state agencies

and private entities. Any collaborative partnership facilitating this project will be considered. This project can be coordinated with other funded projects particularly those implemented by the University of Alaska, Alaska Department of Fish and Game, and the Alaska Department of Environmental Conservation.

Public Process

A direct product that could have considerable application in public education is the information accessible through database query by interactive software tools through terminals established at public facilities. The costs for this component have not been included in the proposal.

Personnel Qualifications (see attached)

Preliminary Budget Estimate for Fiscal Year 1995

Personnel:		
Principal Investigator		$5,000
Researcher	$20,000	
Research/Field Assistant	$10,000	
Travel:		$1,500
Contractual Services: (i.e. 21 days vessel contract)		$21,000
Commodities:		$1,000
Equipment:	$3,500	
Capital Outlay:		$5,000
General Administration:	$6,500	
Total:	**$73,500**	

CURRICULUM VITAE: MEGAN N. DETHIER

WORK ADDRESS:
University of Washington
Friday Harbor Laboratories and Inst. for Environmental Studies
Friday Harbor, WA 98250 Phone: (206) 378-2165 (work)

ADV. DEGREE: PhD, University of Washington, Seattle, Wa., Department of Zoology, 1981.

RECENT RELEVANT FUNDING:

Minerals Management Service, 2-year grant to study the impact of an oil spill on the intertidal biota of Olympic National Park (1989-1991).

National Park Service, 2 year (renewable to 4 years) grant to continue a baseline monitoring program for intertidal resources and biodiversity in Olympic National Park (1993-1994).

RELEVANT BIOLOGICAL POSITIONS

Research Scientist, National Park Service: conducted an inventory and began a monitoring program for the intertidal plants and animals of Olympic National Park; 1988.

Research Scientist II, Washington State Dept. of Natural Resources, Natural Heritage Program: designed a marine and estuarine habitat classification system and detailed habitat descriptions for use by state agencies; 1988-1989.

Research Biologist, Washington State Department of Ecology's Oil Spill Compensation Group: modified habitat classification system and researched possible oil damage to habitat types; 1990.

Marine Ecologist, TMA Corporation: assessed ecological sensitivity to oil spills of marine waters and shorelines of Washington and Oregon; project funded by the Coast Guard; 1991-1992.

Research Assistant Professor. Institute for Environmental Studies, University of Washington; 1990 - present.

Peer-Reviewer for research plan for Prince William Sound, Exxon Valdez Trustees Council; Dec. 1993.

PUBLICATIONS: Since 1980, 16 basic research papers (primarily in intertidal ecology) in peer-reviewed journals, plus several relevant reports, including:

Dethier, M.N. 1990. A Marine and Estuarine Habitat Classification System for Washington State. Natural Heritage Program, Washington Department of Natural Resources. 60 pp.

Dethier, M.N. 1991. The effects of an oil spill and freeze event on intertidal community structure in Washington. Final Report. Report prepared for the U.S. Dept. of the Interior, Minerals Management Service, Pacific OCS Region. OCS Study MMS 91-0002. 160 pp.

Dethier, M.N. 1993. A baseline survey and inventory of intertidal communities in San Juan Island National Historic Park. Report submitted to the Naitonal Park Service, Dec. 1993. 56 pp.

DETHIER, MEGAN N.: B.A., 1975, Carleton College, Minnesota; PhD, 1981, University of Washington. Employer -- University of Washington. Specialties - Intertidal community structure, marine and estuarine habitat classification, plant-herbivore interactions, ecology of marine algae. Marine Ecosystem Expertise - temperate intertidal communities (rocky, cobble, sand, mud) and the impacts of oil spills on them; workshop panelist for Olympic Natural Resource Center Ecosystem Conference. Special honors - graduated from Carleton magna cum laude and with honors in biology; NSF Graduate Fellow 1975-1979; Sigma Xi, Phi Beta Kappa; president of Western Society of Naturalists, 1991; appointed to the governor of Washington's Marine Oversight Board, 1991-present; Washington Natural Heritage Advisory Council.

CURRICULUM VITAE: CARL SCHOCH

Mailing Address:

Oregon State University
College of Oceanic and Atmospheric Science
COAS 104
Corvallis, OR 97331
Tel: 503-737-3504

EDUCATION:

MS (in progress), Oregon State University, Corvallis, OR 97331, College of Oceanic and Atmospheric Science, 1995.

B.S. Geology, 1977, Oregon State University, Corvallis, Oregon

Post Baccalaureate work in Arctic Hydrology, 1983-1985, University of Alaska, Anchorage, Alaska

RELEVANT POSITIONS:

National Park Service, Coastal Programs Division, Physical Scientist

Designed and implemented a long term stranded oil persistence study, comprehensive shoreline habitat sensitivity analyses, aerial photography and digital coastal zone mapping programs, photogrammetric interpretation of coastal resources, and shoreline geomorphology classifications for 3 coastal parks (1989-1993).

R & M Consultants Inc., Anchorage, Alaska 99503, Hydrologist, project manager for the

design, coordination and implementation of stream bed sediment studies, stream morphology, glaciology, meteorology, water quality, suspended sediments and various other projects associated with the proposed Susitna Hydroelectric Project. Conducted research on river ice formation and the effects of a modified ice regime on salmon habitat following hydropower development (1980-1986).

U.S. Geological Survey, Topographic Mapping Division, Denver CO., Cartographer, geodetic surveying and mapping of topographic quadrangles (1979-1980).

Ocean Systems, Inc., Houston, Texas, Commercial Diver, provided underwater support for oil and gas exploration and production drilling rigs using saturation and mixed gas techniques (1977-1979).

PUBLICATIONS: Since 1981, 8 technical reports on various Susitna River hydrological projects including: river ice regime, suspended sediments, water quality, and hydrographic surveys, with 5 published research papers; also 4 technical reports on Exxon Valdez oil spill assessments of Kenai Fjords and Katmai National Parks, and Aniakchak National Monument, with 2 published papers; including:

Schoch, C., H. Berry, and M. Dethier, 1994 (in review), A Statistical Model for the Relationship Between Intertidal Flora and Fauna Abundance and Physical Habitat, Friday Harbor Laboratories, WA.

Schoch, C., 1994, Geomorphological Shoreline Classification and Habitat Sensitivity Analysis For Katmai National Park and Preserve, Alaska: Proceedings, The Coastal Society, Charleston, SC, April, 1994. 4pp.

Schoch, C., 1993, Stranded Oil Persistence Study on Kenai Fjords National Park and Katmai National Park and Preserve: National Park Service, Coastal Programs Office, Anchorage, AK. 75pp.

Schoch, C., 1991, EXXON Valdez Oil Spill, Katmai National Park and Preserve and Aniakchak National Monument Shoreline Oil Assessment: National Park Service, Coastal Programs Office, Anchorage, AK. 768pp.

Schoch, C., 1989, EXXON Valdez Oil Spill, Kenai Fjords National Park Shoreline Oil Assessments: National Park Service, Anchorage, AK. 120pp.

References

Duggins, D. and K.A. Miller, 1990, Final report: Pre- and Post- Oil Intertidal Biological Assessments in Kenai Fjords National Park, National Park Service, Alaska Regional Office. 70pp.

Schoch, C., H. Berry, and M. Dethier, 1994 (in review), A Statistical Model for the Relationship Between Intertidal Flora and Fauna Abundance and Physical Habitat, Friday Harbor Laboratories, WA.

Schoch, C., 1994, Geomorphological Shoreline Classification and Habitat Sensitivity Analysis For Katmai National Park and Preserve, Alaska: Proceedings, The Coastal Society, Charleston, SC, April, 1994. 4pp.

Killer Whale Monitoring in Prince William Sound, Alaska

Project Number: 95013

Project Leader: Craig O. Matkin

Organization: North Gulf Oceanic Society

Cooperating Organization: Prince William Sound
Science Center

Cost of Project: 105,024 (FY 1995)

Startup: January 1995/ Completion : (FY 1995) April 1996

Project Duration: Alternating years until recovery

Geographic Area: Western Prince William Sound

Contact Person: Craig O. Matkin
North Gulf Oceanic Society
P.O. Box 15244
Homer, Alaska 99603
(907) 235-6590

B. Introduction

Baseline population information based on photoidentification was collected by members of the North Gulf Oceanic Society (NGOS) prior to the EVOS (Leatherwood et al. 1990, Matkin et al. 1994, Matkin and Saulitis, 1994, Matkin 1994). This data was used for damage assessment following the EVOS. The EVOS Trustee Council funded this work in 1989, 1990, and 1991. Damage assessment fieldwork for Prince William Sound was completed, and the data was analyzed, and published by NGOS under contract to the National Marine Mammal Laboratory (Matkin et al. 1994). A total of 13 whales were lost from AB pod (initially 36 whales) between March 1989 and June 1990. Through recruitment the pod increased from 23 whales in June 1990 to 26 whales in 1993, it will require years for complete recovery. Nine whales in the AT1 transient group have not been photographed since 1989. Because immigration and emigration between transient groups does occur, we cannot be certain these missing whales are mortalities (except for one which was identified dead on a beach in 1990). However, we strongly suspect that they are dead. As a result of these findings, killer whales (Orcinus orca) have been listed by the EVOS Trustee Council as a damaged but recovering resource.

We propose to continue a monitoring program of resident and transient killer whales in Prince William Sound and to interface this program with proposed ecosystem studies. The program will focus on the population dynamics of AB pod and the AT1 group in relation to other resident and transient groups that use Prince William Sound.

C. Need for project.

Without careful monitoring of the damaged/recovering killer whale population, it will not be clear whether recovery has occurred. Because killer whales demonstrate a low reproductive rate long-term monitoring is necessary to clearly establish that recovery has or has not occurred. Careful analysis may identify problems that might inhibit recovery. Although AB pod appears to be recovering at this time, the status of the AT1 group is uncertain and should be monitored as well. The dynamics of these groups should be judged relative to the changes within the other frequently encountered pods. This necessitates a thorough census of all pods that regularly use the study area.

D. Project Design

1. Objectives. 1)To photographically identify resident and transient killer whale pods in Prince William Sound. 2)To map population dynamics within all pods and monitor recovery or lack of recovery of injured groups.

2. Methods. Methods will be similar to those used by the NGOS to monitor killer whales in Prince William Sound for the past ten consecutive years. Photoidentification of each individual in each pod/group as detailed in Matkin et al. (1994) will be the primary tool. Photographic negatives will be analyzed using a photographic database that spans ten years. Identities of each whale that appears in every frame of usable film will be recorded and stored in VAX computer system. Final analysis and assessment will follow Matkin et al. (1994). (Attached)

3. Schedule. Monitoring should occur in 1995 and at least every other year thereafter until full recovery is demonstrated (only 1995 is budgeted here). Field work will occur in July/August/September of 1995. A total of 90 vessel days will be spent in the field. Data analysis will occur in October and November. A draft report will be submitted by late December followed by a review period of two months. The final report will be submitted by April 1996.

4. Technical Support. The NGOS owns or will lease all equipment necessary for the successful completion of the project. A frame by frame analysis of photographic data will be computerized and archieved with a copies supplied to the National Marine Fisheries Service and the Prince William Sound Science Center. NGOS has archieved all photographic data collected since 1984 in an established computerized format.

5. Location. Field work will center in southwestern Prince William Sound. Vessels will be operate from Chenega Village and dock space rented from the Village Council (contact:Paul Kompkoff). Fuel will be stored at Port San Juan and Chenega Village. (We currently have a fuel storage aggreement with Port San Juan and Chenega). As in the past, close contact will be kept with tourboat and recreational boaters in the area. An observer's network which exhanges information on whale sightings has been maintained for 10 years in western Prince William Sound.

E. Project Implementation.

Accurate long-term monitoring is essential to determine recovery of this injured resource. The proposed project complements long-term systematic research projects begun by the North Gulf Oceanic Society 1983. The methods employed in the proposed work and the historic

database essential for interpretation were developed by NGOS. Data collection has been supervised by the same individuals and photoidentifications made by the same individuals from 1984 to 1994. During that ten year span, over 50,000 frames of film have been examined and each whale in each usable frame of film identified. The validity of the photoidentifications has been tested independently and found to be accurate (Dahlheim and Matkin 1994). The NGOS maintains the specific equipment (boats, cameras, lab equipment, etc.) and expertise to continue this project in a consistent and cost effective manner.

This is a significant opportunity for the Council to fund a project conducted by a private Alaskan entity, staffed by individuals who reside and work in the spill area and who were conducting similar work prior to the EVOS. It would appear contrary to the intent guidelines established by the Trustee Council and PAG to fund a government agency at the exclusion of established and professional local expertise. If this project is delegated to an agency (as in 1993), there will be no opportunity for this research to be conducted by private entities (see cover letter).

NGOS is maintaining ongoing killer whale studies in Prince William Sound in 1993. A biopsy sampling for killer whales has recently been initiated. Genetic analysis of these tissues will help identify populations of killer whales. It will be accompanied by analysis to determine levels of environmental contaminants in the whales.

F. Coordination.

Researchers will coordinate efforts with hydroacoustic surveys conducted under the Sound Ecosystem Assessment Plan (SEA) and the Prince William Sound Science Center. (NGOS operates with a memorandum of understanding with the PWSSC). Data necessary for interpretation of the proposed "Effects of Killer Whale Predation on Recovery Rates of Injured Resources" (NMML/NMFS) or other EVOS projects will be provided to the appropriate agencies.

G. Public Process.

As a non-profit research and education group NGOS regularly disseminates the results of our research. We are constantly informing the public via formal and informal meetings and lectures and via visits to schools and other institutions. Tour boat operators will be regularly briefed on the status of our work. Operators have been provided with whale identification catalogues and other literature. As members of the spill area community, we are readily available to interact with other community members, including recreational and commercial users. All results and activities will be discussed with Chuck Totemoff, President of the Chugach Regional Corporation and a presentation given in Chenega Village school located in the study area. Presentations of our work will be given in Cordova, Valdez, and Homer. Copies of our book, An Observers Guide to the Killer Whales of Prince William Sound will be provided to schools in the spill area. In addition, NGOS will participate in any workshops or review meetings held by the Trustee Council.

H. Personnel Qualifications

Craig Matkin (M.S. University of Alaska), is the project leader and has studied killer whales in Prince William Sound since 1977. He initiated systematic killer whale photoidentification in Prince William Sound, and is the founder of NGOS. Recently he completed the "The Biology and Management of Killer Whales in Alaska" for the U.S. Marine Mammal Commission. He is currently publishing EVOS killer damage assessment results ("The Status of Killer Whales in Prince William Sound 1984-1992", Craig O. Matkin, G. M. Ellis, M.E. Dahlheim, and J. Zeh in T.R. Loughlin's, The Effects of the Exxon Valdez Oil Spill on Marine Mammals.) Eva L. Saulitis (M.S. University of Alaska) has conducted fieldwork on killer whales in Prince William Sound each season since 1987 and recently completed her MS thesis "The Behavior and Vocalizations of the AT Group of Killer Whales in Prince William Sound, Alaska." at the University of Alaska Fairbanks. Olga von Ziegesar has conducted humpback whale and killer whale photoidentification research in the Sound since 1980. She led the humpback whale damage assessment project in 1989 and 1990 and is publishing the results of that work. ("The Effects on Humpback Whales", Olga von Ziegesar, B. Miller, and M. E. Dahlheim, in T.R. Loughlin, The Effects of the Exxon Valdez Oil Spill on Marine Mammals.) Graeme Ellis has been studying killer whales in Canada and Alaska for over 20 years. He directs whale identification at the Pacific Biological Station in Nanaimo, British Columbia and has done final identifications on Prince William Sound killer whale photographic negatives since 1983. His ability to accurately identify Prince William Sound killer whales from photographic negatives is unequaled.

References

Leatherwood,S., C.O. Matkin, J.D. Hall, and G.M. Ellis. 1990 Killer whales (Orcinus orca) photoidentified in Prince William Sound, Alaska 1976 through 1987. Canadian Field-Naturalist 104(3):362-371.

Matkin, C. O. and E. Saulitis. 1994. Killer whale (Orcinus orca) biology and management in Alaska. U.S. Marine Mammal Commission, Washington, D.C. (in press).

Matkin, C.O., G.M. Ellis, M.E. Dahlheim, and J. Zeh. 1994. Status of killer whales in Prince William Sound, Alaska 1985-1992. In T.R. Loughlin ed., The Impact of the Exxon Valdez Oil Spill on Marine Mammals. Academic Press. San Diego, CA. (in press)

Matkin, C.O. 1994. An Observers Guide to the Killer Whales of Prince William Sound. Prince William Sound Books, Valdez, Alaska.

Budget

Personnel	
P.I. (Matkin) 4 mo. @ 3791/ mo.	15,164
Field biologist (Saulitis)	
3.5 mo. @ 2500/mo.	8,750
Field technician	
3 mo. @ 1500/mo.	4,500
Photographic analyst (Ellis)	
2 mo. @ 3500/mo.	7,000
Biometrician	
1.0 mo. @ 3791/mo.	3,791
Computer technician	
1.0 mo. @ 2100/mo	2,100
Benefits (12% salaries)	4,680
Total	46,262
Travel	
4 RT Homer/Anch	680
3 RT Homer/Cordova	980
1 RT Homer/Fairbanks	325
1 RT Homer/Seattle	600
14 days per diem	1400
Total	3981
Contractual	
27' research vessel 70 days @ 170/day (w/o operator)	11,200
43' research vessel 20 days @ 700/day (w/o operator)	14,000
Total	25,200
Commodities	
Phone	400
Food, 12./person/190 days	2736
Film processing 300 rolls/15.00 roll	4500
Fuel, 25 gal/day/1.30/gal for 90 days	2925
Postage/shipping	450
Total	11,461
General Administration (NGOS 10%)	8,572
Subtotal	95,476
University of Alaska (pass through 10%)	9,548
TOTAL	105,024

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Predation by Killer Whales in Prince William Sound: Feeding Behavior and Distributions of Predators and Prey.

Project Number: 95014

Project Leaders: Craig O. Matkin, NGOS
David Sheel PWSSC

Lead agency: Prince William Sound Science Center

Cooperating agencies: North Gulf Oceanic Society

Cost of project/FY 95: $156,874

Cost of Project/FY 96: $148,750

Project Start-up/Completion Dates: October 1994/May 1987

Geographic Area: Prince William Sound, Alaska

Contact: Craig O. Matkin
North Gulf Oceanic Society
P.O. Box 15244
Homer, Alaska 99603

B. Introduction

The classic view of predator-prey relationships is that prey populations are limited through losses to predation while predator populations are limited by restricted numbers of available prey (e.g. Lotka 1925, Volterra 1926). However, this view has often been unsatisfactory because apex predators in any system are usually diet generalists. That is, the composition of their diet will change with prey availability. Decline of a common prey may result in prey-switching, rather than in a population-level decline in apex predator numbers. The consequences of prey switching are that predation rates on one prey species can vary independently from the population size of both that prey and the predator.

Prey switching allows predator populations to remain high, even when some prey species decline. Non-lethal effects of predation increase the costs of risky activities (such as foraging) for prey species (Brown 1992). Prey-switching has already been recognized as a possible factor important in the recovery of pink salmon (juvenile pollack possibly switch from zooplankton to salmon fry when zooplankton abundance is low). Now consider that two of the most visible, index species of apex predators affected by EVOS, bald eagles and killer whales, are both listed as "Recovering", while important food sources for these species are "Not recovering" (e.g. pink salmon for eagles, salmon and harbor seals for killer whales). In addition, according to researchers at recent EVOS Trustee-sponsored workshops, losses to these predators may be contributing to declines or lack of recovery in harbor seals, kittiwakes, and sea otters.

Food availability is considered the probable cause of failure to recover from oil spill

injury for some populations, with predation pressure considered as an alternative hypothesis. However, predation pressure is related to food availability, because predators respond to changes in their prey populations by prey switching, and because foraging and other risky activities become more costly when predation risk is high. In part because population sizes of predators appear to be recovering from EVOS-related mortality, little attention has been given at workshops to discussion of predator diet or its impact on other resources.

Some additional work is needed to more completely understand the role of predation by killer whales in Prince William Sound. Investigations into the food web dynamics of killer whales have been proposed using stable isotope and fatty acid analysis (M. Dahlheim). Additionally, historical data on killer whale distributions, and feeding behavior are available (C. Matkin). These data should be analyzed in conjunction with continued field observations in Prince William Sound to determine to what extent killer whale diet or habitat use has changed. Changes that are correlated with the distribution of prey indicate that prey-switching has occurred. This analysis should be coordinated with a feeding behavior/habitat use model of predation rates in order to estimate the impact of whales on their primary prey populations.

C. Need for the Project.

This proposal is focused on killer whale predation in Prince William Sound. The killer whale was injured by EVOS and is currently listed as recovering. However, a number of staple prey species of killer whales are listed as injured and not recovering. These include harbor seals, pink salmon, and Pacific herring. At least for harbor seals, predation by killer whales is considered an important alternative to the food limitation hypothesis as an explanation for continued lack of population growth. The unrecovered status of these species may alter whale feeding patterns and behaviors. Further, the recovery of these species may be impacted by predation by whales.

D. Project Design

1. Objectives: This project addresses the role of killer whale predation in Prince William Sound, and will accomplish five objectives:

1) Analyze historical data on feeding, habitat use and distribution of killer whales.
2) Continue field studies to photoidentify and record distribution and feeding behavior of killer whales in PWS. Pre-spill patterns of behavior documented in 1) will be compared to current behavior to evaluate prey-switching or other changes in whale behavior.
3) Determine if residents and transients killer whale pods using PWS are distinct genetically, and continue estimation of feeding differences between the two types.
4) Expand sampling of killer whale distributions into late fall and winter to determine year-round residency of whales in the Sound. This will be accomplished through remote, acoustical sampling in southwestern PWS.
5) Develop trophic models based on (1-3) to evaluate the flexibility of whale diets and to estimate the impact whales have on their prey populations in PWS. This objective will utilize information from a number of EVOS studies (acoustic sampling of pink salmon and herring, forage fish distributions, harbor seal distribution and habitat use, killer whale food-web

relationships, killer whale genetic studies) to provide the best possible numerical estimates of predation rates.

2. Methods

Analyze historical data on feeding, habitat use and distribution of killer whales using GIS. Documentation of historical whale behavior is needed to establish trends related to the changing availability of prey in their environment. Private and public data have been collected by this group of researchers (Matkin) on killer whales since 1983. Locations of all sightings, behavior, and information on prey types recorded during each siting will be entered into a geographic information system. The extent and geographic distribution of sampling effort will also be reconstructed. Feeding data from stomach contents, scales from fish attacked by the whales, and marine mammal tissue collected following kills is also available. Using this database, historical movements and behaviors of whales will be analyzed for evidence of changes in diet or area-use patterns. Critical area will be identified and feeding behaviors will be related to the distributions of prey (data on prey distribution is being collected under SEA and other studies).

Continue field studies to identify and record distribution and feeding behavior of killer whales in PWS. Detailed photographic records of sightings provide the continuity necessary for this long-term study. This segment of the proposal relies on the monitoring of the killer whale population injured in EVOS (see proposal: "Monitoring Killer Whales"). In addition, further data on movements and feeding behavior is needed to document dietary changes (if any) and to estimate predation rates on harbor seals, salmon, and other species. Behavioral data will be taken at each encounter while researchers are with the whales. Where possible, samples of prey remains (e.g. fish scales, tissue from marine mammals) will be collected as the whales feed. This technique has been used successfully in the past. However, it has not always been possible to know what whales are feeding on. By running this study in the same area and at the same time as the SEA program, detailed observations on the general distribution and composition of fish schools will allow greater certainty in identifying whale prey. A concurrent study examining isotope ratios and fatty acid composition may provide complementary data on gross diet composition.

Assess genetic differences between transient and resident-type pods using Prince William Sound. Behavioral observations in the Sound and limited genetic work in other areas suggest that at least two populations of killer whales (resident and transient) exist sympatrically in the Gulf of Alaska, and use Prince William Sound (Matkin, et al. 1994). Whales of both types appear to have been lost since the EVOS (from AB pod and the AT1 group, respectively. Matkin, et al. 1994). However, while the AB pod appears to be recovering numerically, the AT1 group is not. To the extent that the two killer whale types are genetically and behaviorally separate, the AT1 group may represent a distinct, non-recovering population. Further, there is

evidence, that at least seasonally, the AT1 group consumes primarily marine mammals while resident whales (AB pod and others) consume primarily fish in the Sound (Matkin, et al. unpublished data). Thus, to adequately understand the impact that whale predation has on marine mammal populations in Prince William Sound, it is important that the level of genetic separation and differences in food habits be established for these potentially distinct populations.

Expand historical sampling into late fall and winter to determine year-round residency of whales in the Sound. It is currently not known how many whales stay in PWS into the winter, nor for how long. This is due to sampling limitations from winter weather and low light conditions that limit photography. However, this data is necessary in order to fully understand the impact whales may be having on their prey. We will use a hydrophone system to monitor killer whale movements year round. Each resident pod of killer whales has a unique dialect of vocalizations, allowing individual pod recognition by voice-print. Two hydrophone systems will be placed in the southwestern Sound. When whales are in acoustic range, a voice-activated system records their vocalizations. The system can be monitored by VHF radio from a nearby fish hatchery. Recordings will be used to determine the duration of residency for specific pods during all months of the year.

Develop trophic models based on (1-3) to evaluate the flexibility of whale diets and to estimate the impact whales have on their prey populations in PWS. Using data from this study, in conjunction with fish distributions from SEA and forage fish studies, and isotope/fatty acid results from the proposed NMFS studies, we will model predation rates of whales in PWS. The model will link whale behavior (foraging, habitat use) with predation rates on their primary food species (suspected to be harbor seals and salmon). As apex predators, whales are generally flexible in their diet (although there is some evidence that this is not the case with killer whales). We will model the effects on different prey of prey-switching by whales, to evaluate how changes in one prey populations may be linked to the availability of alternative prey.

3. Schedule.

Input of historical data into the PWSSC GIS system will begin in November 1994. Fieldwork will coincide with the "Killer Whale Monitoring" program. The final report for year one will be submitted by April 1996. A simplified model will be constructed by the end of year one. A more detailed model will be completed by year two, April 1997.

4. Technical support

Data input, computer and GIS support will be provided by the Prince William Sound Science Center. Field equipment and support will be provided by the North Gulf Oceanic Society.

5. Location.

Field work will be centered in western Prince William Sound, Alaska (see "Killer Whale Monitoring").

E. Project Implementation

The project should be implemented as a combined effort of two spill area non - profit groups, the NGOS and PWSSC. NGOS owns or leases all equipment needed to complete the field operations in this project. NGOS will provide the historical feeding data necessary for the analysis and modeling. NGOS is currently collecting biopsy samples from killer whales for the initial genetic analysis. The PWSSC has the GIS system in place and the modeling and computer capabilites necessary to complete the project.

F. Coordination

Research efforts in the field will be tightly coordinated with the SEA plan surveys. This research will be coordinated with the SEA research program, and will utilize results of SEA modeling. This project also integrates with harbor seal, and forage fish studies. Data analysis will be coordinated with the proposed studies under the Marine Mammal Ecosystem group.

G. Public Process

This project has and will continue to receive public input and review through EVOS Trustee Council sponsored workshops and close interaction with the SEA program. The NGOS is well connected with local communities (see Killer Whale Monitoring)

H. Personnel Qualifications

Craig Matkin, Principal Investigator, Director, North Gulf Oceanic Society. Craig Matkin (M.S. University of Alaska), is the project leader and has studied killer whales in Prince William Sound since 1977. He initiated systematic killer whale photoidentification in Prince William Sound, and is the founder of NGOS. Recently he completed the "The Biology and Management of Killer Whales in Alaska" for the U.S. Marine Mammal Commission. He is currently publishing EVOS killer damage assessment results ("The Status of Killer Whales in Prince William Sound 1984-1992", Craig O. Matkin, G. M. Ellis, M.E. Dahlheim, and J. Zeh in T.R. Loughlin's, The Effects of the Exxon Valdez Oil Spill on Marine Mammals.)

David Scheel Phd. Principle Investigator. Associate Scientist, Prince William Sound Science Center. His research projects have included predator-prey dynamics of Serengeti lions and their prey, habitat selection models of Texas mammals, frequency and density dependence in models of community evolution, social behavior and resource/ habitat use of primates in Gombe.

References

Brown, J.S. 1988. Patch use as an indicator of habitat preference, predation rishk and competition. Behavioral Ecology and Sociobiology 22: 37A47

Brown, J. S. 1992. Patch use under predation risk: I. Models and predictions. Ann. Zool. Fennici 29:301Ä309.

Lotka, A.J. 1925. Elements of physical biology. Williams and Wilkins, Baltimore.

Matkin, C.O. 1994. An Observers Guide to the Killer Whales of Prince William Sound. Prince William Sound Books, Valdez, Alaska.

Matkin, C.O. and E. L. Saulitis. 1994. Killer Whales (Orcinus orca) Biology and Management in Alaska. Special Publication of the Marine Mammal Commission. in press.

Matkin, C.O., G.M. Ellis, M.E. Dahlheim, and J. Zeh. 1994. Status of Killer Whales in Prince William Sound, Alaska, 1985-1992. In: Thomas R. Loughlin, ed. The Impact of the Exxon Valdez Oil Spill on Marine Mammals. Academic Press,San Diego. in press.

Volterra, V. 1926. Fluctuations in the abundance of a species considered mathematically. Nature 118:558-560.

BUDGET

Personnel

North Gulf Oceanic Society

C. Matkin, P.I.	
Killer Whale Genetics 2 months @ 3791/mo.	7562
Killer Whale Acoustics 1 month @ 3791/mo.	3791
Field biologist (E. Saulitis) 2 mo. @ 2600/mo.	5200
Geneticist (L. Barrett Lennard) 3 mo. @ 3500/mo.	10,500
Acoustic analyst (E. Saulitis) 2 mo. @ 2600/mo.	5200
Benefits (12% of salaries)	3870

Prince William Sound Science Center

Trophic modeler 6 mo. @ 5940/mo.	35,688
Computer Technician 6 mo. @ 3470/mo.	20,820
Total	92,631

Travel

North Gulf Oceanic Society

Vancouver/PWS 2 RT	1100
Homer/Anchorage 1 RT	250
per diem, Anchorage 10 days @120/day	1200
per diem, Cordova 10 days @ 120/day	1200

Prince William Sound Science Center

Cordova/Anchorage 2 RT	400
per diem 10 days @ 120/day	1200
Total	5350

Contractual

North Gulf Oceanic Society	
Research vessel 27' 20 days @ 170/day	3400
Research vessel 43' 10 days @ 700/day	7000
Hydrophone/reciever maintainance (1 year)	3600
Total	14,000

Commodities

North Gulf Oceanic Society

Phone	450
Food ($12/person/day-70 days)	840
Fuel 25 gal/day/30 days	975
Postage and shipping	475
Genetic lab/field supplies	2300

Prince William Sound Science Center

Phone,fax, e-mail	500
Postage, shipping	200
Office, Computer supplies	1000
Total	6740

Equipment

North Gulf Oceanic Society

Scale Nets, hydrophones, misc equip.	1600
Dart guns and biopsy darts	740
Remote hydrophones and monitors	3150
Total	5490

NGOS administrative costs, (10% direct costs)	6440
PWSSC administrative cost (20% direct costs)	11,961
University of Alaska passthrough (10% total costs)	14,261
TOTAL	156,874

Permits for scientific research have been granted under the Marine Mammal Protection Act. This project should qualify for a categorical exclusion from the requirements of the National Environmental Policy Act.

DOC. #950615011 A-B 95013/95014

NORTH GULF OCEANIC SOCIETY

P.O. BOX 15244
HOMER, ALASKA 99603
(907) 235-6590

James R. Ayers, Executive Director
EVOS Trustees Council
645 G Street Suite 402
Anchorage, Alaska 99501

June 14, 1994

Dear Mr. Ayers

I wish to thank the Trustees Council for soliciting proposals from non-agency groups, making our submission possible. Enclosed find two proposals concerning study of killer whales in Prince William Sound, Alaska in 1995. At the request of the SEA Plan directors and ADF&G our group has submitted another proposal "Herring Predation by Humpback Whales" as part of the SEA plan package (not included here). The NGOS initiated systematic photoidentification of killer whales in Prince William Sound and has continued research annually for over ten years. Although the monitoring interfaces with the other aspects of the "Predation by Whales" proposal as well as with NMFS proposed "Effects of Killer whale Predation on Damaged Resources" it can be maintained and reported on separately.

It is essential that this aspect of killer whale research be considered for private funding because: 1) The three year killer whale damage assessment program in Prince William Sound was conducted effectively by our locally operated private non-profit from project design to publication. 2) We have substantial historical data on killer whales that will aid in proposed or future ecosystem and monitoring projects. 3) the killer whale photoidentification research will greatly benefit from the the long- term continuity we can provide. 4)Our local base of operations and participation in the spill affected communities will help connect the Trustee Council research process with these communities.

Our photoidentification work was funded through the National Marine Fisheries Service National Marine Mammal Laboratory (NMML) during the EVOS damage assessment phase. We completed that work from project design to peer reviewed scientific publication (see enclosed Matkin et al. 1994). However, under the 1993 monitoring program, the NMML no longer wished to contract research. In the 1993 RFP from the NMML, only photography of killer whales and vessel charter were contracted. Photographic analysis, data analysis, reporting, and permission to publish were not included in the contract. The contract recipient was not permitted to examine the photographic data. This is

certainly not contracted research. After ten years of research and the contribution of substantial private data to the damage assessment process, NGOS was essentially eliminated from research process established by the Trustee Council. We ask that you allow our re-entry into this process.

The enclosed proposals have been submitted to the University of Alaska for approval. We are working with Rosemary Ruff at the University to insure that these proposals are acceptible for University pass through. (Note: budgets include U of A pass through funds.)

We appreciate the new research approaches being proposed to the Trustee Council and wish to fully integrate our work with ecosystem related studies. In Prince William Sound we have just initiated work on killer whale genetics (population separation) and analysis of environmental contaminants found in killer whale tissue. The enclosed permit application (permit has been approved by NMFS) describes this work. We wish to provide integrated research relevant to Trustee Council's research plan. However we, as well as other residents of the spill area, take great exception to the replacement of long-term private research efforts by government agencies. We ask that you allow our re-entry into the Trustees research process by seriously considering the enclosed proposals. We hope to work with you and the NOAA/NMFS in these endeavors.

I am hopeful I might meet with you or Molly McCammon when I am in Anchorage on July 1.

Sincerely

Craig O. Matkin, Director

A Tribute to Prince William Sound

PROJECT NUMBER: *95016*

PRINCIPAL INVESTIGATORS: *Gary Kremen*
3605 Arctic Blvd., #2777
Anchorage, AK 99503
(602)991-2405

DURATION: *One Year and Re-evaluation After That*

PROPOSED START DATE: *Immediately*

AMOUNT REQUESTED: *$161,000*

PROPOSE AS A PROJECT

The injured service the project would address is tourism. The proposal is to work in conjunction with the Prince William Tourism Coalition. First to determine through public discussion what areas and recreational activities should be pinpointed. Secondly, to formulate a scheduled tour for the exhibit "A Tribute to Prince William Sound." That schedule will include various national trade shows, whereby the exhibit would promote tourism in the specified areas and concerns of Prince William Sound.

The exhibit valued at $147,000 has already been completed and has received much national and international attention.

WHY THE PROJECT WILL HELP RESTORATION

Recovery of tourism will also occur when more people are made aware of the beauty that yet remains in the Prince William Sound area. This can be done by taking the exhibit to key high profile showings and distributing promotional material regarding the area. The exhibit already has a superb track record of generating much T.V. and press coverage wherever it has been exhibited. (See enclosed material)

PROJECT DESIGN

Objective: Is performing as a sounding stage at key exhibitions throughout the United States, enticing people to come visit this area. The exhibition will be held at trade shows where people have the funds to travel to Prince William Sound.

Methods Include: Showing the exhibit "A Tribute to Prince Williams Sound," which generates much interest, T.V. and press and dispersing various printed material regarding tourism in Prince William Sound.

Schedule: The exhibit has already been completed at a value of $147,000 and has a successful proven track record. It is ready to go back on tour at any time as per an exhibition schedule is worked out in conjunction with the Prince William Sound Tourism Coalition.

Technical Support: Would come from The Prince William Sound Coalition, which would determine the necessary promotional material to disperse and what areas of Prince William Sound should, and could be promoted for tourism.

Project Implementation: The project could be implemented through The Prince William Sound Tourism Coalition, or the Alaska Tourism and Marketing Council, or the Alaska Department of Tourism.

Coordination of Integrated Research Effort: The project would be coordinated with Alaska's Department of Tourism and the Alaska Tourism and Marketing Council. For instance, where and when these entities gear their promotional drives to certain locations throughout the United States is where the exhibit tour would key.

Public Process: This would include public discussions and meeting(s) with those that live in the Prince William Sound area as to what, where, and how they would most like to promote tourism within the area.

PERSONNEL QUALIFICATIONS

Karen Kroon, head of Prince William Sound Tourism Coalition; Mary Pinyalberri, head of Alaska Department of Tourism; Gary Kremen, Artist (See attached resume).

BUDGET: (One Year Tour)

1. Personnel	$60,000.00
2. Travel (On Tour 1 Year)	23,000.00
Travel (Public Meetings)	2,000.00
Contractual Services	55,000.00
4. Equipment	6,000.00
5. General Administration	15,000.00
	$161,000.00

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Port Graham Coho Salmon Subsistence Fishery Restoration Project

PROJECT NUMBER: *95017*

PRINCIPAL INVESTIGATORS: *David Daisy*

DURATION: *1 Year*

PROPOSED START DATE: *October 1, 1994*

AMOUNT REQUESTED: *$587,900*

Project Goal:

The goal of this project is to restore the Coho salmon subsistence fishery in Port Graham from its current harvest level of around 350 to its historic annual harvest level of around 2,000.

How:

This goal will be achieved by creating an annual return of 6,000 Port Graham River coho to the salmon hatchery in Port Graham. A return of this size to the village hatchery will provide a subsistence harvest at the historic 2,000 level, 500 for broodstock and a cost recovery harvest of around 3,500 to pay those hatchery operating expenses that are directly related to this project.

Using the standard ADF&G survival assumptions, 150,000 hatchery produced coho smolt will be needed to generate a return of 6?000 adults. At a final smolt loading density of 20 kilograms per cubic meter (kg/m3) in the raceways and a total water exchange of 2 times per hour (R2), approximately 2,300 liters per minute (lpm) of high quality fresh water will be needed. Currently the hatchery~ has only 1,100 lpm for this project. The additional 1,200 lpm will need to be developed. A water source has been identified and an engineering study done to determine the cost of bringing this water into the hatchery.

In addition to the extra water, the project will need a separate module set up in the hatchery for the coho with its own set of incubators and raceways.

Developing the additional water for the hatchery will need to be done under a construction contract. The raceways and incubators will be built at the village welding shop. The construction of the coho module, installation of the incubators and raceways, etc. will be done by the hatchery staff.

When:

Assuming that funds are appropriated in FY 95, the project will observe the following schedule:

October 1, 1994 to February 28 1995	Final design and permitting
March 1, 1995	Water project put out for bid; hatchery module materials ordered
March 20, 1995	Begin building incubators and raceways
March 30, 1995	Bid awarded for water project
May 1, 1995 to September 15, 1995	Water project under construction
June 1, 1995 to July 15, 1995	Construction on hatchery module

Budget:

Personnel - hatchery module	$23.0
Contractual - water project	$496.7
Equipment- incubators and raceways	$46.9
Supplies - hatchery module	$21.3
Total	$ 587.9

DOC.#9506140l4

Project # 95018

SFOS 94-182

PROPOSAL

94843

TO: Exxon Valdez Oil Spill Trustee Council
Restoration Office
645 G Street, Suite 402
Anchorage, AK 99501

FROM: Institute of Marine Science
School of Fisheries and Ocean Sciences
P.O. Box 757220
University of Alaska Fairbanks
Fairbanks, AK 99775-7220

TITLE: Partitioning of primary production between pelagic and benthic communities

PRINCIPAL INVESTIGATORS:

A. Sathy Naidu
Professor
SS#574-26-7802

Bruce P. Finney
Assistant Professor
SS#473-72-3045

NEW/CONTINUING: New

DURATION: 12 Months

PROPOSED START DATE: 1 October 1994

AMOUNT REQUESTED: $197,136

A. Sathy Naidu /Date
Principal Investigator
(907)474-7032

Bruce P. Finney 6/8/94 /Date
Co-Principal Investigator
(907)474-7724

Joan Osterkamp 6/8/94 /Date
Executive Officer
School of Fisheries and Ocean Sciences

A. V. Tyler 6/8/94 /Date
Associate Dean
School of Fisheries and Ocean Sciences

Donald M. Schell 6/8/94 /Date
Director
Institute of Marine Science

Ted DeLaca 6/9/94 /Date
Director, Office of Arctic Research
University of Alaska Fairbanks

95018

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL

FY94 DETAILED PROJECT DESCRIPTION

A. COVER PAGE

Project Title: Partitioning of primary production between pelagic and benthic communities

Project ID#: New Project

Project Type: Research and Monitoring

Project Leader(s): Drs. A. Sathy Naidu and Bruce P. Finney

Lead Agency: Alaska Department of Fish and Game

Cooperating Agency: NOAA, ADF&G, PWSAC, PWSSC, and SEA Project

Cost of Project: FY95 $197,136

Start Date: October 1, 1994

Duration of Project: 1 Year

Geographic Area: Prince William Sound

Name of Project Leader: A. Sathy Naidu

Project Manager: To be determined by ADF&G

B. INTRODUCTION

Particulate organic carbon (POC) derived from phytoplankton is the primary source of food and energy for marine organisms. Consequently, the dynamics of primary production and the subsequent fate (e.g. horizontal advection, consumption, flux, accumulation, mineralization) of the generated POC are one of major importance to a holistic study of any marine ecosystem investigations. This is particularly relevant to the SEA (Sound Ecosystem Assessment) hypothesis that has been developed for Prince William Sound. The hypothesis essentially states that the ecological state of Prince William Sound is closely linked to the oceanographic forcing of circulation in the Sound which alternates between years of strong through-flow river-like conditions, and relatively stagnant, lake-like conditions. The changes are controlled by the extent of ingress of Gulf of Alaska waters into the sound. One of the suggested implications of the hypothesis is that the rate of primary production in Prince William Sound controls the standing crop of primary consumers (e.g. zooplankton) and associated higher trophic organisms (e.g. salmon, herring, bottom fish species). For the benthos, the flux of phytodetritus within the water column is the linking factor to primary production. For high standing crops of zooplankton it is critical that a sustained supply of phytoplankton is available. In contrast, high flux of POC to the bottom would be vital to support a high abundance of benthic animals. It is conceivable that in areas of high primary production, the concentrations of zooplankton may not correspondingly be high because of loss of the phytodetritus and phytoplankton from the generating euphotic zone via horizontal advection and/or rapid sinking. However, the strong relationship between primary production and particle flux out of the euphotic zone has been amply demonstrated in numerous studies (see Knauer et al., 1984). The extent of correlation between the two would, of course, depend upon the grazing rates and hydrodynamics of water flow. Thus, it is imperative that investigations relating to the partitioning of particulate organic carbon (POC) within the water column be an integral part of the SEA study.

In Prince William Sound there is no regional data base available on the flux of POC either to the bottom or within the euphotic zone. However, extensive data are available, spanning over several years (1979-1991, including pre- and post Exxon Valdez spill years), on the concentrations and accumulation rates of organic carbon, nitrogen, C/N ratios and stable isotopes of organic carbon in sediments from widely-located stations in Prince William Sound (Klein, 1983; Naidu and Klein, 1988; Naidu et al, 1993). The only data published on the POC flux is that locally for Port Valdez (Naidu and Klein, 1988). In Port Valdez there is apparently a close link between the yearly concentrations of benthos and zooplankton with implied coupling with the POC flux and primary consumers (Feder and Shaw, 1994). Given the extensive data base that we have on organic carbon contents as well as accumulation rates of sediments, studies to determine water column POC fluxes would help to complete the carbon budget, and define food web linkages within the overall ecosystem of Prince William Sound. Our proposed investigation will include the deployment of a mooring with two sediment traps at a selected location in central Prince William Sound, to obtain time-series (monthly) and sequential samples of mass particle and POC flux. This project will be closely integrated with the proposed studies by Drs. McRoy and Eslinger on nutrient dynamics and primary production and will ultimately have strong bearing on the investigations on zooplankton led by Dr. Cooney under the SEA project.

C. PROJECT DESCRIPTION

1. Resources and/or Associated Services.

As mentioned earlier our proposed investigation on particle and POC flux will have strong relevance to understanding the role of carbon flux partitioning in the supply of food to pelagic primary consumers and to the benthic system. The data obtained under this investigation will be shared with Drs. McRoy, Eslinger and Cooney in attempting to test the SEA hypothesis, and with other investigators working in the sound area.

2. Relation to Other Damage Assessment/Restoration Work:

In attempting to address damage assessment/restoration of the Prince William Sound ecosystem subsequent to the Exxon Valdez oil spill, it is critical first to have a quantitative understanding of the natural forces and processes which drive the ecosystem of the sound. This concern has been identified by the EVOS Trustee Council (1994, p.26-27) as a high priority research topic. Without the above baseline it would be difficult, except in obvious high direct impact situation, to make any value judgement as to what the damages and restorations may have occurred consequent to the spill. Therefore, the investigations proposed under the SEA hypothesis, of which our studies will be a complementary component, will serve an useful purpose in assessing damage and designing steps for restoration. Our study will link the individual yet related investigations that are being proposed by Drs. McRoy and Eslinger on primary production and by Dr. Cooney on zooplankton dynamics. Additionally, we will examine our data on time-series changes in the carbon flux within the water column in context of the investigation on hydrodynamics that are being proposed by Dr. Salmon. In fact, all the above studies have been conceived, with mutual understanding, from the standpoint of a multidisciplinary approach to ecosystem analysis. Perhaps, the results of our investigations and that of the SEA, could be extended to nearshore regions which are now being impacted by crude reworked from the beaches, to help assess the causes of environmental changes.

3. Objectives

The specific objectives of the proposed studies are as follows:

(a) To estimate the time-series variations in the natural vertical fluxes of particulate organic carbon (POC) in Prince William Sound, and the partitioning of the flux between faecal pellets and loss of intact diatom cells via sinking.

(b) To establish the relationship between our data on time-series changes in the POC fluxes and the timing and biomass of phytoplankton cycles that Drs. McRoy and Eslinger have proposed to measure and the time-series changes in hydrodynamics that would be recorded at the C-Lab and other buoy stations in Prince William Sound. The overall objective of this task would be to test the SEA hypothesis.

(c) To integrate the water column POC flux data with the sediment POC accumulation rate estimates that are available from our previous work in the sound. This will assist in assessing the demand and consumption of POC by benthos and the rates of organic matter remineralization and burial.

4. Methods:

To successfully meet the task objectives of this proposal the flux measurements must be closely integrated with the studies that have been proposed by other investigators of the SEA project, especially with the phytoplankton and zooplankton studies. The flux measurements will be carried out by taking time-series (monthly) samples of POC flux using two sets of sediment traps. The trap design will be after the prototype model PARFLUX Mk6 (Asper, 1988), which is one of the most sophisticated

types in use today. This trap has the capability of collecting time-series, sequential flux of settling particles with flexible intervals without hiatus for 18 months. The sampler has a 0.52m intake vent which opens into individual receptacles that rotate into position sequentially at preset time intervals programmed by a microprocessor (refer to Asper, 1988 for further details on the trap design and operation).

We propose to deploy two sediment traps, effective November 1994, at different depths on a mooring that has an array of instruments deployed by the SEA investigators and/or Dr. D. Salmon. The flux measurements will be carried out for two years, which will allow assessment of the changes in fluxes between years and several seasonal cycles that might have significant shifts in the rate of primary production. Care will be taken to ensure minimum interference by other instruments in the collection of vertical flux of settling particles. One of the traps will be emplaced just below the thermocline and the other near the bottom of the sound at water depth where resuspension of particles is assumed to be absent. The upper trap samples will provide estimates of the time-series fluxes of POC out of the euphotic zone and thus the food supply available to the primary consumers. The lower trap samples will provide estimates of the time-series fluxes of POC to the sound floor. Each of the sample receptacles in the trap will be filled with water having a density higher than the surrounding water to help retain the trapped particles in the receptacle. This high density water will be poisoned with HgCl to preserve the samples from bacterial degradation. The exact time of deployment and retrieval of the traps will be noted.

Each of the samples collected in the field will be transferred into prewashed glass bottles and stored frozen (-20° C) until ready for analysis. The determination of the total particulate content, POC, N and C/N will be after the methods outlined in Feely et al. (1991), Knauer (1991) and Bodungen et al. (1991). Briefly, each of the samples will be filtered through GF/F glass filter membrane which has been prewashed with deionized water, precombusted at 500° C for 4 hrs and preweighed. Following filtration the samples will be rinsed in deionized water to free the samples of salts. The dry weight of particulates retained on the membrane divided by the days of deployment and the trap mouth cross-sectional area will provide the total flux rate of particulates. Prior to analysis of the POC the samples will be exposed to vapors of a weak acid to remove carbonates. The concentrations of POC and N, which will be analyzed in an automatic CHN analyzer, will be reported on a dry weight basis. The sediment traps will be calibrated against known rates of Pb-210 based sediment accumulation rates for the study area (Naidu and Klein, 1988).

D. SCHEDULES:

The start date for this project will be October 1, 1994 and the end date will be September 30, 1996. It is intended to collect flux samples for every month starting from November 1994, so that we will have samples corresponding to various seasons and cycles of primary productivity. During the above duration it is assumed that productivity, zooplankton and hydrographic data will be simultaneously collected by the SEA project.

E. EXISTING AGENCY PROGRAM:

None

F. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS:

None needed.

G. PERFORMANCE MONITORING:

The proposed studies and the contract will be managed by Drs. A. Sathy Naidu and Bruce P. Finney, Professors at the Institute of Marine Science, University of Alaska Fairbanks.

H. COORDINATION OF INTEGRATED RESEARCH EFFORT:

As mentioned earlier this project will closely interact with other studies, especially those that are being proposed under the SEA project and by Dr. D. Salmon on water circulation. Sample collection will be in conjunction with the SEA project and the deployment of the sediment traps will be integrated with the mooring to be set by the SEA project and/or by Dr. Salmon. The POC flux data will be integrated and examined in context of the data that will be obtained by the investigators addressing the phytoplankton, zooplankton, and water mass dynamics. We will fully cooperate and be involved with the modelers who will be testing the SEA hypothesis and other ecosystem modelers working in Prince William Sound. The proposed study has been discussed with the investigators of the SEA project and with Dr. Salmon, all of whom have agreed to collaborate. The budget reflects support for the effort involved by Dr. Salmon in the mooring operations. We will be needing four days of ship time in a year for the deployment and retrieval of the sediment traps. It is anticipated that the ship time will be provided by the Alaska Department of Fish and Game as an overall effort in the deployment of moorings concerned with the SEA project and/or Dr. Salmon's hydrographic investigations. However, sufficient funds have been budgeted in our proposal to share part of the cost of the trap deployment. The cost of the acoustic release (10K) as stated in the subcontract proposal will be refunded to the EVOS Trustee Council in case the primary responsibility of the installation, deployment and recovery of the moorings to which our sediment traps will be integrated, is entrusted to investigators of the SEA project.

I. PUBLIC PROCESS:

R. T. Cooney: An Integrated EVOS-Sponsored Ecosystem Approach to Marine Fish, Bird and Mammal Issues in Prince William Sound: Sound Ecosystem Assessment (SEA) and Related Studies (Project 94320 Summary).

J. PERSONNEL QUALIFICATIONS:

Dr. A. Sathy Naidu, Professor in Marine Science, University of Alaska Fairbanks received his Ph.D. from the Andhra University, Waltair (India). Dr. Naidu has had 30 years of experience (25 years in Alaska) on a variety of multidisciplinary projects relating to marine sedimentological, geochemical, pollution and ecosystem investigations. Some of these investigations have involved carbon flux measurements using sediment traps in the Alaskan arctic and subarctic. Research funding to support these projects have been provided since 1969 by the U. S. Atomic Energy Commission, NOAA/OCSEAP, MMS, U. S. Geol. Survey and U. S. Bureau of Mines. He has taught and guided several graduate students. Dr. Naidu has published 45 papers in several journals and books. He has chaired and participated in the United Nations EP/SCOPE Carbon Cycling Study, as well as chaired Federally-sponsored workshops to design pollution monitoring in Alaska. Dr. Naidu was elected a Life Member to the Clare Hall, University of Cambridge (U.K.). He has extensive research experience in the Prince William Sound region. Dr. Naidu will be responsible for supervising all phases of the analysis, managing the project, report submission and coordinating with the P.I.s associated with the SEA project.

Dr. Bruce Finney, Assistant Professor at the Institute of Marine Science, received his Ph.D. from Oregon State University in 1986 and conducted postdoctoral research at Duke University. He has experience in sedimentary processes, geochemistry, and paleoenvironmental reconstruction. His analytical experience includes both sediment and water column particulates. He has been involved with several major marine and geological field programs, including a multidisciplinary study that developed a carbon budget for a basin off Southern California. He has given talks at more than 15 national/international meetings, and has more than 15 publications.

8. References

Asper, V. L. 1988. A review of sediment trap technique. MTS Jour., 21: 18-25.

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Naidu, A. S. and L. H. Klein. 1988. Sedimentation processes. In D. G. Shaw and M. J. Hameedi (eds.), Environmental Studies in Port Valdez, Alaska. Springer-Verlag, Berlin. 70-91.

Naidu, A. S., S. C. Jewett, H. M. Feder and M. K. Hoberg. 1993. Stable carbon isotope ratios of Prince William Sound subtidal sediments, prior and subsequent to the Exxon Valdez oil spill. Proc. Exxon Valdez Oil Spill Symposium, Anchorage, Feb. 1993. 341-342.

Budget

SALARIES AND BENEFITS			
Wages	*Mos.*		
Naidu, S.	3.00	$21,966	
Finney, B.	1.00	$4,547	
M.S. Student	6.00	$5,459	
Leave Accrual			
Naidu, S.		$4,415	
Finney, B.		$914	
M.S. Student		$0	
Benefits			
Naidu, S.		$7,730	
Finney, B.		$1,600	
M.S. Student		$0	
TOTAL SALARIES AND WAGES			$46,631
TRAVEL			
4 R/T Fairbanks-Valdez		$3,328	
Per diem - Valdez (12 days @$138)		$1,656	
4 R/T Fairbanks-Anchorage		$1,200	
Per diem - Anchorage (14 days @$170/day)		$2,380	
R/T Fairbanks-San Diego		$800	
Per diem - San Diege (3 days @$115/day)		$345	
TOTAL TRAVEL			$9,709
SERVICES			
Communications		$500	
Report preparation		$2,000	
Biochemical analyses		$3,000	
Shipping		$4,000	
Subcontract to PWSSC (see attached)		$57,910	
TOTAL SERVICES			$67,410
SUPPLIES			
Glassware, filters, chemicals		$2,000	
TOTAL SUPPLIES			$2,000
EQUIPMENT			
2 Sediment traps @$18,000 each		$36,000	
TOTAL EQUIPMENT			$36,000
TUITION			
1 Semester		$2,530	
TOTAL TUITION			$2,530
TOTAL DIRECT COSTS			$164,280
INDIRECT COSTS (20% TDC)			$32,856
TOTAL FUNDING REQUESTED			$197,136

Food limitation on recovery of injured resources: an ecosystem approach to the restoration of marine birds; distribution and abundance of forage fish as indicated by puffin diet sampling

Project Number: 95019

Principal Investigator: Scott A. Hatch

Lead agency: National Biological Survey

Project costs: FY95 $284.4K (Budget for each fiscal
FY96 $204.2K year includes cost of data
FY97 $204.2K analysis and write-up.)

Start-up date: 10/94

Completion date: 3/98

Project duration: 3 years (Useful results can be obtained in 1 year. A 3-year project is recommended to assess interannual variation in composition of forage fish stocks.)

Geographic area: Naked Island
Smith Island
Porpoise Rocks
Wooded Islands
Chiswell Islands
Barren Islands

Contact person: Scott A. Hatch
National Biological Survey
Alaska Science Center
1011 East Tudor Road
Anchorage, AK 99503
907-786-3529

B. INTRODUCTION

Tufted puffins are widely distributed in breeding colonies throughout the Exxon Valdez oil spill area. During the chick-rearing period, adults make several trips daily to the nesting burrow, carrying fresh prey to their young. By intercepting those food deliveries, it is possible to sample the nestling diet of puffins systematically and nonconsumptively. Puffins are representative of seabirds (common murres, marbled murrelets, pigeon guillemots, black-legged kittiwakes and others) that rely in summer on a common food base consisting of forage species like capelin, sandlance and smelts, and the juveniles of commercially important species such as pollock,

herring, and salmon. This project will use puffin diet sampling as a means to quantify seasonal, annual, and geographic variation in the composition of the forage fish community at selected stations within the spill area. The project will complement traditional, more costly approaches involving hydroacoustics and net sampling and will also provide a reliable source of seabird prey specimens for laboratory analaysis.

C. NEED FOR THE PROJECT

Three species of marine birds (common murre, marbled murrelet, and pigeon guillemot) and one pinniped (harbor seal) were injured by the Exxon Valdez oil spill and are not recovering. An additional species (black-legged kittiwake) showed early effects on reproduction (comparing oiled and unoiled areas) and has experienced widespread breeding failure throughout Prince William Sound in the last two years. The summer diets of these and other members of the pelagic community of vertebrate predators (birds, mammals, and fish) are known to overlap. One hypothesis to explain the failure of recovery of injured species is that adverse changes are occurring in the quantity or quality of these species' prey. To test that hypothesis, it is necessary to quantify the status and trends of prey populations, particularly the forage fish that comprise an important part of the summer diet. Few data are available on the distribution and abundance of forage fish, because most species are not commercially harvested, and traditional methods of fishery science tend to be difficult and expensive. In the Gulf of Alaska, tufted puffins have proved to be excellent samplers of the forage fish community, providing annual indices of the distribution and relative abundances of keystone species such as capelin, sandlance, pollock, myctophids, and squids. Conducted over a span of years, this approach offers a cost-effective means of monitoring key components of the pelagic ecosystem and testing the hypothesis that recovery of marine birds and mammals is influenced by changes in the composition of marine fish stocks.

Seabirds in general, and puffins in particular, may constitute an important mortality factor on the early life stages of commercially important species. In the Gulf of Alaska, Hatch and Sanger (1992) calculated that tufted puffins took 11 billion pollock from mid July to mid September, roughly one-tenth of the first-year juveniles available just prior to chick-rearing and ten times the number of fish surviving to the following March. On the Barren Islands in 1993, puffins frequently delivered juvenile sockeye salmon, although the smolt were too large to be readily ingested by the chicks, and many went to waste (A. Kettle, pers. comm.).

Whether seabird predation proves to be a significant source of mortality or not, previous results suggest that diet sampling can provide an early indication of year-class strength in some species. For instance, the proportion of pollock in tufted puffin diets at the Semidi Islands (western Gulf of Alaska) was strongly correlated over three years with independent measures of year-class strength obtained in fishery investigations (Hatch and Sanger 1992). A similar outcome might be obtained for sockeye salmon at the Barren Islands or pink salmon in Hinchinbrook Entrance to Prince William Sound, where an out-migration of juveniles in late summer and fall (PWS Fisheries Research Planning Group, 1993) would encounter the sizeable puffin colonies on Porpoise Rocks and the Wooded Islands.

Because puffins deliver whole, undamaged prey to their chicks, this project can serve as a ready source of specimens for determination of prey quality (composition and energy density), population structure (age-sex ratios, genetic stock identification), and trophic studies (fish stomach contents, stable isotope ratios and/or lipid analysis). Puffin samples have also been used to estimate daily growth increments of juvenile sandlance and pollock (Hatch 1984, Hatch and Sanger 1992).

D. PROJECT DESIGN -- Objectives, Methods, Schedule and Location

1. Objectives

- Annually assess the species composition of the forage fish community near selected colonies of seabirds in the northern portion of the Exxon Valdez oil spill area.
- Cross check the species composition of forage fish as determined by puffin diet sampling and hydroacoustic/net sampling techniques.
- Assess the timing and magnitude of puffin predation on commercially important prey species including Pacific herring, pink salmon, and sockeye salmon.
- Furnish whole prey specimens on demand for complementary studies of prey energetics, food web relationships, and fish population characteristics.

2. Methods

Puffin diet samples are collected most efficiently by placing wire screens over the entrances to burrows. Unable to enter, returning adults frequently drop their food loads on or near the screens, which are removed when the samples are retrieved after 1-3 h. Samples are washed, bagged and preserved for later analysis in the laboratory. Any temporal sampling design that may be desired can be implemented, but for maximizing the quantity of food obtained, morning hours tend to be most productive because puffins generally make a food delivery soon after first daylight.

One issue raised by this sampling approach is whether puffins take different types of prey in proportion to their relative abundances in the water column. Therefore, a desirable element of the field work during the first year of this project would be a comparison of the results from puffin diet sampling with simultaneous deployment of hydroacoustics and net sampling offshore at one or more colonies. The offshore work is not budgeted for in this proposal, but it is anticipated that the coordinated study would be achieved through cooperation with other projects (forage fish assessment or SEA plan) proposed for fiscal year 1995.

Puffin productivity (chicks per burrow surviving at a late stage of the breeding season) and breeding chronology (estimated from chick wing lengths) will be monitored at little or no

additional cost in each of the study colonies.

3. Schedule

Fiscal Year 1995

Nov-June	Establish contracts, recruit personnel, safety training, boat and collection equipment preparation.
July-Aug	Field collection of puffin diet samples at six sites in Prince William Sound and northern Gulf of Alaska; coordinated investigation of sampling methods at Porpoise Rocks.
Sept	Laboratory analysis of food samples.

Fiscal Year 1996

Oct-Dec	Complete laboratory analysis; data analysis and report writing.
Jan	Draft annual report.
March	Final annual report.

4. Technical Support

Prey samples may be identified and measured under contract to the University of Alaska or a private consultant.

5. Location

The Porpoise Rocks colony in Hinchinbrook Entrance is strategically located relative to juvenile salmon migration. It is probably also the best location for a comparative study of sampling techniques. Additional colonies in Prince Willaim Sound would include Naked Island, Smith Island, and the Wooded Islands. Outside the Sound, but in the path of the oil spill, colonies of first choice include the Chiswell Islands and Barren Islands. There is some question whether puffin habitat on the Chiswells is sufficiently accessible; if not, at least one alternative site would be worked along the Kenai Peninsula or in the Kodiak Island area.

E. PROJECT IMPLEMENTATION

This project will be implemented by the Alaska Science Center, National Biological Survey. Center personnel developed the field techniques proposed for puffin diet sampling and have successfully applied the methods at more than 20 puffin colonies in the Gulf of Alaska since 1985.

F. COORDINATION

As previously noted, coordination with offshore operations that sample forage fish by traditional methods is a highly recommended component of this project. The project will contribute to and draw upon SEA investigations of juvenile salmon and herring, and will use information on physical oceanography generated by other EVOS funded studies in the interpretation of seasonal, annual, and geographic variation in forage fish communities.

G. PUBLIC PROCESS

The concept of using puffins as fish samplers was introduced and discussed with members of the public at both the April 1994 EVOS restoration planning workshop and at a follow-up meeting (Anchorage, 9 May 1994) of public and government representatives interested in forage fish research. A representative of the Kodiak Groundfish Databank, in particular, has expressed interest in the prospects of this study to provide information relevant to the management of pollock and other fisheries.

H. PERSONNEL QUALIFICATIONS

Dr. Scott A. Hatch, Principal Investigator, is employed as a Supervisory Research Biologist in the Alaska Science Center, National Biological Survey. Dr. Hatch has conducted research on the population dynamics and feeding ecology of seabirds in Alaska since 1975. He has authored more than 30 published papers on those topics and has managed interagency programs for seabird research and monitoring since 1987. Curriculum vitae are filed and available on request from the Restoration Office, Exxon Valdez Oil Spill Trustee Council.

I. BUDGET

FY95 ($K)	
Personnel	149.0
Travel	15.0
Contractual services	20.0
Commodities	10.0
Equipment	45.0
Capital outlay	0.0
Subtotal	239.0
General administration	45.4
NEPA compliance	0.0
Total	284.4

J. LITERATURE CITED

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Food limitation on recovery of injured resources: an ecosystem approach to the restoration of marine birds; seasonal movements and pelagic habitat use by common murres from the Barren Islands

Project Number: 95021

Principal Investigator: Scott A. Hatch

Lead agency: National Biological Survey

Project costs: FY95 $251.1K
FY96 $212.5K (Budget for each fiscal year includes the cost of data analysis and write-up.)

Start-up date: 10/94

Completion date: 3/97

Project duration: 2 years (Useful results can be obtained in 1 year. A 2-year project is recommended to assess interannual variation in the foraging behavior of common murres.)

Geographic area: Barren Islands

Contact person: Scott A. Hatch
National Biological Survey
Alaska Science Center
1011 East Tudor Road
Anchorage, AK 99503
907-786-3529

B. INTRODUCTION

Small (30 g) satellite transmitters have recently become available for use in wildlife telemetry. These implantable devices are proven effective when deployed on birds in the size range of common murres, i.e., about 1 kg. In this project, satellite transmitters will be surgically implanted in a sample of murres from the Barren Islands to determine both the summer feeding areas and wintering areas of birds from this heavily impacted colony. This information will be vital for designing and optimizing an investigation of food availability to murres and for testing the hypothesis that food limitation is constraining the recovery of the Barren Islands population following the Exxon Valdez oil spill.

As diving birds, murres do not access the entire water column uniformly, but concentrate their foraging activity in depth ranges dictated by the distribution of their preferred foods and limitations imposed by their own diving physiology. This additional information is needed to

address the question of food limitation on murre productivity and recovery. Externally mounted depth recorders will be used to determine the average time-at-depth for common murres foraging in the vicinity of the Barren Islands.

C. NEED FOR THE PROJECT

Common murres were among the vertebrate species most seriously injured by the Exxon Valdez oil spill. About 75% of the 35,000 bird carcasses recovered during and shortly after the event were murres, and estimates of murre losses were in excess of 100,000 individuals. After the oil spill, fewer breeding murres were found at the Barren Islands compared to historical data, and annual censuses have not detected any recovery in numbers. Also, based on data from Nord Island, production of chicks was almost zero in both 1989 and 1990, and still low in 1991 and 1992 compared to colonies outside the spill zone.

One hypothesis to explain the failure of recovery in common murres is that food availability is limiting the ability of birds to breed successfully or to survive in sufficient numbers during the nonbreeding season. An evaluation of that hypothesis requires that we identify the principal feeding areas of murres in both seasons and design appropriate oceanographic studies to assess the factors affecting food availability. Telemetry offers a more cost-effective approach for determining foraging patterns and habitat use than is possible using traditional survey methods.

In many populations of seabirds, the majority of natural mortality occurs during the winter months (Hatch 1987, Hatch et al. 1993). Problems with the food supply on the wintering grounds may constrain the recovery of Barren Islands murres even if productivity improves. Probably there is another critical period in fall, when recently fledged young make the transition to self-feeding (Burger 1980). However, the existence or location of possible "nursery areas" is all but unknown for this and other populations of seabirds.

Through the combined use of satellite transmitters and time-depth recorders, this project will provide a three-dimensional view of murre foraging patterns around the Barren Islands in summer. Additionally, transmitters deployed in fall and tracked through the winter months will reveal the primary wintering areas used by this population. It may also be possible to locate key foraging areas of juvenile murres by deploying transmitters on breeding males late in the season. Flightless murre chicks are led to sea by their male parents, who continue to provide parental care for several weeks as the young learn gradually to feed themselves.

D. PROJECT DESIGN -- Objectives, Methods, Schedule, and Location

1. Objectives

- Determine the foraging range and primary feeding areas of common murres from the Barren Islands, including assessment of individual and temporal variation.

- Locate important nursery and/or wintering areas of common murres from the

Barren Islands and determine the timing of use of those critical habitats.

- Obtain average time-at-depth profiles for a sample of foraging murres from the Barren Islands.

2. Methods

Murres will be captured with poles and nooses during incubation and chick-rearing periods in the Lighthouse Rock portion of the colony on East Amatuli Island. Transmitters will be surgically implanted by a qualified veterinarian. The ARGOS Data Collection and Location System will be used to track the movements of instrumented birds. Transmitters will be programmed to emit signals on one of two duty cycles: (1) continuous transmission, providing frequent information on locations (accurate to $\leq$ 1 km) over a 3-week period (expected battery life), or (2) low-interval transmissions (e.g., 6 h every 3 days) for less frequent position data over the course of an annual cycle (52 weeks). Position data will be mapped using CAMRIS (Computer Aided Mapping and Resource Information System) or other suitable GIS software.

Time-depth recorders are relatively inexpensive devices employing hypodermic syringes and photographic film to record the depth-dependent position of an light-emitting diode (Wilson et al. 1989). The instruments are attached externally to the dorsal feathers and must be retrieved after an appropriate interval to obtain the data on diving depths. Information on the depth and duration of dives is cumulatively recorded on the film, and the exposed film is analyzed using a densitometer. Each unit is calibrated prior to deployment. LED depth recorders have been used successfully with thick-billed murres in the Canadian Arctic (Croll et al. 1992) and on smaller alcid species in the North Pacific (Burger 1991).

3. Schedule

Fiscal Year 1995

Nov-June	Establish contracts, recruit personnel, procure satellite transmitters and LED depth recorders.
July-Aug	Field operations at East Amatuli Island, begin data acquisition via ARGOS.
Sept	Continue ARGOS data acquistion, densitometer readings and interpretation of LED depth recorder films.

Fiscal Year 1996

Oct-Dec	Continue ARGOS data acquisition, data analysis and report preparation.
Jan	Draft annual report.
March	Final annual report.

4. Technical Support

The manufacture, calibration, and optical density measurements of LED depth recorders will be contracted to a qualified specialist. This project also requires the services of an experienced veterinarian and access to the ARGOS data-logging and distribution system, both of which are available in the Alaska Science Center of the National Biological Survey.

5. Location

These studies will be carried out in the colony at the north end of East Amatuli Island, the more accessible of two colonies of common murres in the Barren Islands.

E. PROJECT IMPLEMENTATION

The project will be implemented by the Alaska Science Center, National Biological Survey. In addition to the in-house technical support mentioned above, Center personnel have unique experience with implantable satellite transmitters for recording the movements of birds at sea (Petersen et al., MS). The Principal Investigator for this project has scheduled a pilot study of transmitter implants and satellite tracking of common murres in the Gulf of Alaska during July 1994.

F. COORDINATION

Work on East Amatuli Island will be coordinated with the monitoring study of common murres proposed for that site to facilitate the telemetry study and avoid any conflicts between the two. Results of this study should be used in planning future investigations of the food limitation hypothesis as it pertains to common murres.

G. PUBLIC PROCESS

The idea of using satellite transmitters to identify the foraging areas of common murres was introduced at a meeting of public and government representatives interested in forage fish research (Anchorage, 9 May 1994). Should this project be funded, further opportunities for public input will be available at two winter workshops planned for 1994-95 by the Exxon Valdez Oil Spill Restoration Office.

H. PERSONNEL QUALIFICATIONS

Dr. Scott A. Hatch, Principal Investigator, is employed as a Supervisory Research Biologist in the Alaska Science Center, National Biological Survey. Dr. Hatch has conducted research on the population dynamics and feeding ecology of seabirds in Alaska since 1975. He has authored more than 30 published papers on those topics and has managed interagency programs for seabird research and monitoring since 1987. Curriculum vitae are filed and available on request from the Restoration Office, Exxon Valdez Oil Spill Trustee Council.

Dr. Alan E. Burger, collaborator for the study of diving behavior, is an Assistant Professor of Biology at the University of Victoria in British Columbia. His research specialty is the foraging patterns and diving physiology of penguins and alcids, on which he has published widely in the ornithological literature. Dr. Burger was involved in the original development of LED depth recorders and has used the devices extensively in recent research on the diving characteristics of alcids.

I. Budget

FY95 ($K)	NBS
Personnel	107.0
Travel	10.0
Contractual services	10.0
Commodities	30.0
Equipment	54.0
Capital outlay	0.0
Subtotal	211.0
General administration	40.1
NEPA compliance	0.0
Total	251.1

J. LITERATURE CITED

Burger, A.E. 1991. Maximum diving depths and underwater foraging in alcids and penguins. Pages 9-15 in W.A. Montevecchi and A.J. Gaston, eds. Studies of high-latitude seabirds. 1. Behavioural, energetic, and oceanographic aspects of seabird feeding ecology. Can. Wildl. Serv. Occ. Pap. 68, Ottawa.

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Croll, D.A., A.J. Gaston, A.E. Burger, and D. Konnoff. 1992. Foraging behavior and physiological adaptation for diving in thick-billed murres. Ecology 73: 344-356.

Hatch, S.A. 1987. Adult survival and productivity of northern fulmars in Alaska. Condor 89: 685-696.

Hatch, S.A., B.D. Roberts, and B.S. Fadely. 1993. Adult survival of black-legged kittiwakes (Rissa tridactyla) in a Pacific colony. Ibis 135: 247-254.

Petersen, M.R., D.C. Douglas, and D.M. Mulcahy. MS. Use of implanted satellite transmitters to locate spectacled eiders at sea. National Biological Survey, Alaska Science Center, Anchorage, AK.

Wilson, R.P., A.E. Burger, B.L.H. Wilson, M.-P.T. Wilson, and C. Noldeke. 1989. An inexpensive depth gauge for marine animals. Mar. Biol. 103: 275-283.

Project title: Foraging efficiencies at temporary food patches.

Project Number: 95022

Project type: Research/Monitoring

Name of project leader(s): Dr. David Scheel, Prince William Sound Science Center

Lead agency: Prince William Sound Science Center through National Biological Survey

Cooperating agencies: University of Alaska Fairbanks (UAF)
Alaska Department of Fish & Game (ADF&G)
Prince William Sound Aquaculture Corporation (PWSAC)

Cost of project: FY95: $183.1K

Start-up date: October 1, 1994

Completion date: September 30, 1995

Duration: 2 or more years

Geographic area of project: Prince William Sound

Contact: Dr. David Scheel
PWS Science Center
P.O. Box 705
Cordova, AK 99574
Tel: (907) 424-5800

B. INTRODUCTION

Populations of several bird and mammals species, particularly those that feed on fish in pelagic areas, have declined over the past twenty years. Recent EVOS Trustee sponsored workshops, as well as regional conferences (e.g., Is It Food? 1993), focused on the hypothesis that changes in food availability are responsible for these population declines, or prevent the recovery of populations following mortality from the Exxon Valdez oil spill. Testing of this hypothesis has been identified as a research priority by the EVOS Restoration Office.

A change in the abundance, composition, or distribution of prey will be reflected in the efficiency with which animals forage. Foraging efficiency refers to the ability of an animal to gather food from the environment: more efficient foragers can feed profitably at food availabilities too low for less efficient foragers (Brown 1988, 1992). Marine birds and mammals often depend on food that occurs in rich, temporary patches (e.g., Piatt 1992). For example, the spring spawning of herring attracts large aggregations of predators such as humpback whales,

sea lions, gulls, shorebirds and other birds that prey on both adult herring and herring eggs. Other examples include predators attracted to schooling fish or to salmon fry out-migration. The relative foraging efficiencies of species that feed on the same or similar prey can be measured in the field through studies at feeding sites.

A concentration of vulnerable prey attracts many foragers. However, as predators feed, the prey is depleted or becomes more difficult to capture. Rich patches also attract predators such as bald eagles that may prey upon animals aggregated to utilize the food source, thereby further decreasing their ability to feed efficiently. For these reasons, the concentration of available food in an area will decline once foragers begin to feed. In any mixed-species aggregation of foragers, the species least efficient at feeding will give up first as prey become more difficult to get. More efficient foragers will continue to feed until insufficient capture rates force all species to give up. If a measure of the quality of the food patch is available, this information is also useful. Only efficient foragers should be found on lower quality patches whereas all foragers can profitably feed in the richest patches. Measures of patch quality would include, for example, acoustic measurements of fish schools indicating biomass, density, and size distribution. In this manner, the composition of a foraging aggregation can be used to assess relative feeding efficiencies of competing species.

Data on foraging, the act of gathering food, provide the most direct tests possible of hypotheses concerning the limitation of populations by their ability to gather food. Observational studies of foraging aggregations in important bird and mammal foraging areas, coupled with acoustic measurements of fish, offer opportunities to quantify the foraging efficiencies of the animals attracted by such prey. This proposed study will collect foraging data on predators feeding in mixed-species aggregations, and will examine foraging efficiencies, population indices, and food web relationships in the context of the community dynamics of fish-eating birds and mammals.

C. NEED FOR THE PROJECT

A number of species injured by the Exxon Valdez oil spill and currently showing little or no sign of recovery have in common a habit of foraging in the pelagic environment on small, schooling fish. These include harbor seals, common murres, marbled murrelets, and pigeon guillemots. A 1991 workshop on population declines in these north Pacific marine birds and mammals listed studies of foraging behavior among the most useful for testing the hypothesis that food availability limits population growth and recovery for these species (Springer 1993). Workshop participants also concluded that studies focusing on community dynamics of fish-eating predators were an important ingredient to understanding seabird declines. Investigation the food-limitation hypothesis has been identified as a research priority for these species by the Exxon Valdez Restoration Office.

As food becomes scarce in any environment, less efficient foragers should experience food shortages earlier and more severely than more efficient foragers. Preliminary observations from foraging aggregations on overwintering schools of 1-2 year-old herring suggest that animals are structured in this manner even within a single foraging aggregation (D. Scheel, unpublished

data). The food availability hypothesis predicts that population declines will be correlated with food shortages, and hence with feeding efficiency. This study of foraging efficiency thereby provides a simple approach to addressing the general hypothesis that a shortage of food is responsible for the lack of recovery of injured species.

In addition to providing a simple test of the food-limitation hypothesis, results of this study may be useful in developing: 1) indices of population size, distribution or foraging behavior for fish-eating birds and mammals; 2) estimates of mortality to some small schooling fish species (e.g., salmon fry and juveniles, herring) from bird and mammal predation; and 3) a better understanding of shifts in food web structure among seabirds, their prey, and their predators.

D. PROJECT DESIGN

1.1. General Objectives

This study will estimate relative foraging efficiencies of foragers in mixed-species aggregations of birds and mammals feeding on small, schooling fish (i.e., forage fish). Results will be used as a test of the food-limitation hypothesis for declines or lack of recovery among sea birds and mammals. Specifically, I will test the prediction that, for foragers on small, schooling fish, relative foraging efficiencies measured at temporary foraging aggregations are correlated with the severity of population decline.

1.2. Objectives for 1995

Sampling will be conducted during the field seasons of the SEA and the Pelagic Predator research programs, when foraging aggregations form within the focal study areas of those two programs. Objectives for this sampling are:

1) Record size and composition of foraging aggregations feeding on small, schooling fish. For aggregations persisting less than several hours, record arrival and departure sequence of foragers.

2) Sample behavior at foraging aggregations to measure dive and capture rate for foragers that bring prey to the surface before consuming them (e.g. gulls and terns). This provides a test of the assumption that foraging efficiencies for these species are indicated by the composition of, and departure time from, foraging aggregations.

3) Use data from this proposal and from acoustic surveys to conduct a test of the food-limitation hypothesis, base on foraging efficiencies.

2.1 Methods

1) Size and composition of foraging aggregations: Foraging aggregations will be observed from a small boat, from shore, or where necessary and if space is available, from acoustic

survey boats. All foragers present (including potential predators on foraging birds) will be counted and identified to species if possible, or to species group, and foraging behaviors noted. Aggregations will also be photographed for later counting to check on-site estimates. Repeated counts through out the observation period will be used to record arrival and departure sequence. Pelagic Predator focal study areas are designed to contain important PWS foraging areas for these species, and I will request information on locations of foraging 'hot spots' from both SEA and Pelagic predator research boats.

2) Behavior: Focal-animal sampling will be conducted on-site if possible, and from video tapes otherwise to estimate dive rates for each prominent species (or species-group) of forager and to estimate capture rates for each species that brings food to the surface before consumption (e.g., gulls and terns). Response to and interactions with potential predators (e.g., eagles) will be recorded to estimate impact of predation risk on foraging.

3) Analysis: Estimates of foraging efficiencies will be made from the composition of aggregations, the arrival and departure sequence of species and the dive success rate (only for species consuming prey on the surface). The food-limitation hypotheses will be examined and evaluated in light of this data.

2.2 References

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Brown, J. S. 1992. Patch use under predation risk: I. Models and predictions. Ann. Zool. Fennici 29:301-309.

Is it food? 1993. Addressing marine mammal and seabird declines: workshop summary. Alaska Sea Grant College Program, AK-SG-93-01.

Piatt, J. F. 1990. The aggregative response of common murres and Atlantic puffins to schools of capelin. Avian Biology 14:36-51.

Springer, A. M. 1993. Report of the seabird working group. Is it food? Addressing marine mammal and seabird declines: workshop summary. Alaska Sea Grant College Program, AK-SG-93-01. (Pages 14-29)

2.3. Schedule

Jan- Mar: Organize logistics, purchase equipment and hire personnel
Apr-Aug/Sep: Field work in coordination with SEA and Pelagic Predator studies.
Sep-Dec: Begin analysis and report writing.

2.4. Technical Support

This project benefits from the availability of acoustic and net sampling data from SEA and Pelagic Predator research, but is not dependant on those projects to achieve its objectives.

2.5. Location

Field research will be conducted primarily in Prince William Sound, and analysis will occur at the PWS Science Center.

E. PROJECT IMPLEMENTATION

This research is proposed by and should be conducted by the Prince William Sound Science Center. The theoretical basis for this work developed from Science Center staff's (D. Scheel, PI and T. Vincent) past work and interaction with colleagues (e.g., Vincent, Scheel, Brown & Vincent. In prep. Tradeoffs and coexistence in consumer-resource models: it all depends on what you eat.).

This work will utilize data from both the SEA program and Pelagic Predator project. Close interaction and access to SEA researchers and data make the Science Center an appropriate choice. It is also designed to complement other proposed research involving Science Center collaboration, including components of the SEA Herring program, SEA Predator-prey program, and the Science Center proposal to conduct a forage fish assessment.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is designed with input from the SEA program, and the Pelagic Predators and Nearshore work groups and compliments research proposed within those groups. The PI of the proposed work has been and will continue to be an active participant in SEA and EVOS Trustee meetings to integrate research.

G. PUBLIC PROCESS

This project was developed following consultation with SEA, Pelagic Predator and Nearshore work groups, and participation in EVOS workshops focused on research priorities. The public has been involved in this project through their participation in those activities. This research is integrated with two projects under the SEA program (Predation on hatchery fry, Herring overwintering), each of which will be involving interested public volunteers to collect some data. Data from these two projects may contribute to tests of hypotheses described here.

H. PERSONNEL QUALIFICATIONS

Principle Investigator: David Scheel, Associate Scientist, Prince William Sound Science Center. Education: Ph.D. (Ecology, 1992, University of Minnesota), MS (Ecology, 1986, Univ. of MN), BS (Biology, 1980, Renesselaer Polytechnic Institute). Professional experience: 1993-present, Associate scientist, PWSSC; 1992-93, Postdoctoral associate, University of Houston; 1986-1992, Research scientist, Serengeti Wildlife Research Institute, Serengeti, Tanzania; 1984-1992, student/post-doc/consultant, Univ. of Minnesota. Selected publications: Scheel, D. 1993. Profitability, encounter rates and the prey choice of African lions. Behav. Ecol. 4(1):90-97.

Cameron, G. N., & D. Scheel. 1993. A GIS model of the effects of global climate change on mammals. Geocarto International 4:19-32. Research projects: Predator-prey dynamics of Serengeti lions and their prey, habitat selection models of Texas mammals, frequency- and density dependence in models of community evolution, social behavior and resource/habitat use of primates in Gombe.

I. BUDGET (Amounts shown in thousands).

	FY95	FY96
Personnel	94.8	94.8
Travel	10.6	10.6
Contractual	8.4	8.4
Commodities	8.9	8.9
Equipment	29.9	0
Total direct costs	152.6	122.7
Indirect costs (20%)	30.5	24.5
Project Total	$183.1	$147.2

Project title: Food limitiation on recovery of injured resources: an ecosystem approach to the restoration of marine birds; food-web relationships of pelagic species exhibiting long-term declines

Project Number: 95023

Principal Investigator: David Cameron Duffy

Lead Agency: University of Alaska through National Biological Survey

Project costs: FY 95 $168.0K (Budget for each fiscal year
FY 96 $170.0K includes the cost of data
FY 97 $145.0K analysis and write-up.)

Start-up date: 10/94

Completion date: 9/98

Project duration: 3 years (Useful results can be obtained in one year. A three-year project is recommended to assess the effects of interannual variation on the diets of the species in the study and to develop a model of trophic interactions of Prince William Sound.)

Geographic area: Prince William Sound and adjoining portions of the *Exxon Valdez* oil spill area

Contact person: David C. Duffy
Alaska Natural Heritage Program
Environment and Natural Resources Institute
School of Public Affairs
University of Alaska
707 A Street
Anchorage, Alaska 99501
(907) 257-2703, FAX 276-6847

B. INTRODUCTION

This project will look at the food webs of Prince William Sound, focusing on diets of seabirds damaged by the *Exxon Valdez* oil spill, the Common Murre, Marbled Murrelet, Pigeon Guillemot and several other seabirds selected for their utility as environmental samplers (Tufted Puffin and Black-legged Kittiwake: Hatch and Sanger 1992; Springer 1992). Diets will be examined in relation to those of Pacific herring and other forage fish and to the predatory fish such as Walleye pollock that might interact with either the birds, as competitors, or the forage fish, as competitors or predators (Springer 1992).

We will use historical data from published studies and from stable-isotope analysis of existing specimens if possible to compare with data gathered during through subprojects of this one, from other EVOS studies, and from recovery of carcasses of animals found dead.

These data will be used to develop simple carbon-flow models to examine the relative importance of different pathways between decades and between areas and to compare these pathways with what is known of changes in the populations of EVOS-injured species and other ecosystem indicators.

C. NEED FOR THE PROJECT

Marine ecosystems can fluctuate and, in the North Pacific, they vary at a wide variety of scales that affect seabirds and other marine organisms (Duffy 1993). his variability can enhance, retard or obscure the effects of single events such as the spill of the *Exxon Valdez* in Prince William Sound, Alaska. For example, resources that were damaged by the oil spill may not have recovered because of climatic variability that rendered the environment less favorable or there may be lingering effects of the spill that might be open to amelioration. Reductions in some species might trigger increases in their prey that then in turn compete with third species, preventing their recovery.

We can not address these or other possibilites concerning recovery or manage Prince William Sound as an ecosystem unless we understand the existing trophic networks that operate within the ecosystem. While understanding an entiretrophic structure of the Sound is an open-ended project that would require years, if not decades, we can test hypothesesand develop models centering on injured resources that should help give us a working knowledge of how the trophic networks function, sufficient to allow us to assist the restoration process or, in the very worst case, at least to understand the magnitude of the task.

D. PROJECT DESIGN

The project will run for three years, to test interannual variability. The first year will involve collection of historical data and synthesis of data from ongoing studies. The second year will continue data collection and the initial modelling exercise. The third year will see refinement of the model and testing of its predictions through limited field work.

The project will have two sampling components and analysismethods to provide the data for model construction. For examination of trophic interactions at short-terms over small scales, we will undertake analysis of diet through classical diet analysis techniques (Duffy and Jackson 1986). We will collect diets through direct field work by research collaborators and ourselves. To get a larger-scale picture of trophic interactions, we will use our own collections and public salvage of specimens for stable-isotope analysis of the trophic levels of constituent species (Rounick and Winterbourn 1986; Peterson and Fry 1987; Hobson 1991).

We will then use either carbon-flow (Schneider and Hunt 1982; Schneider et al. 1986; Springer

et al. 1986), biomass (Springer 1992), trophic level models (Sanger 1987), or spatial/oceanographic (Shuntov 1993; Schneider and Hunt 1982) approaches to modelling the food web.

1. Objectives

- Define the food web relationships of key species in the pelagic ecosystem of Prince William Sound and adjacent portions of the spill zone.

- Assess seasonal, annual, decadal and regional variation in the diets of injured species of marine birds (common murre, marbled murrelet and pigeon guillemot) and selected indicator species including tufted puffins and black-legged kittiwakes that may serve as monitors of the ecosystem.

- Test the null hypotheses that 1) no changes in diet occurred cohesively among several species between decades; and that 2) interannual variability in diet does not occur at a scale that might obscure interdec-adal change. If the null hypotheses can be rejected, we will test the overall project hypothesis that Prince William Sound has shifted from a pelagic to a demersal ecosystem in terms of fish production.

- Synthesize information on trophic dynamics in Prince William Sound and the northern Gulf of Alaska and derive a model or models of species interactions that predict the relative importance of competition and predation on the recovery of injured species.

2. Methods

- The project will coordinate with other studies in the marine bird program. It will use diet data on food habits collected using nonconsumptive techniques in subprojects B,C,F. We will undertake fieldwork to fill in any gaps in coverage. We will provide technical assistance on stomach pumping to increase the use of non-lethal sampling (Duffy and Jackson 1986) and will coordinate efforts to ensure complete coverage.

- The project will encourage widespread efforts by the public and governmental agencies to collect carcasses of birds found dead (washed up, dead in fishery operations, etc).

- The project will undertake stable isotope analysis using material from dead birds recovered as above, from stomach contents derived from nonlethal sampling of birds, and from forage and predatory fish from fishery operations and from the SEA Plan.

- Diet contents will be assigned to broad trophic levels or guilds and analyzed for spatial and temporal variation and for congruence in diet and diet change between species. Carbon flow models for different areas and decades will be constructed. We will then examine known or inferred changes in populations of the constituent species (temporal change) and relative abundance of species (geographic variation) that might represent

transitions between the different carbon models.

- We can test spatial predictions of models by sampling in new areas in the third year. Temporal predictions may be more difficult to test unless significant climatic or other change can be detected independently.

3. Schedule

Fiscal Year 1

Oct-Apr	Establish contracts, set up public involvement process for collecting of specimens, training for field sampling, preparation for field work.
Feb-Mar	Undertake winter sampling.
Feb	Begin public collection process and analyze specimens as they become available.
June-Aug	Field work in Prince William Sound and adjacent spill areas.
Sept	Analyze data from collaborators as they become available. Initial report completed.

73 Fiscal Year 2

Oct-Dec	Continue analysis of specimens from public salvage efforts and from own field work and collate data from collaborators. Initial scoping effort to determine most effective models relative to available data.
Jan	Prepare report on first field season; town meetings on results in Anchorage, Valdez and Seward. Begin modelling exercise.
Feb-Mar	Undertake winter sampling.
May	Prepare for summer sampling.
May-Sept	Continue analysis of specimens from public salvage efforts, undertake own field work and collate data from collaborators.
June-Aug	Field work in Prince William Sound and adjacent spill areas.
Sept	Second-year report completed.

Fiscal Year 3

Oct-Dec	Continue analysis of specimens from public salvage efforts and from own field work and collate data from collaborators.
Jan	Prepare report on second field season; town meetings on results in Anchorage, Valdez and Seward. Continue modelling, integrating second year's data.
Feb-Mar	Undertake winter sampling.
May-July	Limited final field work in Prince William Sound and adjacent spill areas to test model predictions or gather missing data.
July-Aug	Final analysis of data, running of final model and preparation of report.

4. Technical Support

A stable-isotope laboratory and a lipid laboratory will be involved in the project in the first year. Based on initial results, their roles will be determined for the second two years. Field work will be conducted on private vessels and collection of specimens of organisms fround dead in the Prince William Sound area will require support from management and regulatory agencies (U.S. Fish and Wildlife Service, Alaska Division of Fish and Game, U.S. Coast Guard, local police) and nongovernment groups (Native Corporations, fishermen and anglers). Collection of samples will be coordinated with other EVOS-funded researchers and any others active in the area. Modelling efforts in the second and third year may require additional participants.

5. Location

Prince William Sound and adjacent portions of the spill area. Particular locations will be determined by work by cooperating scientists and by specimens contributed by the public. Our field work will be directed at filling in geographic 'gaps' in coverage in the first two years. In the third year, we will use field work to test model predictions in a previously unsampled area.

E. PROJECT IMPLEMENTATION

Project will be managed by the Alaska Natural Heritage Program (AKNHP), with field work and data collection by personnel from AKNHP, National Biological Survey, and other agencies. AKNHP have extensive experience coordinating projects involving multiagency efforts. AKNHP is also by mission and experience able to handle and integrate data from diverse sources, as will be required for this project.

F. COORDINATION

This project will rely heavily on coordination and cooper-ation with other researchers who will collect data on diets as parts of their own studies. Initial mechanisms for coor-dination stem from the scientific planning meeting of the Oil Spill office in April. Further coordination would be an integral part of the overall marine bird project. Also we plan to rely on provision of carcasses found by the public (fishermen, beachcombers, tourist operators) and by various state and federal agencies. This will be achieved by site visits, town meetings, use of media, and extensive communication with appropriate governmental and other agencies.

G. PUBLIC PROCESS

The need for the overall project of which this is a component was identified at the public EVOS restoration planning workshop in April 1994. Public input will occur during the annual workshops sponsored by the Restoration Office. In addition, we will undertake an extensive media effort and a speaking tour to seek public cooperation in salvaging dead birds and other animals. These will be turned over to state and federal wildlife authorities for our use. This

system is already used effectively for reporting of U.S. Fish and Wildlife Service bird bands. Nevertheless, we will plan to make a vigorous case for the need for specimens to local residents and resource users. This will allow us to sample from a wider area and to limit collecting of live birds to minimum levels.

We plan to use the media to provide periodic updates on the results, to maintain public attention for the need for specimens and to "reward" such efforts. We would also plan to take out space in local papers to thank cooperators on an annual basis.

H. PERSONNEL QUALIFICATIONS

D. Duffy has worked extensively on seabird/fishery trophic interactions in Peru (Duffy 1983), South Africa (Duffy et al. 1987a), and Galapagos (Ricklefs et al. 1984). He has worked on the physiological constraints on diet analysis in seabirds (Duffy et al. 1985; Laugksch and Duffy 1986) and published several investigations of diet physiology (Duffy and Laurenson 1983; Furness et al 1984; Duffy et al. 1987b; Jackson et al. 1987) and a review on diet methodology (Duffy and Jackson 1986). Finally, he has examined the consequences of interannual variation in the North Pacific and the Peruvian upwelling, with special emphasis on the El Nino/Southern Oscillation phenomenon (Duffy 1983; Duffy and Siegfried 1987; Schneider and Duffy 1988; Duffy 1990, 1993). He also has undertaken several trophic modelling exercises involving fish, seabirds and seals (e.g., Duffy and Wissel 1988; Butterworth et al. 1988; Schneider et al. 1992).

Duffy has been involved in multinational data-synthesis efforts for FIBEX (Anon. 1985) and, as chair of the working group on upper-level predators for the Benguela Ecology Programme, he helped set the scientific direction and facilitated integration of predator data into ecosystem research for management of the Benguela upwelling. A complete cirriculum vitae is on file at the EVOS office.

I. FY95 Budget($K)

This project requires three years to develop an initial data set, develop a model in the second year, with further data collection, and to test the model in the third year. Budget projections past the first year will conditional on progress in each year.

Personnel	$52.0
Travel/Vessel	$21.0
Contractual Services	$35.0
Commodities	$10.0
Equipment	$5.0
Subtotal	$123.0
General Administrative Expenses*	$45.0
Total	$168.0

* Projected rate of 36.4% indirect costs as determined by OMB Circular A-88, subject to final determination by the Office of Naval Research.

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Project # 95024

A. Cover Page

1. ENHANCEMENT OF PRINCE WILLIAM SOUND WILD SALMON STOCKS

2. PROJECT LEADER- ,

3. LEAD AGENCY-NATIVE VILLAGE OF EYAK

4. COST OF PROJECT-FY95-350.: FY96-685.5(estimated)

5. PROJECT START-UP/COMPLETION.ONGOING
OCTOBER 1,1994-SEPTEMBER 30,1995

6. PROJECT DURATION; 10 YEARS

7. GEOGRAPHIC AREA; PRINCE WILLIAM SOUND

8. CONTACT: NATIVE VILLAGE OF EYAK
P.O.BOX 1388
CORDOVA, AK 99574-1388
907-424-7738 fax# 907-424-7739

Enhancement of Wild Pink Salmon

Project: 95024

B. INTRODUCTION

WILDSTOCKS OF PINK AND CHUM SALMON IN MANY PRINCE WILLIAM SOUND STREAMS HAVE BEEN AT SEVERELY DEPRESSED LEVELS FOR MANY YEARS DESPITE FISHERY CLOSURES. RECOVERY OF THESE SALMON STOCKS WAS ADVERSELY AFFECTED BY THE OIL SPILL EITHER DIRECTLY OR WHEN FRY OUTMIGRATED THROUGH oiled AREAS.

THESE WILD STOCKS OF SALMON HAVE BEEN THE BASIS OF A SUBSISTENCE WAY OF LIFE FOR THE NATIVE PEOPLE FOR THOUSANDS OF YEARS. SINCE THESE STOCKS ARE NOT RECOVERING, A PROJECT TO REHABILITATE AND RESTORE WILD PINK AND CHUM SALMON IS PROPOSED.

THE GENERAL CONCENSUS OF OPINION OF THE RESIDENTS OF PRINCE WILLIAM SOUND AFFECTED BY THE OIL SPILL IS THAT THE RESULTS OF ALL THE MONEY SPENT ON "RESTORATION STUDIES" THUS FAR PROPOSED WILL BE ANOTHER LARGE LIBRARY AND EMPLOYMENT FOR EXPERTS FROM UNAFFECTED AREAS. STUDIES USUALLY HAVE A NET NEGATIVE EFFECT ON THE SUBJECT POPULATION. WHEN ALL OF THE MONEY HAS BEEN SPENT BOTH THE AREA RESOURCES AND ACCESS TO THOSE RESOURCES BY THE DEPENDENT HUMAN POPULATION WILL BE REDUCED.

THIS PROPOSAL IS DESIGNED TO REHABILITATE RATHER THAN STUDY DEPRESSED POPULATIONS OF WILD PINK AND CHUM SALMON AS WELL AS THE SUBSISTENCE, COMMERCIAL, AND RECREATIONAL FISHERIES DEPENDENT ON THOSE POPULATIONS. THIS WILL BE ACCOMPLISHED USING ESTABLISHED FISH CULTURE TECHNIQUES WHICH WHEN PROPERLY IMPLEMENTED HAVE PROVEN SUCCESSFUL.

EXISTING AND PROPOSED STUDIES WILL BENEFIT FROM THIS PROJECT BY THEIR BEING PROVIDED WITH KNOWN POPULATIONS OF PINK AND CHUM SALMON AS WELL AS ACCESS TO THE LOGISTICAL SUPPORT NECESSARY TO ACCOMPLISH THE PROJECT.

LOCAL HIRE WILL SUPPLY MOST OF THE PROFESSIONAL, TECHNICAL, TRAINING AND LOGISTICAL SERVICES REQUIRED TO IMPLEMENT THIS PROJECT. THIS WILL PROVIDE EMPLOYMENT OPTIONS TO SOME OF THOSE MOST SEVERELY IMPACTED BY THE OIL SPILL.

C. NEED FOR THE PROJECT

THIS PROJECT WILL AID IN THE RESTORATION OF WILD PINK SALMON (noted by EVOS as a non-recovering biological resource), WILD CHUM SALMON, AND THE SUBSISTENCE FISHERY (noted by EVOS as a lost or reduced service).

THE RESTORATION OF THE SUBSISTENCE FISHERY BY THOSE MOST AFFECTED AND THE JOBS CREATED BY THIS PROJECT WILL CREATE HOPE FOR THE FUTURE. THIS COULD HELP ALLEVIATE THE INCREASE IN DIVORCE, DOMESTIC VIOLENCE, ALCOHOLISM, AND OTHER SOCIAL ILLS CAUSED BY THE CULTURAL DISRUPTION AND ECONOMIC DESPERATION DUE TO THE OIL SPILL.

hancement of Wild Pink Salmon Pid: 95024

D. PROJECT DESIGN

1. OBJECTIVES

(a) THE FIRST PHASE OF THE PROJECT WILL BE TO IDENTIFY WHICH STREAMS IN PRINCE WILLIAM SOUND HAVE BEEN BELOW MINIMUM ADF&G ESCAPEMENT GOALS FOR THREE GENERATIONS(two generations for chum salmon) BUT WHICH HAVE A REMNANT POPULATION THAT CAN BE USED AS AN EGG SOURCE. SPECIAL EMPHASIS WILL BE PLACED ON STREAMS WITH A PREVIOUS HISTORY OF GOOD PRODUCTION WHERE THE LIMITING FACTOR IS INADEQUATE ESCAPEMENT.

THIS TASK CAN BE ACCOMPLISHED BY REVIEW OF EXISTING ADF&G RECORDS.

(b) PHASE TWO OF THE PROJECT WILL INVOLVE SITE SURVEYS TO DETERMINE ITS SUITABILITY FOR STREAMSIDE INCUBATORS AND NETPEN REARING SITES.

(c) PHASE THREE WILL INVOLVE THE INSTALLATION OF STREAMSIDE INCUBATORS AND THE NEGOTIATION OF AGREEMENT WITH EXISTING HATCHERY OPERATORS FOR THE REMOTE INCUBATION OF SALMON EGGS FROM THE CANDIDATE STREAMS.

(d) PHASE FOUR WILL BE THE ACTUAL FISH CULTURE PORTION INCLUDING: EGGTAKES, EGG AND FRY TRANSPORTATION, INCUBATION, MARKING, AND PEN REARING OF FRY TO ACHIEVE OPTIMUM SURVIVAL RATES.

(e) THE FINAL PHASE WILL BE THE EVALUATION OF THE ADULT RETURNS TO DETERMINE IF THE OBJECTIVES OF THE PROJECT ARE BEING MET.

2. METHODS

DEPRESSED STOCKS OF WILD PINK AND CHUM SALMON WILL REREHABILITATED IN SELECTED PRINCE WILLIAM SOUND STREAMS BY A COMBINATION OF THREE TECHNIQUES.

(1) STREAMSIDE INCUBATORS WILL BE INSTALLED WHERE SUITABLE CONDITIONS EXIST.

(2) EGGS WILL BE COLLECTED FROM CANDIDATE STREAMS, INCUBATED AT AN EXISTING HATCHERY FACILITY AND RETURNED TO THEIR NATIVE STREAM FOR RELEASE

(3) PEN REARING WILL BE UTILIZED IN SOME INSTANCES TO INCREASE SURVIVAL RATES BY RELEASING LARGER FRY. THIS TECHNIQUE CAN ALSO BE USED TO HOLD EARLY EMERGENT FRY SO THEY CAN BE RELEASED WHEN ZOOPLANKTON POPULATIONS ARE CONDUCIVE TO MAXIMUM SURVIVAL.

EGGTAKE, INCUBATION, MARKING, FRY TRANSPORT, AND REARING OPERATIONS WILL BE CONDUCTED USING TECHNIQUES THAT HAVE PROVEN SUCCESSFUL IN PREVIOUS PRINCE WILLIAM SOUND FISH CULTURE PROGRAMS.

3. SCHEDULE- A DETAILED SCHEDULE OF ACTIVITIES WILL BE PROVIDED WITH THE WORK PLAN BUT GENERALLY ALL FISH CULTURE OPERATIONS WILL BE DEPENDANT ON THE NEEDS OF THE SALMON

Enhancement of Wild Pink Salmon

Pict # 95024

4. TECHNICAL SUPPORT- WITH THE EXCEPTION OF THE SERVICES OF THE ADF&G PATHOLOGY AND MARK RECOVERY LABS MOST OF THE TECHNICAL SUPPORT WILL BE PROVIDED BY THE PROPOSER.

5. LOCATION- PRINCE WILLIAM SOUND. THE COMMUNITIES AFFECTED ARE CORDOVA, TATITLEK, VALDEZ, WHITTIER AND CHENEGA.

E. PROJECT IMPLEMENTATION- THIS PROJECT IS PROPOSED BY THE NATIVE VILLAGE OF EYAK TRIBAL COUNCIL WHICH HAS INTEREST IN THE HEALTH OF THE SALMON RESOURCE AND THE SUBSISTENCE FISHERY IT SUPPORTS.

F. COORDINATION OF EFFORT- IT WILL BE NECESSARY TO DEVELOP A WORKING RELATIONSHIP WITH THE ALASKA DEPT. OF FISH AND GAME, U.S. FOREST SERVICE, VILLAGE OF TATITLEK, CHENEGA BAY, AND THE PRIVATE AQUACULTURE OPERATORS IN PRINCE WILLIAM SOUND.

H. SEE RESUME

I. BUDGET- COSTS ARE ESTIMATED BY STREAM, THE COSTS WILL BE LOWER AFTER INITIAL PURCHASE OF EQUIPMENT AND WILL BE PRORATED OVER THE TOTAL NUMBER OF STREAMS.

COST OF COMPLYING WITH REGULATIONS, PERMITTING AND COORDINATION WITH INVOLVED AGENCIES:

3 PEOPLE	
36 MM @ 4500/mo	$162,000
12 trips/mos 12 mo 144 trips	
airfare avg 500	72,000
perdiem @ 200/day & 3 day trips	86,400
Meetings Public Announcements, lobbying	30,000
COST OF PERMITTING	$350,400.
COSTS INSTREAM DIRECT RELEASE	137,100
@$70,000 per stream	70,000
COSTS INSTREAM PEN REARED	195,000
@70,000 per stream	70,000
OFF SITE DIRECT RELEASE	97,000
	70,000
OS-SITE REARED	194,400
	70,000
COST SCENERIO FIRST YEAR AFTER PERMITTING USING INSTREAM DIRECT RELEASE METHOD	
5 STREAMS @137,100.	$685,500.

Enhancement of Wild Pink Salmon Pict #: 95024

The Native Village of Eyak Tribal Council
P.O. Box 1388
Cordova, Alaska 99574-1388
(907) 424-7738 • Fax (907) 424-7739

EYAK TRIBAL COUNCIL
RESOLUTION 94-615-2

In support of a proposal to the Exxon Valdez Oil Spill, Restoration of Subsistence.

WHEREAS The Native Village of Eyak is a Federally recognized tribe; and

WHEREAS The Tribal Government of the Native Community of Eyak and Cordova is the Native Village of Eyak Tribal Council; and

WHEREAS The Native Village of Eyak is committed to enhance and improve subsistence foods.

WHEREAS This proposal is designed to rehabilitate wildstock of pink and chum salmon in the Prince William Sound for subsistence, recreational and commercial harvesting.

THEREFORE BE IT RESOLVED that the Eyak Tribal Council approves this proposal to the Exxon Valdez Oil Spill Trustee Council.

Dated this 15th day of June, 1994.

THE NATIVE VILLAGE OF EYAK

Robert J. Henrichs

Robert Henrichs, President

Enhancement of Wild Pink Salmon Pict # 95024

The Native Village of Eyak Tribal Council
P.O. Box 1388
Cordova, Alaska 99574-1388
(907) 424-7738 • Fax (907) 424-7739

THE NATIVE VILLAGE OF EYAK TRIBAL COUNCIL
SPECIAL MEETING

A Special Meeting of The Native Village of Eyak Tribal Council was called to order at 1:45 p.m. at the Tribal Office in Cordova.

Board Members Present: Robert Henrichs, Julia DeMott and Cheryl Lettich. Excused absent was Marlena Fonzi.

Motion by Cheryl Lettich to support Resolution 94-615-1. Seconded by Julia DeMott. Motion carried unanimously.

Motion by Julia DeMott to support Resolution 94-615-2. Seconded by Cheryl Lettich. Motion carried unanimously.

Motion by Cheryl Lettich to approve the Grant Writing Contract between The Native Village of Eyak's Tribal Council and Jameson & Associates. Seconded by Julia DeMott.

Motion to adjourn the Special Meeting at 1:46 p.m.

Submitted by: Cheryl M. Lettich

Dated this 12th day of June, 1994.

Attest by: Robert J. Henrichs
Robert Henrichs, President

Factors Affecting Recovery of Sea Ducks and their Prey

Project Number: 95025-A

Principal Investigator: Daniel Esler (Lead), Karen Laing

Lead agency: National Biological Survey

Cost of project: $393,650

Start-up date: 1994

Completion date: 1999

Project duration: 5 years

Geographic area: Prince William Sound

Contact persons: Daniel Esler
National Biological Survey
1011 E. Tudor Road
Anchorage, Alaska 99503
786-3485

or

Karen Laing
U.S. Fish & Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska 99503
786-3459

B. INTRODUCTION

Sea ducks are an important avian component of the nearshore ecosystem of Prince William Sound, particularly in winter. During March 1972 - 1991, sea ducks constituted 36% of birds observed from Prince William Sound boat surveys (Klosiewski and Laing 1994). The sea duck community is composed of a diverse assemblage of species, including harlequin ducks (Histrionicus histrionicus), Barrow's (Bucephala islandica) and common (B. clangula) goldeneyes, white-winged (Melanitta fusca), surf (M. perspicillata), and black (M. nigra) scoters, oldsquaw (Clangula hyemalis), buffleheads (B. albeola), and mergansers (Mergus spp.).

Sea duck studies are an appropriate use of restoration funds both because sea ducks were injured by the EVOS and because they affect populations of other injured organisms on which they prey. Sea ducks reside in nearshore habitats, where continuing oil contamination is likely. Harlequin duck populations in the oiled zone of Prince William Sound were documented as injured by the EVOS (Klosiewski and Laing 1994, S. Patten unpubl. data); harlequins are

classified as an injured resource. Some evidence of injury to scoters and goldeneyes in the oiled zone was documented by marine bird surveys (Agler et al. 1994, Klosiewski and Laing 1994). The surveys also documented extreme Sound-wide declines of scoters in the two decades preceding the spill. These species were not studied individually during the Damage Assessment process; given the reliance of sea ducks on nearshore habitats that retained oil, it is probable that such studies would have documented further injury. In addition, sea ducks prey on intertidal and shallow subtidal organisms, such as mussels. These prey organisms were classified as injured resources. It is possible that continuing predation by sea ducks is limiting recovery of these organisms.

Wintering biology and ecosystem interactions of sea ducks are poorly known. Most ecological studies of wintering sea ducks are from Europe or the Atlantic coast (e.g., Stott and Olson 1973, Goudie and Ankney 1986, 1988, Durinck et al. 1993). While some work has been done in the Pacific with sea duck winter foraging (e.g., Vermeer and Levings 1977, Vermeer and Bourne 1982), only two winter studies have been conducted in Alaska (Koehl et al. 1982, Sanger and Jones 1982), neither in Prince William Sound. Most aspects of sea duck wintering biology have not been addressed. For example, it is possible that harlequin duck breeding and winter populations in Prince William Sound are comprised of the same individuals. The Restoration Strategy should include winter studies to examine the possibility that breeding harlequins are failing due to continued contamination or food shortage throughout the winter.

An intensive study of sea duck wintering ecology and ecosystem interactions would serve to elucidate factors that limit populations and may be influencing recovery of injured species and systems. This study is comprised of two related components: survival and movements, and foraging ecology of wintering sea ducks.

C. NEED FOR THE PROJECT: Why this Project will Help Restoration

Survival and movements: Overwinter survival of sea ducks in Prince William Sound likely has important, direct effects on annual population dynamics and specific annual variation of wintering numbers in Prince William Sound. Factors that are influencing survival must be understood to identify processes limiting recovery of injured species and systems. Through incorporation of estimated survival rates into population dynamics models (e.g., Goudie et al. 1994), sustainability of populations can be determined.

Sea duck survival is a good measure of the health and productivity of the nearshore system. Sea ducks rely on intertidal and shallow subtidal areas for foraging. Disturbances of these habitats and the invertebrate prey inhabiting them likely directly affect benthic foragers like sea ducks.

Condition and foraging ecology: The foraging ecology component will address several concerns related to restoration of sea ducks and their prey. These concerns include whether (1) trophic interactions, competition, food availability, or food quality are limiting recovery of sea ducks, (2) injured benthic invertebrates are not recovering because they are important sea duck food

items, or (3) oil continues to be ingested and/or accumulated by sea ducks.

Herring eggs might be an important food for sea ducks in late winter (Bayer 1980, Vermeer 1982). Spring condition has important implications for subsequent reproductive performance in many waterfowl species (e.g., Esler and Grand 1994).

PROJECT DESIGN: OBJECTIVES AND METHODS

OVERALL OBJECTIVES

1) Identify major causes of sea duck mortality and limiting effects of winter survival for sea duck recovery

2) Examine whether trophic interactions, competition, food availability, or food quality are limiting recovery of sea ducks

3) Identify major sea duck prey species, so that related studies of injured benthic invertebrates can evaluate whether those species are not recovering because they are important sea duck food

SURVIVAL AND MOVEMENTS.

Objectives. In Prince William Sound, there are several potential sources of sea duck winter mortality including harvest, starvation or exposure, predation, disease, and exposure to contaminants, including residual oil. To identify causes of mortality and potential limiting effects of winter survival for recovery of species, we propose a study to measure survival and mortality sources in harlequin duck and Barrow's goldeneye females. The study would address the following questions:

-does overwinter survival limit population growth of sea duck species?

-what are sources of mortality? Is mortality higher in oiled habitats than unoiled habitats?

-what are frequency and distance of wintering sea ducks movements? Do they move among oiled and unoiled habitats?

-How are sea ducks distributed throughout the Sound?

-do harlequin ducks marked during fall and winter breed in Prince William Sound?

Methods. Sea ducks would be captured during fall by a variety of techniques, potentially including: driving molting flocks, net guns, rocket nets on roosting sites, mist nests, night-lighting, and capturing from underwater using scuba or rebreather technology. Females would be outfitted with radio-transmitters. Only females would be assessed because their survival

dictates population dynamics (Goudie et al. 1994). Capturing, marking, and tracking birds will be conducted cooperatively with Alaska Department of Fish and Game investigators studying harlequin ducks.

Transmitters equipped with mortality switches would be implanted in the body cavity with an external antenna. Surgeries would be conducted by a certified veterinarian. Radio telemetry flights would be conducted weekly through winter and early spring. Flights would locate each marked individual and note status, flock size, coordinates, and general habitat. For birds indicated as dead, the carcass would be recovered by boat or float plane as soon as possible. Collected carcasses would be examined for causes of mortality.

We propose analyzing existing data from boat-based marine bird population surveys conducted in March (1972-73, 1984-85, 1990-91, 1993) (Klosiewski and Laing 1994, Agler et al. 1993, Agler et al. unpub. data) and aerial surveys conducted in March and October (1989-90) (Klosiewski and Hotchkiss N.D.) by the U.S. Fish and Wildlife Service to clarify winter distribution of sea ducks in the Sound. Combining survey data with existing information on shoreline type will also allow us to formulate hypotheses concerning habitat factors affecting distribution.

D. CONDITION AND FORAGING ECOLOGY

Objectives: We propose a foraging ecology study that would assess variation in physiological condition and prey species of harlequin ducks, Barrow's goldeneyes, and white-winged scoters. Also, potential competition within the sea duck community and with other benthic foragers (e.g., sea otters) would be determined. The study would answer the following specific questions:

-does condition (as a measure of health) change through winter? Is condition related to habitat (including oiled vs. nonoiled)?

-what taxa and size classes of prey are sea ducks eating in the winter?

-does potential competition exist among benthic foraging predators (including sea ducks, sea otters, invertebrate predators) for food items of sea ducks?

-are prey species abundances linked to specific habitats, including oiled vs. unoiled habitats?

-does energy expenditure (as measured by foraging behavior) differ among habitats (including oiled vs. unoiled)?

Methods. We would assess condition and diets of female harlequin ducks, Barrow's goldeneyes, and white-winged scoters by collecting approximately 40 individuals of each species annually, for 2 or 3 seasons. Upon collection, the digestive tract would be dissected immediately, and contents of the esophagus, proventriculus, and gizzard would be preserved and stored separately. In the laboratory, foods would be sorted, identified, analyzed for oil, and their

volume and dry weight measured. Body composition analysis would be conducted as described by Esler and Grand (1994).

We would assess foraging behavior by observing marked birds for periods during which the proportion of time spent foraging would be measured. Time spent foraging during these periods would be measured either through continuous observations, or by sampling behavior instantaneously at pre-determined intervals (e.g. every 20 seconds)(Altmann 1974). By identifying habitats used by focal birds at each sampling point, we would also quantify time spent foraging in different habitats (e.g., Laing and Raveling 1993).

E. PROJECT DESIGN

1. SCHEDULE

To adequately understand factors influencing sea duck populations and annual variation, a study of 5 years or longer should be initiated. Field work supported with FY95 funds would begin in fall 1994 and continue through March 1995. Annual reports would be completed by the winter following field work.

2. TECHNICAL SUPPORT

Contracts for laboratory work will be required for physiological condition and digestive tract content analysis, and for consultation with a statistician to insure appropriate analysis techniques are used.

3. LOCATION

Prince William Sound, at study sites to be determined in conjunction with investigators studying sea otters and benthic invertebrate communities.

F. PROJECT IMPLEMENTATION

This project would be implemented by the Alaska Science Center of the National Biological Survey, and by the U.S. Fish and Wildlife Service. Personnel in these agencies have extensive experience studying population dynamics of waterfowl in Alaska.

G. COORDINATION OF INTEGRATED RESEARCH EFFORT

This sub-project is a joint effort by biologists in two trust agencies (NBS and USFWS). Success of this project also relies on other investigators within the Nearshore Project collecting information on (1) prey abundance, size class, and distribution and (2) foraging ecology of other predators of benthic invertebrates such as sea otters, octopus or sea stars. We are in close contact with potential investigators of these projects, and with investigators of the harlequin duck breeding population. We plan to share proposals and results, and to realize cost-

efficiencies by working at common field sites.

These studies of wintering sea duck ecology in Prince William Sound would be most valuable as concurrent, integrated investigations. For example, studies of foods and trophic interactions would identify possible food limitations and pathways for pollutants, and seasonal changes in condition. Survival studies are necessary to link these factors to risk and causes of mortality. Habitat studies could further advance our understanding by identifying underlying, proximate causes of variation in food, behavior, and condition that may affect survival.

H. PUBLIC PROCESS

We would involve the public in this sub-project by holding information-sharing meetings in local communities. We would use these meetings to share our results, to answer questions, and to solicit information from residents about their observations of sea ducks. We would also request contributions of digestive tract contents from birds killed by subsistence hunters. In addition, we would solicit use of local boats and other services through standard government contracting procedures.

I. PERSONNEL QUALIFICATIONS

Daniel Esler is a Wildlife Research Biologist for the Alaska Science Center, National Biological Survey with a Master of Science in Wildlife Ecology, Department of Wildlife and Fisheries Sciences, Texas A&M University (Avian associations with hydrilla) and Bachelor of Science in Biology/Environmental Studies, Northland College, Ashland, WI. He has nine publications in national peer reviewed journals such as Wildlife Management, Wilson Bulletin, Journal of Field Ornithology, Condor and others. Karen Laing is a Wildlife Biologist for Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, Alaska with a Master of Science in Ecology, Univ. of California, Davis (Habitat and food selection, behavior and body composition of nesting Emperor Geese), Bachelor of Science in Biology, The Evergreen State College, Olympia, Washington, and Bachelor of Arts, Stanford University. Since 1991 she has designed, conducted and analyzed population surveys of waterfowl throughout the state. Earlier she was the Principal Investigator for Exxon Valdez Oil Spill Damage Assessment Bird Study No. 2 and conducted boat surveys of marine bird and mammal populations in Prince William Sound, Alaska. Her publications/reports include Oil Spill Natural Resources Damage Assessment Bird Study No. 2., publication in Condor, Applied Animal Behavoral Science, and Raptor Research and various reports.

BUDGET

Personnel		
Principal Investigator GS-11	1.0 FTE	58.0K
Wildlife Biologist GS-11	0.3 FTE	17.4K
Research Biologist GS-9	1.0 FTE	46.0K
Bio. Tech. GS-5 (3 X .33years)	1.0 FTE	29.0K
Veterinarian contract (+ NBS agency match)		15.0K
Aircraft Charter		55.0K
Boat Charter		35.0K
Travel		8.0K
Equipment		
Radios (150 at $175)		26.3K
Other		40.0K
Contracts		
Body Composition		25.0K
Food Habits		5.0K
Statistical Consultation		2.0K
Commodities		9.0K
Publication Costs		3.0K
Administration/Overhead		20.0K
TOTAL		$393.7K

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Sea Otter Abundance and Distribution, Food Habits and Population Assessment

Project Number: 95025-B

Principal investigators: B.E. Ballachey and J.L. Bodkin

Co-investigator: A. Rebar (Purdue University)

Lead agency: NBS

Cost of project: $162.7K (FY 95)
$82.8K (FY 96)
$29.2K (FY 97)
$274.7 Total Combined Total

Start up date: Spring 1995

Completion date: Summer 1997

Project duration: 2 Years

Geographic area: Prince William Sound

Contact person: Leslie Holland-Bartels
Branch Chief, Marine Mammals/Fisheries
National Biological Survey
Alaska Science Center
1011 East Tudor Road
Anchorage, Alaska 99503
(907) 786-3312, FAX 786-3636

B. INTRODUCTION

Sea otters are the most abundant of the the Alaskan marine mammals affected by the *Exxon Valdez* oil spill (EVOS). They were hunted almost to extinction in the 17th and 18th century, but have since reoccupied most of their original range in Alaska, including areas in Prince William Sound (PWS). Otters play a major role in structuring the nearshore community through predation on nearshore marine invertebrates.

Sea otters were severely injured by the EVOS, with an estimated initial loss throughout the spill area of approximately 4000 animals. Sea otters in PWS suffered the greatest effects, and oil-related injury to the otters residing in western PWS appeared to persist through at least 1991. Although there is evidence that the health of the otters has improved since 1991, there is uncertainty about the status of recovery of sea otters in oiled areas. Specifically, concerns arise in regard to 1) relatively low densities and 2) poor survival of juvenile sea otters in western

PWS. Survival rates of juveniles in western PWS were significantly lower than in non-oiled areas in both 1990-91 and 1992-93. However, survival rates for both areas improved in 1992-93 compared to 1990-91. Low densities of sea otters are observed in areas that were heavily oiled relative to lesser or non-oiled areas. For example, densities of sea otters around northern Knight Island and Naked Island are relatively low compared to the densities observed around Green Island. Factors (including oil effects) causing varying otter densities and juvenile survival rates are not understood. Availability of prey for sea otters may be a contributing factor.

Further concern over the health of sea otters in oiled areas arises from differences in blood values of sea otters living in oiled versus non-oiled areas of PWS. We have observed increased levels of blood serum enzymes indicative of liver disorders (ALT, GGT), and white cells (eosinophils) that may be related to subclinical disease from oil exposure. The increased levels of serum enzymes are consistent with changes observed in oiled otters exhibiting kidney and liver pathologies at the rehabilitation centers. The differences between otters in oiled and non-oiled areas persisted through 1992; no blood samples have been collected since then.

This project is a component of an integrated effort to examine recovery of injured species in the nearshore ecosystem. We address the status of recovery of sea otters in PWS and the interactions among sea otters and other species in the nearshore community that have potentially been injured by oil exposure. Specific accomplishments of this project will include evaluation of 1) the extent of recovery, 2) factors contributing to differences in densities, 3) health and condition, and 4) food habits of sea otters among areas in PWS that vary in oiling and in densities of otters.

Sea otter studies previously funded by the Trustees include NRDA Marine Mammal Studies #6 & #7, and Restoration Project 93043, conducted on sea otters in PWS from 1989 through 1994. This project represents a logical continuation of certain elements of those studies.

C. NEED/HELP TO RESTORATION

This project will 1) monitor recovery of sea otters through the collection of data on the abundance and distribution, 2) assess possibile chronic effects of oil exposure on sea otters in oiled areas of PWS, and 3) enhance our understanding of the role that sea otters play in structuring nearshore communities that have been impacted by the EVOS. Information will be obtained on factors limiting recovery of sea otters and on alterations in the nearshore community affected by or affecting sea otters.

D. DESIGN

This project has 3 elements:

- Surveys: to evaluate abundance, distribution, reproductive rates, and mortality.
- Health and Condition: to evaluate sea otter body condition and health and possibly

hydrocarbon burdens (if warrented, based on shellfish and sediment hydrocarbon results).

- Food Habits: to evaluate the role of sea otters as a top-level predator in the nearshore community.

1. OBJECTIVES

SURVEYS

a. Monitor sea otter recovery: conduct a survey of sea otter abundance and distribution in PWS.

b. Conduct seasonal surveys of sea otter abundance and distribution at specific study sites.

c. Conduct a survey of sea otter reproductive rates, based on ratios of pups to adults.

d. Quantify age distribution of sea otters dying over the winter at Green Island.

HEALTH AND CONDITION

a. Assess body condition of sea otters.

b. Assay markers of immune function in sea otters.

c. Collect fat tissue samples for potential analyses of hydrocarbon levels.

FOOD HABITS

a. Quantify prey selection and foraging efficiency of sea otters at specific study sites.

2. METHODS

Study sites will be selected based on discussions with other investigators in the integrated nearshore ecosystem project. We anticipate identifying up to 4 sites in PWS to be the focus of this project.

SURVEYS

- PWS-wide aerial survey (methods as developed under Restoration Study # 93043) of distribution and abundance, summer 1995. This element of the project is for monitoring recovery.

- Site-specific aerial surveys of distribution and abundance, quarterly (spring, summer, fall, winter 1995).

- Boat-based survey of relative abundance of adults and pups, to estimate reproductive rates. The ratio of the number of pups to adults will be estimated and compared to existing data on pre- and post-spill ratios.

- Carcass recovery - survey Green Island shorelines in early spring to recovery beach-cast carcasses, and estimate age at death from reading of premolar tooth.

HEALTH AND CONDITION

- Capture sea otters at study site - collect body measurements (weight, length, and girth), blood, fat biopsy for possible hydrocarbon analysis, premolar tooth to estimate age; and flipper-tag otters with unique color-coded tags to allow identification of individuals.

- Evaluate immune function through 1) B & T cell activities, including levels of IGG, IGE, IGA, and IGM as indicators of humeral immunity, and 2) blast transformation assays to measure T-cell activities. Laboratory work to be done in cooperation with Dr. Alan Rebar at Purdue University.

- Evaluate blood CBC's and chemistries - laboratory work to be done by PML laboratories.

FOOD HABITS

- Observations of foraging behavior at study sites (observe all otters present, with preferential collection of data on flipper-tagged individuals when possible). Data to include prey items, prey sizes, # prey recovered/dive and dive times. Foraging data to be collected twice, in late winter and late summer of 1995.

3. SCHEDULE

TIME	ACTIVITY
FALL 1994	1. DEVELOP DETAILED STUDY PLAN - WORKING IN CLOSE CONJUNCTION WITH OTHER INVESTIGATORS TO MAXIMIZE EFFICIENCY OF DATA COLLECTION 2. PERMIT APPLICATION - OTTER CAPTURE
SPRING 1995	1. CARCASS RECOVERY - GREEN ISLAND 2. SITE SPECIFIC SURVEYS OF DISTRIBUTION AND ABUNDANCE
SUMMER 1995	1. SURVEY OF DISTRIBUTION AND ABUNDANCE - ALL PWS 2. SITE SPECIFIC SURVEY OF DISTRIBUTION AND ABUNDANCE 3. OTTER CAPTURE AT SPECIFIC SITES 4. FORAGING OBSERVATIONS AT SPECIFIC SITES
FALL 1995	1. SITE SPECIFIC SURVEY OF DISTRIBUTION AND ABUNDANCE
WINTER 1996	1. SITE SPECIFIC SURVEY OF DISTRIBUTION AND ABUNDANCE 2. FORAGING OBSERVATIONS AT SPECIFIC SITES
SPRING 1996	1. COMPLETE DATA ANALYSIS AND WRITE REPORTS ON 1ST YEAR WORK 2. CARCASS RECOVERY - GREEN ISLAND
SUMMER 1997	1. SURVEY OF DISTRIBUTION AND ABUNDANCE - ALL PWS

4. TECHNICAL SUPPORT

The primary need for technical support is integration of data collected on other components of the Nearshore Ecosystem project with data collected on sea otters.

5. LOCATION

The project will be conducted in western PWS. Communities that will be involved or affected include New Chenega (may provide a base for winter operations), Cordova and Whittier. The extent of involvement of these communities will depend on finalizing the project design, in coordination with other investigators, to identify specific study sites.

E. PROJECT IMPLEMENTATION

This component of the Nearshore Ecosystem project will be implemented and overseen by staff of the sea otter project, Alaska Science Center (ASC), NBS. Most of the equipment needed for project activities outlined herein is already owned by the ASC.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project will be a component of and will coordinate closely with other projects in the Nearshore Ecosystem project.

G. PUBLIC PROCESS

This project description was developed in conjunction with other investigators studying injured resources in the nearshore ecosystem. Summaries of our early discussions on potential directions of the work were sent to participants in the nearshore ecosystem group at the April 1994 Workshop, with invitations to participate in or provide comments on project development.

H. PERSONNEL QUALIFICATIONS

The Principal Investigators for this study are Dr. Brenda Ballachey and Mr. Jim Bodkin of the Alaska Science Center. They have over 20 years of combined experience studying sea otters, including implementation and oversight of previous NRDA and Restoration studies on sea otters, and have developed many of the techniques to be used in data collection. Blood and immune functions analyses will be overseen by Dr. Alan Rebar, clinical pathologist and Dean of Graduate Studies at the School of Veterinary Medicine at Purdue University.

I. FY95 BUDGET(($K)

FY 95 (assume start April 1, 1995)

PERSONNEL			
6 months - GS11 wildlife biologist @ 5000/mo	25.0K		
6 months - GS6 biotechnician @ 3000/mo		18.0K	
0.5 month - GS14 Project Manager @ 7500/mo		3.7K	
TRAVEL		15.0K	
Estimated at 15K total for all elements. Specific costs will require ID of specific sites and cost-sharing with other subproject components.			
CONTRACTUAL SERVICES			
Support vessel for capture - 21 days @1400/day		29.4K	
Aerial survey - summer 1995 - 80 hrs @ $200/hr		16.0K	
Seasonal surveys, specific sites/80 hrs @ $200/hr		16.0K	
Blood CBC's and Chemistries - 80 @ $25		2.0K	
Assays of immune function - 80 @ $125	10.0K		
COMMODITIES Fuel - 2000 gal. @ $3.00/gal	6.0K		
EQUIPMENT			
Maintenance/Repair		5.0K	
Safety equipment		5.0K	
ADMINISTRATIVE OVERHEAD		11.6K	Σ162.7K

FY 96

PERSONNEL		52.0K	
TRAVEL		5.0K	
CONTRACTUAL SERVICES		16.0K	
COMMODITIES		1.5K	
ADMINISTRATIVE OVERHEAD		8.3K	Σ 82.8

FY 97

PERSONNEL		7.0K	
TRAVEL		2.0K	
CONTRACTUAL SERVICES		18.0K	
ADMINISTRATIVE OVERHEAD		2.2K	Σ 29.2
			ΣΣ 274.7

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Pigeon guillemots and river otters as bioindicators of nearshore ecosystem health in Prince William Sound.

Project Number: 95025-C

Principal Investigator: Daniel D. Roby, Assistant Unit Leader
Alaska Cooperative Fish & Wildlife Research Unit
University of Alaska
Fairbanks, AK 99775

Co-Investigators: Lawrence K. Duffy, Chair
Department of Chemistry
University of Alaska
Fairbanks, AK 99775

R. Terry Bowyer, Professor
Institute of Arctic Biology
University of Alaska
Fairbanks, AK 99775

Cost of project: FY 95 179.6K,
FY 96 179.9K
FY 87 180.1K Σ539.6K

Start up date: 1 October 1994

Completion date: 1 September 1998

B. INTRODUCTION

This study is relevant to EVOS ecosystem research because it is designed to develop a better understanding of how petroleum hydrocarbon pollution affects the nearshore marine environment in Prince William Sound (PWS). Results from this study will allow us to test biostatistical models that predict ecosystem health and environmental deterioration. Use of bioindicators will lead to a better understanding of ecosystem processes in PWS. Our proposal describes a research approach for assessing the biological and ecological significance of contaminants present in the environment. In this research our primary focus is the pigeon guillemot (*Cepphus columba*) as an indicator of environmental stress.

The guillemot model will be used as an upper trophic level sentinel of bioavailable contaminants, such as oil, and as a surrogate to estimate the potential exposure and risk to other organisms that are components of the PWS nearshore ecosystem (Leighton 1985, Peakall et al. 1986). This research approach utilizes biomarkers (biochemical and cellular indicators of exposure), reproduction rates, and data on mortality to identify and quantify the present level of variability within the PWS ecosystem. This approach is necessary because evaluation of the

potential for exposure to contaminants in the environment is extremely complex due to the differences in the biological availability of contaminants at different trophic levels and varying toxicological interactions within exposed organisms.

Focusing on the biological responses in indicator species overcomes many of the limitations that plague chemical analysis of the environment (Payne et al. 1987). While measuring body burdens is an important aspect of using a bird as a biomonitor, equally important is the measurement of biomarkers because they:

1) Provide evidence of exposure to compounds that do not bioaccumulate or are rapidly metabolized;

2) Integrate the toxicological interactions resulting from exposure to complex mixtures of contaminants;

3) Present a biologically relevant measure of the cumulative adverse effect; and

4) Measure early responses of organisms to toxicant exposure and serve as short-term predictors of long-term adverse effects.

By proper selection of a bird from an upper trophic level, specific sources and routes of exposure can be identified. Analysis of biological markers in birds may offer a means of identifying exposures due to toxic sites from those due to other natural exposures. In guillemots we will measure induction of immune system, acute phase proteins, and cytokines as biomarkers. We will compare our results from guillemots with previous work on other bird species (Fry and Lowenstine 1985), our PWS work on river otters (*Lutra canadensis*), and results from current research on guillemots in Kachemak Bay. The work on river otters will help "truth" our study of guillemots and our biostatistical model. This model (Duffy et al. in press) is far more detailed than those for any bird, and maintains a mammalian component for human comparisons. While guillemots are easier to capture and handel than otters during the breeding season, including otters as a component of the research may be essential because guillemots are principally available during nesting, whereas otters are year-round residents.

Guillemots

We are currently developing pigeon guillemots as an avian bioindicator for coastal ecosystems in Alaska. This research is currently underway in Kachemak Bay, Alaska, and will provide crucial baseline information for the proposed work in PWS. Guillemots are the most neritic members of the marine bird family Alcidae, which includes the murres, puffins, and auks. Pigeon guillemots are the best-suited species for monitoring nearshore ecosystem health for several reasons: 1) they are a common and widespread seabird species breeding in coastal Alaska, and in PWS specifically (Sowls et al. 1978, Sanger and Cody 1993); 2) they forage within 5 km of the nest site in the subtidal and nearshore zones (Drent 1965, Kuletz 1983); 3) unlike most seabird species, they do not breed in large, dense colonies; 4) they raise their young

almost entirely on fish, preying primarily on intertidal and nearshore bottomfish (e.g., blennies, sculpins; Drent 1965, Kuletz 1983); 5) the one- or two-chick broods are fed in the nest until the young reach adult body size.

Guillemots first breed at 2 years of age and adults have high annual survivorship (85%; Asbirk 1979). Young guillemots normally return to the natal area to breed. Nest site fidelity of breeding pairs is high and even in instances when pairs relocate nests, the distances involved are usually small (<30 m). Eggs are laid in a wide variety of natural crevices and holes, but most nest sites in the study area are located in cavities in rock masses (K. Kuletz and K. Oakley, pers. comm.). Eggs are usually laid about 50 cm from the entrance of the nest crevice (Asbirk 1979), thus eggs, chicks, and attending adults are frequently accessible for data collection. Guillemots are unusual among alcids in that they normally lay two-egg clutches and raise two chicks per nesting attempt. Guillemots carry whole fish in their bills to the nest-site crevice to feed their young. Thus individual prey items can be identified, weighed, measured, and, if necessary, collected for contaminant analyses.

Other potential avian bioindicators of Alaska coastal ecosystems are unsuitable for several reasons. *Larus* gulls (e.g., glaucous-winged and herring gulls) have been used as models for studies on the sublethal effects of crude oils on marine birds (Peakall et al. 1982, Miller et al. 1978, Lee et al. 1985, 1986) and are widespread and common components of Alaska coastal ecosystems. But gulls frequently feed at dumps and scavenge fish offal from fishing vessels where exotic contaminants may be encountered. *Larus* gulls may also commute long distances to utilize these food sources; consequently the source of anthropogenic contaminants in the diet may be difficult to determine. Other alcid species (e.g., puffins, murres) and kittiwakes (*Rissa tridacyla*) forage offshore (up to 100 km from the nest site) on pelagic schooling fish and are restricted to breeding at a few relatively inaccessible colonies in the study area. Thus they are inappropriate bioindicators of nearshore ecosystem health and potential contaminants in food webs close to breeding colonies. In addition, these species are sensitive to social stimulation at the breeding colony. Thus direct mortality from plumage oiling can result in reduction of colony-wide reproductive success even in the absence of a contaminated food supply. Other alcids that forage in the neritic zone and are noncolonial (e.g., marbled murrelet) may nevertheless forage at considerable distance from nest sites, and active nests high in mature timber are extremely difficult to locate and monitor.

Guillemots have served as subjects in previous studies to assess the effects of ingested crude oil on marine birds (Peakall et al. 1980). Nestling black guillemots (*Cepphus grylle*), a very closely-related sibling species of the pigeon guillemot, were fed single doses of weathered South Louisiana crude oil (WSLC) and subsequently monitored in their natural nest site where they were cared for by their parents. These experiments demonstrated that single doses of as little as 0.1 ml WSLC resulted in declines in growth rates, increases in plasma sodium levels and increases in nasal and adrenal gland masses. The effects of the single dose were not transient, as nestlings that were dosed at roughly two weeks post-hatch were 20% lighter than controls at five weeks of age (just prior to fledging). Such persistent sublethal effects may have serious consequences for post-fledging survival. Peakall et al.'s (1980) study clearly demonstrates that

guillemot nestlings living normally in their chosen habitat are tolerant to the handling and disturbance associated with assessing pollutant toxicity.

We will monitor population size, reproduction, and blood parameters in pigeon guillemots breeding at Naked Island, PWS. Naked Island supports the highest breeding densities of guillemots in PWS (Sanger and Cody 1993) and a breeding population that is adequate for the proposed research (Oakley 1981, Kuletz 1983). The following parameters will be measured at accessible guillemot nests as indices of parent-offspring productivity: 1) chick feeding rates; 2) chick meal size; 3) taxonomic composition of chick diets; 4) biochemical composition of chick food items; 5) chick growth rates and body composition; 6) nestling survival; and 7) fledging age, body mass, and body composition. Productivity will be compared with blood parameters used to monitor contaminant exposure. Nondestructive indices to stress induced by petroleum hydrocarbon ingestion will be used, such as levels of selected plasma immunoglobulins, blood plasma proteins, cell counts, and interleukin levels in blood of adults and chicks, body mass and body composition of adults and chicks, chick growth rates, and fledgling mass. These data will then be used to evaluate the factors that limit guillemot productivity. The results of this research project will provide us with the background necessary to use guillemots as avian indicators of nearshore ecosystem health in PWS.

The population status of pigeon guillemots in PWS and the northern Gulf of Alaska has been of concern for nearly a decade due to declines in number of adults observed on survey routes (Klosiewski and Laing, unpugl. data). Low fledging success has been attributed to changes in the abundance and distribution of forage fish resources within foraging range of guillemot nests. There is a troubling lack of information on the factor(s) responsible for poor reproductive performance (Oakley and Kuletz, unpubl. ms.).

River Otters

River otters inhabiting marine environments make extensive use of, and concentrate their activities in intertidal and subtidal zones (Bowyer et al. in press; Dubuc et al. 1990, Larsen 1984, Woolington 1984). These high trophic-level carnivores are long-lived (≥12 years of age; Doctor et al. 1987), and occur at densities of 0.2-0.8 otters/km of shoreline throughout the Gulf of Alaska (Testa et al. in press). River otters are extremely sensitive to aquatic pollutants, yet continued to reside within the area of oil-contaminated shorelines in Prince William Sound, Alaska following the *Exxon Valdez* oil spill (Testa et al. in press). These characteristics make river otters an excellent model for assessing the effects of marine pollution on mammals, and provide an overall index to the health of the nearshore ecosystem.

River otters consume a diet dominated by marine fishes, which they prey upon in intertidal and subtidal zones, although they also consume a wide variety of marine invertebrates. Such nearshore areas are the most often affected by pollution. For instance, oil spilled from the *Exxon Valdez* contaminated extensive areas of the intertidal and subtidal environments, which was reflected in a loss of dietary diversity for otters inhabiting oil-contaminated shorelines (Bowyer et al. in press). Likewise, river otters living in oiled areas exhibited a significantly

lower body mass (when controlled for sex and total body length) than did otters inhabiting oil-free areas (Duffy et al. 1993). Otters have extremely large home ranges (20-40 km of shoreline; Bowyer et al. in review, J. Mammal.), and hence integrate the effects of pollution over wide areas.

We already have developed a nonlethal method for evaluating the effects of marine pollutants (in this instance, crude oil) on the blood-enzyme chemistry of river otters (Duffy et al. in press). We first noted that blood haptoglobins (an acute-phase protein) were elevated in otters inhabiting areas where crude oil was prevalent one year following the oil spill (Duffy et al. 1993). Even two years after the oil spill and a major effort to clean oil-contaminated shores, we were able to construct a biostatistical model, using logistic regression, in which we classified >86% of river otters correctly as having been captured in oiled or nonoiled zones. This highly sensitive model used only blood values for haptoglobin, interleukin 6 (a cytokine), and AST (a liver enzyme). Our approach has already been extended for evaluating other marine mammals (Zenteno-Savin et al. 1993), and may be applicable to other vertebrates, especially marine birds. The strength of this line of research is that we have already developed the expertise necessary to live-capture river otters, have base-line data from oiled and nonoiled areas throughout PWS, and have a predictive model that assesses the effects of oil contamination on otters, thereby providing an index to environmental health. Coupling our knowledge of otters with similar physiological data for pigeon guillemots will provide a sensitive tool for examining the health of nearshore ecosystems.

Objectives

This proposal's overall goal is to identify the internal dosage of oil-related pollutants received by intertidal-subtidal feeding birds in PWS, Alaska through measuring key parameters associated with biochemical toxicity. Thus, we will quantify the biochemical changes in birds inhabiting this fragile ecosystem. The guillemot will provide insight into the pathways and effect (if any) on food webs and the long-term health of the ecosystem. The objectives of this study are to:

1) Identify guillemot nest sites and river otter latrine sites;

2) More accurately assess the effects of oil exposure. It is our intent to collect blood from guillemots in several areas of PWS to establish control areas;

3) Use blood samples from the guillemot population to determine levels of acute phase blood proteins such as haptoglobin, albumin and metalothionine, which are indicative of exposure and tissue damage. We also will measure cytokines such as IL-1 and IL-6 and liver enzymes such as AST;

4) Supplement our molecular work by cellular studies such as red cell volume, hematocrits and immune functions (Heinz bodies will be looked for in guillemot and river otter samples);

5) Generate risk-assessments based on these biomarkers; and

6) Measure trophic level using stable isotope analysis of guillemot samples and plants and scats from river otter latrine sites.

This proposal will produce background values for selected biomarkers and allow the development of "blood associated indices" of environmental stress in mammals and birds. These indices will be useful in comparing current and future levels of petroleum hydrocarbon contamination in PWS.

METHODOLOGY

Guillemots

Field studies will be conducted during the 1995 and 1996 breeding seasons in PWS, Alaska. Approximately 800 pigeon guillemots nest along the shores of Naked Island (Sanger and Cody 1993). Seventy-five active and accessible nests will be located and marked during early incubation in each of the two breeding seasons. These nests will be closely-monitored until the young fledge or the nesting attempt fails. Known-age chicks will be weighed regularly to determine individual growth rates throughout the nestling period. Blood samples (1 ml) will be collected by brachial vein puncture from each nestling at ages 20 and 30 days post-hatch (guillemot chicks normally fledge at 30-40 days post-hatch). These blood samples will be collected using SOPs developed by us during the *Exxon Valdez* spill studies to preclude sample contamination. Blood samples will be analyzed for molecular and cellular biomarkers (e.g., characteristic morphological lesions of red blood cells associated with hemolytic anemia caused by oil ingestion [Leighton 1985]). Total body fat of chicks at 20 and 30 days post-hatch will be determined by noninvasive measurement of total body electrical conductivity (Walsberg 1988). Body mass and total body fat measurements will be used to develop a condition index for each chick at 20 and 30 days post-hatch.

The impact of contaminant exposure on breeding adults will be monitored using a combination of direct and indirect methods. Attentiveness of adults will be monitored during the incubation period. Frequency of chick meal delivery and meal size will be determined during the chick-rearing period by a combination of monitoring adult nest visitation rates and periodic weighing of chicks. Individual variation in exposure of adults (and chicks) to petroleum hydrocarbons will be monitored by periodically collecting food samples from adults as they return to the nest site to feed chicks. In the lab, samples of chick food will be analyzed to determine levels of aliphatic and aromatic hydrocarbon fractions using an Iatroscan MK-5 TLC/FID Analyzer System. During the chick-brooding period (0-7 days post-hatch), adult guillemots will be captured in the nest crevice, banded for later identification, and blood samples (1 ml) collected from the brachial vein. Blood samples will be analyzed for molecular and cellular biomarkers of contaminant exposure using the same techniques applied to chick blood samples. These measurements will allow us to monitor the impact of various levels of contaminant exposure on physiological condition of chicks and foraging efficiency of adults.

Otters

Otters, which are relatively abundant in PWS, will be captured using Hancock live traps (Melquist and Dronkert 1987) placed on trails at latrine sites and monitored by means of a trap transmitter (Telonics, Mesa, Arizona, USA) that signals when a trap was sprung. We have used this method successfully in the past (Duffy et al. 1993, in press). The otter initially will be immoblized in the trap with a hand injection of ketamine hydrochloride (11 mg/kg estimated body weight, Sigma, St. Louis, Missouri, USA) and placed in a drugging box (Melquist and Hornocker 1983). Weights and measurements (see Duffy et al. 1993) will be taken and the blood sample drawn from the jugular vein. Sexes will be distinguished by the relative position of urogenital openings and palpitation of the baculum (Larson 1984). Age determinations will be based on tooth wear and overall size of otters (Stephenson 1977).

ANALYSES

The following biomarker analyses will be performed on the samples: Blood plasma protein and liver enzymes, cell counts and Heinz bodies, interleukin levels. The following organism analyses will be performed for guillemots: reproductive success, nest and site abandoment, trophic level using stable isotope ratios of guillemot tissues and prey.

In the area of data analysis and interpretation, we plan on linking our data with the results on sea otters and nearshore invertebrates in PWS. Proposed studies on invertebrates, sea otters, and ours on guillemots and river otters in PWS gives these studies a holistic ecosystem approach. All data from this study will become public information. The data will be forwarded to the EVOS Trustee Council in journal formats for archiving. Also, the data will be available to the public through the use of peer reviewed journals. Any different format will be mutually agreed to.

DELIVERABLES

Quarterly reports and annual reports to Trustees Council (1 abstract 1996, 1 paper 1997). We will provide baseline data on certain biomarkers in guillemots. We will further test a predictive models developed during earlier *Exxon Valdez* oil spill studies that already are established for otters (and other mammals) and develop baselines for guillemots (1 paper 1998). Graduate students and undergraduates will gain field and laboratory experience.

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BUDGET

	FY 95	FY 96	FY 97	Total
Salaries				
Duffy, L;1.5 m	8,810	9,251	9,713	
Bowyer, T.;1 m	5,014	5,265	5,528	
Graduate student, Ph.D.	13,500	15,000	15,500	
Technician;13 w @ $8.87/h	4,612	4,843	5,085	
Technician;13 w @ $7.54/h	3,921	4,117	4,323	
Total Salaries				$114,484
Benefits, Leave				
Duffy, L; 20.1%	1,771	1,859	1,952	
Bowyer, T.; 1.9%	95	100	105	
Subtotal Benefits				$5,883
Benefits, Staff				
Duffy, L.; 29.3%	3,100	3,255	3,418	
Bowyer, T.; 29.3%	1,497	1,572	1,651	
Technician, Field; 8.9%	411	431	453	
Technician, Student; 8.9%	349	342	359	
Subtotal Staff Benefits				$16,837
Travel				
Fai-Valdez-Fai, 8 RT @ $380/trip	3,040	3,040	3,040	
Sitka-Valdez-Sitka, 1 RT @ $460	460	460	460	
Per Diem for volunteers	1,000	1,000	1,000	
Travel to National Conference	500	1,000	3,000	
Subtotal Travel				$10,500
Service				
Administrative services	3,500	3,000	3,000	
Communication - radio rental	3,500	3,000	3,000	
Telephone/duplication	800	800	800	
Postage/freight	3,600	3,600	3,600	
Computer maintenance	500	500	500	
Lease computer/stware 180d:$15/d	2,700	2,700	2,700	
Subcontract ADFG/SE Reg/Wldf Cons. personnel services	10,000	10,000	10,000	
Lease Weatherports, oil heater stove, etc., $100 d @ 90/d	9,000	9,000	9,000	
Lease propane freezer, 90 d @ $8/d	720	0	720	

Lease boats, 2 15', engines, trailer, & safety equipment 90 d @ $250/d	22,500	22,500	22,500	
Lease 34 Hancock traps, 60 d @ $4.50/d	9,180	9,180	9,180	
Lease 3 vehicles from FAI-Valdez-FAI 1,200 mi @ $.50/mi	1,800	1,800	1,800	
Lease 3 binoculars 90 d @ $5/d	1,350	1,350	1,350	
Boat charter to PWS islands, 30 d @ $350/d	10,500	10,500	10,500	
Lease 3 spotting scope & tripod, 90 d @ $5/d	1,350	1,350	1,350	
Stable isotope analysis	4,500	4,500	4,500	
Publication costs	1,000	3,000	1,500	
Subtotal Services				$244,280
Commodities				
Field food, 13 w @ $500/w	6,500	6,500	6,500	
Miscellaneous field supplies	1,000	1,000	1,000	
Lab supplies/assay kits				
Interleukin kits	1,100	1,100	1,100	
P450 kits	520	520	520	
Clinical blood panners assays	2,380	2,380	2,380	
Sleeping bags,	650	650	0	
Sleeping pads	195	195	0	
Notebooks, data sheets	325	225	225	
Blood sampling supplies	2,000	0	0	
Miscellaneous lab supplies	1,500	300	300	
Fuel for stoves, freezer	1,000	1,000	1,000	
Rain gear	800	700	600	
Fuel, 90 d x 35 g/d @ $2/g	6,300	6,300	6,300	
Subtotal Commodities				$65,065
Student Tuition				
Spring 95-Fall 95	4,824			
Spring 96-Fall 96		4,824		
Spring 97-Fall 97			2,412	
Subtotal Student Tuition				$9,648
Total Direct Costs	$163,675	$164,009	$163,924	$466,697
Indirect Costs 10% direct costs - tuition	$15,885	$15,919	$16,151	$47,955
Total Funding Required	$179,560	$179,928	$180,075	$539,564

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Settlement Rates of Nearshore Invertebrates, Oceanographic Processes and Population Recovery: Are They Linked?

Project Number: 95025-D

Project leader(s): Gail V. Irvine (NBS) and Dave Salmon (PWSSC)

Lead agency: National Biological Survey

Cost of Project: FY 95: $435.7K

Project start-up date: 1 October 1994

Completion dates: 1 October 1999

Geographic area: Prince William Sound (initially)

Contact person:
Dr. Gail V. Irvine
Alaska Science Center
National Biological Survey
1011 East Tudor Road
Anchorage, Alaska 99503
(907) 257-2529

B. INTRODUCTION

The *Exxon Valdez* oil spill directly and indirectly affected numerous organisms, including various species inhabiting nearshore environments. Some species in intertidal and subtidal habitats have not recovered fully since the spill, so the question remains: What is limiting the recovery of affected organisms?

This proposal addresses the hypothesis that physical factors (climatic, oceanographic) may be limiting the recovery of some intertidal and subtidal organisms by limiting settlement and possibly recruitment into these populations. This has been judged a high priority research issue for intertidal and subtidal organisms. With a focus on the connection of the pelagic to the benthic or epibenthic, this proposal attempts to build a bridge between the SEA study and nearshore studies. Additionally, it may provide information to address the question of whether processes limiting invertebrate prey ultimately limit vertebrate predators affected by the spill. Investigations into settlement limitation may also indicate which organisms and processes would serve well as long-term, cost-effective monitoring indicators of broad-scale processes.

The central questions of this proposal are:

1) Are populations of some nearshore organisms (e.g., mussels, barnacles, clams) limited by settlement of larval forms from the plankton, and has oiling of sites affected settlement rates or recruitment?

2) Do offshore (pelagic) physical forcing functions control settlement of planktonic larvae into nearshore environments, affecting the ability of the adult populations to recover from the *Exxon Valdez* oil spill?

3) Can the distribution and abundance (or settlement rate) of larvae of select species be used as indicators of mesoscale circulation of marine waters, linking transport phenomena with a characterization of which habitats may be more resilient to disturbance (i.e. they recover from disturbance more easily)?

Future work outside of Prince William Sound would address additional questions. For example, do differences in circulation and larval biology account for some of the differences observed in the Coastal Habitat intertidal studies between and among regions (e.g., results for Prince William Sound and Kodiak/Alaska Peninsula sites being more similar than Cook Inlet/Kenai Peninsula sites for some species)?

Results from studies conducted since the *Exxon Valdez* oil spill have indicated that plants and animals living in the upper portion of the intertidal zone have suffered more extensive injury than those lower in the intertidal and have shown less recovery. Among those affected species are barnacles, limpets, littorines, and *Fucus*. Additionally, mussel beds in some sites were heavily oiled, and due to the sequestration of oil in sediments among the byssal threads, oil has remained and has shown retarded weathering.

This project will evaluate the best candidate species for investigation, based on their response to oiling and cleanup activities following the *Exxon Valdez* oil spill, their relative abundance and importance in nearshore communities, and their possession of a planktonically dispersed larval stage. This proposal focuses on settlement and recruitment of barnacles and mussels. Mussels are also taken in subsistence harvests, so injured services are indirectly being addressed.

C. NEED FOR THE PROJECT

This research is designed to examine whether offshore (pelagic) physical forcing functions control settlement of planktonic larvae into nearshore environments, affecting the ability of the adult populations to recover from the *Exxon Valdez* oil spill. Intensive site-specific manipulations, such as those being performed at Herring Bay, provide data on locally operating mechanisms, but this proposed study is designed to address variability in the contributions from the plankton on a broader scale, and thus may allow broader interpretation of differences observed within Prince William Sound and between Prince William Sound sites and those in the Cook Inlet-Kenai Peninsula region and Kodiak-Alaska Peninsula region.

Ecosystem processes are being viewed as the primary factors influencing the recovery of nearshore communities. This proposal addresses two of the four most important research questions relating to community structure impacts that were identified in the "Invitation to Submit Restoration Projects" booklet (May 1994). These ask whether recruitment limitation or physical processes limit recovery of the nearshore communities.

Results of this study will indicate whether recruitment limitation and physical factors are linked and how they are affecting two important intertidal groups. Recovery may be attained when indications from this study and monitoring of oiled and non-oiled (control) sites (another study) and Herring Bay studies suggest that larval settlement is not limiting and populations of affected organisms are not different between treatments. A combination of results from this study and Herring Bay work may allow determination of intrinsic differences between oiled and control sites.

D. PROJECT DESIGN

1. Objectives for 1995

a. Evaluate other candidate species (than mussels and barnacles) for settlement/recruitment studies based on synthesized information from existent studies, needs of other investigators, and degree of knowledge and appropriateness of larval life history (e.g. littorines, limpets).

b. Identify specific sampling sites in Prince William Sound based on site visits and criteria listed below (Methods).

c. Evaluate multiple methodologies for investigating settlement rates of barnacles, mussels, and other chosen species (settling plates, cleared rock substrates, passive plankton collection tubes [Yund, Gaines, and Bertness, 1991], collections of filamentous algae and plastic toughies for mussels, etc.).

d. Measure within and between site variation in settlement rates of chosen species.

e. Use PWSAC plankton watch collections (March-June) to describe the timing, duration, magnitude and species composition of larvae in the springtime zooplankton stocks. Extend plankton collections to more distant sites and for a longer season (through August).

f. Collect nearshore physical oceanographic data and integrate nearshore conditions with more offshore oceanographic conditions. Provide information for development of a nearshore oceanographic smear model.

g. Compare and integrate physical oceanographic measurements, larval distribution and abundance, and settlement rates within and across sites.

h. Work cooperatively with SEA investigators, Herring Bay investigators, and other nearshore investigators to maximize information gain, make logistics more efficient, and facilitate information exchange.

2. Methods

Specific sampling sites in Prince William Sound will be identified based on physical parameters (and the ability to tie into offshore oceanographic sampling), community composition, oiling history, proximity to PWSAC plankton watch collection locations, ability to tie into existent studies (notably CHIA and Herring Bay), and coordinated needs of other nearshore investigators.

Examination of settling rates will be conducted from April through August, with greater effort projected during the April through June period, when there are peaks of barnacles settling (Rucker, 1983). Multiple methodologies will be evaluated and some tested as to their efficacy. These will include: clearing of rock substrates, settling plates, possibly a passive plankton collection tube (Yund, Gaines, and Bertness, 1991), and specifically for mussels, seasonal scrapes of filamentous algae and artificial substrates (plastic toughies, astroturf).

Determination of recruitment limitation of populations will be based on comparison of settlement rates, relative success of settlers through time (= recruitment) and the impact of recruitment on population structure versus competition and predation. Effects of predation on recruits will be examined by comparing caged and uncaged settling plates. Permanent transects and quadrats will be established to look at community change through time. Results of the other studies will be compared to changes in focus species through time.

Nearshore physical oceanographic measures will be decided upon, in consultation with Dr. Dave Salmon, and will be conducted in conjunction with the PWSAC plankton tows.

Larval availability will be determined through interpretation of the twice weekly PWSAC plankton tows. If a passive plankton collection tube is feasible, then it may provide another measure of cumulative larval plankton abundance over the season; tubes could be set in place and more sites could be examined over the same time period.

3. Schedule

October 1994	Coordination meeting/workshop for nearshore investigators. Synthesize questions, information, decide on sites to maximize overlap and focus, coordinate for logistics, include representatives from nearby communities or subsistence investigators.
November 1994	Preparation of detailed study plan. Initiation of necessary contracts (e.g., vessel charter).
April-Aug 1995	Field work.
Sept, Oct, Nov	Data analysis.
Dec 1995	Report writing.
Feb 28, 1996	Draft annual report.
June 1996	Revised Annual Report.

4. Technical Support

Technical support needed to complete this project includes the taking and analysis of the PWSAC plankton tows. Currently this is being coordinated and analysis supported by the SEA plan. The broader success of this project will be enhanced by linking the nearshore biological and physical processes with those offshore in Prince William Sound. Effort (and money) should be dedicated to achieving that integration. Additional monies should be put towards developing a nearshore smear model. Basic computer support will be provided by the National Biological Survey. Data management needs to be broadly integrated and coordinated for EVOS Restoration Projects. Geographic Information System (GIS) services will be needed from the Alaska Department of Natural Resources to prepare publication quality maps of the sites (FY 96). Statistical or modelling support may be needed to integrate projects/data/models.

5. Location

Locations of sites will be determined in consultation with other nearshore investigators and SEA plankton and oceanographic investigators. Locations need to be in close proximity to the PWSAC plankton collections, and plankton work needs to be tied into community dynamic investigations at the Herring Bay site.

6. References Cited

Rucker, T.L. 1983. The life history of the intertidal barnacle, *Balanus balanoides* (L.) in Port Valdez, Alaska. Masters Thesis, University of Alaska, Fairbanks. 250 pp.

Yund, P.O., S.D. Gaines, and M.D. Bertness. 1991. Cylindrical tube traps for larval sampling. Limnol. and Oceanogr. 36(6):1167-1177.

E. PROJECT IMPLEMENTATION

This project will be implemented by staff of the National Biological Survey (NBS), in coordination with other agencies and private organizations listed in Section F, below. It is appropriate for the NBS to implement this project, due its focus on ecosystem functioning and its designation of Prince William Sound as one of its focus ecosystems. Staff expertise to implement this project also resides within the NBS.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This effort will be integrated with other nearshore investigations to various extents. The most concerted integration will occur with projects looking at subtidal settlement, with the PWSAC collection programs and SEA plankton and oceanography studies, with other nearshore investigators - especially those focusing on whether prey are limiting vertebrate predators, and with Herring Bay studies. Because this study attempts to explain broad differences among sites, it will also be essential to coordinate with recovery monitoring of intertidal (and subtidal) sites in Prince William Sound, and with future recovery monitoring of those sites outside of Prince

William Sound. This project will also coordinate with subsistence studies. Cost reductions are expected to be achieved through coordination and integration. Some reduction in scope may be possible through integration with Herring Bay studies.

G. PUBLIC PROCESS

Public input has, thus far, been received during the EVOS Trustee Research Priorities workshop (April 1994) and via comments by Jody Seitz regarding subsistence. As mentioned above, this project will coordinate with subsistence investigators, and will communicate with nearby affected communities.

H. PERSONNEL QUALIFICATIONS

Principal investigators include Dr. Gail Irvine and Dr. Dave Salmon. Dr. Irvine is a Coastal Resources Specialist/Marine Ecologist working with the National Biological Survey in Anchorage. She has been principal investigator and/or project manager on two *Exxon Valdez* oil spill projects: the Oiled Mussel Project in the Gulf of Alaska, and the Persistence of Oil Study in the Gulf of Alaska. Also, she has been a principal investigator in studies of intertidal community structure along the Katmai National Park and Preserve and Kenai Fjords National Park coastlines. Previous experience also has included broad-scale analysis of oil effects on communities, and serving aa a technical reviewer for a large, multi-year study on the effects of a coastal oil spill being conducted by the Smithsonian Tropical Research Institute in Panama. Dr. Salmon is a physical oceanographer with the Prince William Sound Science Center, and Assistant Director of the Prince William Sound Oil Spill Recovery Institute. He received his Ph.D. at the University of Alaska in Fairbanks, and has conducted research and published in the area of long-term oceanic climate variability. He is also is an investigator in the SEA study.

I. FY95 BUDGET($K)

Personnel	221.0
Travel	26.0
Contractural Services	103.0
Commodities	8.0
Equipment	31.0
Capital Outlay	0
General Administration	46.7
Total	**$435.7**

Algal Competition Limiting Recovery in the Intertidal

Project Number: 95025-E

Project leader(s): Michael S. Stekoll (UAF) and Gail Irvine (NBS)

Lead agency: University of Alaska

Cooperating agencies: National Biological Survey

Cost of project: FY 95: 222.5K

Start-up date: 1 October 1994

Completion date: 1 July 1996

Geographic area: Cook Inlet - Kenai Peninsula

Contact Person: Michael S. Stekoll
JCSFOS
11120 Glacier Highway
Juneau, Alaska 99801
(907) 465-6279, FAX 465-6447

B. INTRODUCTION

The EXXON VALDEZ oil spill and subsequent clean-up efforts had a major impact on affected intertidal communities as shown by the Coastal Habitat Injury Assessment project (CHIA). During the CHIA studies it was discovered that certain areas a nd habitats in the intertidal community were particularly sensitive to oiling/clean-up. One of these habitats was the lower intertidal in the highly diverse, sheltered rocky habitats in the Cook Inlet-Kenai Peninsula area (CIK). Normally the annual kelp, Alaria, dominates the lower intertidal area during the summer seas on. In spring (around April) the cryptic gametophytes germinate to produce small Alaria sporelings. These rapidly growing plants usually outcompete Fucus and other perennials in this zone giving rise to a large bed of Alaria plants in the lower intertidal. We believe that the oil spill and/or clean-up, occurring in April, significantly damaged either the gametophytes or young sporelings of Alaria. These damaged plants died, and the newly created bare substrate was colonized by Fucus gardneri and by Neorhodomela, both perennial algae. Alaria would be slow to recolonize this area because it is an annual and relies on the dispersal of spores from the large, adult sporophytes, which occurred in depressed numbers since the sporelings were destroyed by the spill. Alaria probably have a limited dispersal range of a few meters. Therefore, without the fertile adults nearby, spores for the next year's generation were not available. Meanwhile Fucus and other slow growing perennials were able to gain an ever increasing foothold. As of the end of the field season in 1991, the shift in

community structure still existed.

This shift in the intertidal algal community poses an important ecological question. Will the year round presence of Fucus gardneri and other perennials in the lower intertidal now prevent the annual Alaria from returning to its natural state as the dominant provider of food and habitat in the lower intertidal community? The proposed new studies would be a continuation of CHIA research and monitoring supplemented by experiments designed to answer specific questions regarding the recovery of Alaria.

C. NEED FOR THE PROJECT

This project addresses the recovery of an injured resource, namely, the lower intertidal sheltered rocky habitat in CIK. Continued studies directed toward injured sheltered rocky intertidal communities are needed to determine how and when recovery may take place. If the shift in the dominant algal type as seen in CIK sheltered rocky algal communities persists, it may have an effect on other organisms along the food chain. Possible repercussions of Alaria's absence could be loss of habitat and food for other marine organisms. Alaria is a viable food source for sea urchins which in turn are preyed upon by sea otters.

This project is an outgrowth of the CHIA studies carried out in 1989-1991 in the Cook Inlet Kenai Peninsula area. The results will contribute to our understanding of the limits to recovery in the sheltered rocky habitat in CIK. The study is one that would fit in well with the ecosystem studies of Herring Bay. However, there is no Alaria in Herring Bay and, thus, this study can only be done in CIK. The CIK area is unique for this project due to the algal communities in region and to the oiling/clean-up history. This project will benefit by close cooperation with the researchers involved in the Herring Bay Monitoring and Restoration project because of the similar nature of the experiments and data analysis.

D. PROJECT DESIGN

1. Objectives and Methods

a. Quantify the population dynamics and reproductive potential of Fucus gardneri, Neorhodomela, and Alaria on matched oiled and non-oiled sites in CIK sheltered rocky habitats. Counts and measurements of each species will be carried out to determine densities, size classes, and reproductive capabilities.

b. Assess the competitive interactions between Fucus gardneri, Neorhodomela, and Alaria in recolonizing newly created bare substrata on matched oiled and non-oiled sites in CIK sheltered rocky habitats. Reciprocal clearings will be created and revisited for quantification to detect successional interactions between Alaria, an annual alga, and Fucus gardneri and Neorhodomela, perennial algae. Some parallel field experiments will also be set up at Juneau in areas where Alaria beds are adjacent to beds of Fucus.

c. Monitor the natural recovery of damaged algal communities on matched oiled and non-oiled sites in CIK sheltered rocky habitats. This will be a continuation of the CHIA algal percent cover experiment initiated in 1991 and provides continuity for monitoring the sites.

d. Determine the physiological factors limiting the recruitment of Alaria. Laboratory experiments will be set up to test various abiotic elements as limiting parameters for the recruitment of Alaria. Of particular interest is the toxic effect of oiling to the growth and recruitment of Alaria sporelings and gametophytes.

2. Schedule

During the summers of 1995 and 1996 there will be two trips to CHIA sheltered rocky sites in CIK. A tentative schedule for working days in the field is as follows:

Trip #1: April 15-30
Trip #2: July 25-August 9

A schedule of major landmarks is as follows:

Finalize the study plan	Jan-Mar 1995
Arrange boat charter	Mar-Apr 1995
Field sampling period	Apr-Jul 1995
Laboratory experiments	Apr-Sep 1995
Data compilation	Jul-Sep 1995
Data analysis/interpretation	Sep 1995-March 1996
Submit annual report	April 1996
Field sampling period	Apr-Jul 1996
Laboratory experiments	Apr-Sep 1996
Data compilation	Jul-Sep 1996
Data analysis/interpretation	Sep 1996-March 1997
Submit annual report	April 1997
Submit final report	July 1997

3. Technical Support

-Vessel charter to support field work will be necessary. About 20 days per season will be needed.

-Laboratory facilities will be provided by the Juneau Center, School of Fisheries and Ocean Sciences of UAF.

4. Location

The original study sites used in the CHIA study will be used in this project. CHIA sheltered rocky sites (reference/oiled) in the Cook Inlet-Kenai Peninsula area are: Nuka Bay / McArthur Pass, Chance Cove / Morning Cove, Yalik Bay / Tonsina Bay. An additional site in Juneau will be utilized for the performance of more detailed experiments examining competition between Fucus and Alaria.

E. PROJECT IMPLEMENTATION

This project should be implemented by the University of Alaska in cooperation with the National Biological Survey as part of the NBS nearshore recovery research. The University already has an extensive data set on these sheltered rocky sites in CIK, including data on the percent cover and biomasses of Fucus, Alaria and ot her intertidal algae. This proposed study will continue an important aspect of the CHIA monitoring by updating the last information from the 1991 field season.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is closely coordinated with the past CHIA studies in CIK and with the proposed continued monitoring of the CIK intertidal areas. The project is also linked with on-going assessments being conducted by NBS in the Kenai Fjords National Park. In addition there will be close coordination and cooperation with the Herring Bay Restoration and Monitoring studies with respect to experimental design and data analysis.

G. PUBLIC PROCESS

Previous related work by the principal investigators has been presented at the EVOS Oil Spill Symposiums in Anchorage to which the public was invited. Each proposal and report will be available to the public for comment in accordance with the procedures established by the Trustee Council.

This current proposal is a result of conversations that occurred during the public workshop concerning "Research Priorities for Restoration" held in Anchorage during April 13-15, 1994.

H. PERSONNEL QUALIFICATIONS

Dr. Michael Stekoll, Professor, UAF/JCSFOS and UAS, Juneau - co-principal investigator. Dr. Stekoll has been a principal investigator on three Exxon Valdez Oil Spill projects: the Coastal Habitat Injury Assessment project, the Herring Bay Experimental and Monitoring Studies, and the Shallow Subtidal Assessment project. He has co-authored annual and final reports for these projects and has produced refereed publications on various aspects of these projects. His specialties include, marine pollution biology, the biology and ecology of seaweeds in Alaska, especially Macrocystis and Fucus, and the mariculture of kelps and red seaweeds.

Dr. Irvine has been a principal investigator and/or project manager on two *Exxon Valdez* oil spill projects: the Oiled Mussel Project in the Gulf of Alaska, and the Persistence of Oil Study in the Gulf of Alaska. She has been involved in the reporting of these studies. Also, she has been a principal investigator in studies of intertidal community structure along the Katmai National Park and Preserve and Kenai Fjords National Park coastlines following the *Exxon Valdez*.

I. BUDGET

Personnel	$116.6K
Travel	$ 8.1K
Contractual	$ 46.4K
Commodities	$ 3.0K
Equipment	$ 4.5K
Miscellaneous	$ 4.8K
Total Direct	$185.4K
Indirect @ 20%	$ 37.1K
Project Total	$222.5K

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The Availability and Utilization of Musculus spp. as Food for Sea Ducks and Sea Otters

Project Number: 95025-F

Principal Investigators: Thomas A. Dean, Ph.D.
Coastal Resources Associates, Inc.

Stephen Jewett
University of Alaska, Fairbanks

Lead agency: National Biological Survey

Project cost: $4.6K

Start up date: March 1995

Project duration: 2 years

Geographic area: Prince William Sound

Contact person: Thomas A. Dean
Coastal Resources Associates, Inc.
1185 Park Center Dr. #A
Vista, California 92983
(619) 727-2004, FAX 727-2207

B. INTRODUCTION

This project will examine the utilization of *Musculus* by sea ducks and sea otters in Prince William Sound. *Musculus* spp. are small mytilid mussels that live attached to eelgrass and algae. Large numbers of *Musculus* recruit to selected eelgrass beds within the Sound each spring, and can reach densities of 40,000 or more per square meter. By fall, most of the mussels reach about 1 cm in length. The vast majority of the mussels disappear over the winter. Densities of larger *Musculus* (greater than 1 cm) are seldom greater than 10 per sq. meter. These small mussels provide a potentially valuable food source for both sea otters, and (more likely) sea ducks.

Monitoring of *Musculus* densities on eelgrass has been carried out as part of the subtidal coastal habitat studies (S. Jewett and T. Dean, Principal Investigators), and will likely be continued as part of a subtidal monitoring program in FY 95.

C. NEED FOR THE PROJECT

Musculus provide an important potential food source for sea ducks and otters. Evidence for the utilization of *Musculus*, which are generally more abundant at oiled sites, may help rule out

prey availability as a factor limiting otter or sea duck recovery.

D. PROJECT DESIGN

1. Objectives

Determine if *Musculus* are utilized a food by either otters or sea ducks, and determine changes to *Musculus* densities that may result from predation by otters or ducks.

2. Methods

No additional field work will be proposed for FY 95 for this task. Instead, we will concentrate our efforts on collating existing observations on the feeding habits of ducks and otters, distribution patterns of ducks and otters, and the distribution of *Musculus* within the Sound. We will examine the possibility that otters and ducks are utilizing *Musculus* by examining observational and (perhaps for ducks) gut contents of the predators. Also, we will assess utilization by overlaying distribution and abundance data for *Musculus* with that for ducks and otters. It is anticipated that we will obtain *Musculus* distribution data as part of the subtidal monitoring program, and that these data will be obtained from areas which cover a range of otter and duck densities. Additional studies (e.g., direct observations of the effects of winter feeding by ducks in eelgrass beds on *Musculus* density) may be proposed for FY 96 if the FY 95 data suggest that *Musculus* are being utilized as food.

3. Schedule

The field work (conducted under separate contract) that will generate data to be used in this task will be largely completed by December 1995. Data analysis and draft report preparation will be completed in May 1996. Deliverables will consist of an FY 95 progress report to be submitted in September 1995, and a final report to be completed by May 1996.

4. Technical Support

No outside technical support will be required.

5. Location

The project will be undertaken in Prince William Sound.

E. PROJECT IMPLEMENTATION

Principal Investigators for this project have been conducting injury assessment studies in the shallow subtidal within Prince William Sound since 1989, and are submitting several proposals for continued monitoring and assessment of subtidal resources, including *Musculus*. The investigators involvement in other related projects makes them uniquely qualified to conduct

cost effective studies on the interactions among *Musculus* and otters or sea ducks.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is being submitted as an integrated part of proposals dealing with the nearshore ecosystem. It is anticipated that the studies of *Musculus* will be fully integrated with other studies (e.g., monitoring within eelgrass beds) being proposed by the same investigators, and with proposed sea otter and sea duck investigations. It is anticipated that sea otter and sea duck investigators will make key distribution and feeding observations that will be critical in evaluating the interactions between *Musculus* and its vertebrate predators.

G. PUBLIC PROCESS

Investigators in this project have taken part of public participation workshops sponsored by the Trustee Council to examine research needs. Future workshops will be supported. All documents produced will be made available for public review.

H. PERSONNEL QUALIFICATIONS

Thomas A. Dean - Dr. Dean is President of Coastal Resources Associates, Inc. Dr. Dean has over 20 years of experience in the study of nearshore ecosystems, and has authored over 20 publications in scientific journals as well as numerous unpublished reports. Dr. Dean has published several papers dealing with sea urchin and kelp interactions, and with impacts of the *Exxon Valdez* oil spill on subtidal invertebrates and plants. Dr. Dean has been co-principal investibator of *Exxon Valdez* oil spill injury assessment and restoration studies for subtidal invertebrates and plants in Prince William Sound since 1989.

Stephen Jewett - Mr. Jewett is a Senior Research Associate with the University of Alaska Fairbanks, with over 25 years of research experience in the Alaskan coastal ecosystems. Mr. Jewett is author of over 15 publications, including several recent papers dealing with the effects of the *Exxon Valdez* oil spill on subtidal invertebrates. Mr. Jewett has been co-principal investigator of *Exxon Valdez* oil spill injury assessment and restoration studies for subtidal invertebrates and plants in Prince William Sound since 1989.

I. BUDGET

The following is a preliminary budget for the proposed study:

Personnel	$3.2K
Travel	$1.2K
Supplies	$ .6K
General administration	$ .8K
Total	$4.6K

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