Lingering Oil and Predators: Pathways of Exposure and Population Status

Project Number: 030620

Restoration Category: Research and Monitoring

Proposers:
Part I: NOAA- ABL — Stanley Rice, Jeff W. Short, Mandy Lindeberg; NMFS, Auke Bay Laboratory; ABL Program Manager: Dr. Stan Rice
NOAA Trustee Liason: Pete Hagen

Part II: DOI-USGS: James L. Bodkin and Brenda E. Ballachey
DOI Program Manager: Dede Bohn

Lead Trustee Agency: NOAA

Cooperating Agencies: DOI-USGS

Alaska Sea Life Center: No

Duration: 1st year of a 1 year project

FY03 Part I (NOAA): 167.6 K
Part II (USGS): 192.3K Phase I; 75.9K Phase II
FY04 30K (Estimated: closeout)

Geographic Area: Prince William Sound, Gulf of Alaska

Injured Resource/Service: Intertidal, Sediments, Sea Otters, Harlequin Ducks

ABSTRACT
Lingering oil and continued effects to sea otters and sea ducks are the most surprising and best documented long term impacts of the *Exxon Valdez* oil spill. Strong evidence is accumulating which implicates lingering oil as a factor constraining recovery of the nearshore ecosystem in western Prince William Sound (PWS). Acute and chronic contamination of sediments and prey species were well documented during the years following the spill. Twelve years later, elevated biomarker levels in sea otters and sea ducks (top-level predators) have indicated continued exposures to hydrocarbons (USGS). Evidence implicating a route of exposure to date has been largely circumstantial. However, in 2001 and 2002, extensive sampling was undertaken by NOAA (ABL) to document the distribution, abundance, and bioavailability of lingering oil along those shorelines most heavily impacted by the 1989 *Exxon Valdez* spill. This has paved the way for identifying specific areas where sea otters and sea ducks could be currently foraging and exposed to lingering oil. There are two parts to the proposal, both are targeted at linkage between oil and effects to the predators.

GENERAL INTRODUCTION

From the late 1990's to present, the finding of oil persistence and evidence of continued exposure and impacts to sea otters and sea ducks are the most surprising and best documented of the long term impacts of the *Exxon Valdez* oil spill. The results were unanticipated, and have sparked some levels of controversy. Acute toxicity was expected in the early days of the spill, but the lingering oil and effects 12 years after the spill were never anticipated. In 2001, rigorous field surveys documented the extent and intensity of the lingering oil throughout the western part of Prince William Sound, thus giving strong support to the growing evidence of continued exposure to sea otters and sea ducks, and providing a chemical basis for the positive biomarker findings. These results suggest that the poor recovery of the top level predators in some areas of the sound is constrained by the continued oil exposure. In particular, some of the heaviest oiled areas in 1989 continue to have a significant incidence of oil, including subsurface oil that is relatively low in the intertidal zone and in the biologically productive zone. The species continuing to show impacts share one thing in common; they live, forage, or spawn in the intertidal zone, where stranded oil continues to have some persistence. Hence there is a match between oil persistence and life history traits.

In 2002, the focus of a joint study by USGS and ABL, was the study of 5 sites with an emphasis on bioavailabiltiy of oil and linkage to continued effects. The 5 sites ranged from no oil to sites where oil was present to the “worst case” sites. The potential for oil bioavailability was the focus of the chemistry studies by ABL, while USGS continued the study of biomarkers and impacts to sea otters and sea ducks. This was the first year of the joint study, and a subset of the 2001 ABL sties was targeted, to give a better integration of the two research themes. These studies are in progress, but field results to date continue to demonstrate the probability of a linkage between oiled sites, oiled prey, and exposure/poor recovery of these species. For example, clams were sampled in March 2002 that were determined visually to be in oiled sediments at the zero tide level in Herring bay, and the shells were stained with oil (chemical analyses has not been completed, but is expected to confirm high PAH contamination).

In 2003, further linkage studies are proposed, which are an outgrowth of the current studies. The two research themes will continue to be integrated from a site perspective with further attempts to define the significance (linkage) of lingering oil and biological effects. Bioavailability is a measure of exposure potential, but is not a true measure of significance. In 2003, the two studies will focus primarily on the northern Knight Island area where groups of otters and ducks will be radio tagged and followed in the winter season, while the habitat studies will focus on oil contamination levels at these areas (including prey). The study area will compare oil and feeding in three areas, ranging from heavily oiled and few predators to less oiled with predators. Ultimately, our goal is to define the significance of oil in the habitat with continue sublethal effects measurements and feeding activity. This can not be done practically for a large region; therefore we will focus on three study areas: (A) Herring Bay, arguably the worst contaminated site, still does not have otters residing and utilizing the forage, although it supported about 35-40

otters in 1989 prior to the spill; (B) the Lower Passage area where some oil exists and significant otter numbers begin; and (C) Bay of Isles has some localized high contamination areas, but for the most part, is probably much less oiled, and has partial utilization by resident sea otters. These areas will act as "canaries" for the northern Knight Island area--- when the bioavailability of oil at these sites is negligible, and otters have re-established, then the spill can probably be declared as over. The linkage theme will be further evaluated by USGS, through continued biomarker research and population monitoring, along with assessments relative to the extensive 2001 field survey for oil. Linkage is the focus for both parts of the study, and is expected to be a one year study, followed by closeout.

Overall Objectives:

Mini-workshop: in early October 2002 a review of progress for ABL and USGS studies in 2001/2002 was completed. Sampling designs for the current proposal were reviewed and refined.

<u>Part I (NOAA-ABL)</u>: Pathways of exposure and significance

1. Determine level of intertidal contamination in observed habitual foraging locations for sea otters and harlequin ducks.

2. Determine the potential for chronic exposure to oil by placing surface sampling devices at observed habitual resting and feeding locations of sea otters and harlequin ducks.

3. Analyze prey items for hydrocarbons from very specific feeding patches of sea otter and harlequin ducks with high P450 values.

4. Using information from the 2001 shoreline survey database, estimate the volume of oil remaining in a restricted area where both sea otters and harlequin ducks are still showing symptoms of oil exposure.

5. Refine the estimated volume of oil remaining in these restricted areas by going to a selected number of random sites and measuring subsurface oil to the zero tide line.

Population Status

1. Obtain current estimate of the WPWS sea otter population size.

2. Obtain current estimate of the northern Knight Island sea otter population size.

3. Identify locations where sea otters and harlequin ducks with known blood and liver P450 values are residing and foraging, and evaluate those locations for lingering oil.

4. Monitor survival of marked sea otters at Knight Island and relate survival outcome to CYP1A levels and liver alterations.

PART I: Lingering Oil and Predators: Pathways of Exposure (NOAA-ABL)

ABSTRACT

Lingering oil from the *Exxon Valdez* oil spill remains throughout Western Prince William Sound and appears to have chronic effects on sea otter and sea duck populations in these areas. Studies conducted in 2001 have documented the extent of oiling throughout the sound, and studies in progress in 2002 will attempt to document the bioavailability of the oil to prey and oil sampling devices (5 sites; within and near known oil patches). As of this writing, we have determined that oil is bioavailable to predators, however, we do not know if the predators have been exposed, but the possibility definitely exists in some areas. Bioavailability defines potential for exposure, but is not equal to exposure or significance. In 2003, we will attempt to determine the significance of the oil that remains, by quantifying the probability of oil encounters in a limited area of northern Knight island, where there is overlap with worst case oil areas and otters and sea ducks. Contamination at specific prey sites (as determined from the radio tagging studies in Part II) will also be conducted, to potentially document direct linkage between oil and predators. Part II will attempt to measure habitat utilization as well as continued monitoring of oil effects in sea otters and harlequin sea ducks, who forage in the lower intertidal where oil is still present in some contaminated areas. The coordination initiated in 2002 will be ramped up to more of an integration in 2003, with a synthesis product in 2004 coming from both projects.

INTRODUCTION

In 2001-2002, studies by ABL have determined that lingering oil remains in some of the hard hit areas of Northern Knight Island, while USGS studies have measured a low level biomarker effects and population effects on both otters and sea ducks. There is an obvious correlation between oil presence and low level predator effects, but the case for linkage is weak. The P450 results could be stimulated by other factors, and the population recovery could have been constrained by other unknown factors. The quantities of lingering oil found in summer 2001 was surprising in some locations, as well as the predominance in the lower intertidal, which is closer to the biological zones where the predators sometimes feed. This stimulated the bioavailability study in 2002, and the positive results from bioavailability indicate that linkage between predators and lingering oil should be studied more directly. Since direct oil contamination is highly unlikely to be observed, the linkage studies will be challenging. Any group of predators in an oiled area could be exposed, but encounters will not likely be 100% for any group, hence numbers and statistics become a major design issue.

There are two basic strategies that could be used in linkage studies; direct observation and indirect (or probabilistic) approach. Both approaches have advantages and disadvantages, and this study contains elements of both approaches.

The direct observation of linkage would be the preferred approach, if it worked. In this approach, otters and sea ducks would be sampled for elevated p450, radio tagged, and followed for a portion of the year to determine their home range and primary feeding areas. Then the specific feeding

habitat would be sampled to determine if the prey and habitat still contain oil, or not. This approach would have had a higher probability of success in earlier years, but as the lingering oil diminishes with time, and P450 results recover to base levels, there will be lower chances of finding specific predators with elevated P450 feeding in specific oiled locations. What we do not know is how many exposures, or how often, does it take to diminish the survivals of otters or sea ducks, or to sustain an elevated P450. Will one contaminated feeding per week, or per month sustain the biomarker effects? If the exposures are from rare encounters, will the limited visual observations catch the animal at the appropriate site? Can we sample enough predators, and enough habitats? This approach will be attempted by sampling the habitat and prey, based on observations from USGS on otters and Harlequin ducks that have been sampled for P450 and radio tagged.

The indirect or probabilistic approach has a higher probability of success. We can determine how much oil remains within a specific feeding range, including prey, but we may never actually observe an animal feeding at specific oiled patch. That is the "weak link" in this approach. In this approach, we would determine the amount of lingering oil remaining within a certain range and sample the intertidal down to the "zero" tide level, where oil and prey are known to exist. The random approach utilized in the original 2001 shoreline survey would be modified, but the approach would be similar. The numbers of sample sites within three areas, ranging from Herring bay (heavily oiled, no otters) to Lower Passage and Bay of Isles where some oil and predators are present. By combining the results of Part II tracking studies, we can determine how many days specific otters or Harlequin ducks spent in a restricted area that contains an estimated amount of oil in their feeding habitats. What we would not know is the relationship of estimated oil remaining with otter forage. Conducting an otter forage (habitat study) could be done, but using harlequin ducks with a tighter restricted range, and one that is restricted to a higher dependence on the intertidal zone may be a better use of resources.

NEED FOR THE PROJECT

A. Statement of Problem

The 2001 shoreline survey revealed that a significant amount of oil still remains on beaches in Prince William Sound and certain bays have persistent patches of oil. This study determined that more oil remained than previously thought, and that much of the liquid oil was lower in the intertidal zone than expected (Short et. al 2002). The design of the project was limited to the upper half of the intertidal zone, and was not designed to pick up what ended up being the zones with the most oil, and the most biologically productive zones. The estimates of remaining oil are conservative underestimates. Remaining oil may not be bioavailable, and the studies in 2002 focused on determining if oil at oil patch sites was available to prey items, and available to surface oil collectors. Oil is bioavailable at many of these sites, but the doses are not high, and bioavailability does not equate to direct linkage and significance. The studies in 2003 will integrate radio tagged predator studies that determine habitat use with contaminant studies that determine bioavailability and exposure. By combining the two parts (contaminants and predators use), we hope to determine the significance of remaining oil to the predators, their constrained

population recovery, and continuing biomarkers effects. This coordinated work will assess the oiled areas as a source of chronic oil exposure, and the significance of that contamination to the limiting recovery of those species.

B. Rationale/ Link to Restoration

Part I of this proposal will establish estimates of oiled shoreline in three areas where sea otters and sea ducks have not recovered from the *Exxon Valdez* oil spill. Individuals observed foraging and captured in contaminated areas can be linked to chronic exposure data (Part II). This study will help determine if chronic oil is part of the problem constraining recovery of otters and sea ducks, or not. The pathways of chronic exposure will build into an impressive body of evidence: individuals habitually foraging and resting in close proximity to known subsurface intertidal oil patches, oil collecting in their fur or feathers, feeding on contaminated prey, and/or having elevated levels of P450. Full recovery from the spill will have occurred when contaminated foraging habitat and chronic exposure to top level predators has fallen below detection levels at these "worst case bays".

C. Location

All surveying and sampling will be conducted within Herring Bay, Lower Passage and Bay of Isles located on northern Knight Island in Prince William Sound.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Charters to support the research will be solicited from the spill impacted area. Further, some labor support for some of the field operations may be solicited from the Native villages.

PROJECT DESIGN

A. Objectives

1. Determine level of intertidal contamination in observed habitual foraging locations for sea otters and harlequin ducks.

2. Determine the potential for chronic exposure to oil by placing surface sampling devices at observed habitual resting and feeding locations of sea otters and harlequin ducks.

3. Analyze prey items for hydrocarbons from very specific feeding patches of sea otter and harlequin ducks with high P450 values.

4. Using information from the 2001 shoreline survey database, estimate the volume of oil remaining in a restricted area where both sea otters and harlequin ducks are still showing symptoms of oil exposure.

5. Refine the estimated volume of oil remaining in these restricted areas by going to a selected number of random sites and measuring subsurface oil to the zero tide line.

B. Methods

Contamination of specific foraging areas

Sea otters and harlequin ducks are mobile predators which present a problem for random sampling designs. There is a good chance the randomly selected shorelines for surveying lingering oil will not correlate with foraging predators. To overcome this shortfall, a 10 day cruise will directly survey those beach segments where habitual observations of foraging have been made. The specifics of the design will evolve after USGS researchers are well into their winter observations and preliminary results can be reviewed prior to implementation in the spring.

Potential for chronic exposure to sea otters and sea ducks

Oil in the water may be one pathway sea otters and harlequin ducks are receiving chronic exposures. Oil from disturbance events (storms, tidal action, or foraging) may be introduced into an individuals fur or feathers. Preening to remove this oil requires additional energy, less time for feeding, and possible ingestion of the oil. Sampling fur and feathers for residual oil is not an established procedure for acute or chronic exposures. Instead, we will use monitoring devices (LDPEs) at the sea surface where foraging and resting activities have been observed. These devices will act as surrogates for fur and feathers. If our LDPEs detect oil then it is more than likely that sea otters and harlequin ducks in these areas have also been exposed to oil.

Twenty-five LDPEs will be deployed within each area (Herring Bay, Lower Passage, and Bay of Isles) and specifically where sea otters and harlequin ducks have been observed resting and foraging. Locations will be prioritized by shoreline oiling history, numbers of individuals observed and/or individuals with elevated P450 values (January workshop). The monitoring devices will sample surface waters 10 m offshore for a 30 day period.

Hydrocarbon analyses

To determine the source and weathering condition of remaining oil, 10 sediment samples from pits with visible subsurface oil will be collected. To confirm contamination in prey and supplement elevated P450 data in sea otters and harlequin ducks, approximately 30 prey samples will be collected and analyzed for PAHs from heavily oiled and/or observed foraging areas. Subtidal clams will be collected from 10 sites via scuba and analyzed for PAHs. This will address sea otters who habitually feed on clams in the subtidal zone (~10 - 20m). All samples will be analyzed by GC-MS (summarized in Short et al. 1996) to determine whether PAH composition matches weathered *Exxon Valdez* oil. A weathering index (Short and Heintz 1997) will be determined for each sample.

Estimated volume of oil remaining within a specific area

The 2001 survey provided estimates of oiled shoreline and the volume of oil remaining

throughout the spill area. The northern Knight Island area remains heavily oiled and sea otter and harlequin duck populations have not recovered from this region. This area represents the "worst case" in recovery from the spill and begs for a contamination estimate just for these regions. The 2001 survey data is structured so that these specific regions can be defined and oil estimates recalculated (Table 1). This would be a statistical exercise only and would not require field work.

Refining contamination estimate within a specific area

The 2001 shoreline effort was directed at the upper intertidal, whereas most of the oil was found on the lower intertidal surveyed area. The 2001 estimates potentially underestimate the prevalence of contaminated shoreline for the biologically important forage/predators. Therefore, a more refined oiled shoreline survey is necessary. The design will be loosely based on the 2001 SCAT sampling design but with a few alterations as dictated by the findings from that survey. The scope of the survey will be reduced to the three worst case areas, Herring Bay, Lower Passage and Bay of Isles, sampled as separate strata. An equal random sampling effort will be given to moderately and heavily oiled shorelines (1 strata). Sampling will extend down to the minus 0.5m tide level (when possible) which will allow for detection of oil well into the biological zone and foraging habitat.

Similarly to the 2001 SCAT survey, the beach segments will be partitioned into rectangular blocks by a number of equal-width alongshore columns and 1.0 m tidal elevation intervals ranging from +2.5 m to -0.5 m (tide permitting). The maximum beach segment length, 100 m, will be divided into 5 columns, each 20 m wide, resulting in 15 blocks and 30 random pits. The number of pits and size of blocks may be modified based on a review of 2001 survey data. Shorter beach segments will be divided into fewer columns and blocks. Two 0.25 m2 quadrats will then be randomly placed within each block and a test pit excavated within each to a depth of 0.5 m or until boulders or bedrock are encountered. Oiled surface and subsurface area and its variance for any sampled segment will be estimated from these random quadrats, using standard SRS formulas as per 2001 shoreline survey. Gravimetric samples will be collected from each beach segment, representative of the oil classifications found on that beach, as to obtain a volumetric estimate of the oil. To enhance our biological information, major changes in substrate types (bedrock, boulder, cobble, pebble, granule, peat) and biological zones (algal cover, mussel beds, eelgrass and kelp beds) will be documented along vertical transects within our sampling grid. This baseline survey will have a cost effective and statistically proven design which can be repeated in outlying years to determine when PWS is clean.

Sampling Locations:

1. Herring Bay: impacted bay; "worst case" site for recovering otters and sea ducks; acute exposures (See Figure 1).
2. Lower Passage: impacted pass; marginal numbers of recovering otters and sea ducks; chronic exposures. This area will span from Passage Pt. to the southern tip of Ingot island.

3. Bay of Isles: impacted bay; marginal numbers of recovering otters and sea ducks; chronic exposures (See Figure 2).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The overall project is a joint effort with NOAA-ABL and USGS-BRD based on their expertise and Trustee funded research in the past. ABL personnel will conduct studies on oiled shoreline survey as described in Part I of this DPD. USGS-BRD personnel will be responsible for directing and conducting sea otter and sea duck studies as described in Part II of this DPD.

SCHEDULE

A. Measurable Project Tasks

October 2002:	Mini-workshop; review field sampling designs (*completed*)
January 2003:	Mini-workshop; review winter foraging data/P450; choose intertidal sites.
April 2003:	LDPE deployment cruise.
May 2003:	Survey 10 sites for lingering oil and pick up LDPEs.
June 2003:	Survey 10 sites.
July 2003:	Survey otter and duck sites for lingering oil.
December 2003:	Complete oiled shoreline estimates and chemical analyses.
January 2004:	Attend Annual Workshop.
April 15, 2004:	Complete Final Report.

B. Project Milestones and Endpoints

FY03: Four cruises will be carried out during the large spring tides of April, May, June, and July. This will maximize our ability to sample in the biological zone. All chemical analyses will be initiated in FY03.

FY04: Close out of the project is anticipated for both agencies in FY03. Further work would be dependent on results, and would be applied for as an independent proposal. At this time we believe that the field work of 2003 will provide direct publications, plus a synthesis between Parts I and II in FY 04. Some chemical analyses will spill into FY04, but all data analyses will be completed by Jan 2004. Final report, with a synthesis would be due April 15, 2004.

C. Completion Dates

This is a one year field project, followed by a closeout year. All field collections and analyses will be completed in the FY03 funding cycle. Chemical analyses will be completed by December 2003 and a final report by April 15, 2004.

PUBLICATIONS AND REPORTS

We will provide a final report to the Trustees office by April 15, 2004.
Expected publication titles:

1. Significance of oiled habitat and prey as a probable cause of chronic impacts to sea otters and harlequin ducks.
2. Estimate of EVOremaining in non-otter/otter zones of Northern Knight Island, PWS.

PROFESSIONAL CONFERENCES

The EVOS Trustee meetings will be attended by the principal investigators. One additional scientific meeting will be attended by one of the principal investigators (AMOP or SETAC).

NORMAL AGENCY MANAGEMENT

None of these projects are part of normal agency management activities.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is related to the Shoreline assessment and Lingering Oil and Bioavailability of Lingering Oil projects and will use information generated from these studies. Likewise, the sea otter and harlequin duck work is an outgrowth of projects funded in FY 01and 02, and will utilize information from those projects. Further, there has been coordination between the two agency component parts in development of the proposal, to ensure geographical overlap and relationship.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

N/A

PROPOSED PRINCIPAL INVESTIGATORS

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PRINCIPAL INVESTIGATORS

Stanley D. Rice
GM-14 Physiologist

Received BA (1966) and MA (1968) in Biology from Chico State University, and PhD (1971) in Comparative Physiology from Kent State University. Employed at Auke Bay Fisheries Laboratory since 1971 as a research physiologist, task leader and Habitat Program Manager since 1986. Rice has researched oil effects problems since 1971, and has published over 115 papers, including over 75 on oil effects. Studies have ranged from field to lab tests, behavioral to physiological to biochemical studies, from salmonids to invertebrates to larvae to meiofauna. Rice has conducted and managed soft funded projects since 1974, including the Auke Bay Laboratory *Exxon Valdez* damage assessment studies since 1989. Activities since the oil spill have included leadership and management of up to 10 damage assessment projects, field work in PWS, direct research effort in some studies. Quality assurance of all studies, particularly the biological impacts research has been the continuing focus through the restoration years. Principal investigator in subtidal sediment studies, pink salmon effects studies, and in the SCAT surveys of 2001. In addition, Rice has lead the effort on use of LDPE research by the Auke Bay Lab.

Jeffrey W. Short
Research Chemist

Education: M.S. (Physical Chemistry). 1989- Present: Established and managed the hydrocarbon analysis facility at ABL to analyze hydrocarbon samples generated by the *Exxon Valdez* NRDA effort. Responsible for quality control and data interpretation of all data hydrocarbon data produced by ABL labs. Principle investigator of several EVOS projects through the damage assessment and restoration years, paarticularly those studies involved in tracking oil (subtidal sediments), tracking the Hydrocarbon Data Base, several specific projects (Pristane; Coal as a

background source), and most importanly, principal investigator of the large shoreline assessment project (SCAT) in FY 2001. Many publications.

Mandy R. Lindeberg
Fisheries Research Biologist

B.S. Marine Biology. 1990- present: Mandy has been involved in *Exxon Valdez* oil spill research for the last 11 years. Her research includes studies on intertidal invertebrates and seaweeds, mussel populations, and a co-principal investigator of spot shrimp populations in Prince William Sound. She was the field chief of the intensive PWS oiled shoreline survey during 2001 and lingering oil bioavailability in 2002. Her responsibilities include quality control of field and laboratory sample processing, data analysis, graphics, and proposal/report preparation.

OTHER KEY PERSONNEL

Chemists Marie Larsen, Larry Holland, Josefina Lunasin will participate in the chemical analyses of the samples.

LITERATURE CITED

See combined "Literature Cited" section for Parts I & II.

Summary of ABL Budget

Support Logistics: Vessel Charter			
Spring LDPE deployment cruise:	4 days, ($1300/day)	5.2 K	
Summer Survey I	10 days, ($1300/day)	13.0 K	
Summer Survey II	10 days, ($1300/day)	13.0 K	
Summer Survey III (forage sites)	10 days, ($1300/day)	13.0 K	
			44.2 K
Materials and Supplies:			
Strips, collectors, anchors, line, shipping		6.7 K	
Misc field gear		3.3 K	
			10.0 K
Contracts:			
Soft Labor:	2 ABL for 4 cruises, prep, data entry	15.5 K	
	2 villagers for 2 cruises	8.0 K	
			23.5 K
Travel:			
ABL- to PWS (RT)	(4) LDPE deployment	2.4 K	
	(5) summer survey I, LDPE pickup	3.0 K	
	(5) summer survey II	3.0 K	
	(5) summer survey III	3.0 K	
Cordova air charters		3.0 K	
ABL-ANC (RT)	(1) Trustee meetings	2.0 K	
			16.4 K
Analytical costs:			
100 LDPEs at $ 200 per strip		20.0 K	
sediments: 12 samples at $500 ea		6.0 K	
prey samples 30 at $500 ea		15.0 K	
150 gravimetric samples		10.0 K	
			51.0 K
Labor:			
Lindeberg, field party chief (1 mos; OT)		6.0 K	
Maselko, statistical, field (0.5 mo, OT)		2.7 K	
		8.7 K	
	Subtotal	153.8 K	
	Plus overhead (9%)	13.8 K	
	Total:		***167.6 K***

Table 1. Current estimates (meters or kilometers) of habitat shore types for Bay of Isles and Herring Bay, Prince William Sound based on the EVOS GIS database. Estimates from the 2001 shoreline survey of total contaminated shoreline can be calculated.

	Shore	Bay Length	
Bay of Isles	**Type**	**(meters)**	**(km)**
Exposed rocky shore	1	1,046.41	1.05
Exposed wavecut platforms	2	486.22	0.49
Fine-grained sand	3	0.00	0.00
Coarse grained sand	4	0.00	0.00
Mixed sand and gravel	5	12,779.77	12.78
Gravel, cobble, and boulder	6	327.82	0.33
Exposed tidal flats	7	0.00	0.00
Sheltered rocky	8	16,008.14	16.01
Sheltered tidal flats	9	0.00	0.00
Marshes	10	2,095.97	2.10
		32,744.33	**32.74**
Estimated oiled shoreline 2003		**?**	**?**

	Shore	Bay Length	
Herring Bay	**Type**	**(meters)**	**(km)**
Exposed rocky shore	1	4,710.27	4.71
Exposed wavecut platforms	2	955.54	0.96
Fine-grained sand	3	0.00	0.00
Coarse grained sand	4	0.00	0.00
Mixed sand and gravel	5	13,261.52	13.26
Gravel, cobble, and boulder	6	0.00	0.00
Exposed tidal flats	7	0.00	0.00
Sheltered rocky	8	31,088.00	31.09
Sheltered tidal flats	9	0.00	0.00
Marshes	10	0.00	0.00
		50,015.33	**50.02**
Estimated oiled shoreline 2003		**?**	**?**

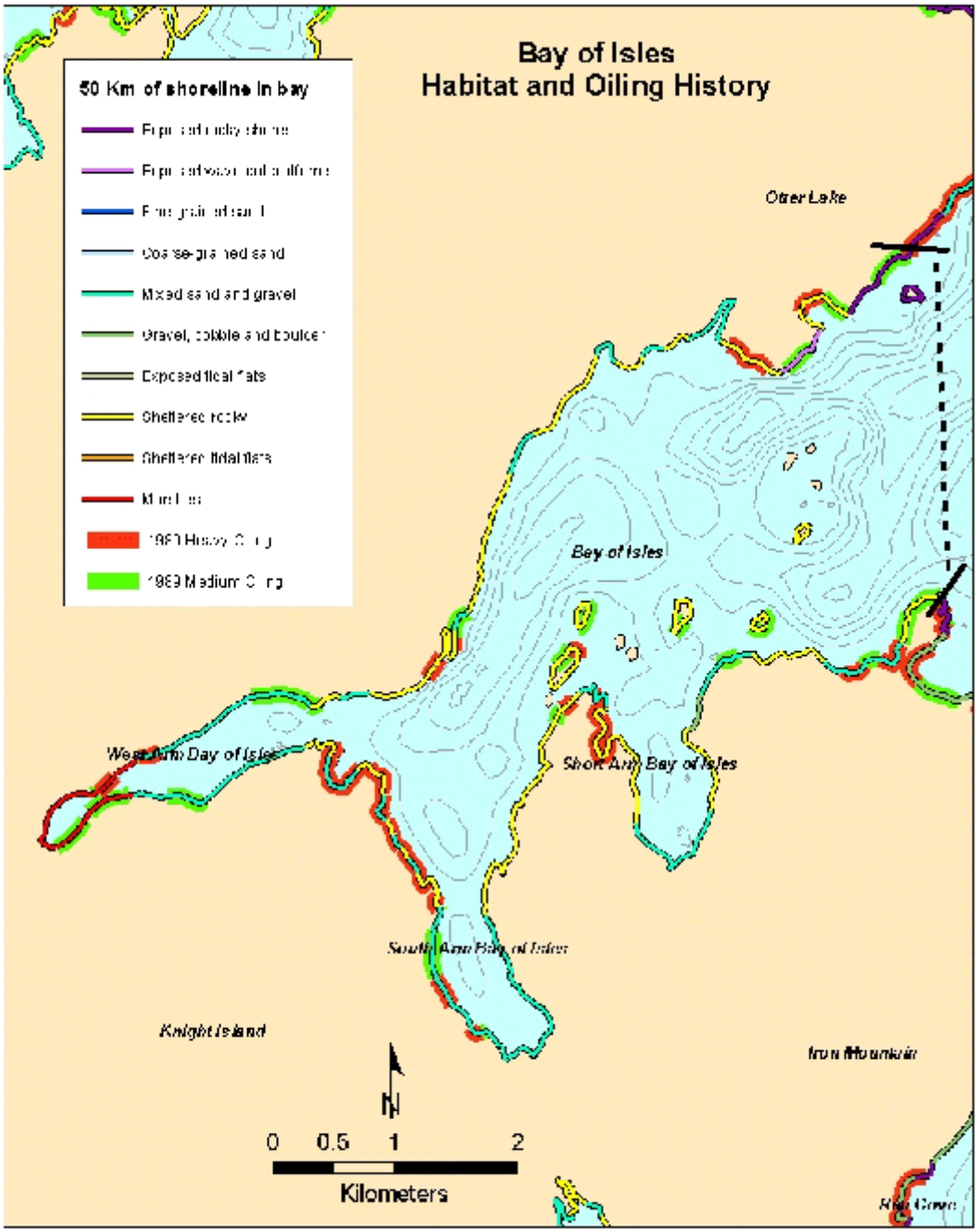

Figure 1. Map of Bay of Isles, Prince William Sound generated by EVOS GIS database showing shore types and oiling history.

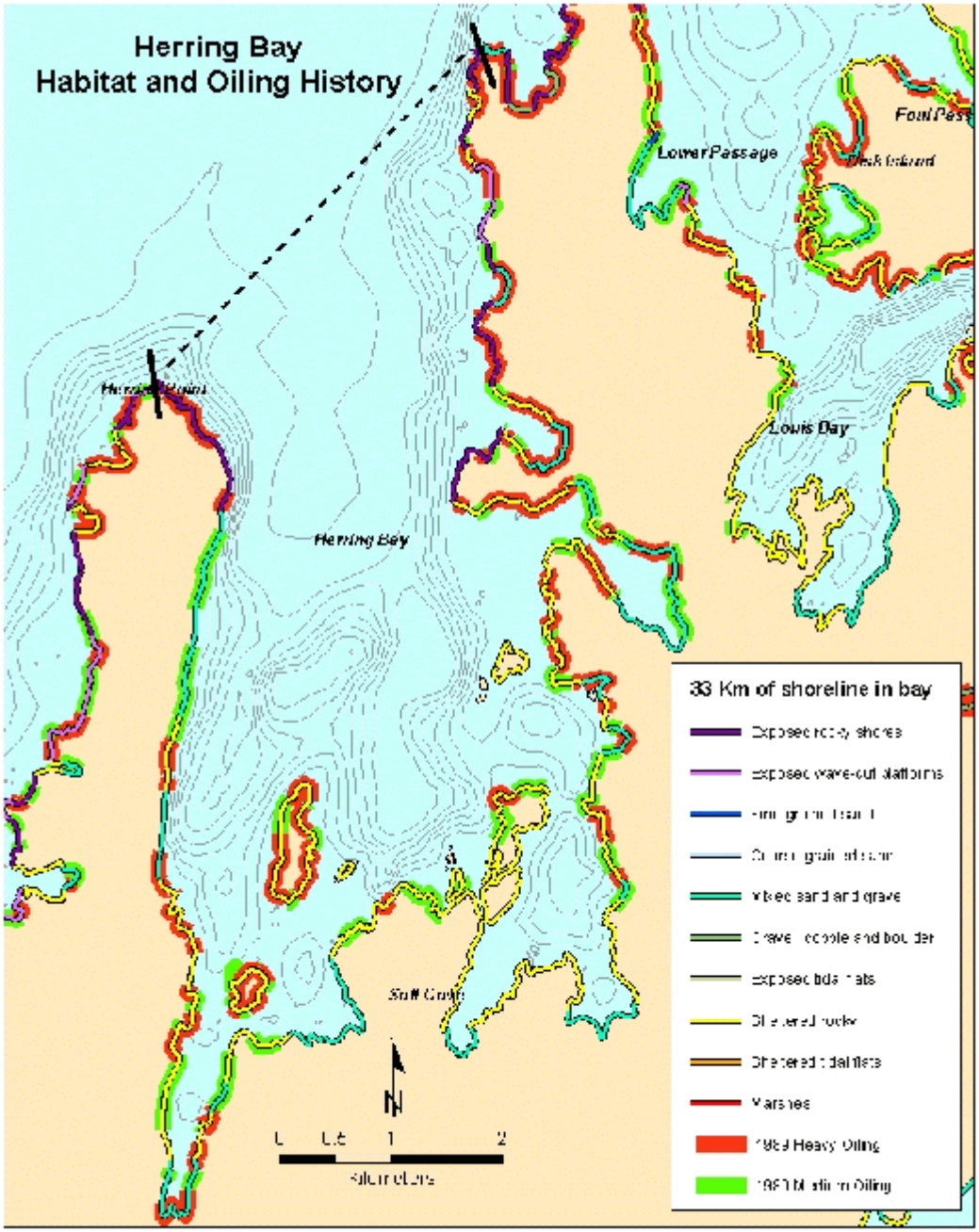

Figure 2. Map of Herring Bay, Prince William Sound generated from the EVOS GIS database showing shore types and oiling history.

Part II. Lingering Oil and Predators: Pathways of Exposure and Population Status (DOI-USGS)

ABSTRACT

Accumulating evidence strongly implicates lingering oil as a factor constraining recovery of the nearshore ecosystem in western Prince William Sound (WPWS). Elevated levels of cytochrome P4501A (CYP1A), a biomarker of exposure to hydrocarbons, have been documented in fishes, birds and mammals that occupy high trophic level positions in the nearshore food webs of WPWS. In the heavily oiled areas, sea otters and harlequin ducks have failed to demonstrate population level recovery, which is at least in part attributable to elevated mortality rates. Continued exposure to hydrocarbons, expressed in elevated hydrocarbon tissue burdens, has been documented in clams and mussels in the heavily oiled areas of WPWS. These clams and mussels provide important foods for the sea otter and sea ducks (including harlequin, goldeneye and scoters), thus providing a potential pathway between lingering oil and exposure at the apex of the food webs. While potential links between lingering oil and constrained ecosystem recovery are becoming better understood, the evidence implicating a route of exposure is largely circumstantial. Because locations and extent of lingering oil were poorly documented, exposure routes of higher vertebrates to lingering oil were by necessity implied. However, in 2001 and 2002, extensive sampling was undertaken by NOAA to document the distribution, abundance, and bioavailability of lingering oil along those shorelines most heavily impacted by the 1989 spill. We propose to use the results of the NOAA shoreline sampling as a foundation to document routes of exposure of sea otters and sea ducks to lingering oil. The proposed work will (1) use the large sample of marked sea otters and harlequin ducks residing in the heavily oiled areas of Knight Island, with known CYP1A values, to test for differences in CYP1A levels between animals that forage and/or rest in areas of lingering oil and those that do not, and (2) monitor survival of sea otters at Knight Island and relate survival outcome to CYP1A level and liver condition. Aerial surveys for sea otters will provide a current measure of population status. The results of this work will provide current information on sea otter population status, linkages between residual oil and exposure of sea otters and harlequin ducks, and identify and prioritize those shoreline segments where restoration would be most beneficial to sea otters and sea ducks.

INTRODUCTION

In summer 2001, the NOAA Auke Bay Laboratory (ABL) shoreline assessment project identified about 20 acres of beach in Prince William Sound that were still contaminated with oil, and changed our perception of how much oil remains and where on the beach it is located (ABL, unpub. data). Further, the shoreline assessment provided evidence of a potential pathway of oil through the ecosystem to those top-level predators that are exhibiting delayed recovery, including sea otters and harlequin ducks. Oil was found at 58% of the 91 sites examined; 6,775 randomly stratified sampling pits were assessed to have the linear equivalent of 7.8 km of oil-contaminated shoreline. The 20-acre estimate of oil-contaminated shore was more than twice the estimate coming from surveys in 1993 (1993 surveys covered more beaches, but dug far fewer holes) (Gibeaut and Piper, 1998a,b). Most of the oil found in 2001 was classified as "light", but was still

readily located and observed. All the pits used in the assessment were dug by hand, and all the initial classifications were made from visual observations. Over a period of about 100 days, 91 sites were visited, each site picked randomly from a population of sites judged to be heavily or moderately oiled in one of the surveys from 1989-1993.

In 2001-2002, ABL is assessing bioavailability of lingering oil through deployment of LDPE's (low density polyethylene devices) at sites with and without lingering oil. Oiled patches discovered and mapped during the 2001 survey will be relocated (patches found in lower zones near the biological active zones will be targeted) and LDPE's placed in close proximity. These deployments are being made in both the winter and in the summer of 2002. In addition, mussels are being sampled for bioavailability of hydrocarbons at the locations of LDPE deployment. The research completed and underway by ABL provides the data layer necessary to ask the question of how sea otters and sea ducks (harlequin, goldeneye and scoters) are being exposed to lingering oil.

Sea otter recovery in the general spill area of WPWS is evident based on an increase of about 900 animals between 1993 and 2000 (Bodkin et al. in press). However, recovery of sea otters and harlequin ducks in the North Knight Island area has not occurred. Through 2001, there has been no increase in sea otter abundance at northern Knight Island, and the population remains at about half the estimated pre-spill number (Bodkin et al. in press). Surveys of sea duck abundance also indicate delayed recovery in this area. Oil exposure has been suspected as a factor constraining recovery, particularly in consideration of elevated levels of Cytochrome P4501A (CYP1A), a biomarker of aromatic hydrocarbon exposure, in sea otters and sea ducks from oiled areas (Ballachey et al. 2001a, Trust et al. 2000), and liver alterations observed in sea otters in the oiled area in 2001 (USGS, unpub. data, 02423 Annual Restoration Report). Higher mortality rates have been demonstrated for sea otters (Monson et al. 2000) and harlequin ducks (Esler et al. in press) residing in oiled areas of western PWS, but without confirming bioavailability and identifying exposure pathways, it has not been clear that lingering oil was responsible. Earlier studies showing significant oil concentrations in contaminated mussel and clam beds (Babcock et al. 1996, Fukuyama et al. 2000, Carls et al. 2001) suggested a pathway, but there was never an exhaustive survey of oiled prey populations to determine their distribution and potential significance to predators. The ABL survey indicates relatively more oil lower down on the beach, near the biological zone, and raises the possibility that oil deposits at high impact sites may be limiting recovery of sea otters and sea ducks.

Field studies in 2003 will focus on four primary questions:

(1) Is there evidence of sea otter population recovery in WPWS and in the heavily oiled northern Knight Island Archipelago?

An aerial survey in WPWS and replicate aerial surveys at northern Knight will be conducted in 2003 to determine the current status of sea otter populations affected by, and not recovered from the EVOS.

(2) Do sea otters and harlequin ducks with known CYP1A values utilize nearshore habitats with known deposits of residual Exxon Valdez oil?

Remote recording of the presence or absence of sea otters and harlequin ducks with known oil exposure histories (based on an observed range of elevated CYP1A values) and instrumented with VHF transmitters will occur at shorelines with known residual oil.

(3) Is there any relation between residual EVOS oil in nearshore areas and exposure of sea otters and harlequin ducks?

Intensive monitoring of sea otters and harlequin ducks instrumented with VHF transmitters will be done to determine areas of high use for foraging and resting. These areas will subsequently be tested by ABL for the presence of residual oil. Biomarkers and health of individual otters and ducks will be related to time spent in areas with lingering oil.

(4) What is the survival rate of sea otters at Knight Island, and does survival of individual otters relate to CYP1A values and liver alterations?

Sea otters instrumented with VHF transmitters will be monitored to determine survival. Survival outcomes will be related to observations made on the animals at the time of capture (CYP1A and liver histology).

The results of the proposed work will identify areas where sea otters and sea ducks are being exposed to lingering oil. From these findings, it will be possible to prioritize patches of oiled habitat for restoration.

NEED FOR THE PROJECT

A. Statement of Problem

In 2001, lingering oil from the 1989 oil spill was identified, located and quantified at relatively small and accurate spatial scales in WPWS. In 2002, measures of bioavailability in seawater and mussel beds were obtained, relative to previously identified patches of oiled shoreline. While we have data identifying where lingering oil exists and compelling evidence of continued, chronic exposure to oil throughout the food webs, we have not yet identified the locations where top-level predators are being exposed. Not until we have such information can we make defensible decisions on where to focus habitat restoration efforts.

Sea otters and sea ducks in the most heavily oiled areas of WPWS have not yet recovered from the *Exxon Valdez* oil spill, based on several lines of evidence from studies conducted as part of the NVP project (/025) and the continuing work as part of project /423. Significant and consistent results on sea otters and sea ducks include lack of population growth in the oiled study area (Bodkin et al. in press, Dean et al. 2000, USGS unpub. data), evidence of relatively poor survival rates from the oiled area (Bodkin et al. in press, Monson et al. 2000, Esler et al. in press), and

increased induction of CYP1A in the oiled area in 1996-98, and again in 2001 for sea otters and 2000 for harlequin ducks (Ballachey et al. 2001a, USGS unpub. data) (CYP1A data for harlequin ducks in 2001 are pending). Although all sea otters sampled at Knight exhibit some degree of CYP1A induction relative to otters in the unoiled area, large variation is observed in the values, suggesting differences among the otters in the oiled area in their exposure to lingering oil. In 2001, livers of sea otters and sea ducks were biopsied for histopathology. Sea otters in the oiled area were observed to have a higher incidence and severity of lesions (see 2002 Annual Report for 02423), and for 2 of the 15 animals sampled, the alterations in the liver were severe and life threatening. Further, the two otters with the most severe liver lesions also had the highest CYP1A values; both were from Bay of Isles at Knight Island. Histopathology results on liver samples from the harlequin ducks are not yet available.

Elevations in CYP1A do not appear to be due to background or natural hydrocarbon sources, as these were found to be negligible in intertidal areas of PWS (Short and Babcock 1996), nor to differential contamination of areas by PCBs (Trust et al. 2000; USGS unpub. data). Continued exposure to residual *Exxon Valdez* oil is the most plausible explanation for CYP1A elevations. Residual oil is still stranded in intertidal areas of PWS (Babcock et al. 1996, Carls et al. 2001, Hayes and Michel 1999), providing a continuing potential source of contamination. However, the locations where sea otters may be acquiring continuing exposure to residual oil remained largely unknown until 2001/2002. With the data now available on distribution and abundance of lingering oil we can identify those locations where sea otters and sea ducks are most likely acquiring their continued exposure, and prioritize areas for restoration. Further, we can evaluate relations between exposure of those individuals, based on their resting and foraging locations, their health and their subsequent survival.

B. Rationale/Link to Restoration

This research will provide a means to relate observed levels of CYP1A induction and liver histopathology in sea otters and harlequin ducks from heavily oiled areas of northern Knight Island to locations where those individuals forage and rest. Although all otters sampled at Knight show at least a low level of induction, only a small proportion of the sea otters exhibit high CYP1A levels. Thus, it appears likely that exposure may result from a relatively small number of animals using areas where oil is persistent, as opposed to all animals using all habitats equitably. This research also provides the opportunity to relate the abundance and behavior of sea otters and sea ducks to the proximity of lingering oil. Once sea otter and sea duck density and oil exposure history can be tied to known patches of lingering oil, and therefore exposure, direct restoration measures and locations can be identified and prioritized.

C. Location

The surveys will be conducted in western PWS and intensive replicate surveys at northern Knight Island. Sampling of oiled and unoiled shoreline segments for the abundance and behaviors of sea otters and sea ducks will be conducted at northern Knight Island. Oiled and unoiled shoreline

segments identified from project 02585 (NOAA) and within this project (NOAA component) will serve as the foundation for our study design relating sea otter and harlequin duck oil exposure histories to their potential use of oiled shorelines.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

We will be available to interact with local communities in meetings to explain and discuss ongoing restoration projects (this effort coordinated with similar activities for project 03423).

1. Obtain current estimate of the WPWS sea otter population size.

2. Obtain current estimate of the northern Knight Island sea otter population size.

3. Identify locations where sea otters and harlequin ducks with known blood and liver P450 values are residing and foraging, and evaluate those locations for residual oil.

4. Monitor survival of marked sea otters at Knight Island and relate survival outcome to CYP1A levels and liver alterations.

B. Methods

Sea otter population monitoring-

We will continue to use previously developed aerial survey techniques which employ counts along systematic transects, and intensive search units (ISU's) to estimate a correction factor for each survey (Bodkin and Udevitz, 1999). We will conduct a single survey of the entire WPWS in 2003. We will conduct replicate surveys (5 or more replications per survey) of the heavily oiled northern Knight Island study site (previously sampled in NVP and /243).

Locations of sea otters and harlequin ducks with known oil exposure levels in relation to lingering oil patches—

Sea Otter telemetry: In 2001, fifteen sea otters were captured, visually marked, and blood and liver samples collected for CYP1A assays. In 2002, an additional 30 sea otters will be captured and similarly processed at northern Knight Island under project 02585. These animals will provide a sample of sea otters with measures of relatively recent (blood and liver CYP1A) and longer-term (liver histopathology) exposure to hydrocarbons. We propose to instrument the 30 sea otters captured in 2002 with VHF radio transmitters, to document use of oiled and unoiled nearshore habitats by individual otters, particularly in relation to their CYP1A values, and foraging resting behaviors. In addition, a sample of harlequin ducks instrumented with VHF transmitters under project //423 (PI Dr. Dan Esler) in fall 2002 will allow us to document use of oiled and unoiled nearshore habitats by individual ducks, particularly in relation to their P450

values and foraging behaviors. We will establish remote VHF radio data loggers at 8 oiled sites at northern Knight Island. Remote data logging stations will be established for three 2-week periods: in fall 2002, in late winter 2003 and in summer 2003. Continuous monitoring of oiled shoreline segments during these three periods for the presence/absence of radioed animals within monitored segments will allow us to identify the use of oiled shorelines by animals with known oil exposure histories (based on CYP1A). In addition, we will conduct intensive monitoring of instrumented sea otters during three 2-week periods in Oct./Nov. 2002, March/April 2003 and July 2003 to identify foraging and resting areas of these otters. (Harlequin ducks are monitored separately as part of //423). Subsequently, ABL will monitor the locations of high use by sea otters and harlequin ducks, for presence of residual oil, and we will then test to see if there is a relation between CYP1A or liver condition, and residual oil in the otter or duck's home territory. We anticipate the need to recapture marked sea otters in July 2003, to measure CYP1A concurrent with the ABL measures of residual oil in areas of high use by the otters. A final decision on recapture will be made after examining 2002 CYP1A data, and repeatability of CYP1A on animals recaptured during 1996-2002, in combination with increased understanding of the home ranges of marked sea otters gained from the fall intensive monitoring period. We will also monitor survival of the instrumented otters by weekly aerial tracking flights (October 2002 through July 2003) to locate individuals.

SCHEDULE

A. Measurable Project Tasks

FY02
-Capture, sampling, and implantation of sea otters with vhf radios. (under project 02585)

FY03

Oct/Nov: -Monitor locations and behaviors of radio-instrumented otters.
-Sample use of oiled shorelines through VHF transmitters on sea otters and harlequin ducks.

April: -Monitor locations and behaviors of radio-instrumented otters
-Sample oiled shorelines through VHF transmitters on sea otters and harlequin ducks.

June/July: -Monitor locations and behaviors of radio-instrumented otters.
-Sample oiled shorelines through VHF transmitters on sea otters and harlequin ducks.
-Recapture of radio-instrumented sea otters to obtain current estimates of CYP1A

Oct/July: -Aerial tracking of sea otters with VHF transmitters to monitor survival.

B. Project Milestones and Endpoints

July 2002:	Instrument 30 sea otters with radio transmitters. (capture supported under 02585)
Oct 2002:	Commence data collection.
July 2003:	Complete data collection.
August 2003:	Commence data analysis.
April 2004:	Report submission - April 15, 2004.

C. Completion Date

This is a one year project. Data collections and analyses will be completed in FY2003 and a final report submitted by April 15, 2004.

PUBLICATIONS AND REPORTS

We will provide a final report to the EVOSTC office by April 15, 2004.

PROFESSIONAL CONFERENCES

None planned for FY2003.

NORMAL AGENCY MANAGEMENT

The work proposed here is not part of normal agency management and is related specifically to research addressing oil spill restoration concerns. No similar work has been conducted, is currently being conducted, or is planned using agency funds.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is dependent on sea otter capture in 2002 for monitoring Cytochrome P450 as part of Project 02585; otherwise we cannot complete the stated objectives. Data loggers will be made available from prior EVOS Restoration Projects (PI Dr. David Irons). Sea otter transmitters (30) will be provided by USGS, but will require battery replacement. Access to Harlequin duck radio frequencies and marking locations will be provided by Dr. Dan Esler. We will provide Dr. Esler with reports of our findings as they are available to aid his survival tracking efforts.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

NA

PRINCIPLE INVESTIGATORS

James L. Bodkin, B.S., M.S. California State Polytechnic University in 1986. Research Wildlife Biologist, and team leader for coastal ecosystem research in Alaska for the Alaska Science Center of USGS. He has over 40 peer-reviewed scientific publications and directs an active coastal marine research program. He has studied and published on sea otter foraging ecology and community structuring since 1988 and has been a principal investigator for EVOS research projects //025, //423, and //585.

Dr. Brenda Ballachey is a Research Physiologist at the USGS Alaska Science Center in Anchorage. She was Project Leader for sea otter NRDA studies from 1990 through 1996, and has been involved in all aspects of post-spill research on sea otters, including the Nearshore Vertebrate Predator (NVP) project, with primary responsibilities for examining effects of residual oil on biomarkers and health of sea otters and other NVP study species. She has authored numerous peer-reviewed journal publications, reports and presentations. She received her M.S. in 1980 at Colorado State University, and Ph.D. in 1985 Oregon State University.

OTHER KEY PERSONNEL

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2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2002	Proposed FY 2003	PROPOSED FY 2002 TRUSTEE AGENCIES TOTALS ADEC	ADF&G	ADNR	USFS	DOI	
							$94.8	
Personnel		$29.7						
Travel		$15.0						
Contractual		$149.3						
Commodities		$29.4						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$223.4			Estimated FY 2004	Estimated FY 2005		
General Administration		$20.1						
Project Total		$243.5			$30.0	$0.0		
Full-time Equivalents (FTE)		0.5						
Other Resources		$0.0			$0.0	$0.0		

Comments:

The Auke Bay Laboratory will lead the lingering oil surveys (Part I); USGS will lead the sea otter and sea duck surveys (part II).

NOTE: This funding ($243.5) adds to $192.3 approved for USGS for this project by the Trustee Council 8/6/02.

FY03

Prepared: 10/23/2002

Project Number: 030620
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Lead Agency: NOAA- Auke Bay Laboratory

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2002	Proposed FY 2003
Personnel		$8.7
Travel		$13.4
Contractual		$105.3
Commodities		$26.4
Equipment		$0.0
Subtotal		$153.8
General Administration		$13.8
Project Total		$167.6
Full-time Equivalents (FTE)		0.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2004	Estimated FY 2005		
		$0.0	$0.0		

Comments:

Supervision and participation by J. Rice and J. Short contributed.

FY03

Prepared: 10/23/2002

Project Number: 030620
Project Title: Lingering Oil and Predators: Pathways of Exposure and Population Status
Agency: NOAA - Auke Bay Laboratory

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		P
Name	Position Description	Step	Budgeted	Costs	Overtime	
Mandy Lindeberg	Fisheries Research Biologist	GS-11	1.0	6.0		
J. Maselko	Fisheries Biologist	GS-9	0.5	5.4		
	Subtotal		1.5	11.4	0.0	
					Personnel Total	

Travel Costs:		Ticket	Round	Total	Daily	P
Description		Price	Trips	Days	Per Diem	
Spring LDPE deployment	Juneau/Cordova	0.5	4	2	0.2	
Summer Survey I and LDPE pick-up	Juneau/Cordova	0.5	5	2	0.2	
Summer Survey II	Juneau/Cordova	0.5	5	2	0.2	
Summer Survey III	Juneau/Cordova	0.5	5	2	0.2	
EVOS Workshop - Jan. 2004	JNU-ANC	0.7	2	3	0.3	
					Travel Total	

FY03

Prepared: 10/23/2002

Project Number: 030620
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: NOAA- Auke Bay Laboratory

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:			P
Description			
Vessles Charter			
Spring Habitat Survey	4 days	1.3 K per day	
Summer Survey I and LDPE pick-up	10 days	1.3 K per day	
Summer Survey II	10 days	1.3 K per day	
Summer survey III	10 days	1.3 K per day	
Cordova Air			
Temporary labor (NOAA) -			
Field Work (ABL and villagers), prep, data entry			
Analytical (LDPE, GC)			
150 Gravimetric samples			
When a non-trustee organization is used, the form 4A is required.		**Contractual Total**	

Commodities Costs:	P
Description	
Laboratory and Field Supplies	
Analytical	
chemicals and glassware (LDPE and GC)	
Commodities Total	

FY03

Prepared: 10/23/2002

Project Number: 030620
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: NOAA- Auke Bay Laboratory

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

New Equipment Purchases:	Number of Units	Unit Price	P
Description			
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	

Existing Equipment Usage:	Number of Units	I
Description		
NOAA/NMFS- Auke Bay Laboratory		
Computer/Software		
HPLC		
GCMS		

FY03

Prepared: 10/23/2002

Project Number: 030620
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: NOAA- Auke Bay Laboratory

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2002	Proposed FY 2003
Personnel		$21.0
Travel		$1.6
Contractual		$44.0
Commodities		$3.0
Equipment		$0.0
Subtotal		$69.6
General Administration		$6.3
Project Total		$75.9
Full-time Equivalents (FTE)		0.4
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2004	Estimated FY 2005		
		$0.0	$0.0		

Dollar amounts are shown in thousands of dollars.

Comments:
cs: subtidal clam sampling
so: recapture of radiotagged sea otters in summer 2003

NOTE: USGS has already received $192.3K in FY03 for Phase I of this project, which was approved by the Trustee Council on August 6, 2002. The budget shown here represents additional costs being requested for Phase II work only.

FY03

Prepared: 10/23/2002

Project Number: 030620
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: DOI/USGS - Sea Otters and Harlequin Ducks

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		P
Name	Position Description	Step	Budgeted	Costs	Overtime	
B. Ballachey	Research Physiologist (so)	GS-12/4	1.0	7.2		
G. Esslinger	Zoologist (cs, so)	GS 9/2	2.0	4.2		
H. Coletti	Fishery Biologist (cs, so)	GS 7/1	2.0	2.7		
	Subtotal		5.0	14.1	0.0	
					Personnel Total	

Travel Costs:		Ticket	Round	Total	Daily	P
Description		Price	Trips	Days	Per Diem	
Travel (cs)	Anchorage/Cordova/Anchorage	0.0		2	0.2	
Travel (so)	Anchorage/PWS/Anchorage	0.0		6	0.2	
(ntoe: Per diem costs are primarily for overnight in Whittier if needed)						
					Travel Total	

FY03

Prepared: 10/23/2002

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2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	P
Description	
Veternarian support, so Vessel charter, July, 15 days @ 2000/day, so Bioassays, Purdue University, so Blood analyses, so Airplane contract for location of marked sea otters during capture, and for rapid shipment of blood samples from field site, so	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	

Commodities Costs:	P
Description	
Shipping and misc. supplies, cs Fuel and shipping costs, so	
Commodities Total	

FY03

Prepared: 10/23/2002

Project Number: 030620
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: DOI/USGS - Sea Otters and Harlequin Ducks

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

New Equipment Purchases:	Number of Units	Unit Price	P
Description			
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	

Existing Equipment Usage:	Number of Units	I
Description		

FY03

Prepared: 10/23/2002

Project Number: 030620
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: DOI/USGS - Sea Otters and Harlequin Ducks