FY07 Invitation: Narrative Forms for Proposals

PROPOSAL SIGNATURE FORM

THIS FORM MUST BE SIGNED BY THE PROPOSED PRINCIPAL INVESTIGATOR AND SUBMITTED ALONG WITH THE PROPOSAL. If the proposal has more than one investigator, this form must be signed by at least one of the investigators, and that investigator will ensure that Trustee Council requirements are followed. Proposals will not be reviewed until this signed form is received by the Trustee Council Office.

By submission of this proposal, I agree to abide by the Trustee Council's data policy (*Trustee Council Data Policy**, adopted July 9, 2002) and reporting requirements (*Procedures for the Preparation and Distribution of Reports***, adopted July 9, 2002).

PROJECT TITLE: **Sea otter recovery and nearshore synthesis**

Printed Name of PI: ____Brenda E. Ballachey_____

Signature of PI: _____ Date _____

Printed Name of co-PI: ____James L. Bodkin _____

Signature of co-PI: _____ Date _____

* **www.evostc.state.ak.us/Policies/data.htm**
** **www.evostc.state.ak.us/Policies/Downloadables/reportguidelines.pdf**

Trustee Council Use Only Project No._____ Date Received: _____

FY07 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Sea otter status and nearshore synthesis

Project Period: 1 October 2006 - 31 September 2008

Proposer(s): Brenda E. Ballachey and James L. Bodkin, USGS Alaska Science Center
brenda_ballachey@usgs.gov, james_bodkin@usgs.gov

Study Location: Prince William Sound, Alaska

Abstract: Sea otters, and other nearshore birds and mammals were severely impacted by the 1989 *Exxon Valdez* oil spill. In areas where acute effects were greatest and lingering oil persists longest, recovery for some of those nearshore birds and mammals remains incomplete through 2005. We present three objectives in this proposal: (1) Evaluate progress toward sea otter recovery through surveys of abundance and carcass deposition. (2) Evaluate factors contributing to the status of sea otter populations through the synthesis of long-term data sets on individual exposure to oil, health, condition, behavior, and home range in the context of long-term survival. (3) Conduct spatial synthesis of elevated biomarkers in mammals, birds, and fishes. Anticipated outcomes will identify shorelines where lingering oil most likely persists and which may be candidates for restoration or remediation.

Funding:

EVOS Funding Requested: FY07 $154.0K, FY08 $97.7

Non-EVOS Funds to be used: FY07 $33.6K, FY08 $21.6

EVOS total, both years: $251.7K; Non-EVOS total, both years: $55.2K

TOTAL: $306.9K (includes EVOS, NOAA and USGS funding, FY07 & FY08)

Date: 4 August 2006

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PROJECT PLAN
Sea Otter Status and Nearshore Synthesis

Brenda Ballachey and James Bodkin
U.S. Geological Survey
Alaska Science Center

I. NEED FOR THE PROJECT

A. Statement of Problem

More than 17 years ago the T/V *Exxon Valdez* spilled some 11 million gallons of crude oil into Prince William Sound (PWS) and the Gulf of Alaska, resulting in widespread mortality among marine plants and animals, with injury most long-term and severe among species occupying nearshore habitats (Spies et al. 1996). Perhaps contrary to some expectations, oil persists in intertidal habitats in western PWS and is particularly evident in those bays and passages where oiling was heaviest in 1989 (Short 2004). Further, evidence throughout the nearshore trophic web indicates an invertebrate pathway of exposure to upper trophic levels, including sea otters and sea ducks, with chronic effects resulting in delayed ecosystem recovery (Dean et al. 2000, Trust et al. 2000, Esler et al. 2000, Fukuyama et al. 2001, Ballachey et al. 2001a, Ballachey et al. 2001b, Bodkin et al. 2002, Esler et al. 2002). Studies conducted in 2001-2005 (EVOS projects //585 and //0620) have documented the abundance (but not the distribution) of residual oiling throughout the western Sound and the bioavailability of the oil to both predators and their prey populations. Aerial surveys of sea otter abundance through 2005 demonstrate no recovery of the population in those areas that were heavily oiled in 1989 (Ballachey and Bodkin 2006), despite significant increases in population size at Montague Island and in the entirety of WPWS. While the biomarker of exposure to aromatic hydrocarbons, cytochrome P4501A (CYP1A), has equilibrated between oiled and unoiled areas in sea otters (Ballachey and Bodkin 2006), significant differences in biomarkers persisted through 2005 in harlequin ducks, Barrow's goldeneyes, and black oystercatchers (Ballachey et al. 2006).

Continuous research since 1989 on sea otters provides perhaps the most comprehensive description of progress toward, and constraints to recovery experienced by any injured resource. A recent synthesis of prior sea otter research conducted by Integral Consulting (Seattle, WA) was aimed largely at the status of sea otters relative to recovery goals. Integral concluded that sea otters, particularly at northern Knight Island, had not attained recovery objectives. The intent of this proposal is to synthesize information which was not included in the Integral project and which is directed specifically at improving our understanding of why sea otters have not recovered, with the goal of identifying potential direct restoration activities. Beginning in 1995, detailed study of individual sea otter health, condition, and exposure were initiated that identified lingering oil as a contributing factor to delayed sea otter recovery (Bodkin et al. 2002). Beginning in 2002, studies of individual sea otter survival, movements, and home ranges using conventional radio telemetry demonstrated the use of oiled nearshore habitats. In 2004 and 2005, archival time depth recorders (TDR's) supplemented radio transmitters to provide detailed information on the distribution of forage dive depths, particularly in intertidal habitats where lingering oil persists (Ballachey and Bodkin 2006) and on activity time budgets.

In consideration of the delayed sea otter recovery, we identify two research needs: (1) to determine the current status of sea otter populations, particularly at northern Knight Island, and (2) to evaluate constraints to sea otter recovery. The first research need can be met through continuation of surveys of abundance and continued monitoring of carcass data to determine survival patterns. The second research need can be met through integration and synthesis of existing data sets that will relate the detailed individual health and condition data, and detailed individual behavioral data (forage locations and activity budgets) acquired through TDR's and visual observations, with individual survival and oil exposure (biomarker) data through risk assessment models (Ballachey et al. 2003). Model outcomes will aid in identifying factors contributing to survival probabilities and thus contributing to delayed recovery of sea otter populations.

The problem of chronic long-term exposure to oil of a suite of nearshore birds and mammals identifies a third research need, to identify areas where nearshore consumers continue to be exposed to lingering oil. Resolution of this problem will allow consideration of direct or indirect restoration activities. Knowledge of the present distribution and magnitude of lingering oil suitable to guide restoration activities has been hampered by both inaccuracies in maps of the distribution of oiled shorelines in 1989 and the difficulty in mapping the distribution and abundance of sub-surface lingering oil. This third research need will be met through spatially explicit analysis of areas of habitat use demonstrated by individuals and taxa exhibiting elevated exposure to lingering oil through biomarkers. The outcome of these multi-species syntheses will be the identification of areas where individuals and species are acquiring exposure to oil, and potentially areas where individuals and species may be avoiding lingering oil deposits. These analyses will aid researchers in identifying locations and common pathways of exposure, potential constraints to recovery through habitat avoidance, and identify potential locations for restoration activities by managers.

B. Relevance to the 1994 Restoration Plan Goals and Scientific Priorities

Recovery of the PWS ecosystem from the *Exxon Valdez* oil spill may not be considered complete until individuals are no longer exposed to spilled oil and when populations reach pre-spill levels of abundance. Clearly, sea otters have not attained population level recovery goals, and lingering oil remains implicated in the lack of nearshore ecosystem recovery. The proposed work will allow continued evaluation of the state of the affected sea otter populations, through continued estimates of sea otter population size and the identification of factors contributing to lack of growth in the sea otter population. The proposed synthesis of the spatial intersection of areas where nearshore species have exhibited elevated exposure to lingering oil will identify those nearshore habitats that may be responsible for providing exposure to lingering oil and, therefore, where restoration efforts may be of greatest potential benefit to nearshore species as a group and the nearshore ecosystem as a whole. The work proposed under Objectives 1 and 2 directly addresses items contained in the 2007 invitation for proposals pertaining to obtaining population abundance data and synthesizing existing sea otter data. The work proposed under Objective 3 addresses the request for proposals to map the distribution and assess patterns of lingering oil remaining in PWS and to relate oil distribution to migratory patterns of injured

resources or develop models which relate distribution to accessibility and potential bioavailability.

II. PROJECT DESIGN

A. Objectives

Objective 1. (a) Conduct an aerial survey of sea otters in western PWS, including the heavily oiled areas of the northern Knight Island Archipelago, in 2007 and 2008, and (b) continue spring surveys of shorelines for collection of carcasses to obtain age at death data.

Estimates of sea otter population size provide perhaps our best measure of the current status of sea otter populations affected by the *Exxon Valdez* oil spill. Standardized surveys have demonstrated an increase in western PWS (Figure 1), yet fail to demonstrate any increase in population size in the heavily oiled area of northern Knight Island since 1993 (Figure 2). Continued surveys likely will provide our most direct measure of population recovery.

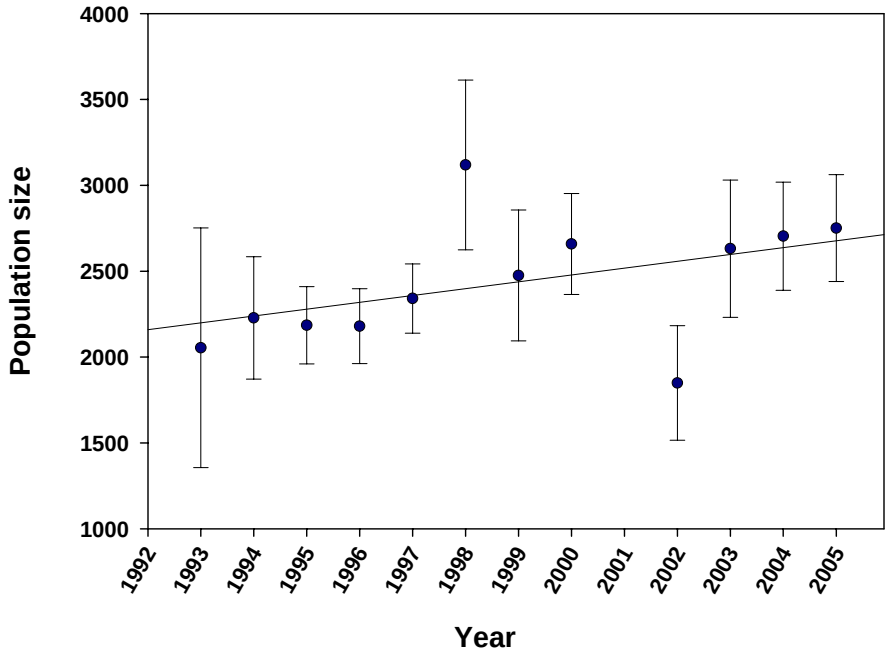

Figure 1. Western PWS sea otter population size estimates (± se), 1993-2005 (except 2001).

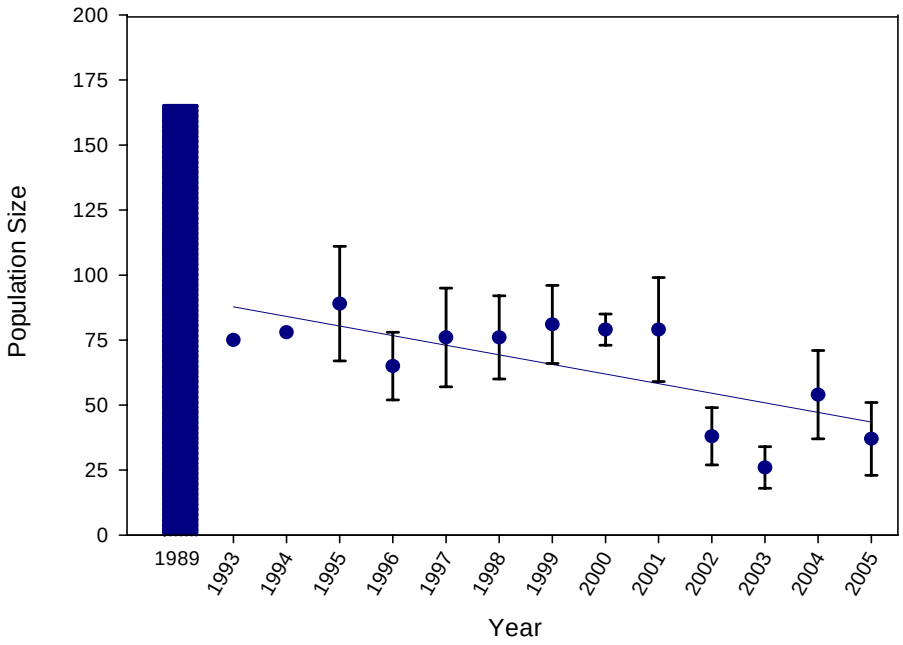

Figure 2. Sea otter population size estimates from heavily oiled Knight Island, PWS, AK, 1989-2005. The 1989 estimate is based on the number of live and dead sea otters captured or removed from the survey area.

Previously, we have used age distributions of sea otters (*Enhydra lutris*) found dead on beaches of western PWS between 1976 and 2005 to model how sea otter mortality patterns have changed following the spill (Monson et al. 2000, Ballachey and Bodkin 2006). The results of our analyses were striking, indicating that sea otters that survived the spill later suffered reduced survival rates, with the greatest effect initially observed in the younger age classes, but increasing over time for the older cohorts. Otters born after 1989 showed less pronounced but continuing negative effects through 2005 (the last year for which carcass data were available at the time of the initial modeling analysis). As cohorts living at the time of the spill die out, overall mortality rates appear to be approaching pre-spill levels, which may be consistent with the gradual declines in average P450 values of sea otters in the oiled area, suggesting diminishing exposure to oil. However, through 2005, mortality patterns are still not normal (relative to pre-spill) and sea otter numbers continue to remain below pre-spill levels at the heavily impacted northern Knight Island area. Carcasses were collected in the spring of 2006, and we propose to continue collection of carcasses in 2007 and 2008, to obtain ages-at-death, with the ultimate goal of rerunning the existing model (Ballachey and Bodkin 2006) to estimate survival rates.

> **Objective 2.** Evaluate factors contributing to the status of sea otter populations through the synthesis of long-term data sets on individual exposure to oil, health, condition, behavior, and home range in the context of long-term survival.

Prior sea otter research included the study of individual exposure to oil, health, survival, and behavior, and population study of abundance, distribution, diet, and mortality. The results identified a pathway of exposure to lingering oil mediated through foraging behavior in the intertidal zone and consistent with reduced survival as the proximate cause of delayed recovery. The proposed work will synthesize the existing data on individual sea otters as covariates in a survival and risk analysis and identify those factors that contribute to elevated biomarkers of oil exposure and mortality resulting in the past and present status of sea otter populations in WPWS.

> **Objective 3.** Identify shorelines where lingering oil most likely persists and that may be candidates for restoration or remediation through a synthesis of the information on locations and magnitude of oil exposure for the 8 bird, mammal and fish species previously or currently exhibiting elevated biomarkers of oil exposure.

Over the past decade hundreds of individual mammals, birds, and fishes have demonstrated elevated expression of the CYP1A enzyme in response to exposure to lingering *Exxon Valdez* oil spilled in 1989. This exposure has been implicated as a causal factor in delayed species and ecosystem recovery and proposals are being sought to restore or remediate these sources of continued exposure. The proposed synthesis of existing data will identify those shorelines that are contributing to expression of the CYP1A biomarker in our study species. Results of this synthesis will aid researchers and managers in locating potential shorelines where oil persists that may be suitable for restoration or remediation.

B. Procedural and Scientific Methods

Objective 1. Sea otter aerial Surveys

We will continue to use previously developed aerial survey techniques which employ standardized strip transect counts along survey lines, 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 western Sound in 2007. We will also conduct replicate surveys (3-5 replications per survey) of the heavily oiled northern Knight Island study site (previously sampled in the Nearshore Vertebrate Predator project (//025) and projects //423 and //620). Results of proposed surveys provide unbiased estimates of population size and density. Proportional standard errors of past surveys in PWS range from 0.09-0.18.

Carcasses will be collected in early spring in western PWS, following methods previous described in Ballachey and Bodkin (2006). Teeth will be extracted to determine ages at death.

Objective 2. Evaluate factors contributing to the status of sea otter populations through the synthesis of long-term data sets on individual exposure to oil, health, condition, behavior, and home range in the context of long-term survival.

Since 1989, detailed studies of sea otter populations and individual sea otters have been conducted in WPWS. Studies have included the capture and instrumenting of individual sea otters to measure health, condition, behavior, biomarkers to oil exposure and survival. During capture a number of physical measurements are taken to estimate body condition and tissues

collected to estimate age, blood and serum chemistries and biomarkers of exposure to oil. Since 2001, livers have been biopsied for histopathology. Over time, tagged individuals are resighted to obtain movement, reproductive, behavioral and survival information. Among years some individuals are recaptured, during which repeated measures of the suite of initial measurements and tissues, and additional survival data are obtained. For a subset of all captured animals we implanted VHF radio transmitters to provide home range estimates, individual dietary data, and annual survival estimates, and in a subset of those animals we inserted archival time-depth-recorders (TDR's) that provide detailed behavioral data including forage dive depth distributions and activity time budgets. The suite of data types collected for each individual captured includes location, age, sex, total length, weight, girth, reproductive status, approximately 50 blood and serum chemistry values, liver histopathology, and CYP1A expression as a biomarker of exposure to oil.

For animals instrumented with radio transmitters, weekly relocations by aircraft or boat were attempted for at least one year following capture. During each relocation, we attempted to obtain a position, date, time, and behavior. From the cumulative record of independent relocations for each individual we calculated 50% and 90% kernel home range estimates (Hooge and Eichenlaub 2000). For animals from which TDR's were recovered, we obtained forage dive depth distributions and calculated a continuous activity time budget for approximately one year following instrumentation. Each animal captured receives a final survival fate based on when it was last relocated (either visually or through telemetry) as either alive, missing with date of last resight, or known dead. We will use a multivariate proportional hazards model to evaluate the effects of age, sex, condition, health parameters (blood and serum chemistries, liver pathology) and home range size and location, diet, and behavior on measured levels of the CYP1A biomarker and on annual and longer term survival probabilities following the methods described in Ballachey et al. (2003).

Objective 3. Identify shorelines where lingering oil most likely persists and that may be candidates for restoration or remediation through a synthesis of the information on locations and magnitude of oil exposure for the 8 bird, mammal and fish species previously or currently exhibiting elevated biomarkers of oil exposure.

Since 1995, research has been conducted in WPWS using the CYP1A biomarker of exposure to oil as a tool to identify if species of mammals, birds, and fishes residing in previously oiled areas of PWS demonstrate elevated exposure to oil compared to their counterparts in unoiled areas. Species that have demonstrated elevated levels of the CYP1A biomarker, relative to unoiled areas, include sea otter, river otter, harlequin duck, Barrow's goldeneye, pigeon guillemot, black oystercatcher, crescent gunnel and masked greenling (Trust et al. 1999, Jewett et al. 2002, Bodkin et al. 2002, Esler et al. 2002, Golet et al. 2002, Bowyer et al. 2003, Ballachey et al. 2006). Generally, captures were done in heavily oiled areas in or adjacent to the northern Knight Island archipelago and CYP1A results were compared with those obtained primarily from unoiled northeast Montague Island, or from other unoiled areas of western PWS (Ballachey et al. 2006). Over the course of the studies, sampling of each species has been repeated over multiple years (with the exception of black oystercatchers, sampled only in 2004), resulting in relatively large sample sizes of individuals of most species at a large number of locations at or near northern Knight Island (Fig. 3). Across species, over 600 individuals from oiled areas have been

assayed for CYP1A induction. Further, each species sampled integrates potential exposure to lingering oil over spatial scales reflective of individual and species specific movements and life history attributes. For example, annual sea otter home ranges average 23.0 km^2, with individual values ranging from 2.9-102 km^2, while the wintering home range of the harlequin duck in PWS includes perhaps only a about 10 km of shoreline. We will use the combined attributes of home range size and relative or standardized (categorical) biomarker values for each species to identify where individuals and species likely acquired their oil exposure (see theoretical example in Fig. 4). Through a synthesis of the relations between exposure values and home ranges (where individuals likely received their exposure to oil) across individuals and across taxa we anticipate providing maps identifying those intersections of areas where shorelines have the greatest probability of harboring lingering oil.

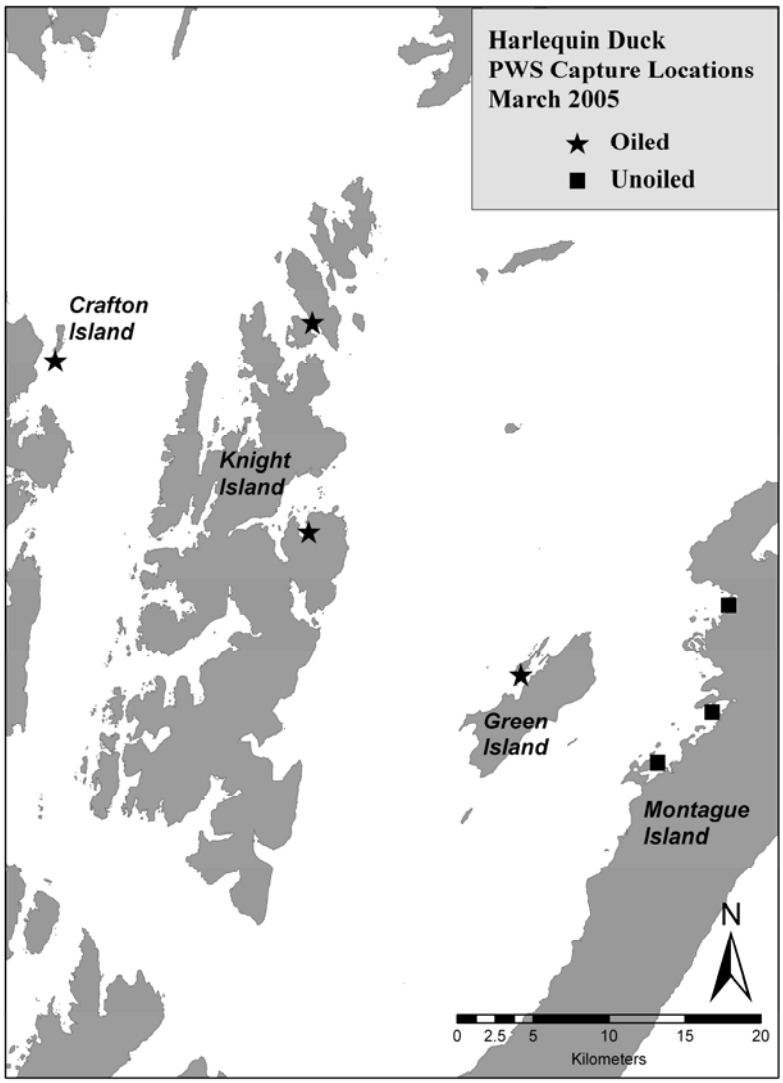

Figure 3. Example of locations where samples were obtained for analysis of the CYP1A biomarker to oil exposure in WPWS. Data shown are actually for harlequin ducks in 2005 (from Ballachey et al. 2006). Similar data for each species are available (see Ballachey et al. 2006).

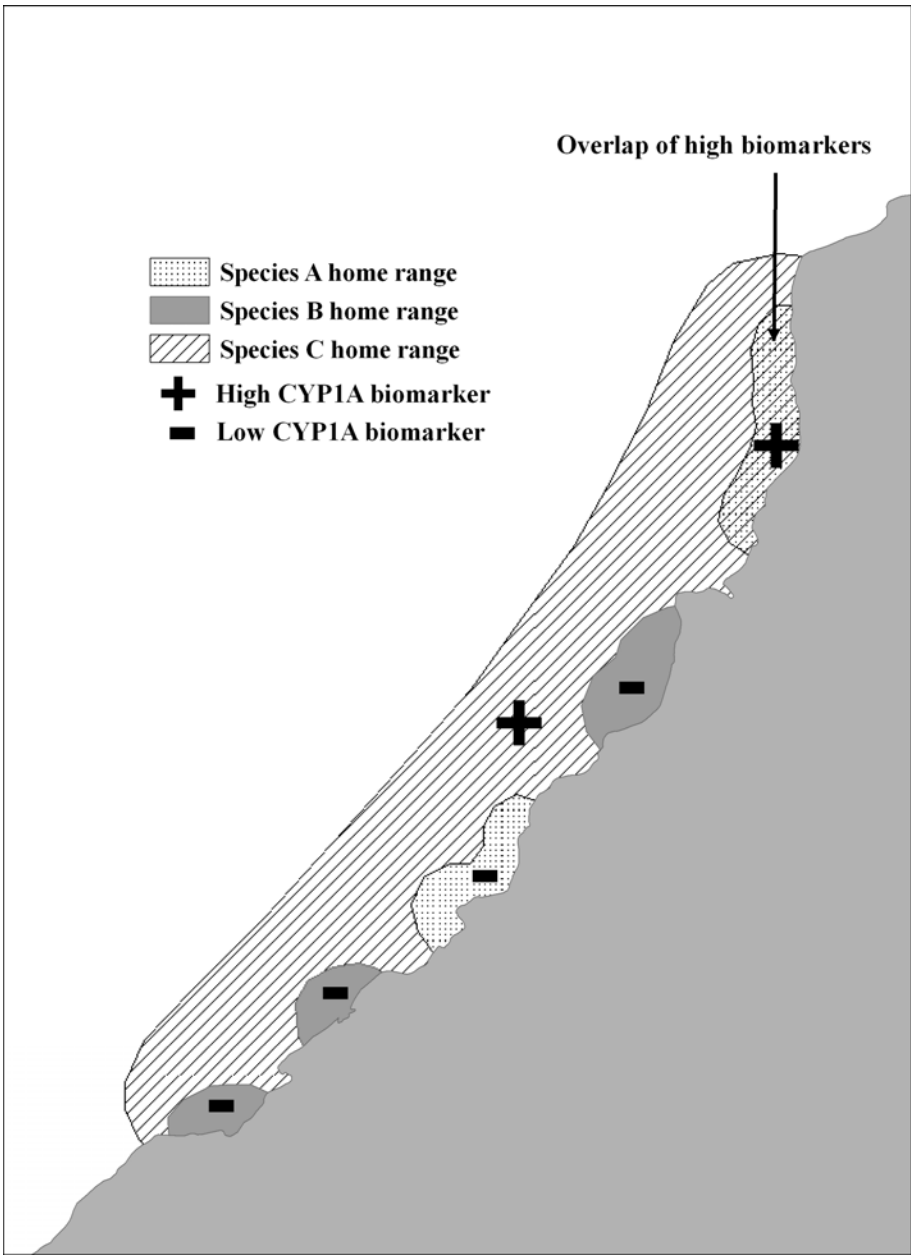

Figure 4. Simplified theoretical diagram of the intersections of areas where individuals of different species were measured with low ("-") or high ("+") biomarkers of hydrocarbon exposure, revealing "hot spots" that could be considered as priority for restoration or remediation.

In recent years NOAA has undertaken research to estimate the volume of *Exxon Valdez* oil remaining in PWS (Short et al. 2004). The resulting research has provided accurate and precise estimates of remaining oil through a random sampling design and has assessed the bioavailability of oil through deployment, retrieval, and analysis of semi-permeable membrane devices that assimilate environmental hydrocarbons over time (Springman et al. in press). An alternative approach in synthesizing animal exposure to oil through biomarker expression and the location and abundance of lingering oil could include an analysis of relations between biomarker levels in

animals, their movement and life history attributes and the location, abundance, and bioavailability of lingering oil. This approach would be from the perspective of the known lingering oil locations, as identified in NOAA/Auke Bay Lab studies, and their potential contribution to elevated biomarkers in mammals, birds, and fishes. This approach could aid in identifying which of the known lingering oil locations may be most suitable for restoration or remediation, but may be less useful in identifying unknown lingering oil locations and may be undertaken under this proposal.

C. Data Analysis and Statistical Methods

Objective 1: Sea otter aerial surveys

Aerial survey data will be collected and analyzed following procedures described in detail in Bodkin and Udevitz (1999). The observer, pilot, and plane will be the same as in prior years (1994-2005). Trends in population abundance over time will be obtained by regressing the log of population estimates over years. Analysis of variance will be used to test for significant change in population abundance over time. For carcasses collected, a tooth will be extracted to determine age, and once several years of data are available, models developed by Monson et al. (2000) and Ballachey and Bodkin (2006) can be applied to estimate survival rates.

Objective 2: Sea otter synthesis and survival modeling

We will analyze the visual and radio relocation data for sea otters in a medical survival/exposure analysis context in order to discern the potential effect of sex, age, health (condition, hematology and serum chemistries, liver pathology), and when available, home range, foraging and behavioral data as covariates on biomarkers of exposure and survival (Pollock et al. 1989). We will use Cox proportional hazards models, in which the hazard function is non-parametrically modeled based on the distribution of the survival times of individuals. The model allows for the incorporation of continuous covariates though a linear function of the log of the hazard ratio. All the covariates were measured either when the sea otters first entered the study, or during the period of monitoring between initial capture and final observation of status (alive, missing, or dead) and their effects on biomarker exposure and survival will be modeled as multiplicative influences on the hazard function (Collett 1994). The parameter estimates from the models can be interpreted as changes in the hazard rate due to changes in the covariate(s) in the model while holding values of the other covariates constant.

Initially, univariate models will be run for each covariate individually (covariates will include age, condition, blood and serum values, liver histopathology scores, home range estimates, forage depth distributions and activity budgets (when available)), and those with a P value of < 0.15 will be selected for further analysis in multivariate models.

Objective 3: Spatial synthesis of elevated biomarkers in mammals, birds, and fishes.

Because the proposed synthesis is novel, exact analytical procedures will likely evolve as a result of preliminary results and data opportunities and constraints. However, we anticipate the following general outline of methods and analyses to meet the objective of a synthetic, spatially

explicit analysis of multi-species biomarker data toward identifying potential "hot spots" of lingering oil that will aid managers in considering direct habitat restoration activities.

Analytical methods are expected to proceed in the following stepwise fashion.

1. The initial step will consist of compiling the species specific biomarker estimates and associated location data.
2. Biomarker data for all species will be standardized categorically in the second procedure. Criteria for establishing categories will be established based on the range of sample sizes across species and the variation of values within and among species.
3. For each species, we will then acquire either empirical data specific for WPWS or from the literature on the home range sizes.
4. For each species, we will then map specific sampling locations for each individual or sample (when capture locations are unchanged and individual home ranges are unknown). As the potential for exposure to lingering oil appears limited to intertidal shorelines, we will then identify all shorelines within the home range of each individual within a species to identify potential locations where exposure may have been acquired. This procedure will be followed for each sample or individual for each species.
5. For each individual or sampling location with a species we will create maps that delineate the intersections of areas among individuals or sample locations with associated categorical biomarker values. Intersections of areas among species with high cumulative biomarker values should represent lingering oil "hot spots" within each species.
6. The final procedure will to integrate the results of the individual species analyses among all species. The results of this analysis should identify potential "hot spots" of lingering oil among all species that have demonstrated continued exposure to hydrocarbons through expression of the CYP1A biomarker.

D. Description of Study Area

The aerial surveys will be conducted in western PWS, with intensive replicate surveys at northern Knight Island. Objectives 2 and 3 consist entirely of syntheses of existing data sets.

E. Coordination and Collaboration with Other Efforts

The proposed work builds on the long history of EVOS and Department of Interior study of sea otters in PWS (Nearshore Vertebrate Predator project, Doroff et al. 1994, Ballachey et al. 1994, Bodkin and Udevitz 1999, Bodkin et al. 2002, Ballachey et al 2003, Monson et al. 2000). Prior project numbers include 99025, 02423, 02585, 03620 and 04620, and 05775. The scope of prior work includes annual sea otter population size estimates since 1993, estimates of reproduction, survival and mortality, prey size and abundance, health and condition, and movements and home ranges. Assays of the CYP1A biomarker have been conducted since 1996 (no samples were collected in 1999 or 2000). The proposed work will require the cooperation of Principal Investigators of past and ongoing EVOS TC sponsored research for the acquisition of location data for past samples collected and analyzed for the CYP1A biomarker. In addition to sea otters, species that exhibited elevated CYP1A expression (and PI's) include river otter (T. Bowyer),

pigeon guillemot (D. Irons), harlequin duck and Barrow's goldeneye (D. Esler), black oystercatcher (D. Irons), masked greenling (S. Jewett) and crescent gunnel (J. Rice).

Approximately 18% of the total cost of the work proposed for FY07 will be funded by the Alaska Science Center, USGS, in the form of salary costs ($18,000), and facilities and equipment ($3,600), and by NOAA/Auke Bay Lab, in the form of salary costs ($12,000).

III. SCHEDULE

A. Project Milestones

Objective 1. Aerial surveys
Data acquisition to be completed by August 2007
Data analysis to be completed by December 2007
(a similar schedule is anticipated for 2008)

Objective 2. Sea otter synthesis and survival modeling
Data compilation to be completed by April 2007
Synthesis and survival modeling to be completed by September 2008

Objective 3. Spatial synthesis of elevated biomarkers in mammals, birds, and fishes
Data acquisition and compilation to be completed by April 2007
Synthesis, analysis, and maps to be produced December 2007

B. Measurable Project Tasks

FY 07, 1st quarter (October 2006-January, 2007)
Complete design of sea otter aerial surveys
Initiate acquisition and compilation of required sea otter synthesis and survival modeling data
Initiate acquisition and compilation of required mammal, bird, and fish biomarker data

FY 07, 2nd quarter (January 1, 2007-April 1, 2007)
Complete logistic requirements for sea otter aerial survey
Continue acquisition and compilation of required sea otter synthesis and survival modeling data
Complete acquisition and compilation of required mammal, bird, and fish biomarker data

FY 07, 3rd quarter (April 1, 2007- July 1, 2007)
Conduct sea otter aerial survey
Conduct shoreline surveys to recover carcasses
Initiate synthesis and analysis of sea otter survival modeling

Initiate spatial synthesis of mammal, bird, and fish biomarker data

FY 07, 4th quarter (July 1, 2007 – October 1, 2007)
Complete analysis of sea otter aerial survey
Continue synthesis and analysis of sea otter survival modeling
Continue spatial synthesis of mammal, bird, and fish biomarker data
Submit annual report

FY08, 1st quarter (October 1, 2007-January , 2008)
Design sea otter aerial survey
Continue synthesis and analysis of sea otter survival modeling
Complete spatial synthesis of mammal, bird, and fish biomarker data

FY 08, 2nd quarter (January 1, 2008-April 1, 2008)
Complete logistic requirements for sea otter aerial survey
Continue synthesis and analysis of sea otter survival modeling
Prepare final report

FY 08, 3rd quarter (April 1, 2008- July 1, 2008)
Conduct sea otter aerial survey
Conduct shoreline surveys to recover carcasses
Continue preparation of final report

FY 08, 4th quarter (July 1, 2008 – October 1, 2008)
Complete analysis of sea otter aerial surveys
Complete and submit final report

IV. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

We will be available to interact with communities in meetings to explain and discuss ongoing restoration projects. Contractual arrangements will be made with Cordova Air Service (907-424-3289) in Cordova to provide aerial support for survey and radio relocations.

B. Resource Management Applications

Results of the proposed survey work, in conjunction with the synthesis of prior work completed under projects //025, //423, //620, and //775, should provide managers with adequate information to make decisions regarding progress toward recovery of sea otter populations at northern Knight Island. Results will also facilitate understanding risk factors, including exposure to lingering oil, which may be contributing to sea otter mortality and delayed rates of recovery, and will identify locations of specific shoreline habitats where populations of marine mammals, birds and fishes have incurred exposure to lingering oil and which may be suitable for direct restoration actions. The combined results of the proposed work will allow managers to better evaluate the current state of progress toward recovery in the nearshore ecosystem in PWS and to identify specific

locations that may be most suitable for and result in the most direct benefit in achieving restoration objectives.

Sea otter populations throughout the Aleutian Archipelago, the Alaska Peninsula, and as far east as Kodiak Island, have experienced declines in abundance ranging from about 50-90% since about 1985 (Estes et al. 1998, Doroff et al. 2003). Although cause of the decline is unclear, predation is thought to be a contributing factor, at least in the Aleutians. The proposed survey effort in western PWS will continue the longest annual sea otter population data set in Alaska and will be of benefit to the Fish and Wildlife Service, Marine Mammals Management (Rosa Meehan, 907-786-3349) who is responsible for sea otter management in Alaska.

V. PUBLICATIONS AND REPORTS

An annual progress report will be submitted to the Trustee Council on 1 September, 2007 and a final report will be submitted by 1 September, 2008. The synthesis of data collected on sea otter recovery from the 1989 EVOS will provide new information on the consequences of and recovery from oil spilled in coastal ecosystems that has not previously been published and will make a new contribution to the primary scientific literature. The results of the spatial synthesis of existing biomarker studies across a suite of taxonomically and trophically diverse species will provide a new perspective into where, and potentially how, consumers gained exposure to lingering oil. Because the persistence of *Exxon Valdez* lingering oil was unanticipated and unprecedented, the linkage between lingering oil and pathways of exposure to higher trophic levels will also provide an original contribution to the primary literature on oil spill effects.

VI. PROFESSIONAL CONFERENCES

We anticipate the results of the proposed work will be suitable for presentation at a national or international scientific meeting during FY08. Because of the global nature of oil spills, the unanticipated magnitude and duration of EVOS effects, and the apparent susceptibility of marine mammals and birds to such events, this will be a particularly valuable opportunity to present the results of this work. We anticipate presenting two papers at the conference, one pertaining specifically to risk factors and survival in sea otters and a second on the spatial analysis of biomarker data as a tool to evaluate pathways of exposure identify specific location for direct restoration activities.

REFERENCES

Ballachey, B.E., J.L. Bodkin and A.R. DeGange. 1994. An overview of sea otter studies. *in* T. Loughlin editor. Marine mammals and the Exxon Valdez. Academic Press. San Diego, CA pages 47-59.

Ballachey, B.E., J.L. Bodkin, S. Howlin, K.A. Kloecker, D.H. Monson, A.H. Rebar and P.W. Snyder. 2001a. Hematology and serum chemistry of sea otters in oiled and unoiled areas of Prince William Sound, Alaska, from 1996-98. Appendix BIO-01 in NVP Draft Final Report (Project 95025-99025).

Ballachey, B.E., J.J. Stegeman, P.W. Snyder, G.M. Blundell, J.L. Bodkin, T.A. Dean, L. Duffy, D. Esler, G. Golet, S. Jewett, L. Holland-Bartels, A.H. Rebar, P.A. Seiser, and K.A. Trust. 2001b. Oil exposure and health of nearshore vertebrate predators in Prince William Sound following the *Exxon Valdez* oil spill. Chapter 2 *in* NVP Draft Final Report (Project 95025-99025).

Ballachey, B.E., J.L. Bodkin, S. Howlin, A.M. Doroff and A.H. Rebar. 2003. Survival of juvenile sea otters in Prince William Sound, Alaska, 1992-93. Can. J. Zoology

Ballachey, B.E. and J.L. Bodkin. 2006. Lingering oil and sea otters: Pathways of exposure and recovery status. Exxon Valdez Restoration Project //0620. Draft Final Report. Exxon Valdez Restoration Office, Anchorage, AK. 112 pp.

Ballachey, B. E., J.L. Bodkin and D.B. Irons. 2006. Oil exposure biomarkers and population trends of Prince William Sound marine invertebrates. Restoration Project //0774. Draft Final Report. Exxon Valdez Restoration Office, Anchorage, AK. 31 pp.

Bodkin, J. L. and M.S. Udevitz. 1999. An aerial survey method to estimate sea otter abundance. in: Garner, G.W., S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson, (eds.) Marine mammal survey and assessment methods. Balkema Press, Netherlands pg. 13-26.

Bodkin, J.L., B.E. Ballachey, T.A. Dean, S. Jewett, L. McDonald, D. Monson, C. O'Clair, and G. VanBlaricom. 2002. Sea otter population status and the process of recovery from the *Exxon Valdez* oil spill. Marine Ecology Progress Series. 241:237-253.

Bodkin, J.L., G.G. Esslinger and D.H. Monson. 2004. Foraging depths of sea otters and implications to coastal marine communities. Marine Mammal Science 20(2):305-321.

Bowyer, R. T., G. M. Blundell, M. Ben-David, S. C. Jewett, T. A. Dean, and L. K. Duffy. 2003. Effects of the Exxon Valdez oil spill on river otters: injury and recovery of a sentinel species. Wildlife Monographs 153: 1-53.

Carls, M.G., M.M. Babcock, P.M. Harris, G.V. Irvine, J.A. Cusick, and S.D. Rice. 2001. Persistence of Oiling in Mussel Beds after the *Exxon Valdez* Oil Spill, Marine Environmental Research, 51 pp. 167-190.

Collett, D. 1994. Modelling survival data in medical research. Chapman and Hall. New York.

Dean, T.A., J.L. Bodkin, S.C. Jewett, D.H. Monson and D. Jung. 2000. Changes in sea urchins and kelp following a reduction in sea otter density as a result of the *Exxon Valdez* oil spill. Marine Ecology Progress Series 199:281-291.

Doroff, A.M. and J.L. Bodkin. 1994. Sea otter foraging behavior and hydrocarbon levels in prey. *in* T. Loughlin, editor. Marine mammals and the Exxon Valdez. Academic Press. San Diego, CA pages 193-208.

Doroff, A. M., J. A. Estes, M. T. Tinker, D. M. Burn, and T. J. Evans. 2003. Sea otter population declines in the Aleutian Archipelago. Journal of Mammalogy 84:55-64.

Esler, D., J. A. Schmutz, R. L. Jarvis, and D. M. Mulcahy. 2000. Winter survival of adult female harlequin ducks in relation to history of contamination by the *Exxon Valdez* oil spill. J. Wildl. Manage. 64:839-847.

Esler, D., T.D. Bowman, K.A. Trust, B.E. Ballachey, T.A. Dean, S. Jewett, and C. O'Clair. 2002. Harlequin duck population recovery following the *Exxon Valdez* oil spill: progress, process and constraints. Mar. Ecol. Prog. Ser. 241-271-286.

Estes J.A., Tinker M.T., Williams T.M., Doak D.F. 1998. Killer whale predation on sea otters linking oceanic and nearshore ecosystems. Science 282:473-476.

Fukuyama, A.K., G. Shigenaka, and R. Z. Hoff. 2001. Effects of residual *Exxon Valdez* oil on intertidal Prototheca staminea: Mortality, growth, and bioaccumulation of hydrocarbons in transplanted clams. Marine Pollution Bulletin 40: 1042-1050.

Hooge, P. N., and B. Eichenlaub. 2000. Animal movement extension to Arcview. Version 2.0. Alaska Science Center. U.S. Geological Survey, Anchorage, Alaska, US

Jewett S. C., T. A. Dean, B. R. Woodin, M. K. Hoberg, and J. J. Stegeman. 2002. Exposure to hydrocarbons ten years after the Exxon Valdez oil spill: evidence from cytochrome P4501A expression and biliary FACs in nearshore demersal fishes. Marine Environmental Research 54(1):21-48.

Monson, D.H., D.F. Doak, B.E. Ballachey, A. Johnson, and J.L. Bodkin. 2000. Long-term impacts of the *Exxon Valdez* oil spill on sea otters, assessed through age-dependent mortality patterns. Proc. Nat'l. Acad. Sciences, USA 97(12):6562-6567.

Pollock, K.H., Winterstein, S.R., and Conroy, M.J. 1989. Estimation and analysis of survival distributions for radio-tagged animals. Biometrics 45: 99-109.

Short, J.W. and M.M. Babcock. 1996. Prespill and postspill concentrations of hydrocarbons in mussels and sediments in Prince William Sound. Pages 149-166 in S.D. Rice, R.B. Spies, D.A. Wolfe, and B.A. Wright, editors. Proceedings of the *Exxon Valdez* Oil Spill Symposium, American Fisheries Society Symposium 18, Bethesda, Maryland.

Short, J.W., M. R. Lindeberg, P. M. Harris, J. M. Maselko, J. J. Pela, and S. D. Rice. 2004. Estimate of oil persisting on the beaches of Prince William Sound 12 years after the *Exxon Valdez* oil spill. Environmental Science and Technology. 38(1):19-25.

Spies, R.B., Rice, S.D., Wolfe, D.A., and Wright, B.A. 1996. The effects of the *Exxon Valdez* oil spill on the Alaskan coastal environment. *In* Proceedings of the *Exxon Valdez* Oil Spill Symposium. *Edited* by S.D. Rice, R.B. Spies, D.A. Wolfe and B.A. Wright. American Fisheries Society Symposium 18, Bethesda, Maryland. pp. 1-16.

Springman, K. R., J. W. Short, M. Lindeberg, and S. D. Rice. 2006/In press. Semipermeable membrane devices link site-specific contaminants to effects: induction of CYP1A in rainbow trout from contaminants in Prince William Sound, Alaska. Marine Environmental Research.

Trust, K. A., D. Esler, B. R. Woodin, and J. J. Stegeman. 2000. Cytochrome P450 1A induction in sea ducks inhabiting nearshore areas of Prince William Sound, Alaska. Marine Pollution Bulletin 40:397-403.

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Areas of Expertise

Sea otters: biochemical, physiological, population and ecological effects of oil exposure
Marine mammals: population status and indices of condition
Environmental toxicology; Biomarkers of contaminant exposure
Mammalian genetics and physiology; Quantitative genetics

Education

Oregon State University, Corvallis, Oregon - Ph.D., 1985
Major: Animal Breeding and Genetics; Minors: Genetics, Statistics
Colorado State University, Fort Collins, Colorado - M.S., 1980
Major: Animal Sciences/Animal Breeding and Genetics
Colorado State University, Fort Collins, Colorado - B.S. with distinction, 1974
Major: Animal Sciences

Professional Experience (1987 to present)

Research Physiologist, 1990 - present
Alaska Science Center, U.S. Geological Survey, Anchorage, AK
(Formerly National Biological Service; Fish & Wildlife Service)
General Biologist, November 1989 to July 1990
Alaska Fish and Wildlife Research Center, U.S. Fish and Wildlife Service, Anchorage, AK
Staff Officer, March 1987 to November 1989
Board on Agriculture, National Research Council (NRC), Washington, DC, USA

Collaborations

Monterey Bay Aquarium, NOAA/ABL, Purdue University, South Dakota State University, USFWS, Woods Hole Oceanographic Institute

Affiliations

American Association for the Advancement of Science
Society for Marine Mammalogy
Society for Environmental Toxicology and Chemistry

Selected Publications

Ballachey, B.E., J. L. Bodkin, and A. R. DeGange. 1994. An Overview of Sea Otter Studies. Chapter 3 in Marine Mammals and the *Exxon Valdez*. T.R. Loughlin, Ed. Academic Press.

Ballachey, B.E., J.L. Bodkin, S. Howlin, A.M. Doroff and A.H. Rebar. 2003. Survival of juvenile sea otters in Prince William Sound, Alaska, 1992-93. Cdn. Jnl. Zoology

Ballachey, B.E., W.D. Hohenboken, and D.P. Evenson. 1987. Heterogeneity of sperm nuclear chromatin structure and its relationship to bull fertility. Biol. Reprod. 36:915-925.

Bickham, J.W., J.A. Mazet, J. Blake, M.J. Smolen, Y. Lou, and B.E. Ballachey. 1998. Flow-cytometric determination of genotoxic effects of exposure to petroleum in mink and sea otters. Ecotoxicology 7:191-199.

Bodkin, J.L., B.E. Ballachey, T.A. Dean, S. Jewett, L. McDonald, D. Monson, C. O'Clair, and G. VanBlaricom. 2002. Recovery of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. Mar. Ecol. Prog. Ser. 241:237-253.

Cronin, M.A., J.L. Bodkin, B.E. Ballachey, J.A. Estes and J.C. Patton. 1996. Mitochondrial DNA variation among subspecies and populations of sea otters (*Enhydra lutris*). J. Mammal. 77(2):546-557.

Esler, D., T.D. Bowman, K.A. Trust, B.E.Ballachey, T.A. Dean, S.C. Jewett and C.E. O'Clair. 2002. Harlequin duck population recovery following the *Exxon Valdez* oil spill: progress, process and constraints. Mar. Ecol. Prog. Ser. 241:271-286.

Lipscomb, T.P., R.K. Harris, A.H. Rebar, B.E. Ballachey and R.J. Haebler. 1994. Pathology of Sea Otters. Chapter16 in Marine Mammals and the *Exxon Valdez*. T.R. Loughlin, Ed. Academic Press.

Loughlin, T.R., B.E. Ballachey and B. Wright. 1996. Overview of studies to determine injury caused by the *Exxon Valdez* oil spill to marine mammals. *In* Rice, S.D., R.B. Spies, D.A. Wolfe and B.A. Wright, Eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium Number 18:798-808.

Monson, D.H., D.F. Doak, B.E. Ballachey, A. Johnson and J.L. Bodkin. 2000. Long-term impacts of the *Exxon Valdez* oil spill on sea otters assessed through age-dependent mortality patterns. Proc. Natl. Acad. Sci., USA 97:6562-6567.

Rebar, A.H., T.P. Lipscomb, R.K. Harris and B.E. Ballachey. 1995. Clinical and clinical laboratory correlates in sea otters dying acutely in rehabilitation centers. Vet. Clin. Path. 32:346-350.

Udevitz, M.S. and B.E. Ballachey. 1998. Estimating survival rates with age structure data. Jnl. Wildl. Mgmt. 62(2):779-792.

James L. Bodkin July 2006
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Education:
1985 -MS, California Polytechnic State University, San Luis Obispo, CA. (Wildlife Biology)
1976- BS, Long Beach State University (Biology), Long Beach, CA
1972 - AS, Cypress College (Biology), Cypress, CA

Memberships:
Society for Marine Mammalogy
American Society of Mammalogists
Society for Conservation Biology
Wildlife Society
National Geographic Society

Responsibilities: I lead Alaska sea otter research and the marine science program for the Alaska Science Center. The mission of the Center is to provide biological information and research findings to resource managers, policymakers, and the public to support sound management of biological resources and ecosystems in Alaska and throughout the North Pacific Ocean. The Alaska sea otter project is one of two USGS sea otter research programs, the other led by James Estes, located in Santa Cruz, CA.

I am responsible for designing, developing and directing multi-disciplinary research programs for studying North Pacific coastal marine ecosystems, focusing on sea otter populations and their role in structuring coastal marine communities in Alaska. Current research programs encompass three broad objectives, including (1) designing, developing and testing methods to assess the status of sea otter populations, (2) describing processes responsible for structuring coastal marine communities, and (3) determining the status of recovery of sea otter populations affected by the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska.

Scope of each of the three research programs:

> **Designing, developing and testing methods to assess the status of sea otter populations**. Appropriate conservation and management of sea otter populations requires accurate knowledge on the status of populations relative to available resources, primarily food and space. Current projects to evaluate population status include measures of abundance (density), age and sex specific fecundity and survival, individual condition and bio-markers, and activity-time budgets. Remote sensing devices (time-depth recorders) are currently being tested as a new method to estimate time budgets.
>
> **Describing processes responsible for structuring coastal marine communities**. Processes responsible for driving the structure and function of north Pacific coastal communities are complex and not well understood, yet managers of coastal resources

need to understand causes of variation and change in coastal communities. Current projects include a) defining coastal marine community structure in terms of physical character, biological productivity, and species composition and abundance of algae, macro-invertebrates, fishes, birds and mammals, and b) employing comparative and experimental methods to allow inference regarding cause of change in the coastal system.

Determining the status of recovery of sea otter populations affected by the 1989 *Exxon Valdez* oil spill in Prince William Sound, Alaska. Natural resources are subjected to increasing levels of anthropogenic disturbance, as exemplified by this nation's largest oil spill, the Exxon Valdez spill of 1989. Previous methods to understand the acute and chronic effects of disturbances at both species and ecosystem levels are poorly developed, often leading to uncertainty. Project objectives include developing new tools and approaches to improve our understanding of catastrophic perturbations and methods to describe the processes of how systems recover and to identify factors that can constrain system recovery.

Selected Publications:

Bodkin, J.L. 1988. Effects of kelp forest removal on associated fish assemblages in central California. Journal of Experimental Marine Biology and Ecology. 117:227-238.

Bodkin, J.L. and R. Jameson. 1991. Patterns of seabird and marine mammal carcass deposition along the central California coast, 1980-1986. Can J. Zool. 69:1149-1155.

Bodkin, J.L. and L. Browne. 1992. Molt frequency and size-class distribution in the spiny lobster (Panulirus interruptus), at San Nicolas Island, California. California Fish and Game. 78(4):136-144.

Bodkin, J.L., B.E. Ballachey, M.A. Cronin and K.T. Scribner. 1999. Population demographics and genetic diversity in remnant and re-established populations of sea otters. Conservation Biology 13(6):1278-1385.

Bodkin, J. L. and M.S. Udevitz. 1999. An aerial survey method to estimate sea otter abundance. in: Garner, G.W., S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson, (eds.) Marine mammal survey and assessment methods. Balkema Press, Netherlands pg. 13-26

Bodkin, J.L., A.M. Burdin and D.A. Ryzanov. 2000. Age and sex specific mortality and population structure in sea otters. Marine Mammal Science 16(1):201-219.

Bodkin, J.L. 2001. Marine Mammals: Sea otters. Pages 2614-2621. in Steele, J. S.Thorpe and K. Turekian (eds.) Encyclopedia of Ocean Sciences. Academic Press, London UK. (invited ms)

Bodkin, J.L., B.E. Ballachey, T.A. Dean, A.K. Fukuyama, S.C. Jewett, L.M. McDonald, D.H.Monson, C.E. O'Clair and G.R. VanBlaricom. 2002. Sea otter population status and the process of recovery from the Exxon Valdez oil spill. Marine Ecology Progress Series. 241:237-253.

Peterson, C.H., S.D. Rice, J.W. Short, D. Esler, J.L. Bodkin, B.E. Ballachey, D.B. Irons. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science 302:2082-2086.

Collaborators:
Dr. B.E. Ballachey, USGS, Dr. T.A. Dean, Coastal Resource Associates, Ms. A.M. Doroff, USFWS, Dr. D. Esler, Simon Fraser Univ., Dr. J.A. Estes, USGS, Dr. D.B. Irons, USFWS, Dr. C.H. Peterson, Univ. North Carolina, Dr. John Piatt, Alaska Science Center, Dr. S.D. Rice, NOAA, Mr. J.W. Short, NOAA, Dr. P. Snyder, Purdue University, Ms. M. Staedler, Monterey Bay Aquarium.

BUDGET JUSTIFICATION

SEA OTTER STATUS AND NEARSHORE SYNTHESIS – Ballachey & Bodkin

Total project cost over two years (FY07, FY08) is $306.9 K, including $33.6 K provided by USGS/ASC and NOAA, Auke Bay Lab in FY07 and $21.6K from USGS in FY08. $154.0K is requested from EVOSTC for FY07; projected FY08 cost is $97.7K; both years total is $251.7K. The costs not covered by the EVOS funds include salary for J. Bodkin (aerial surveys, shoreline surveys, data analysis and interpretation, report preparation) and NOAA/ABL staff (M. Lindeberg, data management and analysis). The project is not legislatively mandated, but will provide information valuable to both sea otter management (USFWS and the Alaska Sea Otter Commission) and the EVOS Trustee Council in terms of understanding sea otter population dynamics, behavioral ecology and recovery from the *Exxon Valdez* oil spill. Indirect costs have been previously arranged between the EVOS office and Trustee Agencies.

FY 2007: Amount requested $154.0K (total project cost for FY07 estimated at $187.6K)
Personnel: $64.5 K Funds will provide the salary support necessary for planning and logistics (aerial survey, shoreline surveys) and for the data management, analysis, interpretation and report writing for the sea otter survival modeling and biomarker synthesis objectives. USGS and NOAA, Auke Bay will be providing 30.0K in additional salary and miscellaneous support.
Travel: $11.3 K total, for EVOS for travel to PWS to conduct aerial survey and carcass collections, 2 trips to Calgary to consult with WEST Inc. on sea otter exposure/survival synthesis, and 1 trip to Vancouver to consult with D. Esler on spatial analysis of birds, mammals and fishes.
Contractual: $65.5 K total. $13.2 K is requested for aerial support for population abundance surveys. $40 K is requested for statistical consultants for exposure/survival synthesis, and $12 K is requested for vessel support for carcass collections. $0.3K is requested for a contract to Matson's Lab for age determinations on sea otter teeth.
Equipment & commodities: No support requested. USGS will provide facilities and equipment valued at 3.6K.

FY 2008: Amount requested $97.7K (total project cost for FY08 estimated at $119.3K)
Salary: $56.8K is requested for salary (planning/logistics for aerial and shoreline surveys, conducting surveys, continuation of sea otter survival modeling and biomarker synthesis, report preparation).
Travel: $6.7K is requested for travel to PWS to conduct aerial survey and carcass collections, and 1 trip to Calgary to consult with WEST Inc. on sea otter exposure/survival synthesis.
Contractual: $26.1K total. $13.8 K is requested for aerial support for population abundance surveys. $12 K is requested for vessel support for carcass collections. $0.3K is requested for a contract to Matson's Lab for age determinations on sea otter teeth.
Equipment & commodities: No support requested. USGS will provide facilities and equipment valued at 3.6K.

DATA MANAGEMENT

1. Study Design: See Research Plan for details.

Aerial Survey & carcass collections: We will continue to use previously developed aerial survey techniques which employ standardized strip transect counts along survey lines, and intensive search units (ISU's) to estimate a correction factor for each survey (Bodkin and Udevitz 1999). We will also continue to utilize methods for collection and processing of carcass parts as outlined in previous EVOS studies.

Sea otter synthesis and survival modeling: We will use data previously acquired and currently being management by the USGS Alaska Science Center in collaboration between EVOS Trustee Council and the USGS.

Spatial synthesis of elevated biomarkers: We will use data previously acquired and currently being management by the USGS Alaska Science Center in collaboration between EVOS Trustee Council and the USGS.

2. Criteria/Acceptable Data Quality

Aerial Survey: The USGS Alaska Science Center's Sea Otter Project has in place a data management plan, developed from the EVOS NVP project. All data will be collected, proofed, and stored under guidelines delineated in the DM plan. New data generated from the synthesis of existing data will be managed in accordance with the existing DM plan.

3. Metadata

a. Metalite Metadata information:
Aerial Survey:
Identification_Information:
Citation:
Citation_Information:
Originator: USGS Alaska Science Center, Brenda Ballachey and James L Bodkin
Publication_Date: 20060415
Title: Sea otter status and nearshore synthesis
Geospatial_Data_Presentation_Form: map
Publication_Information:
Publication_Place: Anchorage, Alaska, United States
Publisher: USGS
Description:
Abstract: There are two new data sets that will be generated by this project: aerial survey data consisting of sea otter sightings (number, group size, activity, GIS locations), and 2007/2008 ages at death of sea otters found dead on beaches in western PWS (Objective 1 a & b). Multiple existing data sets will be compiled and synthesized under the sea otter synthesis and survival modeling objective (2), and the spatial synthesis of elevated biomarkers objective (3).

Purpose: These data sets will be created to allow continued evaluation of the state of the sea otter populations affected by EVOS, through continued estimates of sea otter population size.
Time_Period_of_Content:
  Time_Period_Information:
    Range_of_Dates/Times:
      Beginning_Date: 20070401
      Ending_Date: 20080931
  Currentness_Reference: ground condition
Status:
  Progress: Planned
  Maintenance_and_Update_Frequency: As needed
Spatial_Domain:
  Bounding_Coordinates:
    West_Bounding_Coordinate: -147.2
    East_Bounding_Coordinate: -147.983
    North_Bounding_Coordinate: 60.75
    South_Bounding_Coordinate: 60.15
Keywords:
  Theme:
    Theme_Keyword_Thesaurus:
    Theme_Keyword: sea otter
    Theme_Keyword: oil
    Theme_Keyword: recovery
  Place:
    Place_Keyword_Thesaurus:
    Place_Keyword: Prince William Sound
Access_Constraints: None
Use_Constraints: None
Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Point
Distribution_Information:
Distributor:
  Contact_Information:
    Contact_Person_Primary:
      Contact_Person: James L. Bodkin
      Contact_Organization: USGS Alaska Science Center
    Contact_Address:
      Address_Type: Mailing and Physical Address
      Address:
        Alaska Science Center
        1011 East Tudor Road
      City: Anchorage
      State_or_Province: Alaska
      Postal_Code: 99503
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Distribution_Liability:
Metadata_Reference_Information:
Metadata_Date: 20040413
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: James L. Bodkin
Contact_Organization: USGS Alaska Science Center
Contact_Address:
Address_Type: Mailing and Physical Address
Address:
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1011 East Tudor Road
City: Anchorage
State_or_Province: Alaska
Postal_Code: 99503
Country: United States
Contact_Voice_Telephone: 907.786.3550
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Contact_Electronic_Mail_Address: james_bodkin@usgs.gov
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998

b. Dataset category:
Aerial Survey: Species specific measurements, fields: INTENSIVE SEARCH UNIT, SET, TRANSECT, GROUP, ADULTS, STRIP ADULTS, CIRCLE ADULTS, PUPS, STRIP PUPS, CIRCLE PUPS, CHOP, GLARE, BEHAVIOR, DATE, OBSERVER, PERIOD, AREA, STRATUM, LENGTH, SIDE
Carcass collections: Species specific measurements, fields: DATE, AREA, GPS LOCATION, OBSERVER, CARCASS CONDITION, SEX AND AGE CLASS (IF IDENTIFIABLE), PARTS COLLECTED

Sea otter synthesis and survival: Species specific measurements, fields: OTTER#, COLLDAT, CYP1Ablood, CYP1Aliver
Capture: DATE, AREA, AGECLASS, TOOTHAGE, RECORDER, OTTER NUMBER, SEX, PUP, PUP WEIGHT, PUP LENGTH, WEIGHT, LENGTH, GIRTH, LATITUDE, LONGITUDE, CAPTURE METHOD, TIME OTTER FIRST OBSERVED, CAUGHT WITH, PAW, LEFT TAG POSITION, LCOLOR, LTAG #, RIGHT TAG POSITION, RCOLOR, RTAG #, COMMENTS1, INITIAL FENTANYL DOSE, IFTIME, INITIAL VALIUM DOSE, IVTIME, SUPPLEMENTAL FENTANYL DOSE, SUPPLEMENTAL VALIUM DOSE, STIME, SUPPLEMENTAL2 FENTANYL DOSE, S2TIME, COMMENTS2, TEMPERATURE, TIME, FECAL SAMPLE COLLECTED?, TOOTH CONDITION, CANINES, INCISORS, PREMOLARS, MOLARS, MISSING, BROKEN, CANINE DIAMETER, TOOTH COLLECTED, AGE ESTIMATE, ESTIMATOR, ORAL LESIONS, BIOPSIES/SWABS,

HEAD COLOR, BACULA LENGTH, COMMENTS3, BLOOD VOLUME DRAWN, DRAWTIME, QUEST DIAGNOSTICS NUMBER, NALTREXONE DOSE, NALTIME, COMMENTS4, RELEASE LOCATION, RELTIME, OBSERVERS, OTHER REMARKS
Blood: OTTER#, TREATMENT DATE, TREATMENT TIME, ANALYSIS DATE, ANALYSIS TIME, LABORATORY, WHITE BLOOD CELLS, RED BLOOD CELL COUNT, HEMOGLOBIN, HEMATOCRIT, MEAN CORPUSCULAR VOLUME, MEAN CORPUSCULAR HEMOGLOBIN, MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION, PLATELETS, SEGMENTED NEUTROPHILS, BANDS, LYMPHOCYTES, MONOCYTES, EOSINOPHILS, BASOPHILS, GLUCOSE, TOTAL PROTEIN, CREATININE, URIC ACID, CHOLESTEROL, TRIGLYCERIDES, ALKALINE PHOSPHATASE, SERUM GLUTAMIC OXALOACETIC TRANSAMINASE / ASPARTATE AMINO TRANSFERASE, SERUM GLUTAMIC PYRUVIC TRANSAMINASE / ALANINE AMINO TRANSFERASE, LACTIC DEHYDROGENASE, TOTAL BILIRUBINS, DIRECT BILIRUBIN, SODIUM, POTASSIUM, CHLORIDE, CALCIUM, PHOSPHOROUS, IRON, ALBUMIN, GLOBULIN, ALBUMIN TO GLOBULIN RATIO, BLOOD UREA NITROGEN, CORTISOL, CARBON DIOXIDE, CREATINE PHOSPHOKINASE, HAPTOGLOBIN, RED CELL WIDTH, TOTAL PROTEIN, TRIGLYCERIDES, CHOLESTEROL, HIGH DENSITY LIPOPROTEINS, VERY LOW DENSITY LIPOPROTEINS, LOW DENSITY LIPOPROTEINS, CHOLESTEROL:HIGH DENSITY LIPOPROTEINS, GAMMA GLUTAMYL TRANSFERASE, ALKALINE PHOSPHATASE

Habitat Use Species specific measurements, fields: VHF Frequency, Pup Presence, Date, Time, Easting, Northing, Accuracy, Behavior, Bout, Prey, Observer, Outlier, Comment

Sea otter dive depth distribution and behavior fields: VHF Frequency, Date, Time, Body temperature, depth.

4. Algorithms

See Bodkin et al. 2004 for dive classification algorithms.

5. Sample Collection, Handling, Custody, Storage

Carcass samples (generally whole skulls or skull parts) will be collected from shorelines in western PWS, catalogued and stored at the Alaska Science Center. Teeth will be extracted for aging and submitted to Matson's Laboratory, Jamestown, SD.

6. Analytical Instrumentation

Analytical instruments will not be utilized in this project.

7. Data Reduction and Reporting

Aerial Survey: We will continue to use previously developed aerial survey data analysis techniques which use the standardized strip transect counts and intensive search units (ISU's) to estimate a correction factor for each survey (Bodkin and Udevitz 1999) in order to determine a population estimate. SAS statistical software and ArcInfo GIS software will be used.

Sea otter synthesis and survival modeling: Standard statistical software (e.g. SAS, SYSTAT, SigmaStat) will be used for compiling and synthesizing existing data. West Inc. consulting will

be contracted to conduct the proportional hazards risk and survival analyses under supervision of principal investigators.

Spatial synthesis of biomarkers: Standard geo-spatial software (ArcGIS) will provide the platform for the synthesis and presentation of work to meet this objective. Standard statistical software, (e.g. SAS, SYSTAT, SigmaStat) will be used to quantify relations among species, locations, and exposure.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

Budget Category:	Authorized FY 2006	Proposed FY 2007	Proposed FY 2008	Total Project
Personnel		$64.5	$56.8	$121.3
Travel		$11.3	$6.7	$18.0
Contractual		$65.5	$26.1	$91.6
Commodities		$0.0	$0.0	$0.0
Equipment		$0.0	$0.0	$0.0
Subtotal	$0.0	$141.3	$89.6	$230.9
General Administration		$12.7	$8.1	$20.8
Project Total	$0.0	$154.0	$97.7	$251.7
Full-time Equivalents (FTE)		0.8		
	Dollar amounts are shown in thousands of dollars.			
Other Resources				

Comments:
Total project cost for both years (FY07 and FY08) is $306.9. Project cost in FY07 is $187.6 K, including $33.6 K provided by USGS/ASC and NOAA, Auke Bay Lab. Project cost in FY08 is $119.3, including $21.6K provided by the USGS/ASC.

$154K is requested from EVOSTC for FY07; and $97.7K for FY 08

The costs not covered by the EVOS funds include salary for J. Bodkin (estimated 18.0K each year, in FY07 and FY08), NOAA/ABL staff contributing to data management and analysis (M. Lindeberg, 12.0K, FY07), and equipment and supplies provided by USGS (3.6K each year, FY07 and FY08).

No EVOS funds are requested for the NOAA participation in this project. NOAA will contribute $12.0K in FY07.

FY07 - FY 08

Project Number: 070808
Project Title: Sea Otter Status & Nearshore Synthesis
Agency: DOI - USGS

Prepared:August 3, 2006

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

Format revisions: August 11, 2006

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2007
Ballachey, B.	Research Physiologist		6.0	8.0		48.0
Coletti, H.	Fisheries Biologist		3.0	5.5		16.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		9.0	13.5	0.0	
					Personnel Total	$64.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2007
Anchorage to Calgary	1.4	2	10	0.2	4.8
Anchorage to Vancouver	1.4	1	5	0.2	2.4
Anchorage to Cordova	0.5	1	12	0.2	2.9
Anchorage to Whittier (6 people, 1 trip)		1	6	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$11.3

FY07

Project Number: 070808
Project Title: Sea Otter Status & Nearshore Synthesis
Agency: DOI - USGS

Prepared:

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

Contractual Costs:	Proposed
Description	FY 2007
Contract to conduct survival risk analysis (WEST Inc.)	40.0
OAS contract for aerial survey 60 h @ 220/hr	13.2
Vessel charter for shoreline surveys (carcass collection) 8 days @ 1500/d	12.0
Contract to Matson's laboratory for scoring teeth (30 @ $10)	0.3
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$65.5

Commodities Costs:	Proposed
Description	FY 2007
Commodities Total	$0.0

FY07

Project Number: 070808
Project Title: Sea Otter Status & Nearshore Synthesis
Agency: DOI - USGS

Prepared:

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2007
Description			
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	Inventory Agency
Description		

FY07

Project Number: 070808
Project Title: Sea Otter Status & Nearshore Synthesis
Agency: DOI - USGS

FORM

Prepared:

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2006 - September 30, 2007

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2008
Ballachey, B.	Research Physiologist		5.0	8.0		40.0
Coletti, H.	Fisheries Biologist		3.0	5.6		16.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		8.0	13.6	0.0	
					Personnel Total	$56.8

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2008
Anchorage to Calgary	1.4	1	6	0.2	2.6
Anchorage to Cordova	0.5	1	12	0.2	2.9
Anchorage to Whittier (6 people, 1 trip)		1	6	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					Travel Total	$6.7

FY08

Project Number: 070808
Project Title: Sea Otter Status & Nearshore Synthesis
Agency: DOI - USGS

Prepared:

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

Contractual Costs:	Proposed
Description	FY 2008
OAS contract for aerial survey, 60 hrs at 230/hr	13.8
Vessel charter, shoreline surveys (carcass collection), 8 days at 1500/d	12.0
Contract (Matson's Laboratory) for scoring teeth (age determination), 30 @ 10	0.3
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$26.1

Commodities Costs:	Proposed
Description	FY 2008
Commodities Total	$0.0

FY08

Project Number: 070808
Project Title: Sea Otter Status & Nearshore Synthesis
Agency: DOI - USGS

FORM

Prepared:

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2008
Those purchases associated with replacement equipment should be indicated by placement of an R.			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY08

Project Number: 070808
Project Title: Sea Otter Status & Nearshore Synthesis
Agency: DOI - USGS

FORM

Prepared: