Proposal Title: PWS Herring Research and Monitoring submitted under the BAA #AB1333F-11-RF-0016

Submitted to:

Elise Hsieh
Exxon Valdez Oil Spill Trustee Council
441 West 5th Ave., Suite 500
Anchorage, AK 99501-2340

Matthew Phelps
NOAA, Office of Acquisition and Grants,
Western Acquisition Division
7600 Sand Point Way NE
Seattle, WA 98115-6349

Submitted by:

W. Scott Pegau
Prince William Sound Science Center
Box 705
Cordova, AK 99574
PH: 907-424-5800 x222 e-mail wspegau@pwssc.org

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$913,400	$1,002,500	$1,236,100	$1,095,300	$1,036,700

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W. Scott Pegau, Principal Investigator Nancy Bird, President, PWSSC

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Date Date

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PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here are projects for a program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to “Conduct research to find out why Pacific herring are not recovering” and “Monitor recovery”, listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

II. PROJECT DESIGN

A. Background:

Pacific herring (*Clupea pallasii*) has a distribution in the eastern Pacific from the Beaufort Sea to Baja California, Mexico. They are pelagic forage fish that provide an important transfer of energy from phyto- and zooplankton to a suite of larger predators such as other fish, marine mammals, and birds. For more than 1500 years, herring species from around the world have been captured by subsistence and commercial fisheries for reduction to fish meal, consumption of meat and eggs, and bait for predatory sport fishes (Hay et al. 2001). Many herring stocks have experienced collapses, but unlike other fish species that decline due to fishing, herring are more likely to recover after reduced or zero levels of harvest (Hutchings 2000). In spite of repeated closures of the fishery in PWS the herring population has not recovered to pre-1993 numbers. While research over the last 16 years has been conducted to help pinpoint the cause(s) of the collapse and the lack of recovery, the conclusions are complex and at times conflicting. The mandate set by the EVOSTC is clear, that regardless of the cause of the decline it is imperative to work towards restoration of this important ecological and commercial fisheries stock.

As a forage fish, herring experience high levels of mortality at all life history stages, but certain stages may represent significant population-limiting bottlenecks that determine year class strength. Previous research (Sound Ecosystem Assessment (SEA)project; see (Cooney et al. 2001)) indicated that a population-limiting bottleneck in PWS herring may include mortality that occurs during the overwintering period among age-0 cohorts; consequently, this life stage represents the basis for the current EVOSTC herring research (Project 10100132 A-I).

Every winter, herring enter a starvation period in which they rely on their energy stores to survive through winter. Age-0 herring may be at a disadvantage compared to the older cohorts that are able to start feeding and building energy stores during the period when age-0 herring are eggs and then larvae. The age-0 cohort relies on energy stores for overwinter survival as zooplankton biomass decreases during the fall. Larger Age-1 and older herring tend to have a higher whole-body energy density (WBED) going into winter. Age-0 herring have lower WBEDs (~5.7 kj/g wet) heading into winter than age-1 herring (~8.0 kj/g wet) and age-2 herring (~9.4 kj/g wet), but age-0 herring also have a lower decrease of WBED during winter compared to older age classes (Paul et al. 1998). Larger age-0 herring may have higher survival due to higher WBED and higher assimilation rates (Foy and Paul 1999). Gut content analysis indicate that age-0 herring prey items varied among seasons and among bays (Foy and Norcross 1999). Zooplankton samples were not collected during that study so it is difficult to determine if prey consumption was based upon preference or availability. However, they did find that the spatial and temporal variation in diet composition accounted for the differences in condition of age-0 herring sampled. The compromised overwinter survival among age-0 herring resulting from decreased energy content is further exacerbated by endemic diseases, which add additional bioenergetic demands. For example, *Ichthyophonus*-infected herring demonstrate a 30% reduction in total energy content compared to uninfected cohorts (Vollenweider et al. In press).

The overwintering survival of age-0 herring is just one of the potential factors limiting recruitment. Large gaps remain in our understanding of herring life history that we must fill if we are to better predict herring recovery. The EVOSTC website lists 174 projects intended to address factors contributing to the decline and failed recovery of PWS herring. This number is misleading in that many of these are the same project over several different years and others were part of large programs, such as the Apex Predator Experiment that had components related to herring, but were not focused on herring. There still remain many herring focused research projects, some of which are included in the current PWS Herring Survey program that includes a coordinated set of ten individual research projects. The program proposed here builds upon the needs identified in the EVOSTC Integrated Herring Restoration Program and is designed to complement previous research to improve our understanding of PWS herring stock.

B. Goal and Objectives

Goal: Improve predictive models of herring stocks through observations and research.

This is the long-term goal of an anticipated twenty year program. The general approach will be to conduct monitoring of a limited number of variables combined with process study research. We will break the process study efforts into five-year increments. Within each increment we will focus on particular aspects of the herring life cycle to better predict how factors affecting that life stage influence overall herring stocks. We have identified several areas that require attention such as the larval life stage (least amount of existing information), stock structure (from modeling efforts), context of existing measurements (from synthesis), along with predation and competition questions. By no means is this list meant to be comprehensive. We will rely on a scientific advisory group (described later) to guide the efforts of each five-year effort and to recommend modifications during a five-year period if needed. The remainder of the discussion in this proposal is focused on the proposed efforts between FY12 and FY16.

We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

Objectives

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

C. Procedural and Scientific Methods

Approach: Our iterative approach to addressing the long-term goal of this program "**to improve predictive models of herring stocks through observations and research"** involves testing the relative importance of factors that may be preventing the recovery of PWS herring. The relative importance of these factors will be identified through an integrated set of studies that include monitoring efforts, shorter field-based process studies focusing on particular aspects of the herring life cycle, and controlled laboratory-based studies intended to determine cause-and effect relationships. When combined, this approach is intended to inform more directed herring monitoring and modeling efforts by focusing on important population-limiting factors and providing empirical data for the current ASA model. The work outlined here will be informed by projects outlined in a separate long-term monitoring program, such as monitoring of basic oceanographic conditions, food availability, and predator populations. It also builds upon the existing EVOSTC funded PWS Herring Survey research program. The team lead (W. Scott Pegau) on the proposed work is the same team leader as on the PWS Herring Survey program, which allows the proposed work to be fully integrated with the existing work without unnecessary duplication.

The first component of the proposed work includes monitoring programs. They are designed to complement the existing ADF&G surveys that determine the spawning biomass, the mile-days of spawn, and the age-sex-weight composition of the spawning stock. The ADF&G surveys are central to our understanding of when the PWS adult herring population is recovering. However, these surveys have limitations that this program addresses.

Monitoring Components:

Monitoring components are designed to address objective #1 by either adding desired information that is not currently being collected by ADF&G or collecting information we believe will allow for advances in the ASA model. Below is a brief description of the proposed monitoring projects. An expanded description of the work to be done is provided in an appendix.

1. **Disease in the adult population** – Disease is now a component in the Age-Structure-Analysis model for Prince William Sound; however, it is not part of the ADF&G sponsored surveys. We will provide the disease information for the ASA model by determining annual prevalence and intensity data for the most virulent pathogens that are currently endemic in the PWS herring populations, including viral hemorrhagic septicemia (VHS), viral erythrocytic necrosis (VEN), and ichthyophoniasis.   Monitoring efforts will consist of the annual collection and processing of sixty adult and sixty juvenile herring per site from three sites in PWS to test for disease. Diagnostic techniques for these pathogens will follow standard procedures described in the "Blue Book: Standard procedures for the detection and identification of select fish and shellfish pathogens (American Fisheries Society)." We will also examine efficacy of newly-developed procedures that may forecast the potential for future disease mortalities and simplify the disease surveillance efforts.
2. **Enhanced adult biomass surveys** – Current stock assessment efforts by ADF&G resource managers in PWS focus on the largest spawning aggregations. Additional spawning aggregations exist, but are not regularly surveyed by ADF&G because of funding and personnel limitations; therefore, their relative contributions to the biomass of the PWS metapopulation remain poorly understood. The Prince William Sound Science Center (PWSSC) has also conducted acoustic biomass surveys for the past two decades. We propose to extend the PWSSC acoustic surveys to help identify the relative contributions of these additional spawning aggregations over temporal and spatial scales. This will help establish more accurate estimates of the total herring biomass in PWS and provide an alert to changes in biomass in different regions. The PWSSC survey will overlap with the ADF&G survey to provide a comparative measure between the two studies and to improve the precision of the estimate.
3. **Juvenile biomass index surveys** – The current estimates of herring biomass in PWS is at the threshold for allowing a fishery. A large proportion of the fish in this estimate are the three and four-year old fish expected to recruit to the spawning biomass. The estimates of these new recruits are made with nearly no information about the actual number of juvenile fish in the Sound. The purpose of the juvenile biomass surveys will be to provide an index of the strength of age-0, -1, and -2 herring. This will provide a measure of the expected recruitment to the fishery and provide information needed to better quantify mortality at these early life stages.

Since this is a new effort we will be examining the utility of acoustic surveys and direct capture programs to determine the best method to develop an index.

4. **Age-0 condition** – The energetic state of juvenile, particularly age-0, herring provides an integrated measure of environmental conditions. By monitoring condition parameters of age-0 herring we will be able to better identify the role of environmental conditions in determining survival through this critical time period. This program links the herring and long-term monitoring programs. Understanding the role of bottom-up regulation of herring requires the basic physical and biological oceanographic measurements that are proposed in the long-term monitoring program.

The juvenile biomass index survey and the age-0 condition surveys both are designed to provide predictions of the strength of potential recruitment to the fishery. We anticipate that during the twenty-year period we may drop one of these programs once we determine the most accurate and cost effective approach.

Process Study Components:

The process studies provide the ability to rapidly improve our understanding of the herring population in PWS. Because numerous gaps exist in our understanding of factors controlling the biomass and demographics of herring populations, and some knowledge is based on untested assumptions, the number of potential process studies is very large. We propose grouping projects into thematic areas that can be used to focus our efforts. In the first five-year period we are especially interested in providing the information necessary to ensure the best program moving forward into the future, and also to address issues that can make rapid improvements to the existing modeling efforts. To ensure the best program over the next twenty years we propose to address the four objectives listed earlier during this funding cycle. Below each objective is a brief description of proposed projects that address the objective. The projects are identified by a short name in italics. A more detailed description of the work to be done is included in an appendix.

Objective 1. *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.*

The ASA model has a maturity schedule that according to ADF&G fisheries reports has changed over time and is different among regions. However, this maturity schedule has not been confirmed by direct observations; rather it has been allowed to vary in a limited manner to allow the ASA to provide the best fit to the input data. To address this issue we are proposing a study to examine the age at which herring first spawn and determine if there is evidence of some herring skipping potential spawning events.

Primiparous fish: Determination of age at first spawn has been accomplished via 1) analysis of differential growth increments on scales, and 2) histological analysis of egg development in ovaries. In Atlantic herring, the width of scale annuli has been used to identify years in which the fish did or did not spawn, where growth rings are relatively wide prior to their first spawning event (and during years of skip-spawn), and relatively narrow for years that spawning occurs (Engelhard and Heino 2005). Thus scales provide a spawning history for an individual fish. The presence of post-ovulatory follicles (POV) after spawning indicates an individual fish has recently spawned while oocyte maturation identifies individuals about to spawn. By sampling at a time when both POV and maturing oocytes are present it is possible to discern immature, primiparous and repeat spawning individuals. While the histological method provides direct observation of the spawning history of individuals, it is unlikely that developing oocytes can be observed among spawners. Therefore, the histological analysis must occur some months after spawning (Saborido-Rey and Junquera 1998).

We propose to examine scales of female herring collected from spawning aggregates in PWS to identify the spawning history of each year class. We will also validate the scale technique by comparing the results of scale analysis with that of histological analysis of oocyte development. The validation will likely be used on fish sampled some time after spawning. In order to identify the optimal time we will iteratively sample ovaries in fish held in the lab after spawning. If scale analysis proves to be a viable means to assess age at first spawn and spawning frequency, it would be a relatively inexpensive monitoring tool that could be used to adjust the ASA model in real time.

Genetic stock structure: Understanding if there is one PWS herring stock or multiple stocks is important for proper management of fisheries. We propose to study the fine scale genetic structure in herring from PWS to determine if it may be a complicating factor in the recovery process. A previous genetic study of herring in the region indicated that the PWS herring population was genetically distinct from other stocks spawning outside the Sound (O'Connell et al. 1998), providing an impetus for additional work. Several recent studies have made advancements in herring research using microsatellite loci, and have detected fine-scale genetic differentiation among local regions of herring (Beacham et al. 2008; Andre et al. 2011; Wildes et al. in review). Each microsatellite locus contains multiple alleles making microsatellites ideal genetic markers for analyzing migratory fish with limited stock structure like herring. Based on our experience studying Pacific herring in Southeast Alaska using microsatellite markers (Wildes et al. in review), successful completion of this proposal will require (1) increasing the number of genetic samples per collection from the 50 used in the previous analysis (O'Connell et al. 1998) to 150 fish, (2) using an increased number of informative markers (from 5 to 15), (3) analyzing at least two years of collections to examine temporal stability, (4) comparing at least two year classes to examine the possibility of "spawning waves" as detected in some regions in Atlantic herring, and (5) spatial stability from collections from two different historical locations (east, west). Evaluation of temporal and spatial variation of herring population(s) in PWS using updated genetic protocols will provide important information about herring life history that will contribute to improving the application of the ASA model.

Objective 2. *Inform the required synthesis effort.*

This objective includes efforts to improve access to a wide array of data sources for inclusion in the synthesis efforts. Many of the projects described under Objective 3 will also address this objective.

Data visualization: A data management approach is described later in this proposal; however, we feel it is important that the data management efforts also contribute to our ability to conduct the required synthesis. In year one we plan to focus efforts on integrating existing ADF&G herring data and other important ancillary data sets from the spill affected region (Prince William Sound, Cook Inlet, and potentially Kodiak) into the Alaska Ocean Observing System's (AOOS) data delivery and visualization system. Much of the herring data has been gathered together in projects funded by EVOSTC and the North Pacific Research Board (NPRB). However, the herring portal is currently neither readily available nor regularly updated, and data for herring populations in Cook Inlet have not been incorporated into the portal. We will transfer those data into the AOOS data management and visualization system to allow easier access and to allow the data to be visualized along with other oceanographic conditions, such as water temperature or chlorophyll concentrations. While we do not anticipate that it will be an onerous task to incorporate the existing data into the system, the ability to combine that information with other disparate data types will require some effort. A portion of the effort will involve collection and incorporation of data sets that are not currently part of the AOOS collection. By working with the AOOS data system we will be able to dovetail with other sources of funding that will help with the collection of historical data or in improving data visualization and access.

Herring scale analysis: A very valuable source of information for many PWS herring studies includes approximately 200,000 herring scales (including ancillary data including collection location, date, length, weight, and sex) that are currently maintained in a collection at the Cordova ADF&G office. Unfortunately, only a small portion of these data are converted to an electronic format. We are proposing a project that will examine the growth history contained in scales from PWS. This information will be used to improve our understanding of any temporal and age-specific growth patterns that result in observed changes in size at age. Spatial patterns may also be examined given sufficient sample sizes. Project data can be used to model changes in growth in relation to environmental and population indices.

There is also potential for this information to help identify when fish first spawn as described in the project under Objective 1. There are many more scales than can be analyzed by either of these individual projects and we will ensure that the information collected in each effort can be combined to increase the statistical power of both sets of analyses. We believe that retrospective studies, such as this one, will be extremely useful in improving the quality of the required synthesis.

Objective 3. *Address assumptions in the current measurements.*

Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into spatial and temporal context. This effort will allow the design of the most accurate and efficient monitoring program.

Herring condition intensive: The currently-funded herring monitoring program is designed with coarse temporal and spatial resolution with only two sampling events per year occur at narrowly defined sampling sites in PWS. Greater temporal and spatial coverage is required to impart greater meaning. In the case of temporal variation of herring condition it would be useful to understand (1) how the kinetics of overwinter starvation are affected by inter-annual differences in the initiation of the early winter fasting period (2) the timing of recovery from winter starvation. The latter is important because the overwinter mortality model currently predicts that as little as 1 % of the November population of age-0 herring would survive to May given a continuation of starvation after March. Data from the SEA project suggest that the age-0 herring are in very poor condition as late as May. In the case of spatial variation of herring condition it would be useful to know how sensitive the herring mortality model is to immigration into and emigration from areas immediately adjacent to where herring are sampled at the time of our November and March surveys.

We propose to examine herring condition on a monthly basis for a nine month period. This design will better resolve the time period that fish meet the assumption of the age 0 mortality model that is being developed to predict overwintering mortality. The primary assumptions are that the fish have a period when they are not feeding sufficiently, and the energy lost by the fish has a linear relationship with time. Greater temporal resolution than the current twice a year sampling plan is required to confirm if and when these conditions exist. We propose to collect fish for both the energetics and growth work to identify how the measured variables change through time to improve our interpretation of those measurements and ensure we sample at the most appropriate times.

Fatty acid analysis: Monitoring of age-0 herring has been suggested as an important component of the EVOSTC herring program, but the appropriate spatial scale to monitor is unknown. The juvenile condition and interpretation of acoustic measurements require a basic understanding of the relative contributions of immigration and emigration. The current program assumes age-0 herring remain in their nursery bays over winter. If true, then age-0 monitoring can utilize a series of index bays to evaluate the relative health of herring cohorts. Observations of differences among bays in terms of age-0 condition and marine conditions can provide a basis for identifying environmental conditions which lead to improved recruitment to age-1. However, if age-0 fish move about PWS in winter, then measurements of fish condition are limited to inter-annual variation, severely constraining our ability to identify the conditions contributing to the recruitment of large year classes. Thus the current herring monitoring program requires validation of the assumption that age-0 herring remain in their nursery bays over winter.

We propose to test this assumption by monitoring the fatty acid composition of age-0 herring over winter. Herring foraging on different prey fields likely have different fatty acid compositions because the fatty acid composition of depot lipids derives from diets. Differences in the prey fields in different bays should produce differences in the fatty acid compositions of herring in those bays. During periods of food deprivation, fish fatty acid compositions are conserved. Therefore, the fatty acid composition of age-0 herring in fall can act as a natural tag for identifying migration. We hypothesize that migration of herring will result in increasing similarity of herring fatty acid compositions. Changes in fatty acid composition due to winter feeding are likely to be minimal because age-0 herring experience energy deficits in winter, proscribing lipid storage. Consequently, if the fatty acid composition of age-0 herring in given bays is constant over winter then migration must be limited.

Acoustic consistency: Hydroacoustic surveys of juvenile herring nursery areas in PWS have been conducted during fall and late-winter for the last several years. The objectives of this effort have been to improve understanding of habitat utilization by juvenile herring, especially age-0, and to help identify candidate sites that could be potentially used for supplementation efforts. The number of locations surveyed have varied from 5-9, including the 4 SEA bays. However, each seasonal effort has conducted only a single night survey in each of these locations. Thorne (2010) examined seasonal changes from fall 2006 to spring 2009. He showed that apparent overwinter mortality of age 0 herring appeared to be greatest in Simpson Bay and least in Whale Bay. However, he also pointed out that the differences over winter could also be the result of emigration. Not only might age-0 herring move among bays during the winter, but movement into and out of bays may be progressive during a season. Of concern is that age-0 herring may not have fully recruited into the bays by the time of the fall survey, or have migrated out before the spring survey. Another potential source of variability could be the stage of the moon. Ambient light is known to affect fish distributions. On many occasions, age-0 herring aggregations were readily identified by their distinct distribution: a diffuse layer near the surface, near the shore and near the heads of bay. On other occasions, this distinctive distribution was absent even though age 0 herring were present. The change might have been the result of different ambient light regimes. The accuracy of both annual and seasonal comparisons depends on whether the single-night observations are representative of age-0 herring abundance. Such information is especially critical if hydroacoustic surveys are needed to provide an index of future age-0 herring abundance.

We propose to address these uncertainties with a set of fall and late winter/spring intensive surveys. In each case, we propose three consecutive nightly surveys of each of two bays on four separate occasions, spaced at 2-week intervals. The fall series will start mid-October and extend to the first week of December. The late winter/spring series will begin the 3rd week of February and extend into the 2nd week of April. Such a design will address daily, weekly, and monthly variability, including moon phase. We propose to conduct the surveys in two bays sufficiently adjacent to cover each bay each night, such as Simpson Bay and Windy Bay or St. Matthews Bay and Port Gravina. In addition to the hydroacoustic surveys on 3 successive nights, we propose a single night of direct capture effort in each location for each of the survey weeks.

Hydroacoustic validation: We recognize that a major deficit in our existing program is the lack of an effective means of validating the hydroacoustic signal. Fortunately, if we can establish through ground truth efforts (e.g. direct capture of ensonified fish, camera surveys) that certain patterns in echograms can be interpreted as different year classes of herring, and then we may be able to reanalyze historical acoustic measurements to better understand changes in juvenile herring populations.

In Prince William Sound, juvenile herring acoustic surveys have been conducted at the beginning (November) and end (March) of every winter since March 2007. A variety of methods have been used with limited success to ground truth these surveys. Small mid-water trawls used during fall 2007 and fall 2009 cruises failed to catch fish. In most cases, these trawls were towed 1 day after the acoustic survey and always from a different vessel. Trawling speeds were typically 2-3 knots, producing a high level of net avoidance by the targeted fish. Variable mesh gill nets have also been used to validate acoustic surveys; however, gillnets select for faster swimming fish (Thorne et al. 1983) and in PWS, gillnet deployments have resulted in very small catch rates of juvenile herring.

Pelagic trawls are the recommended method for validating species composition and for obtaining information on length frequency distribution, age, and other biological information (Simmonds et al. 1992, McClatchie et al. 2000, Adams et al. 2006, NOAA 2009). In the proposed program we plan to use a low-resistance, light-weight mid-water trawl capable of increased towing speeds (3-4 knots) as a direct capture method for collecting the number of fish necessary to provide validation. In order to provide accurate data on ensonified fish, the trawl will be towed simultaneous with acoustic surveys for herring and from the same research vessel. We also propose to examine non-lethal approaches such as imaging sonar and camera systems for validating the interpretation of the acoustic signal. Validation efforts will be coordinated with acoustic surveys to provide a rapid assessment of the fish assemblages observed during the acoustic survey.

Disease studies: Mortality from infectious and parasitic diseases has been identified as a leading hypothesis accounting for the decline and failed recovery of PWS herring (Marty et al. 1998; Marty et al. 2003; Marty et al. 2010); unfortunately, the location and timing of the acute and / or chronic mortalities remain unaddressed because of difficulties inherent to sampling in marine systems. However, recent empirical studies provide insights into seasonal periods that are critical to disease processes, based on water temperatures and herring behavioral patterns. For example, the probability of viral hemorrhagic septicemia (VHS) epizootics increase as water temperature decreases, because virulence, magnitude and duration of viral shedding, and VHSV persistence in infected hosts increase as the temperature decreases (Hershberger unpublished data). Similarly, the infectivity of *Ichthyophonus* to Pacific herring is inversely related to temperature, with infection prevalence decreasing from 76%, 54%, and 24% at temperatures of 9.3°C, 12°C, and 15.3°C, respectively.

In association with sampling from other components of this program, we will investigate the seasonality of these diseases by focusing disease surveys during the coldest periods of the year, when *Ichthyophonus* infectivity is highest and VHS is likely to have its greatest impacts. An additional risk factor for VHS mortality includes periods of high aggregation when effective fish-to-fish transmission is most likely to occur (Hershberger et al. 2010; Hershberger et al. submitted); this risk factor is enhanced during cold water periods, when viral shedding from carrier individuals is greatest. Therefore, field disease surveillance efforts will be focused on the overwinter and spring-spawning periods. Additionally, controlled laboratory studies will be performed to further understand cause-and-effect disease relationships and to further develop predictive tools that forecast the potential for disease-related mortality (described in Appendix 1).

Objective 4. *Develop new approaches to monitoring.*

The EVOSTC FY12 request for proposals points out the need for evaluating new technology throughout the program. As described earlier we are looking to use newer genetics tools to examine stock structure, but there are several other projects that examine the development or application of new technologies. We also are proposing to upgrade the hydroacoustic system used in our surveys to provide the benefits associated with recent advances in acoustic technologies.

Herring tagging: We propose to utilize the existing Pacific Ocean Shelf Tracking (POST) tracking array currently deployed in Port Gravina and the arrays planned for deployment in 2011 across the major entrances and passages to Prince William Sound by conducting a pilot study examining the utility of acoustic tags for tracking adult herring. Specifically, we will examine if and when adult herring migrate out from and back into Prince William Sound. The ability to track herring is critical to answer many questions including those about stock structure, migration habits, and the occurrence of skip-spawning. By understanding the capabilities of this technology it will help guide our choice of future research emphasis that may depend on a mature tagging technology.

Disease forecasting: High-throughput techniques intended to forecast the potential for future herring mortalities caused by viral hemorrhagic septicemia are currently being developed, optimized, and validated. The techniques are based on the well-demonstrated concept that survivors of prior VHS exposure demonstrate resistance to the disease after subsequent exposure to the virus. Therefore, the potential for future VHS epizootics and resulting fish kills can be enumerated if we can determine the prior exposure history and subsequent levels of herd immunity conferred to wild herring populations; whereby previously-exposed populations would have high immunity and a resulting low potential for future VHS impacts. We have successfully developed an enzyme-linked immunosorbent assay (ELISA) that quantifies the prior exposure history of herring populations by detecting levels of circulating antibodies that are specific to VHSV. We are in the final phases of ELISA optimization and validation. This tool will be incorporated into the annual herring assessments to determine the potential for future VHS epizootics in the PWS populations. Additionally, we will continue to develop further disease forecasting tools for VHS and other primary diseases of PWS herring, including ichthyophoniasis and viral erythrocytic necrosis.

Non lethal sampling: Interpretation of the acoustic signal, for species or biomass, requires information on the fish distributed within the ensonified volume. We currently rely on direct capture techniques to sample the fish to determine species and size characteristics. New capabilities in optical and acoustic imaging have been demonstrated as promising tools for acquiring the required demographic information on fish in a non-invasive manner. We propose to examine two techniques, one optical and the other acoustic, to evaluate their utility for verification of the hydroacoustic survey data. At the completion of an acoustic survey we will return to locations to reacquire features of interest and then lower a remotely operated vehicle (ROV) and/or imaging sonar to determine the species and/or size composition of the fish observed in the acoustical survey. Alternatively, we may be able to tow the imaging systems at a fixed depth during the survey to provide transect information. The acoustical technique will use either a DIDSON or ARIS imaging sonar and we intend to use an ROV as a vehicle for the optical system. The advantage of using an ROV over a simpler camera system is that it can be used for other purposes, such as acoustic tracking station retrieval and examining herring use of ice habitat.

D. Coordination and Oversight

This proposal is structured to be a collaborative effort being led by the Prince William Sound Science Center. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Pegau will act as the team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program. He will also be responsible for outreach and public input efforts.

Dr. Pegau currently is the coordinator of the existing EVOSTC funding PWS Herring Survey program. This program consists of ten individual projects that provide a coordinated examination of juvenile herring in Prince William Sound. This proposal is heavily influenced by the early findings from that effort. Dr. Pegau also serves as the Research Program Manager for the Oil Spill Recovery Institute (OSRI). In that capacity he is responsible for developing annual work plans, ensuring proper reporting, making reports available, developing partnerships to leverage funding, and to ensure outreach of OSRI activities. All activities that provide experience delivering the team leader duties outline in the request for proposals.

One of his duties is to ensure proper scientific oversight of the research programs. To accomplish this we will be setting up a four-person scientific oversight panel that will help guide the program and ensure the research is relevant to the long-term goal. The team will consist of people representing Alaska Department of Fish and Game, the National Oceanic and Atmospheric Administration, academia, and the local fishing community. There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year's work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermens United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydroacoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

Other important programs for coordinating with are the existing PWS herring survey program and existing ADF&G herring research. This program has been developed with input from both of these programs and the focus of this proposal is extending the interpretation of the data from those two programs. The Herring Survey program will still be operating in FY12 and FY13. There are field observations scheduled in FY12 and in FY13 funds are strictly for analysis and report writing. Included in the report writing is a synthesis of previous and current research. This report will be finished in FY13 and be the basis for the synthesis required under this request for proposals.

E. Research Team Roles

This proposed program is made up from several projects led by Principal Investigators from a number of institutions. We provide a brief description of the role of each Principal Investigator. Curriculum Vitae for the Principal Investigators are provided at the end of the proposal.

Dr. W. Scott Pegau (PWSSC) is to provide coordination of the projects and will also work with the ROV based validation approach and support the study of how herring growth determined from the scale analysis may be connected to environmental conditions.

Dr. Paul Hershberger (USGS) will lead the disease related research components including monitoring for the presence of disease and development of new techniques for monitoring for disease.

Dr. Ron Heintz and Johanna Vollenweider (NOAA) will conduct the research on juvenile condition, fatty acid analysis, genetic stock structure studies, and detection of primiparous fish.

Dr. Jeffrey Guyon and Sharon Wildes (NOAA) will lead the research on identifying stock structure through genetic markers.

Steve Moffitt (ADF&G) will lead the effort to digitize herring scales for the purpose of determining the annual growth intervals.

Dr. Thomas Kline Jr. (PWSSC) will lead the effort for monitoring and research related to energetic condition of age 0 herring.

Dr. Mary Anne Bishop (PWSSC) will lead the direct capture efforts needed for validation of hydroacoustic measurements and disease and condition studies. She will also co-lead the effort to test acoustic tagging in wild herring with Dr. Sean Powers (University of South Alabama).

Dr. Michele Buckhorn (PWSSC) will lead the hydroacoustic surveys for adult and juvenile herring.

Shane StClair (Axiom) will lead the data management and visualization efforts.

Dr. Kevin Boswell (LSU) will lead the efforts to test visible and acoustic imaging systems for validation of hydroacoustic measurements.

F. Data Management

The PWS Herring Survey program has a web presence at http://www.pwssc.org/herringsurvey/index.shtml where basic information about each program can be found and links to the annual reports on the EVOSTC website. We propose to continue to use this as a place to make documents associated with the herring program accessible. We propose to work with the Alaska Ocean Observing system and their data management team at Axiom Consulting for data management and visualization efforts. This effort includes bringing the existing PWS herring portal data into the AOOS data visualization and management framework, along with other important historical herring data sets. Data management plans will also be developed for each research study to ensure that detailed metadata is drafted and that data generated by projects is discoverable, understandable and ultimately usable by other researchers and interested parties. The first year efforts are expected to focus on visualization with increased efforts in the second year developing tools to aid researchers in making their data available. The data submission tools will build upon tools for data management currently being developed for PWSSC researchers under OSRI funding.

G. Outreach and Community Involvement

We will hold annual Principal Investigator meetings in Cordova during the spring and the public will be encouraged to attend and provide feedback. We will work with Cordova District Fishermen United to gather input on the programs from the fishing community. We will also be working with them on sample collection efforts. We will also use the Cordova meeting as one of our opportunities to keep the public informed of our activities. We plan to use the herring survey website (http://www.pwssc.org/herringsurvey/) as another tool for keeping people informed. Included on the website is contact information to reach the Principal Investigators and we intend to change the site to emphasize that we would like input on the programs. The description of more directed outreach efforts follows.

We propose to build off our successes in the existing PWS Herring Survey Program outreach efforts. One of our primary outreach tools is through the development of project profiles. These are one page descriptions of the various projects and their findings. They are designed with the general public as the primary audience. These are the basis for information on the herring website and for articles in the Delta-Sound Connections, a broadly distributed annual paper describing research in PWS and Copper River Delta. Additionally Field Notes radio programs will be developed each year. These radio programs are aired by KCHU, the PWS public radio station. We are proposing to develop three such programs each year focusing on different aspects of the program. Furthermore we propose to support the PWSSC community lecture series. This lecture series is held weekly through the winter and is transmitted to Valdez through the Prince William Sound Community College. We expect that at minimum of three projects each year will provide lectures on their results through this series. Results from the research will also be incorporated into classroom and summer camp activities. These camps involve youth from around Prince William Sound and the Anchorage area.

The first year of this program overlaps with the existing PWS Herring Survey Program. Our outreach program will use the overlap period to focus on being able to expand the coverage of the outreach efforts. The intention is to provide activities that groups outside our delivery area will utilize without direct funding from this program. To increase the geographic impact of the programs we propose to modify the current PWS herring school-year and summer activities so that the focus is on how a fishery (PWS herring) is affected by changes in the ecosystem. The resultant activities will focus on the ecosystem, which is more transferable, than on a particular fish population. At the same time it will continue to use PWS herring as the central example, which maintains its relevance to this program. The second activity that will take place in the first year is to market the revised programs to other marine education programs in the state.   It is important to actively market the activities if we expect them to be utilized by other groups.

H. Description of Study Area

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis.   As part of the synthesis effort we will be reviewing the question “What is the appropriate sampling distribution?” as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

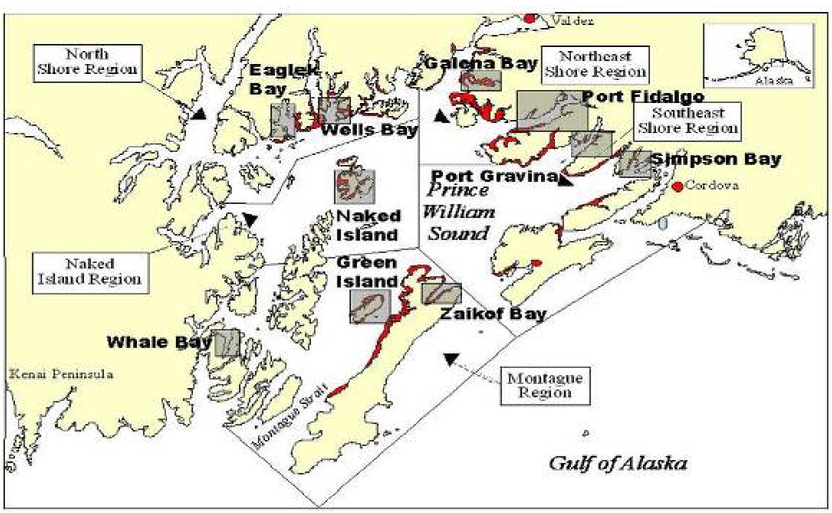

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

III. SCHEDULE

A. Measurable Project Tasks

FY12 1st Quarter (October 1, 11 to December 31, 11)

October	Begin juvenile condition intensive, primiparous fish, and herring scale analysis
October	Purchase acoustic tags
October	Acquire herring for laboratory study
November	Tag adult herring
December	Develop criteria for selection of scales to be processed

FY12 2nd Quarter

January	Annual Marine Science Symposium
January	Begin fasting herring in laboratory
March	Conduct trial scale processing, finalize scale processing design
March	Complete ordering equipment
March	Download acoustic array data
March	Obtain samples for fatty acid analysis, end fasting study

FY12 3rd Quarter

May	Conduct annual PI meeting
June	Submit FY13 work plan for review
June	Collect histology samples (timing depends on results of laboratory study)
June	Download acoustic array data, complete sampling for juvenile intensive

FY12 4th Quarter

August	Submit annual report

FY13 1st Quarter (October 1, 12 to December 31, 12)

October	Begin fatty acid analysis
November	Conduct juvenile index survey
November	Tag adult herring

FY13 2nd Quarter

January	Annual Marine Science Symposium
March	Conduct spring juvenile collection
March	Download acoustic array data

FY13 3rd Quarter

April	Conduct extended adult biomass cruise, collect samples for genetics & histology
May	Conduct annual PI meeting
June	Submit FY14 work plan for review
June	Download acoustic array data

FY13 4th Quarter

August	Submit annual report
September	Complete fatty acid analysis, complete scale analysis

FY14 1st Quarter (October 1, 13 to December 31, 13)

October	Submit synthesis to EVOS science council
October	Begin acoustic intensive study, Begin disease laboratory studies
November	Conduct juvenile index survey, test non-lethal sampling systems
December	Complete acoustic tagging project

FY14 2nd Quarter

January	Annual Marine Science Symposium
March	Complete histology study, complete acoustic intensive
March	Conduct spring juvenile collection
Winter	EVOS sponsored workshop with Herring and Long-term monitoring programs

FY14 3rd Quarter

April	Conduct extended adult biomass cruise, collect samples for genetics
May	Conduct annual PI meeting
June	Submit FY15 work plan for review

FY14 4th Quarter

August	Submit annual report

FY15 1st Quarter (October 1, 14 to December 31, 14)

November	Conduct juvenile index survey

FY15 2nd Quarter

January	Annual Marine Science Symposium
March	Conduct spring juvenile collection

FY15 3rd Quarter

April	Conduct extended adult biomass cruise
May	Conduct annual PI meeting
May	Submit five-year plan for FY17-22 and work plan for FY16

FY15 4th Quarter

August	Submit annual report
September	Complete genetics analysis

FY16 1st Quarter (October 1, 15 to December 31, 15)

November	Conduct juvenile index survey

FY16 2nd Quarter

January	Annual Marine Science Symposium
March	Conduct spring juvenile collection

FY16 3rd Quarter

April	Conduct extended adult biomass cruise
May	Conduct annual PI meeting
June	Submit work plan for FY17

FY16 4th Quarter

August	Submit annual report

IV BUDGET

Provided below in Table 1 is a general budget for the five year period from FY12 to FY16. The numbers in the budget are in thousands of dollars. There may be changes to the budget based on input from the scientific oversight panel, but we present this budget to show the proposed work can fit within the funds available. The budget indicates which projects are expected to be receiving funding and at what level in any given year. *This budget assumes that funding to Trustee agencies will be provided directly to that agency and not through the PWSSC.* Routing funding for Trustee agencies through the PWSSC will cause very significant increases in overhead costs and may incur difficulties in transferring funding from a non-profit organization to a state or federal agency. All non-Trustee organizations involved in this proposal are included as subcontracts to the PWSSC.

The budget provided does not start at one million dollars and increase by 2.75% as described in the request-for-proposals (RFP), but does request the same total dollar amount as indicated in the RFP. The requested funding profile is necessary to achieve the scientific objectives and maximize the ability to share resources.

Table 1. Budget by project and year.

Herring Research	**Lead Organization**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**TOTALS**
Coordination/logistics	PWSSC	178.4	218	240	236.3	225	1097.7
Disease research and monitoring	USGS			267.5	262.0	267.5	797
Herring scales	ADF&G	87.4	42.5				129.9
RNA condition	NOAA		84	84	84	84	336
RNA condition intensive	NOAA	30					30
Primiparous herring	NOAA	23.5	28				51.5
Fatty acid indicators	NOAA		60				60
Genetic stock indicators	NOAA			43	52		95
Energetic condition	PWSSC		130	135	143.7	148.9	557.6
Energetic intensive	PWSSC	159.9	70.9	18.7			249.5
Direct capture	PWSSC	62.4	83.1	135.8	129.4	133.3	544
Acoustic tagging	PWSSC	65	18	16			99
Juvenile acoustic survey	PWSSC	82	71.9	60.1	78.7	77.4	370.1
Juvenile acoustic intensive	PWSSC	24.5		85.5	6.1		116.1
Expanded adult surveys	PWSSC	6.3	76.1	61.5	83.1	80.6	307.6
Non-lethal collection	PWSSC LSU	56		87			143
Data management	PWSSC Axiom	120	120	20	20	20	300
TOTAL		895.4	1002.5	1254.1	1095.3	1036.7	5284

The selection of projects to be conducted in FY12 was primarily driven by the desire to have the best information available to inform the synthesis effort. The ability to address assumptions in the ASA model and testing new technologies also contributed to the selection of projects in FY12. The scheduling of projects in out years was based on building on the existing research programs and ensuring that the projects can support each other.

The coordination and logistics project also includes support for outreach and public involvement efforts. The outreach and public involvement components are described in the text. Part of the coordination effort is the scientific oversight, therefore the budget contains travel funding for participants on that panel to attend an annual P.I. meeting. The logistics component focuses on vessel support. All ship time requests are included in the budget of the coordination and logistics project.

An approximate breakdown each year by major spending category is provided in Table 2. A detailed budget with exact amounts in each category will be provided if we are selected for the herring research.

Table 2. Spending breakdown by category

Herring Research all projects	Year 1	Year 2	Year 3	Year 4	Year 5	TOTALS
Personnel	221	354.8	498	531.3	515.4	2120.5
Travel	19.9	23.9	32.7	37	28.9	142.4
Contracts	299.2	425.2	425	258.5	258	1665.9
Supplies	61.1	37.5	79.3	89	57.4	324.3
Equipment	188.2		0			188.2
Subtotal of Direct costs	789.4	841.4	1035	915.8	859.7	4441.3
Modified Indirect Cost	124	161.1	201.1	179.5	177	842.7
Grand Total	913.4	1002.5	1236.1	1095.3	1036.7	5284

Budget Justification:

Year 1: Year one funding has a low request for personnel because we are utilizing the overlap with the existing PWS Herring Survey Program to be able to reduce the costs of the proposed programs. Salary requests are primarily associated with the herring scale analysis, condition intensive, and herring tagging projects. Travel is for meeting with collaborators and bringing people to Cordova for cruises. Contracts are primarily for the data management, vessel charters, and sample analysis. Much of the funding to NOAA is to be spent through contracts. The supplies request includes normal cruise and laboratory items, but is dominated by the purchase of acoustic tags for the herring tagging project. The equipment in year one includes new hydroacoustic system and processing software, trawl winches, a catch monitor, and a ROV for optical detection of fish.

Year 2: In this year our salary request increases as the proposed monitoring programs come fully on line and we do not have overlap with the existing herring program except in the synthesis development component. Salary requests are primarily from PWSSC with additional request from the scale analysis project. Travel is for meeting with collaborators, attending scientific meetings, and bringing people to Cordova for cruises. Contracts are primarily for the data management, vessel charters, sample analysis, and NOAA contractual work. The supplies request includes normal cruise and laboratory items.

Year 3: Two factors lead to the increased request in salary. The first is that in this year there is a set of intensive acoustic studies that require additional personnel time. The second is that the USGS led disease research project begins in this year.   Additional salary support is requested for the proposed monitoring programs. Travel is for meeting with collaborators, attending scientific meetings, and bringing people to Cordova for cruises. Contracts are primarily for the data management, vessel charters, sample analysis, and NOAA contractual work.   The contract with Louisiana State University is budgeted in this year. The supplies request includes normal cruise and laboratory items.   The laboratory portions of the disease research program contribute to the increased level of supplies needed beginning in this year.

Year 4: The salary support requested is primarily for the disease research and the monitoring programs. Travel is for meeting with collaborators, attending scientific meetings, and bringing people to Cordova for cruises. The decrease in contractual funding request is associated with the end of contract heavy projects and a focus on monitoring and analysis. Contracts are primarily for the data management, vessel charters, and sample analysis.   The supplies request includes normal cruise and laboratory items.

Year 5: The salary support requested is primarily for the disease research and the monitoring programs. Travel is for meeting with collaborators, attending scientific meetings, and bringing people to Cordova for cruises. Contracts are primarily for the data management, vessel charters, and sample analysis.   The supplies request includes normal cruise and laboratory items.

V. CURRICULUM VITAS

BIOGRAPHICAL SKETCH

W. Scott Pegau

Oil Spill Recovery Institute
Box 705
Cordova, AK 99574
ph: 907-424-5800 x222
email: wspegau@pwssc.org

Education:

1990	B.S., Physics, University of Alaska, Fairbanks
1996	Ph.D, Oceanography, Oregon State University

Professional Experience:

1987-1990	Research Assistant, University of Alaska, Fairbanks
1990-1996	Graduate Research Assistant, Oregon State University
1996-1997	Research Associate (Post Doc), Oregon State University
1997-1999	Faculty Research Associate, Oregon State University
1999-2010	Assistant Professor, Oregon State University
2002-2003	Senior Scientist, Kachemak Bay Research Reserve
2003-2007	Research Coordinator, Kachemak Bay Research Reserve
2007-present	Research Program Manager, Oil Spill Recovery Institute

Research Interests:

To develop novel oil spill detection and tracking approaches. Understanding the fate and behavior of oil spilled in cold water environments. Development of response options for oceans with sea ice present. Circulation in Prince William Sound, Cook Inlet and the Gulf of Alaska and the associated larval transport. Relationship between oceanographic conditions and fisheries. Application of remote sensing for understanding coastal processes.

I am working to improve technologies for responding to oil spills in arctic and subarctic waters. I am also currently involved in the ONR Radiance in a Dynamic Ocean (RaDyO) project collecting optical instruments on an AUV.

Publications

Some recent publications

Montes-Hugo, M. A., K. Carder, R. J. Foy, J. Cannizzaro, E. Brown, and S. Pegau, Estimating phytoplankton biomass in coastal waters of Alaska using airborne remote sensing, *Remote Sens. Environ.* **98**, 481-493, 2005.

Wijesekera, H. W., W. S. Pegau, and T. J. Boyd, The effect of surface waves on the irradiance distribution in the upper ocean, *Optics Express*, **23**, 9267-9264, 2005.

Pegau, W. Scott, Inherent optical properties of the central Arctic surface waters, *J. Geophys Res*, **107**, doi. 10.1029/2000JC000382, 2002.

Bartlett, J. S., M. R. Abbott, R. M. Letelier, and W. S. Pegau, Analysis of a method to estimate chlorophyll-a concentration from irradiance measurements at varying depths, *J. Atmos. Ocean. Tech.*, **18**, 2063-2073, 2001.

Chang G. C., T. D. Dickey, O. M. Schofield, A. D. Weidemann, E. Boss, W. S. Pegau, M. A. Moline, and S. M. Glenn, Nearshore physical forcing of bio-optical properties in the New York Bight. *J. Geophys. Res*., **107**, 10.1029/2001JC001018, 2002.

Pegau, W. S., and C. A. Paulson, The albedo of Arctic leads in summer, *Annals of Glaciology*, **33,** 221-224, 2001.

Skyllingstad, E. D., C. A. Paulson, and W. S. Pegau, Simulation of turbulent exchange processes in summertime leads, *J. Geophys. Res.,* **110**, doi:10.1029/2004JC002502, 2005.

Boss, E., R. Collier, G. Larson, K. Fennel, and W. S. Pegau, Measurements of spectral optical properties and their relation to biogeochemical variables and processes in Crater Lake National Park, OR. Hydrobiologia, DOI 10.1007/s10750-006-2609-3, 2007.

Skyllingstad E. D., C. A. Paulson, W. S. Pegau, M. G. McPhee, T. Stanton, Effects of keels on ice bottom turbulence exchange, *J. Geophys. Res.,* **108**, 3372, 2003.

Pegau, W.S., and R. Potter, *Visible remote sensing of the Gulf of Alaska*, Gulf Ecosystem Monitoring and Research final report Project G030685, pp. 51, 2004.

Collaborators

A. H. Barnard (Wetlabs), T. Boyd (OSU), G. C. Chang (UCSB), S. Saupe (CIRCAC), M. Twardowski (WETLabs), H. Wijesekera (OSU/NSF)

ABBREVIATED RESUME

Paul K. Hershberger, Ph.D.
USGS - Marrowstone Marine Field Station
616 Marrowstone Point Road, Nordland, WA 98358
Telephone: (360) 385-1007, Ext 225, Email: phershberger@usgs.gov

Professional Interests

Disease ecology and processes affecting the health and survival of wild fishes
Effects of multiple stressors on the health and survival of wild fishes
Climatic/oceanic factors affecting populations of wild fishes

Membership in Professional Organizations

American Fisheries Society (AFS), and Fish Health Section (FHS)
International Society of Aquatic Animal Epidemiology (ISAAE)
Pacific Northwest Society of Environmental Toxicology and Chemistry (PNW SETAC)
American Society of Limnology and Oceanography (ASLO)

Recent Positions

2010 – Present: Affiliate Associate Professor: School of Aquatic and Fishery Sciences, University of Washington.

2004 – 2010: Affiliate Assistant Professor: School of Aquatic and Fishery Sciences, University of Washington.

2003 – Present: Research Fishery Biologist and Station Leader: USGS- Marrowstone Marine Field Station

1999-2003: Faculty Research Associate - University of Washington

2003: Co-Instructor, UW – Friday Harbor Labs: FISH-499B “Emerging Diseases and Latent Infections in Aquatic Organisms”

2001: Instructor, UW – School of Aquatic and Fishery Sciences: FISH 404 "Diseases of Aquatic Organisms"

2001: Co-Instructor, UW – Friday Harbor Labs: FISH 499B: "Latent Viruses in Marine Fish,"

2000: Co-Instructor, UW – Friday Harbor Labs: FISH-499B: "Marine Fish Disease Research"

Education:

Ph.D. Fisheries, University of Washington 1998

M.S. Fisheries, University of Washington 1995

B.S. Chemistry & Biology, Northland College (Manga Cum Laude) 1993

Recent Awards and Honors:

2008: USGS STAR Award

2004: USGS Exemplary Act Award

2004: USGS STAR Award

2001: Most significant paper of the year 2001: Journal of Aquatic Animal Health

Five Selected Publications Relevant to this Proposal:

Vollenweider, J.J., J. Gregg, R.A. Heintz, P.K. Hershberger. *In Press*. Energetic cost of *Ichthyophonus* infection in juvenile Pacific herring (*Clupea pallasi*). Parasitology Research.

Gregg J, J Vollenweider, C Grady, R Heintz, P Hershberger. *In Press*. Effects of environmental temperature on the kinetics of ichthyophoniasis in juvenile Pacific herring (*Clupea pallasii*). Parasitology Research

Grady, C.A., J.L. Gregg, R.M. Collins, P.K. Hershberger. 2011. Viral Replication in Excised Fin Tissues (VREFT) corresponds with prior exposure of Pacific herring, *Clupea pallasii* (Valenciennes), to *viral haemorrhagic septicaemia virus* (VHSV). Journal of Fish Diseases 34: 34:-12.

Hershberger PK, JL Gregg, CA Grady, L Taylor, JR Winton. 2010. Chronic and persistent viral hemorrhagic septicemia virus infections in Pacific herring. Diseases of Aquatic Organisms 93: 43-49.

Hershberger P, J Gregg, C Grady, R Collins, J Winton. 2010. Kinetics of viral shedding provide insights into the epidemiology of viral hemorrhagic septicemia in Pacific herring. Marine Ecology Progress Series 400: 187-193.

Five Additional Selected Publications

Hart L, GS Traxler, KA Garver, J Richard, JL Gregg, CA Grady, G Kurath, PK Hershberger. 2011. Larval and juvenile Pacific herring *Clupea pallasii* are not susceptible to infectious hematopoietic necrosis under laboratory conditions. Diseases of Aquatic Organisms 93: 105-110.

Hershberger, P.K., B.K. van der Leeuw, J.L. Gregg, C.A. Grady, K. Lujan, S. Gutenberger, M. Purcell, J.C. Woodson, J.R. Winton, M. Parsley. 2010. Amplification and transport of an endemic fish disease by an invasive species. Biological Invasions 12: 3665-3675.

Kocan R, H Dolan, P Hershberger. *In Press*. Diagnostic methodology is critical for accurately determining the prevalence of *Ichthyophonus* infections in wild fish populations. Journal of Parasitology.

Hershberger PK, JL Gregg, CA Grady, RM Collins, JR Winton. 2010. Susceptibility of three stocks of Pacific herring to viral hemorrhagic septicemia. Journal of Aquatic Animal Health 22: 1-7.

Kocan, R. M., J. L. Gregg, P. K. Hershberger. 2010. Release of infectious cells from epidermal ulcers in *Ichthyophonus* sp. – infected Pacific herring (*Clupea pallasii*): evidence for multiple mechanisms of transmission. Journal of Parasitology 96: 348-352.

Recent Collaborators and Co-Authors:

J Winton (USGS), E. Emmenegger (USGS), N. Elder (USGS), D. Elliott (USGS), J. Gregg (USGS), J. Hansen (USGS), R. Kocan (UW-SAFS), G. Kurath (USGS), M. Parsley (USGS), L Hart (USGS), S. LaPatra (Clear Springs Foods), M. Purcell (USGS),G. Traxler (DFO), K. Garver (DFO), J Lovy (HCRS), S. Gutenberger (USFWS), R. Heintz (NOAA).

Curriculum vitae

Ron A. Heintz

Fishery Research Biologist
National Marine Fisheries Service
Auke Bay Laboratory
11305 Glacier Hwy.
Juneau, AK 99801 USA

Voice: (907) 789-6058
Fax : (907)789-6094
EMAIL: Ron.Heintz@NOAA.GOV

EDUCATION:

B.S. Ecology Ethology and Evolution, June 1979, University of Illinois, Urbana May 1979
M.S. Fisheries Biology, May 1987, University of Alaska, Juneau May 1985
PhD: Fisheries Biology, University of Alaska, Fairbanks. May 2009

PROFESSIONAL MEMBERSHIPS:

American Fisheries Society
American Institute of Biological Scientists
American Association for the Advancement of Science

EMPLOYMENT AND STUDY FOCUS:

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory since 1985.

Since 2000
Leads AFSC Nutritional Ecology Laboratory program investigating the nutritional status and trophic relationships of marine forage species.
Prior to 2000
Examined the effects of crude oil exposure during embryogenesis on the life history of fish.

AUTHORSHIP

Authored 10 peer reviewed publications as lead author and 25 as co-author
Bibliography since 2005 is attached
MS Thesis; *Use of space and forage by Dolly Varden char in Osprey Lake*
PhD Dissertation: *Effects of adult salmon carcasses on juvenile salmonids.*

PRINCIPLE FINDINGS:

- The most environmentally persistent PAHs are also the most toxic to sensitive life stages
- Embryonic exposure to crude oil results in life long effects in pink salmon
- Fish populations chronically exposed to sublethal PAH loads have reduced fitness
- Fatty acids can be used to discriminate the energy sources consumed by predators
- The amount of energy available to consumers has a direct influence on life history strategy
- The critical size hypothesis works because the smallest individuals are most likely predated
- Fall energy reserves predict recruitment of age 0+ pollock to age 1+
- Humpback whales predation may account for lack of recovery of depressed herring stocks

CURRENT COLLABORATIONS

ADFG: Shawna Kaparovich,
UAF: Nicola Hillgruber, Elizabeth Siddon, Alexei Pinchuk
USGS: Paul Hershberger
NOAA AFSC: Thomas Hurst, Ben Laurel, Janet Duffy-Anderson, Mike Sigler, Ed Farley
UAS: Jan Straley

BIBLIOGRAPHY SINCE 2005

1. Farley, E. V., A. Starovoytov, S. Naydenko, **R. Heintz**, M. Trudel, C. Guthrie, L. Eisner and J. Guyon. In Press. Implication of a warming eastern Bering Sea on Bristol Bay sockeye salmon. ICES Journal of Marine Science. Accepted Jan. 5, 2011.
2. Hunt Jr., G. L., K. O. Coyle, L. Eisner, E. V. Farley, R. Heintz, F. Mueter, J. M. Napp, J. E. Overland, P. H. Ressler, S. Salo and P.J. Stabeno. InPress. Climate impacts on eastern Bering Sea food webs: A synthesis of new data and an assessment of the oscillating control hypothesis. ICES Journal of Marine Science. Accepted February 17, 2011.
3. Vollenweider, J. J., **R. A. Heintz**, L. Schaufler and R. Bradshaw. Submitted. Influence of habitat on the seasonal cycles in whole-body proximate composition and energy content of forage fish. Marine Biology. 158(2):413-427. DOI 10.1007/s00227-010-1569-3
4. **Heintz, R.** and J. J. Vollenweider. 2010. The influence of size on the sources of energy consumed by overwintering walleye pollock (*Theragra chalcogramma*). Journal of Experimental Marine Biology and Ecology 393:43-50.
5. \Cox, M.K., **R. A. Heintz** and K. Hartman. Sources of error in bioelectrical impedance analysis measures of resistance and reactance in fish. Fishery Bulletin 109:34-47.
1. **Heintz, R. A.**, M. S. Wipfli and J. P. Hudson. 2010. Identification of marine-derived lipids in juvenile coho salmon (*Oncorhynchus kisutch*) and aquatic insects using fatty acid analysis. Transactions of the American Fisheries Society 139:840-854.
2. Wipfli, MS, JP Hudson, JPCaouette, N. L. Mitchell, J.L. Lessard, **R. Heintz** and D.T. Chaloner. 2010. Salmon carcasses increase stream productivity more than inorganic fertilizer pellets: A test on multiple trophic levels in streamside experimental channels. Transactions of the American Fisheries Society 139:824-839.
3. Marty, G. D. and **R. Heintz**. 2010. Ruptured yolk sacs and visceral fungi in emergent pink salmon alevins: histopathology and relation to marine survival. Diseases of Aquatic Organisms 88:115-126.
4. Cox, M. K. and **R. A. Heintz**. 2009. The use of phase angle (PA) as a new condition index for live and dead fish. Fishery Bulletin 107:477-487.
5. Moles, A., and **R. A. Heintz**. 2007. Parasites of forage fishes in the vicinity of Steller Sea Lion (*Eumetopias jubatus*) habitat in Alaska. Journal of Wildlife Diseases 43(3):366-375.
6. **Heintz, R**. **A.** 2007. Chronic exposure to polynuclear aromatic hydrocarbons in natal habitats leads to decreased equilibrium size, growth and stability of pink salmon populations. Integrated Environmental Assessment and Management. 3(3):351-363.
7. Vollenweider, J. J., J. N. Womble, and **R. A. Heintz**. 2006. Estimation of seasonal energy content of Steller sea lion (*Eumetopias jubatus*) diet. Pages 155-176 *in* A. W. Trites, and coeditors, editors. Sea lions of the world. Alaska Sea Grant Colllege Program, University of Alaska Fairbanks, Fairbanks, Alaska.
8. Litzow, M. A., K. M. Bailey, F. G. Prahl, and **R. A. Heintz**. 2006. Climate regime shifts and reorganization of fish communities: the essential fatty acid limitation hypothesis. Marine Ecology Progress Series 315:1-11.
9. **Heintz, R. A**., and J. J. Vollenweider. 2006. Seasonal variation in energy allocation strategies of walleye pollock. National Marine Fisheries Service, Alaska Fisheries Science Center, Auke Bay Laboratory, Juneau, Alaska.
10. **Heintz, R. A**., M. M. Krahn, G. M. Ylitalo, and F. Morado. 2006. Organochlorines in walleye pollock from the Bering Sea and southeastern Alaska. Pages 664 *in* A. W. Trites, and coeditors, editors. Sea Lions of the World. Alaska Sea Grant College Program, University of Alaska Fairbanks, Fairbanks, Alaska.
11. Rice, S. D., and coauthors. 2005. Exxon Valdez Oil Spill: PAH persistence in intertidal sediments, bioavailability, and long term effects.
12. Carls, M. G., **R. A. Heintz**, G. D. Marty, and S. Rice, D. 2005. Cytochrome P4501A induction in oil-exposed pink salmon Oncorhynchus gorbuscha embryos predicts reduced survival potential. Marine Ecology Progress Series 301:253-265.
13. Barron, M. G., and coauthors. 2005. Assessment of the phototoxicity of weathered Alaska North Slope crude oil to juvenile pink salmon. Chemosphere 60:105-110.

Johanna J. Vollenweider
Fishery Research Biologist
NOAA Fisheries, Auke Bay Laboratories
Ted Stephens Marine Research Institute **Voice:** (907) 789-6612
17109 Pt. Lena Loop Rd. **Fax:** (907)789-6094
Juneau, AK 99801 USA **Email:** Johanna.Vollenweider@NOAA.GOV

EDUCATION:

B.S. Marine Biology, Chemistry Minor, June 1998, University of North Carolina, Wilmington
M.S. Fisheries Biology, May 2005, University of Alaska Fairbanks

PROFESSIONAL MEMBERSHIPS:

American Fisheries Society
Marine Mammal Society

EMPLOYMENT AND STUDY FOCUS:

1999 – Present ZPIII – Fisheries Research Biologist

NOAA Fisheries, Auke Bay Laboratories
Nutritional Ecology Laboratory
Juneau, Alaska
Investigating the nutritional status and trophic relationships of marine forage species.

PUBLICATIONS:

Vollenweider J, Gregg J., Heintz R.A., Hershberger P. (In Press) Energetic cost of Ichthyophonus infection in juvenile Pacific herring (*Clupea pallasii*). Journal of Parasitology.

Vollenweider J, Heintz R. (In Press) Seasonal variation in whole-body proximate composition and energy content of forage fish in southeastern Alaska. Journal of Marine Biology.

Gregg J.L., **Vollenweider J.**, Grady C.A., Heintz, R.A., Hershberger, P. (In Press) Effects of environmental temperature on the kinetics of ichthyophoniasis in juvenile Pacific herring (*Clupea pallasii*). Journal of Parasitology.

Csepp D., **Vollenweider J.**, Sigler M. (In Press) Seasonal abundance and distribution of pelagic and demersal fishes in southeastern Alaska. Fisheries Research.

Wildes S, **Vollenweider J**, Guyon J. (Submitted) Genetic stock structure of Pacific herring (*Clupea pallasi*) in Lynn Canal, Southeast Alaska. Fish Bull.

Churnside, J.H., Brown, E.D., Parker-Stetter S., Horne J.K., Hunt G.L., Hillgruber N., Sigler M.F., **Vollenweider J.** (In Press) Airborne remote sensing of a biological hot spot in the southeastern Bering Sea. Remote Sensing.

Heintz R, **Vollenweider J.** (2010) Influence of size on the sources of energy consumed by overwintering walleye pollock (Theragra chalcogramma). J Exp Mar Biol Ecol 393(1-2):43-50

Boswell K, **Vollenweider J**. (*In Draft*) Comparison of acoustic methods of fish biomass estimation.

Sigler M, Tollit D, **Vollenweider J**, Thedinga J, Csepp D, Womble J, Wong M, Rehberg, M Trites A. 2009. Foraging response of a marine predator, the Steller sea lion, to seasonal changes in prey availability. Marine Ecology Progress Series. 388:243-242.

Schaufler L, **Vollenweider J**, Moles A. 2008. Changes in the lipid class and proximate compositions of coho salmon (*Oncorhynchus kisutch*) smolts infected with the nematode parasite *Philonema agubernaculum*. Comp. Biochem. Physiol. 149B:148-152.

Ormseth OA, Conners L, Guttormsen M, **Vollenweider J**. 2008. Forage fishes in the Gulf of Alaska. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, Appendix 2, p. 657-702. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252. FY09

Vollenweider J, Womble J, Heintz R. 2006. Estimation of seasonal energy content of Steller sea lion (*Eumetopias jubatus*) diet, p. 155-176. In A. W. Trites, S. K. Atkinson, D. P. DeMaster, L. W. Fritz, T. S. Gelatt, L. D. Rea, and K. M. Wynne (eds.), Sea Lions of the World. Alaska Sea Grant College Program Publication AK-SG-06-01, University of Alaska Fairbanks, Fairbanks, Alaska.

CURRENT PROJECTS:

Vollenweider J, Heintz R, Hershberger P. Do energy limitations cause overwinter mortality of young-of-the-year and juvenile Pacific herring (*Clupea pallasi*)? Funded by the Exxon Valdez Oil Spill Trustee Council.

Heintz R, Vollenweider J. PWS Herring Survey: Value of growth and energy storage as predictors of winter performance in YOY herring in PWS. Funded by the Exxon Valdez Oil Spill Trustee Council.

Cox K, **Vollenweider J**, Heintz R, Hershberger P. Bioenergetic models for Pacific herring; create or borrow? Funded by the Exxon Valdez Oil Spill Trustee Council.

Boswell K, **Vollenweider J**. (*In Draft*) Contrasting biomass estimates of schooling herring derived with an imaging sonar and traditional echosounder.

Boswell K, **Vollenweider J**. Winter herring biomass in Lynn Canal and Sitka Sound, Alaska.

Vollenweider J, Heintz R, Hudson J. Overwinter energetics of juvenile capelin. Funded by NOAA Essential Fish Habitat Funds.

Ron Heintz, John Moran, **Johanna Vollenweider**, Jan Straley, Terrence Quinn, Suzie Teerlink and Stan Rice. Impacts of Whale Foraging on Three Herring Populations in Alaska (Prince William Sound, Lynn Canal, Sitka Sound). Funded by the Exxon Valdez Oil Spill Trustee Council.

RECENT COLLABORATORS:

Boswell, Kevin. Louisiana State University, LA
Cox, Keith. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK
Csepp, Dave. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK
Gregg, Jake. USGS, Marrowstone Marine Field Station, Nordland, WA
Heintz, Ron. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK
Hershberger, Paul. USGS, Marrowstone Marine Field Station, Nordland, WA
Hilgruber, Nicola. University of Alaska Fairbanks, Juneau, AK
Hudson, John. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK
Kline, Tom. Prince William Science Center, Cordova, AK
Moffit, Steve. Alaska Dept. of Fish and Game, Cordova, AK
Moran, John. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK
Ormseth, Olav. NOAA Fisheries, Alaska Fisheries Science Center, Seattle, WA
Pegau, Scott. Prince William Science Center, Cordova, AK
Quinn, Terrance. University of Alaska Southeast, Sitka, AK
Rice, Stan. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK
Sigler, Mike. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK
Straley, Jan. University of Alaska Southeast, Sitka, AK
Wildes, Sharon. NOAA Fisheries, Alaska Fisheries Science Center, Seattle, WA
Womble, Jamie. University of Alaska Fairbanks, Juneau, AK

Jeffrey R. Guyon
17109 Point Lena Loop Rd, Ted Stevens Marine Research Institute
Juneau, AK 99801
jeff.guyon@noaa.gov Work: (907) 789-6079 Home: (907) 500-9701

EDUCATION:

Jun 1983 - May 1987	B.S. in Mathematics, U.S. Coast Guard Academy, New London, CT
Aug 1993 - Aug 2000	Ph.D. in Biochemistry, University of Notre Dame, Notre Dame, IN

EMPLOYMENT AND WORK EXPERIENCE:

May 1987 - Jun 1993	U.S. Coast Guard, Officer
Aug 1993 - Aug 1997	Graduate student, University of Notre Dame, South Bend, IN
Aug 1997 - Aug 2000	Completed thesis work as a graduate student at Massachusetts General Hospital, Boston, MA
Aug 2000 - Dec 2004	Post-doctoral fellowship, laboratory of Louis M. Kunkel at the Children's Hospital Boston/Harvard Medical School, Boston, MA
Jan 2005 – Jun 2007	Instructor, Children's Hospital/Harvard Medical School, Boston, MA
Jul 2007 – Jun 2008	Fisheries Geneticist, AK Department of Fish and Game, Anchorage, AK
Jul 2008 – Apr 2010	Supervisory Research Geneticist, NMFS Auke Bay Laboratories
Apr 2010 – present	Program Manager, Genetics Program, NMFS Auke Bay Laboratories.

RECENT GRANT SUPPORT:

May 2007 – Mar 2011	Genetic Analysis of Immature Bering Sea Chum (AYKSSI) . Jul 2009 -
Jun 2010	Genetic Analysis of 2008 Chinook Bycatch (AKSSF)
Jul 2009 – Mar 2011	2009 N Boundary Sockeye Districts 101/4 (AKSSF)
Oct 2009 – Dec 2010	Genetic Analysis of Immature Chum Salmon from the 2006-7 BASIS Cruises (BSFA)
Jul 2010 – Mar 2011	Homogeneity of Chinook in Trawls (AKSSF)
Jul 2010 – Sep 2012	Shared Chum Salmon Baseline Development (AKSSF and AYKSSI)
Nov 2010 – Jun 2012	2010 Northern Boundary Area Sockeye Salmon Genetic Stock Identification (Northern Fund)

SCIENCE PUBLICATIONS:

1. Guyon, J.R., Narlikar, G.J., Sif, S. and R.E. Kingston RE. 1999. Stable remodeling of tailless nucleosomes by the human SWI-SNF complex. Mol. Cell. Biol. **19**:2088-97.
2. Shao, Z., Raible, F., Mollaaghababa, R., Guyon, J.R., Wu, C.T., Bender, W. and R.E. Kingston. 1999. Stabilization of chromatin structure by PRC1, a Polycomb complex. Cell **98**:37-46.
3. Kwon, J., Morshead, K.B., Guyon, J.R., Kingston, R.E. and M.A. Oettinger. 2000. Histone acetylation and hSWI/SNF remodeling act in concert to stimulate V(D)J cleavage of nucleosomal DNA. Mol Cell. **6**:1037-48.
4. Guyon, J.R., Narlikar, G.J., Sullivan, E.K. and R.E. Kingston. 2001. Stability of a human SWI-SNF remodeled nucleosomal array. Mol. Cell. Biol. **21**:1132-44.
5. Sullivan, E.K., Weirich, C.S., Guyon, J.R., Sif, S., and R.E. Kingston. 2001. Transcriptional activation domains of human heat shock factor 1 recruit human SWI/SNF. Mol. Cell. Biol. 2001. **21**:5826-37.
6. Mizuno, Y., Thompson, T.G., Guyon, J.R., Lidov, H.G., Brosius, M., Imamura, M., Ozawa, E., Watkins, S.C. and L.M. Kunkel. 2001. Desmuslin, an intermediate filament protein that interacts with alpha-dystrobrevin and desmin. Proc. Natl. Acad. Sci. USA **98**:6156-61.
7. Spencer, M.J., Guyon, J.R., Sorimachi, H., Potts, A., Richard, I., Herasse, M., Chamberlain, J., Dalkilic, I., Kunkel, L.M., and J.S. Beckman. 2002. Stable expression of calpain-3 from a muscle

transgene *in vivo*: Immature muscle in transgenic mice suggests a role for calpain-3 in muscle degeneration. Proc. Natl. Acad. Sci. USA **99**:8874-9.

8. Guyon, J.R., Mosley, A.N., O'Brien, K.F., Volinski, J.M., Zhou, Y., Davidson, A.J., Sheng, X., Chiang, K., Zon, L.I. and L.M. Kunkel. 2003. The dystrophin associated protein complex in zebrafish. Hum. Mol. Genet. **12**:601-15.
9. Guyon, J.R., Kudryashova, E., Potts, A., Dalkilic, I., Brosius, M., Thompson, T.G., Beckmann, J.S., Kunkel, L.M. and M.J. Spencer. 2003. Calpain 3 cleaves filamin C and regulates its ability to interact with gamma and delta sarcoglycans. Muscle Nerve. **28**:472-83.
10. Mizuno, Y., Guyon, J.R., Watkins, S.C., Mizushima, K., Sasaoka, T., Imamura, M., Ozawa, E., Kunkel, L.M. and K. Okamoto. 2004. □-synemin localizes to regions of high stress in human skeletal myofibers. Muscle Nerve. **30**:337-46.
11. Guyon, J.R., Mosley, A.N., Jun, S.J., Montanaro, F., Steffen, L.S., Zhou, Y., Montanaro, F., Nigro, V., Zon, L.I. and L.M. Kunkel. 2005. □-Sarcoglycan is required for early zebrafish muscle organization. Exp Cell Res. **304**:105-15
12. Steffen, L.S., Guyon, J.R., Vogel, E.D., Zhou, Y., Weber, G.J., Zon, L.I. and L.M. Kunkel. 2007. The zebrafish runzel muscular dystrophy is linked to the titin gene. Dev. Biol. **309**:180-92.
13. Langenau, D.M., Keefe, M.D., Storer, N.Y., Guyon, J.R., Kutok, J.L., Le, X., Houvras, Y., Goessling, W., DiBiase, A., Neuberg, D., Kunkel, L.M., and L.I. Zon. 2007. Effects of RAS on the genesis of embryonal rhabdomyosarcoma. Genes Dev. 21:1382-95.
14. Mizuno, Y., Guyon, J.R., Ishir, A., Hoshino, S., Ohkoshi, N., Tamaoka, A., Okamoto, K. and L.M. Kunkel. 2007. □-synemin expression in cardiotoxin-injected rat skeletal muscle. BMC Musculoskelet Disord. **8**:40.
15. Mizuno, Y., Guyon, Okamoto, K. and L.M. Kunkel. 2007. □-Synemin expression in brain. Muscle Nerve. **36**:497-504.
16. Steffen, L.S., Guyon, J.R., Vogel, E.D., Beltre, R., Pusack, T.J., Zhou, Y., Zon, L.I. and L.M. Kunkel. 2007. Zebrafish orthologs of human muscular dystrophy genes. BMC Genomics. **8**:79.
17. Guyon, J.R., Goswami, J., Jun, S.J., Thorne, M., Howell, M., Pusack, T., Kawahara, G., Steffen, L.S., Galdzicki, M. and L.M. Kunkel (2009). Genetic isolation and characterization of a splicing mutant of zebrafish dystrophin. Hum Mol Genet. **18**:202-11.
18. Mizuno, Y., Guyon, J.R., Okamoto, K., and L.M. Kunkel. (2009). Expression of synemin in the mouse spinal cord. Muscle Nerve **39**:634-41.
19. Sohn, R.L., Huang, P., Kawahara, G., Mitchell, M., Guyon, J., Kalluri, R., Kunkel, L.M., and E. Gussoni. (2009). A role for nephrin, a renal protein, in vertebrate skeletal muscle cell fusion. Proc Natl Acad Sci U S A **106**:9274-9.
20. Kawahara, G., Guyon, J.R., Nakamura, Y., and Kunkel, L.M. (2010) Zebrafish models for human FKRP muscular dystrophies. Human Molecular Genetics 19: 623-633.
21. Molecular Ecology Resources Primer Development, C., An, J., Bechet, A., Berggren, Å., Brown, S.K., Bruford, M.W., Cai, Q., Cassel-Lundhagen, A., Cezilly, F., Chen, S.-L., *et al.* (2010). Permanent Genetic Resources added to Molecular Ecology Resources Database 1 October 2009–30 November 2009. Molecular Ecology Resources 10: 404-408.
22. Wildes, S.L., Vollenweider, J., Nguyen, H., and J.R. Guyon. Genetic stock structure of Pacific herring *(Clupea passasi)* in the eastern Gulf of Alaska. *Under review.*
23. Alexander, M.S., Kawahara, G, Kho, A.T., Howell, M.H., Pusack, T.J., Myers, J.A., Montanaro, F., Zon, L.I., Guyon, J.R., and L.M. Kunkel. Isolation and transcriptome analysis of adult zebrafish cells enriched for skeletal muscle progenitors. Muscle Nerve. *In press.*

CURRICULUM VITAE

Sharon Wildes

Current Position: Research Fisheries Geneticist

Address: Ted Stevens Marine Research Institute
Alaska Fisheries Science Center
National Marine Fisheries Service/NOAA
17109 Point Lena Loop Rd.
Juneau, AK 99801
Phone: 907-789-6081
Email: Sharon.Hawkins@noaa.gov

Education:

B. S., Biology, emphasis on Genetics, Hiram College, Hiram, Ohio, 1987.

Graduate Coursework at University of Alaska

- Russian Language I and II, 1992, 1993
- Fisheries Genetics, 1992
- Vascular Plants of Southeast AK, 1991
- Natural History of Alaska, 1990

Graduate Coursework at Case Western Reserve University

- Spanish I and II, 1986, 1987.
- Mammalian Physiology, 1988

Employment:

Research Assistant, Cleveland Metro General Hospital and Case Western Reserve University, 1987-1989. Investigated human neuropathological afflictions.

Research Geneticist, Auke Bay Labs, 1990-present. Population genetics, stock composition analyses, species identification.

Service:

Juneau Federal Employee of the year 1995.

Chair and proceedings editor, 19th N.E. Pacific pink and chum workshop 1999.

Science Outreach- Elementary to University- 1987-present.

Current Research Activities:

Fine scale population genetic structure of Pacific Herring (*Clupea pallasi*) using microsatellite markers.

mtDNA barcoding of pacific sand lance and analysis of sequence data for species identification.

Species identification of rougheye/shortraker rockfish complex using SNP and microsatellite markers.

Publications:

Wildes, S.L., J.J. Vollenweider, H.V. Nguyen and J.R. Guyon. 2010. Genetic stock structure of Pacific herring *(Clupea pallasi)* in the eastern Gulf of Alaska. Pending minor revision, Fishery Bulletin.

Orr, J. W., and **S. L. Hawkins**. 2008. Species of the rougheye rockfish complex: resurrection of *Sebastes melanostictus* (Matsubara, 1934) and a redescription of *Sebastes aleutianus* (Jordan and Evermann, 1898) (Teleostei: Scorpaeniformes). Fishery Bulletin 106(2):111-134.

Hawkins, S.L., L., J. Heifetz, C. M. Kondzela, J. E. Pohl, R. Wilmot, O. N. Katugin, and V. N. Tuponogov (2005). Genetic variation of rougheye rockfish (*Sebastes aleutianus*) and shortraker rockfish (*S. borealis*) inferred from allozymes. Fish. Bull. 103:524-535.

Hawkins, S. L., and R. L. Wilmot (2004). Even-year pink salmon Pacific Rim allozyme baseline and origin of juveniles from Gulf of Alaska coastal waters, 2003. NPAFC technical report No. 5:110.

Hawkins, S. L., N. V. Varnavskaya, E.A. Matzak, V. V. Efremov, C. M. Guthrie III, R. L. Wilmot, H. Mayama, F. Yamazaki, and A. J. Gharrett (2002). Population structure of odd-broodline Asian pink salmon and its contrast to the even-broodline structure. Journal of Fish Biology 60, 370-388.

Noll, C., N. V. Varnavskaya, E. A. Matzak, **S. L. Hawkins**, V. V. Midanaya, O. N. Katugin, C. Russell, N. M. Kinas, C. M. Guthrie III, H. Mayama, F. Yamazaki, B. P. Finney, A. J. Gharrett (2001). Analysis of contemporary genetic structure of even-broodyear populations of Asian and western Alaskan pink salmon, *Oncorhynchus gorbuscha*. Fish. Bull. 99:123-138.

Collaborators/coauthors within last 4 years:

Canino, Dr. Mike, Alaska Fisheries Science Center, Seattle, WA
Guthrie, Charles, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK
Guyon, Dr. Jeffery, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK
Heifetz, Dr. Jon, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK
Kai, Dr. Yoshiaki, Kyoto University, Japan
Katugin, Dr. Oleg, Russian Academy of Science, Vladivostok, Russia
Knoth, Brian, Alaska Fisheries Science Center, Kodiak, AK
Kondzela, Dr. Christine, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK
Orr, Dr. Jay, Alaska Fisheries Science Center, Seattle, WA
Schwenke, Piper, Northwest Fisheries Science Center, WA
Vollenweider, Johanna, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK
Wilmot, Dr. Richard, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK

Steven D. Moffitt

P.O. Box 669
Cordova, Alaska 99574

Work: (907) 424-3212
FAX: (907) 424-3235
steve_moffitt@fishgame.state.ak.us

Professional Background:

Prince William Sound/Copper River Research Project Leader, Alaska Department of Fish and Game, August 2000 to present. Duties: Develop, implement, and evaluate research projects on Pacific herring, Pacific salmon, and eulachon in Prince William Sound and the Copper River. Specific duties include setting spawning escapement goals, preseason forecasts, evaluation of harvest policies, assessment of runs inseason, and local area network supervision. Supervise one full-time Fishery Biologist II and two 11-month seasonal Fishery Biologist I's. Current supervisor: Mr. Lowell Fair, Regional Research Biologist.

Prince William Sound/Copper River Assistant Research Project Leader, Fishery Biologist II, Alaska Department of Fish and Game, November 1991 to August 2000. Duties: Responsible for sampling, compilation, and analysis of age, sex, size, and stock composition data; and salmon catch and escapement reporting. Responsible for assisting with inseason assessment of Pacific salmon and Pacific herring abundance. Supervise five seasonal employees and responsible for five project budgets. Supervisors: Mr. John Wilcock and Mr. Mark Willette, Area Research Biologists

Assistant Project Leader, Fishery Biologist II, Alaska Department of Fish and Game, July 1991 to November 1991. Planned work and supervised five employees in collecting and compiling pink and chum salmon fry/egg abundance and mortality data. Assisted with data analysis and damage assessment report writing. Supervisor: Mr. Sam Sharr, Area Research Biologist

Education:

B.S. Wildlife Management, University of Alaska Fairbanks, 1989.

Selected Publications:

Bue, B.G., S. Sharr, S.D. Moffitt, and A. Craig. 1996. Effects of the *Exxon Valdez* oil spill on pink salmon embryos and preemergent fry. Pages 619-627 *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.

Craig, A., S. Sharr, and S. Moffitt. 1995. A compilation of historical preemergent fry and egg deposition survey data from Prince William Sound, 1961-1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division. Regional Information Report No. 2A-95-49, Anchorage.

P-J.F. Hulson, S.E. Miller, T. J. Quinn II, G.D. Marty, S.D. Moffitt, and F. Funk. 2008. Data conflicts in fishery models: incorporating hydroacoustic data into the Prince William Sound Pacific herring assessment model. ICES Journal of Marine Science, 65: 25–43.

Lambert, M.B., D.J. Degan, A.M. Mueller, J.J. Smith, S. Moffitt, B. Marston, and N. Gove. 2002. Assessing methods to index inseason salmon abundance in the lower Copper River, 2002 Annual Report. USFWS Office of Subsistence Management, Fisheries Resource Monitoring Program, Annual Report No. FIS01-021, Anchorage, Alaska.

Marty, G.D., P-J.F. Hulson, S.E. Miller, T. J. Quinn II, S.D. Moffitt, and R.A. Merizon. 2010. Failure of population recovery in relation to disease in Pacific herring. Dis Aquat Org Vol. 90: 1–14.

Marty, G.D., T.R. Meyers, and S.D. Moffitt. 2002. Effects of disease on recovery of Pacific herring in Prince William Sound, Alaska, Fall 2000 and Spring 2001. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 01462), Alaska Department of Fish and Game, Habitat and Restoration Division, Anchorage, Alaska.

Moffitt, S., B. Marston, and M. Miller. 2002. Summary of eulachon research in the Copper River Delta, 1998-2002. Report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Commercial Fisheries Division. Regional Information Report No. 2A02-34, Anchorage.

Recent collaborators:

Rob Bochenek, Axiom Consulting and Design, Anchorage
Don Degan – Aquacoustics
Fritz Funk - Unaffliated
Peter-John Hulson – University of Alaska Fairbanks
Michael Lambert – Native Village of Eyak
Michael Link – LGL Consulting
Dr. Gary Marty – University of California Davis
Sara Miller – University of Alaska Fairbanks
Dr. Terry Quinn – University of Alaska Fairbanks
Jason Smith – LGL Consulting

2-Page Curriculum Vitae (February 2011)

THOMAS CLAYTON KLINE, JR., Ph. D.

Prince William Sound Science Center
P. O. Box 705
Cordova, Alaska 99574

(907) 424-5800 x233 (voice)
(907) 424-5820 (fax)
tkline@pwsssc.org (e-mail)
Citizenship: United States of America

Education

1991	Ph.D. in Oceanography, University of Alaska, Fairbanks
1983	M.S. in Fisheries, University of Washington, Seattle
1979	B.S. in Fisheries, University of Washington, Seattle
1976	B.S. in Oceanography, University of Washington, Seattle
1972-74	Coursework at Sophia University, Tokyo

Professional Experience

1994-2011	Research Scientist, Prince William Sound Science Center
1995-2011	Diving Safety Officer, Prince William Sound Science Center Scientific Diving Program

***Exxon Valdez* Oil Spill Trustee Council Projects**

Prince William Sound Herring Survey: Pacific Herring Energetic Recruitment Factors (10100132-C: current)
Prince William Sound Herring Forage Contingency (07-090811: 2007-2009)
Nutrient Based Resource Management (040712: 2004-2007)
Prince William Sound Ecology Synthesis (03065: 2003)
Prince William Sound Isotope Ecology Dissemination (00541: 2000)
Prince William Sound Food Webs: Structure and Change (99-01393:1999-2001)
Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined with Natural Stable Isotope Tracers (98-99311: 1998-1999)
Sound Ecosystem Assessment (SEA): Food Webs of Fish (95-98320-I: 1995-1998)
Sound Ecosystem Assessment (SEA): Food Web Dependencies (94320-I: 1994)

Five Project Related Research Papers

1. Kline, T.C., Jr. 2010. Stable carbon and nitrogen isotope variation in the northern lampfish and *Neocalanus*, marine survival rates of pink salmon, and meso-scale eddies in the Gulf of Alaska. Progr. Oceanogr. 87:49-60.
2. Kline, T.C., Jr. 2009. Characterization of carbon and nitrogen stable isotope gradients in the sub-Arctic Pacific Ocean using terminal feed stage copepodite V *Neocalanus cristatus.* Deep-Sea Res. II 56:2537-2552.

3. Kline, T.C. Jr., J.L. Boldt, E.V. Farley, Jr., L.J. Haldorson, and J.H. Helle. 2008. Pink salmon (*Oncorhynchus gorbuscha*) marine survival rates reflect early marine carbon source dependency. Progr. Oceanogr. 77:194-202
4. Kline, T.C., Jr. 2001. The trophic position of Pacific herring in Prince William Sound Alaska based on their stable isotope abundance. *In:* F. Funk, J. Blackburn, D. Hay, A.J. Paul, R. Stephenson, R. Toresen, and D. Witherell (eds.), Herring: Expectations for a New Millennium. University of Alaska Sea Grant, AK-SG-01-04, Fairbanks. p. 69-80.
5. Kline, Thomas C., Jr. 1999. Temporal and Spatial Variability of $^{13}C/^{12}C$ and $^{15}N/^{14}N$ in pelagic biota of Prince William Sound, Alaska. Can. J. Fish. Aquat. Sci. 56 (Suppl. 1) 94-117.

Five Other Research Papers

1. Kline, T.C. Jr. 2008. Ontogenetic, temporal, and spatial variation of feeding niche in an unexploited population of walleye pollock (*Theragra chalcogramma*). *In*: G.H. Kruse, K. Drinkwater, J.N Ianelli, J.S. Link, D.L Stram, V. Wespestad, and D. Woodby (eds), Resiliency of gadid stocks to fishing and climate change. University of Alaska Sea Grant, Fairbanks. AK-SG-08-01. pp. 251-269.
2. Kline, T.C., Jr. 2007. Rockfish trophic relationships in Prince William Sound, Alaska, based on natural abundance of stable isotopes. *In*: J. Heifetz, J. DeCosimo, A. Gharrett, M. Love, V. O'Connell, and R. Stanley (eds) Biology, Assessment, and Management of Pacific Rockfishes. University of Alaska Sea Grant, Fairbanks. AK-SG-07-01. pp. 21-37.
3. Kline, T.C., Jr., C.A. Woody, M.A. Bishop, S.P. Powers, and E.E. Knudsen. 2006. Assessment of marine-derived nutrients in the Copper River Delta, Alaska using natural abundance of the stable isotopes of nitrogen, sulfur, and carbon. *In:* C.A. Woody (ed.), Sockeye Salmon Ecology, Evolution, and Management. American Fisheries Society, Symposium 54:51-60.
4. Kline, T.C., Jr. 2003. Implications of Trophic Level when Assessing the Role of Salmon-Derived Nutrients for Lacustrine Juvenile Sockeye Salmon Ecology using the Natural Abundance of $^{15}N/^{14}N$. *In:* J. Stockner (ed.). Restoring Nutrients to Salmonid Ecosystems. American Fisheries Society, Bethesda. p.229-236.
5. Kline, T.C. Jr. and T.M. Willette. 2002. Pacific salmon (*Oncorhynchus*) early marine feeding patterns based on $^{15}N/^{14}N$ and $^{13}C/^{12}C$ in Prince William Sound, Alaska. Can. J. Fish. Aquat. Sci. 59: 1626–1638.

Recent Collaborators (Since 2006)

Cooney, R., Haldorson, L., Whitledge, T. (U. AK Fairbanks); Welker, J. (U. AK Anchorage); Bishop, M., Buckhorn, M., Campbell, R., Gay, S., Pegau, S., Thorne, R. (PWSSC); Brenner, R., Moffitt, S. (AK Dept. Fish and Game); Knudsen, E., Woody, C., Hershberger, P. (USGS); Farley, E., Helle, J., Vollenveider, J., Heintz, R., Canino, M. (NMFS/NOAA); Patrick, V. (U. MD); Kiefer, D. (U. So. CA); Boldt, J., Hay, D. (DFO, Canada), Brown, E. (unaffiliated).

Graduate and Post-Graduate Advisors

Chew, K. (M.S., Univ. Washington), Goering, J. (Ph. D., Univ. Alaska Fairbanks), Kelley, J. (Post-doctoral, Univ. Alaska Fairbanks)

Graduate and Post-Graduate Advisees

Campbell, R. (PWSSC), Carlisle, Aaron (Stanford Univ.)

MARY ANNE BISHOP, Ph.D.
Research Ecologist,
Prince William Sound Science Center
P.O. Box 705
Cordova, Alaska 99574
907-424-5800 ext 228 (voice) 907-424-5820 (fax)
mbishop@pwssc.org

EDUCATION

Ph.D. Wildlife Ecology, 1988	University of Florida, Gainesville
M.S. Wildlife & Fisheries Sciences, 1984	Texas A & M University, College Station
B.B.A. Real Estate & Urban Land Economics, 1974	University of Wisconsin, Madison

RECENT PROFESSIONAL EXPERIENCE

6/99-present	Research Ecologist, Prince William Sound Science Center, Cordova, Alaska.
11/88-present	Principal Investigator, Tibet Black-necked Crane Project, International Crane Foundation, Baraboo, Wisconsin (job location: Tibet, People's Republic of China).
4/90-3/94 & 4/97-5/99	Research Wildlife Biologist, Copper River Delta Institute, Pacific Northwest. Research Station US Forest Service.
4/94-3/97	Research Wildlife Biologist, Center for Streamside Studies and Dept. Fisheries, University of Washington, assigned to Copper River Delta Institute, Cordova, Alaska.
5/92-4/93	Acting Manager, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska.

CURRENT RELEVANT ACTIVITIES

Co-PI Prince William Sound Herring Survey: Top-down regulation by predatory fish on juvenile herring. funded by Exxon Valdez Oil Spill Trustee Council, 2010-2013.

Co-PI Prince William Sound Herring Survey: Seasonal and interannual trends in seabird predation on juvenile herring. funded by Exxon Valdez Oil Spill Trustee Council, 2010-2013.

Co-PI Tracking movements of Lingcod Ophiodon elongatus in Prince William Sound using acoustic tags and arrays. funded by Pacific Ocean Shelf Tracking Project (Phases I & II), Prince William Sound Oil Spill Recovery Institute (Phase I), 2008-2011.

RECENT RELATED PROFESSIONAL EXPERIENCE

PI & Co-PI Exxon Valdez Oil Spill Trustee Council projects on avian predators in Prince William Sound (1994-1998 SEA and NVP Programs; 2007-2009 Herring Program).

Co-PI Residency and movements of Copper Rockfish *Sebastes caurinus* and Lingcod *Ophiodon elongatus* in nearshore areas of Prince William Sound. funded by NPRB, 2007-2008

Co-PI Trophic dynamics of intertidal soft-sediment communities: interaction between bottom-up & top-down processes. funded by EVOS Trustee Council 2004-2006.

Co-PI Evaluating Artificial Reefs as Marine Habitat Enhancement Tools in Coastal Alaskan Waters. funded by NOAA, USFWS, 2006-2008.

Co-PI Estuaries as essential fish habitat for salmonids: Assessing residence time and habitat use of coho and sockeye salmon in Alaska estuaries. funded by NPRB, 2003-2006.

SELECTED SCIENTIFIC PUBLICATIONS (10 of 44)

Zuur A.F., N.M. Dawson, **M.A. Bishop**, K.J. Kuletz, A.A. Saveliev E.N. Ieno. 2011. Zero inflated Common Murre density data. Cpt. 11 in A.F. Zuur, A.A.Saveliev, E.N. Ieno (eds). Analysing Ecological Data - Practical Solutions When Things Get Complicated. *in press*.

Bishop, M.A., T. Morgan, and W.S. Pegau. 2011. Influence of mesocale hydrographic features on seabird distribution in central Prince William Sound. Continental Shelf Research. *under peer review.*

N.M. Dawson, **M.A. Bishop**, K.J. Kuletz, and A.F. Zuur. 2011. Habitat associations of seabirds during winter in Prince William Sound, Alaska. Condor. *under peer review*.

Bishop, M.A., B.F. Reynolds, S.P. Powers. 2010. An *in situ*, individual-based approach to quantify connectivity of marine fish: ontogenetic movements and residency of lingcod. PLoS One 5(12): e14267.

Reynolds, B.F., S.P. Powers, **M. A. Bishop.** 2010. Application of acoustic biotelemetry to assess quality of created habitats for Rockfish and Lingcod in Prince William Sound, Alaska. PLoS One 5(8): e12130.

Powers, S.P., **M. A. Bishop**, S. Moffitt, and G.H. Reeves. 2007. Variability in freshwater, estuarine and marine residence of Sockeye Salmon (*Oncorhynchus nerka*) within the Copper and Bering River Deltas, Alaska. American Fisheries Society Symposium 54:87-99.

Powers, S.P., **M. A. Bishop**, J. Grabowski and C.H. Peterson. 2006. Distribution of the invasive bivalve *Mya arenaria* L. on intertidal flats of southcentral Alaska. Journal Sea Research 55:207-216.

Powers, S.P., **M. A. Bishop**, J.H. Grabowski, and C.H. Peterson. 2002. Intertidal benthic resources of the Copper River Delta, Alaska, USA. Journal Sea Research 47: 13-23

Bishop, M. A. and S.P. Green. 2001. Predation on Pacific herring (*Clupea pallasi*) spawn by birds in Prince William Sound, Alaska. Fisheries Oceanography 10 (1):149-158.

Cooney, R.T., J.R. Allen, **M. A. Bishop**, D.L. Eslinger, T. Kline, B.L. Norcross, *et al*. 2001. Ecosystem control of pink salmon (*Oncorhynchus gorbuscha*) and Pacific herring (*Clupea pallasi*) populations in Prince William Sound. Fisheries Oceanography 10(1):1-13.

RECENT POPULAR SCIENCE ARTICLES

Warnock, N., **M. A. Bishop**, and J. Takekawa. 2005. Ecology of Western Sandpipers, Dunlins, and Dowitchers that Migrate through Western North America. Birding 37: 392-400

Bishop, M. A. 2002. Great possessions: Leopold's good oak. Pages 72-87 in R.L. Knight and S. Reidel, eds. Aldo Leopold and the Ecological Conscience. Oxford University Press, New York. (originally published Wildlife Society Bulletin 26: 732-740.)

GRADUATE FACULTY

Graduate Faculty, University of South Alabama. Thesis Committee for B. Reynolds (2007-2009).

Curriculum Vitae: Michele Leigh Buckhorn

Prince William Sound Science Center PO BOX 705, Cordova, AK
mbuckhorn@pwssc.org
(907) 424-5800 x 239 fax: (907) 424-5820

Education:

Ph.D. 2009	University of California, Davis, Ecology (AOE Marine Ecology)
	Advisors: Marcel Holyoak, PhD and Peter B. Moyle, PhD
B.A. 1999	University of California, Santa Cruz, Biology
A.S. 1993	American River College, Math and Physical Sciences

Related Employment:

Postdoctoral Researcher Fish Ecologist, Prince William Sound Science Center. 2010 – present

Postdoctoral Researcher. U.C. Davis. Department of Wildlife, Fish and Conservation Biology. 2008-2009.

Publications

Book:

Buckhorn, Michele L. Guide to the Marine Fishes from the Gulf of California. American Fisheries Society. In press.

Journal Articles:

Erisman, B. E., M. L. Buckhorn, et al. (2007). "Spawning patterns in the leopard grouper, Mycteroperca rosacea, in comparison with other aggregating groupers." Marine Biology (Berlin) 151(5):849-1861.

Reports:

Chapman, E.D., A.R. Hearn, M.L. Buckhorn, A.P. Klimley, P.E. Lacivita, W.N. Brostoff, A.M. Bremner (2009). "Juvenile Salmonid Outmigration and Distribution in the San Francisco Estuary: 2008-2009." U.S. Army Corp ofEngineers, LTMS. 87 pp.

In preparation

Buckhorn, M.L., P.T. Sandstrom, and A.P. Klimley. Tidally synched movements of sevengill sharks (Notorynchus cepedianus) in San Francisco Bay. Target journal: Environmental Biology of Fishes

Buckhorn, M.L. Age, growth and reproduction of leopard grouper (Mycteroperca rosacea): evidence of a behaviorally mediated Allee effect. Target journal: Journal of Fish Biology.

Buckhorn, M.L. Identification and monitoring of spawning aggregations to enhance fishery management of leopard grouper (Mycteroperca rosacea) in Loreto Marine Park. Target journal: Fishery Bulletin.

Buckhorn, M.L. Influence of habitat and exploitation on reef fish assemblages in Loreto Marine Park. Target journal: Marine Biology.

Selected Presentations

2009 Buckhorn, M.L. Movements of sevengill sharks (Notorynchus cepedianus) in San Francisco Bay. Poster. Joint Meeting of Ichthyologists and Herpetologists. Portland, Oregon.

2009 Buckhorn, M.L. Movements of sevengill sharks (Notorynchus cepedianus) in San Francisco Bay. California Estuarine Research Society Annual Meeting. Bodega Bay, California.

2007 Buckhorn, M.L. Age and growth of leopard grouper, Mycteroperca rosacea, in Loreto Marine Park, Baja California Sur. Western Society of Naturalists 88th Annual Meeting. Ventura, California.

2007 Buckhorn, M.L. Leopard grouper, Mycteroperca rosacea, spawning aggregations in Loreto Marine Park, Baja California Sur. American Fisheries Society 137th Annual Meeting. San Francisco, California.

2007 Buckhorn, M.L. Age and growth of leopard grouper, Mycteroperca rosacea, in Loreto Marine Park, Baja California Sur. American Fisheries Society 137th Annual Meeting. San Francisco, California.

2005 Erisman, B.E., M.L. Buckhorn, P.A. Hastings. Unusual spawning patterns in the leopard grouper (Mycteroperca rosacea) from the Gulf of California: Implications for conservation and management. Western Society of Naturalists 86th Annual Meeting. Monterey California.

2005 Buckhorn, M.L. Reef organism diversity in relation to leopard grouper spawning sites in Loreto Marine Park: Implications for management. Invited symposium speaker. MPAs: Fitting the Pieces into the Fisheries Mosaic. American Fisheries Society 135th Annual Meeting. Anchorage Alaska.

Recent Collaborators

Scott Pegau, PhD., Prince William Sound Science Center
Dick Thorne, PhD., Prince William Sound Science Center
A. Pete Klimley, PhD., UC Davis
Jorge Torre, PhD., Comunidad y Biodiversidad, AC, Mexico
Andrea Saenz, PhD., Comunidad y Biodiversidad, AC, Mexico
Brad Erisman, PhD., Scripps Institute of Oceanography

Richard E. Thorne, Ph.D.
P.O. Box 705, Cordova, Alaska 99574
(907) 424 -5800 (work), -5820 (fax)

Employment History

Prince William Sound Science Center	Senior Scientist 2000-present
BioSonics, Inc.	Vice President 1996-1999
4027 Leary Way NW	Manager Technical Services 1991-1999
Seattle, WA 98107	Senior Scientist 1988-1999
University of Washington	Affiliate Research Professor 1991-2001
School of Fisheries	Research Professor 1981-1990 (LOA 1988-1990)
Fisheries Research Institute	Research Associate Professor 1976-1981
Seattle, WA	Senior Research Associate 1970-1976
Commercial Fisher (salmon and albacore)	1957-1968

Academic Background

Ph.D., Fisheries-1970, University of Washington, School of Fisheries
MS Degree-1968, University of Washington, Department of Oceanography
B.S. Degree-1965, University of Washington, Department of Oceanography

Selected Publications

Thorne, R.E. and G.L. Thomas 2011. The Role of Fishery Independent Data, Chapter 12, In, Janice S. Intilli (ed) Fisheries Management. Nova Science Publishers, ISBN 978-1-61209-682-7.
Frid, A., J. Burns, G.G. Baker and R.E. Thorne 2008. Predicting synergistic effects of resources and predators on foraging decisions by juvenile Steller sea lions. Oecologia 10.1007/s00442-008-1189-5, 12 p.
Thorne, R.E. 2008. Walleye pollock as predator and prey in the Prince William Sound ecosystem. Pp: 289-304, In: G.H. Kruse, K. Drinkwater, J.N. Ianelli, J.S. Link, D.L. Stram, V. Wespestad and D. Woodby (eds), Resiliency of gadid stocks to fishing and climate change. Alaska Sea Grant, University of Alaska, Fairbanks
Thorne, R.E. and G.L. Thomas 2008. Herring and the “Exxon Valdez” oil spill: an investigation into historical data conflicts. ICES Journal of Marine Science 65(1):44-50.

Frid, A., Dill, L.M., Thorne, R. E., Blundell, G. M. 2007. Inferring prey perception of relative danger in large-scale marine systems. Evolutionary Ecology Research, Vol. 4.

Churnside, J.H. and R.E. Thorne 2005. Comparison of airborne lidar measurements with 420 kHz echos-sounder measurements of zooplankton. Applied Optics **44**(26):5504-5511

Thomas, G.L. and R.E. Thorne 2003. Acoustical-optical assessment of Pacific herring and their predator assemblage in Prince William Sound, Alaska. Aquatic Living Resources **16**:247-253.

Thomas, G.L, J. Kirsch and R.E. Thorne 2002. Ex situ target strength measurements of Pacific herring and Pacific sand lance, North American Journal of Fisheries Management **22**:1136-1145.

Thomas, G.L. and R.E. Thorne 2001. Night-time Predation by Steller Sea Lions. Nature **411**:1013.

Thorne, R.E. and G.L. Thomas 2001. Biological considerations for scaling ecosystem research in Prince William Sound, Alaska. Pp 1-11 in Proceedings (electronic) ACOUSTGEAR2000.

McClatchie, S., R. Thorne, P. Grimes and S. Hanchet 2000. Ground truth and target identification for fisheries acoustics. Fisheries Research **47**:173-191.

Thorne, R.E. 1998. Review: experiences with shallow water acoustics. Fisheries Research **35**:137-141, Elsevier Science, Amsterdam

Thorne, R.E. 1988. Some impacts of remote system technology on future fisheries management. Fisheries 13(4):14-17.

Thorne, R.E. 1988. An empirical evaluation of the duration-in-beam technique for hydroacoustic estimation. Can. J. Fish. Aquat. Sci. 45:1244-1248.

Thorne, R.E. 1983. Assessment of population abundance by echo integration. Proc. Symp. On Assessment of Micronekton. Biol. Ocean. J. 2:253-262.

Trumble, R., R.Thorne and N. Lemberg 1983. The Strait of Georgia herring fishery: A case history of timely management aided by hydroacoustic surveys. Fish. Bull. 80(2):381-388.

Mathisen, O.A., R.E. Thorne, R. Trumble and M.Blackburn 1978. Food consumption of pelagic fish in an upwelling area. Pp. 111-123 in R. Boje and M. Tomczak (eds) Upwelling Ecosystems. Springer-Verlag.

Thorne, R.E., O.A. Mathisen, R.J. Trumble and M. Blackburn 1977. Distribution and abundance of pelagic fish off Spanish Sahara during CUEA Expedition JOINT I. Deep-Sea Res. 24:75-82.

Thorne, R.E. 1977. Acoustic assessment of hake and herring stocks in Puget Sound, Washington and southeastern Alaska. Pp. 265-278 in A.R. Margets (ed), Hydroacoustics in Fisheries Research. ICES Rapp. Et P.-v., Vol 170.

Thorne, R.E. 1977. A new digital hydroacoustic data processor and some observations on herring in Alaska. J. Fish.Res. Bd. Canada 34:2288-2294.

Kevin Mershon Boswell, Ph.D.

Department of Oceanography and Coastal Sciences; 2243 Energy Coast and Environment Building; Baton Rouge, LA 70803; Email: kboswe1@lsu.edu; Tel: (225) 485-8181

Education

PhD, Oceanography and Coastal Sciences (2006), Louisiana State University, Baton Rouge, LA. Minor-Experimental Statistics

BS, Marine Fisheries (1998), Texas A&M University, Galveston, TX

Professional Experience- Past Ten Years

Assistant Professor- Research 2010-Date
Louisiana State University, Baton Rouge, LA
Department of Oceanography and Coastal Sciences

Senior Post-Doctoral Research Associate 2009-2010
Louisiana State University, Baton Rouge, LA
Dept. of Oceanography and Coastal Sciences, Advisor: Dr. James H. Cowan, Jr.

Post-Doctoral Research Associate 2006-2009
Louisiana State University, Baton Rouge, LA
Dept. of Oceanography and Coastal Sciences, Advisor: Dr. James H. Cowan, Jr.

Graduate Research Assistant 2001-2006
Louisiana State University, Baton Rouge, LA
Dept. of Oceanography and Coastal Sciences, Advisor: Dr. Charles A. Wilson

Publications in National and International Journals- Five most recent

Boswell KM, RJD Wells, JH Cowan and CA Wilson. 2010. Biomass, density, and size distributions of fishes associated with a large-scale artificial reef complex in the Gulf of Mexico. *Bulletin of Marine Science*. doi:10.5343/bms.2010.1026

Kimball ME, KM Boswell, LP Rozas and JH Cowan. 2010. Evaluating the effect of slot size and environmental variables on the passage of estuarine nekton through a water control structure. *Journal of Experimental Marine Biology and Ecology.* doi:10.1016/j.jembe.2010.09.003

Mueller AM, DL Burwen, KM Boswell and T Mulligan. 2010. Tail Beat Patterns in DIDSON Echograms and their Potential Use for Species Identification and Bioenergetics Studies. *Transactions of the American Fisheries Society*, 139:900-910.

Boswell KM, MP Wilson, PSD MacRae, CA Wilson and JH Cowan. 2010. Seasonal estimates of fish biomass and length distributions using acoustics and traditional nets to identify estuarine habitat preferences in Barataria Bay, Louisiana. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*, 2:83-97.

Boswell KM, BM Roth and JH Cowan. 2009. Simulating the effects of fish orientation on acoustic biomass calculations. *ICES Journal of Marine Science*, 66: 1398-1403.

Research Grants-

Total funded projects in past 4 years: $7,542,422; Other pending projects: $635,684.

Accomplishments and Awards

American Fisheries Society- Parent Society Travel Award: 2007 (San Francisco, CA)
American Fisheries Society- Southern Division Travel Award: 2007 (Memphis, TN)
Louisiana State University 2006 Distinguished Dissertation Award, Nominee: 2006
Best Student Paper, Gulf and Caribbean Fisheries Institute, Xel-Ha, Mexico: 2005
Best Student Poster, Graduate Student Association Intellectual Gumbo, LSU: 2002
Rockefeller State Wildlife Scholarship- LSU: 2002, 2003
Department of Oceanography and Coastal Sciences, LSU, Enhancement Award: 2001- 2003
William P. Ricker Scholarship awarded for leadership-TAMU: 1997-1998
National Collegiate Student Government Award-TAMU: 1998
Who's Who in American Universities and Colleges Award-TAMU: 1998
Eagle Scout- Boy Scouts of America

Journal Reviews

American Fisheries Society Symposium Series: Red Snapper Ecology & Fisheries in the US Gulf of Mexico; Estuarine, Coastal and Shelf Science; Experimental Marine Biology and Ecology; Gulf of Mexico Science; ICES Journal of Marine Science; Marine and Coastal Fisheries (AFS); Marine Ecology Progress Series Marine Technology Society Journal; North American Journal of Fisheries Management; Transactions of the American Fisheries Society; Southeastern Naturalist

Proposal Reviews

Hudson River Foundation; National Oceanographic & Atmospheric Administration, Chesapeake Bay Fisheries Research Program; North Pacific Research Board; United States Department of Agriculture Small Business Innovation Research; West Coast and Polar Regions Undersea Research Center

Professional Memberships

American Fisheries Society (Parent, Southern Division, Louisiana Chapter, and Marine Fisheries Section); American Society of Limnology and Oceanography; Acoustical Society of America; Coastal and Estuarine Research Federation; Gulf and Caribbean Fisheries Institute; Gulf Estuarine Research Society

Shane StClair

shane@axiomalaska.com

Work Telephone: (907) 350-8526

523 West Eighth Avenue, Suite 104, Anchorage, Alaska 99501

PROFESSIONAL EXPERIENCE

<u>March 2008 – Present</u>

Axiom Consulting & Design, LLC – Senior Software Engineer

<u>September 2006 – February 2008</u>

***Exxon Valdez* Oil Spill Trustee Council (EVOSTC)** – Analyst/Programmer III

<u>June 2002 – September 2006</u>

Alaska Department of Fish & Game, Commercial Fisheries Division – Research Analyst II

<u>Recent Professional Activities</u>

- October 2009 – Participated in the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) Web Portals Workshop in Portland, Oregon.
- June 2009 – Presented prototype data portal at the Copper River Strategy Group meeting in Gakona, Alaska.

<u>Education</u>

B.S. in Biological Sciences, University of Alaska Anchorage, 2002.

<u>Publications</u>

Brannian, L. K., S. Darr, H. A. Moore, and S. StClair. 2004. Scope of work for the AYK salmon database management system. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-29, Anchorage.

Brannian, L. K., S. Darr, H. A. Krenz, S. StClair, and C. Lawn. 2005. Development of the Arctic-Yukon-Kuskokwim salmon database management system through June 30, 2005. Alaska Department of Fish and Game, Special Publication No. 05-10, Anchorage.

Brannian, L.K., S. Darr, H. A. Moore, and S. StClair. 2005. Development of the Arctic-Yukon-Kuskokwim salmon database management system through 2004. Alaska Department of Fish and Game, Special Publication No. 05-04, Anchorage.

Brannian, L. K., K. R. Kamletz, H. A. Krenz, S. StClair, and C. Lawn. 2006. Development of the Arctic-Yukon-Kuskokwim salmon database management system through June 30, 2006. Alaska Department of Fish and Game, Special Publication No. 06-21, Anchorage.

Estensen J. L., S. St Clair. 2003. Pacific herring stocks and fisheries in the Arctic-Yukon-Kuskokwim region of the Bering Sea, Alaska, 2003 and outlook for 2004. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-37, Anchorage.

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VI. DETAILED PROJECT DESCRIPTIONS

Empirical Herring Disease Studies

Principal Investigator: Paul Hershberger, USGS

A leading hypothesis accounting for the decline and failed recovery of Pacific herring populations in Prince William Sound and other locations throughout the NE Pacific involves chronic and acute mortality from infectious and parasitic diseases including ichthyophoniasis, viral hemorrhagic septicemia (VHS), viral erythrocytic necrosis (VEN), and others (Marty et al, 1998; Marty et al. 2003; Marty et al. 2010). Here, we propose to follow up on earlier EVOS TC-funded herring disease studies by:

1) continuing surveillances of PWS herring populations for prevalence and intensity of the primary pathogens and using newly-developed disease forecasting tools to quantify the potential for future disease epizootics,
2) performing field-based disease process studies in coordination with other components of the PWS Herring Project; these observational studies will begin to address epizootiological factors including temporal and geographical patterns of pathogen exposure and resulting disease-induced mortalities that occur in wild herring populations,
3) performing laboratory-based empirical studies intended to determine cause-and effect disease relationships; these relationships will be used to develop additional disease forecasting tools and understand the fundamental disease processes

<u>Rearing of Specific–Pathogen-Free Pacific herring</u>

A critical component of both the field surveillance efforts and the empirical disease process studies involves the availability of laboratory host animals with known exposure and disease histories. We have developed techniques to rear specific pathogen-free (SPF) herring and we currently maintain thousands of SPF herring in each of 4 age classes (age 0, 1, 5 and 6 yr) for use as experimental animals. These laboratory animals are the only SPF herring known to exist and are offered as an in-kind contribution to the proposed project. Additional colonies will be developed and maintained to satisfy the needs described in this proposal; access to these fish will be shared with other herring researchers within and outside this PWS Herring Research project.

<u>*Ichthyophonus* FISH probe</u>

Although *Ichthyophonus* has been recognized as one of the most ecologically and economically important pathogens of marine fishes for more than 100 years (McVicar 1998), causing repeated epizootics in Atlantic herring populations, very little is known about the basic life cycle of the parasite or the ecology of the resulting disease. A major impediment to our understanding of *Ichthyophonus* life history and the resulting disease ecology involves a lack of available diagnostic tools to definitively identify the parasite, including its poorly-described life history stages, in formalin-fixed samples. We propose to address this impediment by developing a fluorescent *in situ* hybridization (FISH) probe, specific to *Ichthyophonus*, that is be capable of visualizing the parasite in morphologically preserved cells or tissues (including marine invertebrates and formalin-fixed, archived samples). Using this technique, fluorescently-labeled oligonucleotide probes specific to *Ichthyophonus* will diffuse into permeablized cells and hybridize to homologous DNA or RNA sequences, similar to in situ hybridization probes that have developed and used to successfully identify closely-related organisms including *Rhinosporidium seeberi* in human tissues and lake water (Fredericks, Jolley et al. 2000; Kaluarachchi, Sumathipala et al. 2008) and *Anurofeca richardsi* in frog feces (Baker, Beebee et al. 1999). Specifically, *Ichthyophonus*-specific oligonucleotide probes will be designed to conserved portions of the 18S small subunit (SSU) ribosomal gene (Criscione, Watral et al. 2002; Rasmussen, Purcell et al. 2010) and attached to5 µm tissue sections from *Ichthyophonus*-positive herring using previously described methods (Carnegie, Meyer et al. 2003) (Fredericks, Jolley et al. 2000). A variety of parameters will be evaluated for optimal assay performance, including (1) probe design, (2) fluorochrome choice, (3) tissue fixation procedures, (4) hybridization conditions and (5) use of tyramide signal amplification (CARD-FISH) to enhance sensitivity. Specificity will be tested using fish infected with marine and freshwater genotypes of *Ichthyophonus* (Hershberger et al. 2008; Rasmussen et al. 2010) as well as tissue samples infected with other mesomycetozoeans.

Estimation of population-level effects of ichthyophoniasis

age 0 Pacific herring with heavy intensities of ichthyophoniasis demonstrate pigmented skin ulcers, particularly in the caudal pedicle region (Kocan et al 2011); the effects of these lesions to the health and survival of the host are poorly understood/. If these lesions are indicative of irreversible disease that culminates in mortality, then periodic surveillances for these lesions would provide a reliable indicator of the proportion of herring that die from ichthyophoniasis each year. We propose, through a series of laboratory studies using *Ichthyophonus*-infected herring, to determine whether these external ulcers are predecessor to predetermined death or whether individuals can recover from this diseased condition. Further, we will determine the mean day-to-death of herring after these disease signs appear, providing useful information that, when combined with seasonal prevalence data, could be used to determine the number of age-0 herring dying from ichtyophoniasis each year.

Herring Response to VHSV at Different Temperatures

Recent break-through studies indicate the importance of temperature in determining the outcome of VHSV exposures to Pacific herring, with cooler temperatures resulting in greater host mortality, duration and magnitude of viral shedding from infected herring, and persistence of virus in the brain of survivors (Hershberger in preparation). Further information is needed to understand the role of temperature on the adaptive immune response of Pacific herring because the presence and titers of circulating antibodies to VHSV are being developed as a predictive tool to forecast the potential for future epizootics (Grady et al 2011, Hershberger et al submitted, Hershberger et al In Preparation). Here, we propose to perform a series of VHSV exposures to replicated groups of SPF Pacific herring at different temperatures, and monitor the kinetics of VHSV antibody production among herring at each temperature. Groups of herring (3 replicate groups / temperature, 30 herring / replicate group, 3 temperatures) will be exposed to VHSV by waterborne immersion (ca, $10^{2.5}$ PFU / mL) for 2 hr; negative controls will be similarly exposed to phosphate buffered saline. Circulating VHSV antibody levels among survivors in all groups will be quantified at different time periods post-exposure using a novel indirect enzyme-linked immunosorbent assay (ELISA) that is currently in the final stages of development, optimization and validation (Purcell unpublished data). Knowledge of the kinetics of antibody production at each temperature will provide a quantitative understanding of the strength and duration of adaptive immunity among VHS survivors, thereby providing further insights into the potential for future VHS epizootics in PWS herring populations.

Expanded Adult Herring Surveys

Principal Investigators: Michele Buckhorn and Richard Thorne, PWSSC

Introduction. The current management of the Prince William Sound (PWS) herring stock by the Alaska Department of Fish and Game (ADF&G) depends heavily on hydroacoustic surveys. Biomass estimates from these surveys provide a direct measure of the stock abundance and are also a primary input into the age-structured assessment (ASA) model that is the primary forecasting tool. The hydroacoustic surveys were initiated in 1993 when fishers were unable to locate concentrations of herring despite a forecast for high abundance. The high forecast was based on an ASA model that relied on age-structure information alone. The hydroacoustic survey revealed that the population had collapsed. March 2011 will mark the 19th consecutive annual survey using hydroacoustic surveys. Over this time period the hydroacoustic survey has shown to be an early and accurate measure of the herring stock abundance and compares well with the recent ASA model estimates that now incorporate hydroacoustic survey information as well as an index of male spawning abundance.

Prior to 2001, the hydroacoustic surveys were conducted exclusively by the Prince William Sound Science Center (PWSSC). Since 2001, the effort has been shared between PWSSC and the Cordova office of Alaska Department of Fish and Game. Over the past 3 years, the PWSSC effort has been supported by EVOS TC. The cooperative effort has been critical since both PWSSC and ADF&G have limited resources for this effort. While ADF&G considers the hydroacoustic surveys to be critical (Steve Moffitt, personal communication) the lack of a commercial herring fishery in PWS since 1998 has reduced management priorities for herring during a time of overall limited funding for the state agency. Thus the PWSSC contribution has become critically important for the long-term, especially if a future fishery appears only a remote possibility.

With the level of effort available over the past several years, PWSSC has achieved herring biomass estimates with a precision of about ±30%. This level of precision is insufficient for management purposes. The level of effort available to ADF&G is similarly insufficient. However, the combined effort currently meets management requirements for precision. There is concern that some concentrations of fish are not located and surveyed under current levels, in which case the estimate is biased, a factor not incorporated into variance calculations for precision.

Objectives. The objective of this study are:

1. to increase the current survey area of adult spawning beyond the Port Gravina and Fidalgo area to provide a more precise estimate of spawning biomass.

Methods. In this proposal for expanded adult herring surveys, we propose an effort level that will meet management needs for precision when combined with the ADF&G effort, and will also reduce current levels of uncertainty with regard to adequate geographic coverage. Beginning in FY2013 and continuing until 2016, hydroacoustic surveys will be conducted in late spring (April-May) to assess adult spawning biomass. Based on an exhaustive review of historic survey coverage, we have determined the effort required to be eight days of vessel survey for PWSSC in addition to that available to ADF&G. ADF&G will continue to conduct direct sampling for age/length/weight, primarily with a 17 FA purse seine, including concentrations located by the PWSSC effort. PWSSC effort will emphasize search for and surveys of concentrations outside the Port Gravina/Port Fidalgo area where the herring have been concentrated during the past several years. Direct capture will be conducted using a midwater trawl at adult spawning sites (See Bishop, this proposal). As has been the case previously, the search effort will utilize all information available including historical records of sighting of both adults and spawn, reports of marine mammal/bird concentrations and some aerial survey effort as well as high speed vessel surveys.

Juvenile Herring Abundance Index

Principal Investigators: Michele Buckhorn and Richard Thorne, PWSSC

Introduction. Management of the Pacific herring stock in Prince William Sound (PWS), Alaska, is based primarily on an age-structured-assessment (ASA) model. The current model, developed in 2005, incorporates both hydroacoustic estimates of the adult herring biomass and an index of the male spawning, called the "mile-days of spawn". Evidence suggests that the current model performs adequately. Unfortunately, the forecast is based on measurements from the previous year and does not have a direct measure of future recruitment. Since herring are a relatively short-lived fish, this uncertain recruitment can be a substantial component of the forecast abundance.

Herring recruit primarily as age 3. Current knowledge suggests that most mortality occurs during the first winter of life, so the relative recruitment may be fixed by the end of the first year. Consequently, estimates of relative abundance of age 1 and age 2 fish should provide an index of future recruitment. An index of age 0 fish would also provide a forecast of recruitment if additional information were available on the magnitude of the first year mortality.

Hydroacoustic surveys of juvenile herring abundance have been conducted over the past 4 years. These surveys have been conducted in both fall and late winter. The focus has been on age 0 herring, driven by interest in the extent of the critical first overwinter mortality, and has included energetics and disease research as well as research on sources of predation mortality.

Objectives. The objectives of this study are:

1. Conduct annual surveys of juvenile herring to create an index of future recruitment
2. Validate species and size composition of fish ensonified during acoustic transects (See Bishop proposal).

Methods. We will conduct annual fall surveys (FY2013-2016) of 8 bays; four of which will be the Sound Ecosystem Assessment (SEA) bays (Cooney et al. 2001). This will maintain a continual database from these locations. The other 4 bays will be selected based upon the survey results of the current EVOSTC FY10 Herring Survey Project (Project 10100132).

Surveys will be conducted using 120 kHz split-beam hydroacoustic unit in a stratified systematic survey design (Adams et al. 2006). Bays will be stratified as MOUTH, MIDDLE, and HEAD. The aerial extent of each strata will be based upon the variance of mean densities from previous surveys in order to reduce overall variance in abundance estimates (Simmonds et al. 1992, Adams et al. 2006).

Historically, direct capture has been oriented to maximize age 0 captures in support of disease and energetics research. For this study, direct capture will be directed to size and species composition. Gill nets have been only been moderately effective in catching juvenile herring during previous surveys and tend to select for faster moving fishes (Thorne et al. 1983, McClatchie et al. 2000). A midwater trawl will be used to sample randomized transects within each strata (See Bishop, this proposal).

We propose to sample during fall rather than spring despite uncertainty about overwinter mortality. Previous experience suggests that the fall period provides better assessment conditions: less ice coverage and better weather. It is anticipated that the results of previous research will allow overwinter mortality to be factored into the juvenile index.

Age 0 Condition Monitoring

Principal Investigators: Thomas C. Kline, Jr., PWSSC, Ron Heintz, NOAA

Objectives 1. Monitor the relative condition of age-0 herring before (in November) and after their first winter (in March).

2. Assess how changes in (1) drive herring recruitment.

Problem statement

The Prince William Sound (PWS) herring population has failed to recruit in significant numbers since before the Exxon Valdez Oil Spill preventing a resumption of the commercial fishery. Studies conducted since the 1990's suggest that age-0 PWS herring begin winter deficient in energy, which leads to significant overwinter mortality. Starvation was confirmed by using RNA/DNA as a physiological indicator. It is hypothesized that when these constraints are relaxed, first winter survival is much greater and this leads to a good recruitment.

Overwinter energy loss based mortality modeling

Each year the Herring Condition Monitoring (HCM) project will make a prediction using an HCM overwinter mortality model, which will use the frequency distribution of energy density observed in November as model initial conditions. In addition to predicting mortality, the model will predict the frequency distribution of the population's March energy density assuming that there was no net energy intake during winter. The difference between predicted and observed March distribution (which is currently very small) may lead to better forecasting if starvation is what is driving recruitment. We will develop a time series of these differences (each year being one difference, i.e. data point, when considering the PWS as a whole) and use the resultant recruitment to test this hypothesis.

The initial overwinter mortality model and the methods used to obtain energy density are as described in Kline and Campbell (2010). Briefly, age-0 herring will be sampled in select Prince William Sound herring nursery bays in November and the following March. Herring will be measured for wet mass, dry mass and length. Water content is calculated from these data. Samples will be ground to a fine power and analyzed for C/N ratio. Energy density will be calculated from these data (Arrhenius and Hanson 1996, Paul et al. 2001). Energy density will also be measured using bomb calorimetry on ten percent of the samples. This dual approach is used for quality control and provides the means for assessing systematic error (Kline and Campbell 2010). Energy density data are applied to the HCM overwinter mortality model as model initial conditions and for comparison with model predictions made for March (this ending time was selected to match our March observations; other ending times are also possible).

Presently, the HCM overwinter mortality model is an improvement over the overwinter mortality model of Kline and Campbell (2010), which used a knife-edge mortality criterion, by using a sliding scale energy density mortality criterion based on the experimental work of Paul and Paul (1998). The improved model predicted a March energy density frequency distribution that was much closer to that observed (Kline 2011). The next step is to incorporate physiological parameters. This is important because there are two ways in which herring mortality might be reduced during winter, one is to begin winter with higher energy density (which can be observed directly) and second, by feeding. A portion of the herring that have been sampled had non-empty stomachs. However, using that information is problematic because of sampling bias and possible sampling artifacts; physiological indicators are expected to more quantitatively reflect a herring population's foraging status.

The HCM overwinter mortality model assumes a winter fast. If fasting extends into starvation then mortality can be expected to occur. Use of proximate analysis and RNA/DNA can indicate the nutritional state and feeding status of fish (Sewall et al. 2011). By contrasting the relative contributions of lipid and protein to over winter energy loss we can establish the proportion of fish found starving at the end of winter. Similarly, by comparing the RNA/DNA levels with levels known from starving and fed fish we can determine if fish in the field are actively feeding. Hence, combining proximate analysis, RNA/DNA and energy density analysis will enable the mortality model to provide better estimates of potential mortality.

Other small fishes are routinely sampled alongside age-0 herring. These are assumed to be sympatric with herring and are important as potential competitors (Kline and Campbell 2010). Their presence and competition with herring may be driving the observed herring energy density. We may gain insight if for example herring were in better condition when there was reduced competition. Competitors may gain energy, or at least break even, at the expense of herring (Paul et al. 1998). Their interaction with age-0 herring has varied over time (Kline and Campbell 2010). We therefore need an index of competition that could be incorporated into the HCM overwinter mortality model. The mass spectrometric method used to obtain C/N ratio used to calculate energy density also provides natural stable isotope abundance, which is used to assess species interaction (Kline and Campbell 2010). We can thus add a sympatric species interaction component to the HCM model at the relatively low cost of the additional analyses of the sympatric species (N ~ 100 to 200 per year according to actual catch).

Tasks (the responsible P.I. indicated by initials):

1. (TK) Systematically assess energy levels of age-0 herring before and after winter (November and March).

2. (TK) Use stable isotope data that is a by-product of the energy analysis to assess changes in competition for food resources with sympatric species over time.

3. (TK) Model overwintering mortality using data from (1) and evaluate year-to-year mortality change in the context of (2) and (4) through collaborating with Heintz.

4. (RH) Systematically assess RNA/DNA and proximate composition of age-0 herring before and after winter.

5. (RH) Collaborate with Kline per (3).

6. Both P.I.'s will contribute to the synthesis effort in 2013 and workshop in 2014.

Experimental Design

Sampling will continue to follow the present experimental design (Kline and Campbell 2010). Sampling occurs during November and March and is focused on four reference bays, known as the SEA bays since they were established as reference sites during the SEA project of the 1990's (Norcross et al. 2001). As well, approximately two other bays will be selected according to observations of herring distribution made by acoustics surveys and available cruise time, which is generally weather-dictated. The size distribution of age-0 herring can vary considerable by bay dictating that sampling additional bays is prudent. A goal of the synthesis will be to assess the affects of sampling in order to improve long-term monitoring.

Primiparous fish **What is the age at first spawning for female herring in PWS?**

Principal Investigators: Johanna Vollenweider and Ron Heintz, (NOAA)

PROBLEM: The predictive capabilities of current population models of herring in Prince William Sound may be improved by validating the estimated proportions of fish in each age class that spawn and knowing the proportions of primiparous individuals in each age class. This latter number provides a means for adjusting estimates of the total post-spawning biomass in the ASA by estimating the proportion of each age class that was not on the spawning grounds in the previous year. Data regarding the proportions of spawners by age class would improve the accuracy of model estimates of spawning stock biomass.

Determination of age at first spawn has been accomplished via 1) analysis of differential growth increments on scales, and 2) histological analysis of egg development in ovaries. Herring lay down annual growth rings on their scales. In Atlantic herring, growth ring width can be used to differentiate years in which the fish did or did not spawn, where growth rings are relatively wider prior to their first spawning event (and during years of skip-spawn), and are narrower for years in which they spawn (Engelhard & Heino 2005). Thus scales provide a spawning history for an individual fish. The presence of post-ovulatory follicles (POV) after spawning indicates an individual fish has recently spawned while oocyte maturation identifies individuals about to spawn. By sampling at a time when both POV and maturing oocytes are present it is possible to discern immature, primiparous and repeat spawning individuals. While the histological method provides direct observation of the spawning history of individuals it is unlikely that developing oocytes can be observed among spawners. Hence the histological analysis must occur some months after spawning (Saborido-Rey & Junquera 1998).

We propose to examine scales of female herring collected from spawning aggregates in PWS to identify the spawning history of each year class. We will also validate the scale technique by comparing the results of scale analysis with that of histological analysis of oocyte development. The validation will likely be used on fish sampled some time after spawning. In order to identify the optimal time we will iteratively sample ovaries in fish held in the lab after spawning. If scale analysis proves to be a viable means to assess age at first spawn and spawning frequency, it would be a relatively inexpensive monitoring tool that could be used to adjust the ASA model in real time.

OBJECTIVES:

1. Determine the optimal time window (likely a summer month) in which histological analysis can be employed to determine spawning history of Pacific herring using a captive population.
2. Sample fish for scale and histological analysis at the optimal time to determine the age at first spawn for a group of PWS herring. Compare estimates of spawning history obtained from scales and histology.
3. The following spring, use scale analysis to identify the age at first spawn of 500 female herring caught during the 2012 spawning period in PWS.

STUDY DESIGN:

Lab Study: *determine field sampling schedule*
Live adult herring will be collected from Lynn Canal spawning aggregations in May 2011 and maintained at Auke Bay Laboratories for up to a year. Monthly collections (n=15) will be taken for histological examination of ovaries. Our objective is to identify the optimal time in which histological analysis can distinguish immature, recruit and repeat spawners, as has been done in Atlantic cod (Saborido-Rey & Junquera 1998). Immature females will be identified when all the oocytes are in the primary growth stage. Recruit females will be identified as those with developing oocytes but no post-ovulatory follicles. Repeat females will be identified as those individuals simultaneously having physiological evidence of prior spawning (post-ovulatory follicles) and new oocyte development. Histological samples will preserved and sent to Dr. Gary Marty for analysis beginning in FY12.

Field Collections:

1. *Summer 2012: Histological assessment of age at first spawn*
   In order to validate the use of scales for detecting age at first spawn, the age of females will be identified and compared with the results of a histological analysis of their ovaries. Wild adult herring will be collected from PWS according to the timeline of female maturation determined in the lab study. Individuals will be classified according to their current maturation state: immature, primiparous or repeat spawner. An immature is regarded as a fish that does not show any sign of imminent or previous maturation, a primiparous fish shows no sign of recent spawning but has developing oocytes, a repeat spawner has post-ovulatory follicles and developing oocytes. The proportion of each state will be recorded for each age class. Note that immature and primiparous fish were all immature during the previous spawning event. Ages will be constrained to 2-5 year-olds based on the assumption that all primiparous females will occur in this age range.

   At the same time, spawning histories will also be examined from scale growth patterns. Based on the developmental state ascertained with histological analysis females will be identified as being mature or immature the previous spawning event. Scale growth patterns will be examined to determine the proportion of fish that were mature or immature during the last spawning event. We will compare the the maturation histories obtained by both methods. We recognize that this comparison only verifies that scales can be used to identify fish that have recently spawned. However, the scale method is based on changes in the growth increment during the year previous to spawning. If scales reliably identify individuals that have spawned then it should be possible to use the growth pattern to project entire spawning history of the fish.

2. *Spring 2013: Scale analysis to detect age at first spawn*
   Pending the outcome of the first field study, 500 female spawning herring will be collected in the spring of 2013 in PWS for scale analysis. At this time, spawning history for the spawning cohorts will be constructed from the scale growth patterns. At this time fish will have completed laying down an annulus, so we will be able to identify those individuals that were spawning for the first time in addition to repeat spawners. The proportion of primiparous fish identified in each age class will be compared with the proportions determined from the histological analysis the previous summer.

Samples will be collected during the ADF&G vessel-based spawning survey. All fish will be measured for length, mass, gonadosomatic index (GSI), and gonad development stage (Modified Hjort scale), and scales will be preserved for microscopic analysis. Aging of scales will be conducted by ADF&G, Cordova for consistency with current aging protocols. Growth increments of scales will be measured by Auke Bay Labs using Nikon NIS-Elements imaging software.

Genetic Stock Structure of Herring in Prince William Sound

Principal Investigators: Sharon Wildes and Jeffrey Guyon, (NOAA)

Statement of Problem:

Pacific herring, once an important fishery, form a critical part of the Prince William Sound (PWS) ecosystem. Stocks remain depressed over the majority of the last 16 years and reasons for lack of recovery remain complex and unknown. Information about herring stock structure is critical to determining the best management objectives for recovery of Pacific herring (*Clupea pallasi*) population(s), particularly if a fishery were re-established. For example, it would be important to understand if the two present major spawning areas were just one stock with multiple spawn sites, or two stocks with different spawning sites. Results from the genetic analysis outlined in this proposal will help managers understand if multiple sub-stocks are involved in issues such as spawning sites and fidelity, which may contribute to the complexities in understanding their lack of recovery.

Proposal:

The purpose of this study is to provide information about fine scale genetic structure in herring from PWS to determine if it may be a complicating factor in the recovery process. A previous genetic study of herring in the region indicated that PWS was genetically differentiated from stocks outside the Sound (O'Connell et al., 1998), providing an impetus for additional work. Several recent studies have made advancements in herring research using microsatellite genotypes, and have detected fine-scale genetic differentiation among local regions of herring (Beacham et al., 2008; Andre et al., 2010; Wildes et al., in review). Each microsatellite loci contains multiple alleles making them ideal genetic markers for analyzing migratory fish with limited stock structure like herring. Based on our experience studying Pacific herring in Southeast Alaska using microsatellite markers (Wildes et al., in review), successful completion of this proposal will require (1) increasing the number of genetic samples per collection from the 50 used in the previous analysis (O'Connell et al., 1998b) to 150 fish, (2) using an increased number of informative markers (from 5 to 15), (3) analyzing at least two years of collections to examine temporal stability, (4) comparing at least two year classes to examine the possibility of "spawning waves" as detected in some regions in Atlantic herring, and (5) spatial stability from collections from two different historical locations (east, west). Evaluation of temporal and spatial variation of herring population(s) in PWS using updated genetic protocols will provide important information about herring life history that will contribute to the overall goal of the Integrated Herring Program to restore population levels in Prince William Sound.

Project Design:

The primary objective of this proposal is to identify fine-scale population structure of herring in Prince William Sound using a group of 15 informative microsatellite markers to:

a. Determine if sub-populations exist by sampling two locations within PWS;
b. Determine temporal stability by sampling for two consecutive years at each location;

c. Determine if fine-scale structure exists across two age classes at each site (Same, or different? Answer will aid in evaluation of the adopted-migrant hypothesis);

d. Determine spawning site fidelity of herring in PWS by comparing PWS spawners and nearby spawners outside of the Sound.

Herring will be collected from two geographical disparate locations within Prince William Sound, one from the east and one from the west. As a means to examine the fidelity of herring remaining in the Sound or returning to spawn in PWS, an additional sample from outside PWS will be used. We suggest Yakutat, as it is upstream from the Alaska current and more likely to be the nearest genetic contributor outside of PWS. Through collaboration with the Alaska Department of Fish and Game (ADF&G) in Cordova and Yakatat, each location will be extensively sampled such that at least 150 samples from each group (for a specific location, year, spawn time, and age class) will be available for analysis. Samples will be collected by coordinating with ADF&G and other EVOS funded projects from three locations, or nearby locations, as outlined in Table 1.

Table 1

Location	**Area**	**Year**	**Collected from Late Spawn**	**Number* Analyzed**
Montague Island	Western PWS	2013	500	300
		2014	500	300
St. Matthews Bay	Eastern PWS	2013	500	300
		2014	500	300
Yakutat (1 year class)	Central Alaska	2013	500	150
		2014	500	150
Total			**3000**	**1500**

*****number analyzed will include two year classes, obtained from the larger amount collected.

Age class will be approximated from size information and DNA will be isolated from two age classes (150 each) from each collection of 500 at the time of collection. Scale reading later will determine the age classes. Samples will be genotyped using 15 microsatellite markers, all of which have already been standardized in our laboratory for Pacific herring (Wildes et al., in press). Resulting genotypes will be analyzed using standard genetic analyses in MICROCHECKER, GENEPOP, and FSTAT. Using PHYLIP, genetic distance among collections will be calculated and a neighbor-joining tree constructed to illustrate genetic relationships. The degree of genetic diversity will be examined with F_{ST}, G-test, and AMOVA among the following collections: (1) inside/outside PWS, (2) between collections within PWS, (3) among year classes within a spawning cohort and (4) among years of collections. Finally, genetic results will be summarized to communicate their biological significance, as well as their significance to management and restoration.

Data Management Support for the Integrated Herring Research Program

Principal Investigators: Shane StClair, Axiom consulting

Summary

This project supports the EVOS Integrated Herring Research Program with critical data management support to assist study teams in efficiently meeting their objectives and ensuring data produced or consolidated through the effort is organized, documented and available to be utilized by a wide array of technical and non technical users. This effort leverages, coordinates and cost shares with a series of existing data management projects which are parallel in scope to the data management needs of the program. During year one and two, this project would initially focus on providing informatics support to streamline the transfer of information between various study teams and isolate and standardize historic data sets in the general spill affected area for use in retrospective analysis, synthesis and model development. This work would scale down in year three thru five to provide support for data preparation and archival.

An EVOS sponsored workshop was held in April 2006 tasked with identifying Prince William Sound herring data gaps and developing restoration or research projects to help herring recovery. Participants indicated that knowledge of spatial and temporal aspects of herring related data sets, e.g., herring spawn, lingering oil, predators, oceanographic conditions and shore zone habitat was necessary to understand how restoration activities might affect herring abundance trajectories. Many herring related data sets not easily accessible to restoration researchers and managers have been standardized and made available through the actions of the PWS Herring Portal (EVOS Project 070822, 080822 and 090822). This proposed project would expand the geographic scope of this work to include datasets in Lower Cook Inlet and potentially Kodiak regions. Additional data for the PWS area will be acquired from the Prince William Sound Science Center. Several restoration options proposed at the Integrated Herring Restoration Program meetings will require spatial and temporal knowledge of herring related data as tools for planning, inputs to models, or to measure the success of restoration actions.
Many of the restoration project ideas from the April 2006 workshop and more recent Integrated Herring Restoration Plan (IHRP) workshops require knowledge of the temporal and spatial relationships of past herring related data to assess possible future restoration actions. For example, updating the circulation and larval drift model requires spatial and temporal herring spawn data as an input. ADF&G has been estimating the linear extent of herring shoreline spawning and spawning biomass in PWS since 1973 (e.g., Brady 1987 and Biggs et al. 1992). ADF&G in Homer also has observations of herring abundance and distribution along the Outer Kenai coast, which is "downstream" of PWS along the Alaska Coastal Current (ACC) and may represent a rearing area for larval/juvenile herring advected from PWS. The ADF&G-Homer data include observations of spawning events and periodic age, sex, length (ASL) composition samples. Other rich datasets available for synthesis in the herring portal include: PWS herring biomass from spawn deposition and acoustics surveys (e.g., Willette et al. 1999); herring disease data from PWS (Marty et al. 2004), Kodiak, and Kamishak; and temporally/spatially explicit herring abundance, distribution, spawn, marine mammal, and fishery performance data from the Kodiak and Lower Cook Inlet management areas. Data sets available from the Prince William Sound Science Center (PWSSC) will contribute herring nursery bay, energetics, and diet data, as well as seabird predation and temporally/spatially explicit PWS oceanographic and zooplankton abundance data. Other data sets

which describe lingering oil, oil spill affects and general coastal morphology and biological habitat will make the herring ecosystem portal an indispensible tool for all herring restoration activities. Fishery managers will also be able to use the portal's powerful query tools to compare current "on-the-grounds" herring observations to historical observations (e.g., ASL, spawn timing and distribution, and temporal biomass trajectories) to better anticipate and manage fishery dynamics in-season.

Objectives and Methods

Objective 1. Provide data management oversight and services for EVOS IHRP project team data centric activities which include data structure optimization, metadata generation, and transfer of data between project teams.

AOOS data management staff will work with EVOS IHRP investigators to document the types of data which will be collected during sampling efforts in addition to document Standard Operating Procedures (SOPs) for data collection to create metadata templates in addition to gauging general data management needs of PIs. This assessment is critical to identify the data management needs and the types of tools needed by researchers to increase their abilities to manage their data in an automated, standard fashion. The assessment will also isolate reporting requirements and specific data transfer needs. Based on the assessment results investigators will develop a data management plan for each logical data collection effort. This plan will address metadata creation and data delivery for investigators.

Objective 2. Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.

This task will involve isolating and standardizing historic data sets deemed necessary for retrospective analysis by EVOS IHRP synthesis efforts. Early in the effort the EVOS IHRP researcher team will be engaged to prioritize sources of relevant data deemed of high value for the synthesis effort. Data will be prioritized by several metrics including length of time series, scientific importance, and quality and precision of the data storage format. All data acquired through efforts of this project will be merged into the AOOS data system for long term archival and access.

Objective 3. Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long term storage and public use.

The ultimate goal of this project is to provide services to assist in the organization, documentation and structuring of data collected and made available via EVOS IHRP project activities so that it can be transferred efficiently to long term data archive and storage centers and made available for future use by researchers and other user groups. This task will leverage the AOOS cyber infrastructure and other active data management projects being undertaken by that organization.

Scales as growth history records for Pacific herring

Primary Investigator: Steve Moffitt, ADF&G Cordova

INTRODUCTION

Fish grow in response to the extrinsic influences of their environment constrained by the intrinsic influences of genetic predisposition for growth and of size already attained (Weathedey and Gill 1987, Weisberg 1993). Understanding how these intrinsic and extrinsic sources of variability influence growth is important for several reasons. The effects of stock size and environmental conditions on growth have been studied by a number of investigators (Anthony and Fogarty 1985, Hagen and Quinn 1991, Kreuz et al. 1982, Martinson et al. 2009, Peterman and Bradford 1987, Rijnsdorp and van Leeuwen. 1992, Stocker et al. 1985), primarily because of the consequences that growth variation can have on reproductive potential through its influences on fecundity and spawn timing (Ware and Tanasichuk 1989), natural mortality, recruitment, and age at maturity (Haist and Stocker 1985, Schmitt and Skud 1978). Haist and Stocker 1985 stated that factors affecting growth rates can be of fundamental importance to the understanding of the dynamics of exploited populations and the responses of natural populations to abundance and environmental influences have remained a central issue in population biology (Tanasichuk 1997). Variation in growth has a strong affect on the selection of appropriate harvest policies that are based on demographic models that reflect the natural processes (Methot 1997, Tanasichuk 1997).

The underlying mechanisms for cyclic changes in annular growth for herring in the northern Gulf of Alaska are currently unknown. A period of the lowest observed average body sizes for PWS herring coincided with a period of historic high abundance followed by a catastrophic population decline associated with outbreaks of viral hemorrhagic septicemia virus (VHSV) and *Ichthyophonus hoferi* (Marty et al. 1998). Although the links between herring energetic condition (growth) and disease susceptibility are not yet well understood, it is postulated that the observed population decline was a result of density dependent growth effects leading to decreased body condition and resistance to disease. Analysis of growth increments between annular patterns on scales can provide a means to reconstruct past growth changes that can assist in determining the possible environmental and density-dependent causes of growth variation. The current picture of growth is based on cross sectional size at age data. In contrast, growth increment information incorporates a longitudinal history of growth that increases the effective degrees of freedom and can be used in modeling changes in growth in relationship to environmental and population indices (Chambers and Miller 1995, Kreuz et al. 1982, Tanaischuk 1997, Weisberg 1993). Determining the underlying distribution of individual growth patterns can provide improved inputs into population dynamics models that are used to establish harvest guidelines.

This project will require use of the scales available in the Cordova ADF&G archives, and research in developing the methodology for measuring growth information from herring scales. Technique development will include the use of image processing methods to semi-automate the data collection. During the first year of this project, it will be necessary to examine criteria for assigned ages, natural variability in scale measurements between and within individual fish from a single population. The second year of this project will consist primarily of completing the measurements of scale growth increments of representative samples from the archived collections.

PROJECT DESIGN

A. Objectives

1. FY2012:
   a. Standardize scale interpretive criteria, evaluate alternative measurement techniques, and develop semi-automated procedures for measuring scale increments of PWS herring.
   b. Measure scale growth increments on scales subsampled from archived collections.
2. FY2013:
   a. Finish measurements of scale growth increments on subsampled scales.

Methods

Extensive scale collections are maintained in the Cordova ADF&G office. Many fish have associated records including location, age, size, weight, and maturation state. Some early collections of scales may not have been collected from the preferred area on the body and their condition and usefulness remains unknown. One task will be to identify the number of scales by year and age class available. To age herring scales consistently and accurately requires experience and training. To help develop consistent criteria for identifying and measuring annuli, sample personnel will meet with experienced age readers in the ADF&G Mark-Tag-Age Lab in Juneau. Side by side comparison and discussion of problems in reading scales and potential biases in measurements will be addressed. Image processing techniques will be used to collect the growth information from scales. Off-the-shelf imaging software will be used where possible, but additional customization of routines maybe necessary, particularly to streamline the data acquisition.

Scale collections were standardized in many locations in the mid 1980s by the identification of a preferred area on body of herring. However for earlier samples there is likely to be considerable variation on scale size and shape. Several approaches will be taken to determine methods for adjusting the growth increment data such that it accurate reflects body growth. The biological intercept model used for backcalculation studies represents one possibility (Campana 1990). Other approaches may involve collecting multiple scales from several individuals and determine which transformations based on body size or scale size achieve the greatest reduction of within individual variation of the growth increments using variance component analysis (Sokal and Rohlf 1981). Concurrent studies on herring energetic may also provide samples by which scale growth can be measured in relationship to known somatic growth. If such specimens are available they will be examined. In addition, with the biological intercept approach for back calculation it is necessary to establish the body size at initial scale formation (Campana 1990). Collections of young of the year herring will be examined to determine those values. Once the methodology is established, production measurements will first be collected from the Prince William Sound archive collections.

Sample Collections: The PWS scale collections extend back to 1979, with some older scales from the early 1970's. The archives contain approximately 200,000 scales classified into different groups (harvest or collection types), and the most complete is the commercial harvest collection. The number of scales drawn from these collections will be determined by a power analysis. A preliminary sample size goal is 50 scales from 6 or 7 age classes per year for as many as 35 years (n=10k to 12k). The goal will be to measure a sufficient number of scales such that biologically significant differences in growth increments between cohorts can be detected. Since the scales themselves may not have examined since they were originally stored considerable effort may have to be expended in pulling out the selected scales to see if they are suitable for digitizing.

Scale Measurements:

Each scale selected for the study will be examined to confirm the original age estimate. Scales will be examined through a microfiche equipped with a scanner. The scanner feeds the image into a framegrabber board in a computer. Using software calibrated to the magnification of the image, a line or series of lines will be overlaid on the scale image from the focus to the scale edge by the reader and they will mark the annuli on the image. The number of annuli and the spacing between annuli will be collected in a database and collated with the existing information about the herring. The image and the overlaid measurements maybe saved for future reference. It is anticipated that this step can occur relatively quickly during the production phases.

Herring condition intensive study

Principal Investigators: Thomas C. Kline, Jr., PWSSC, Ron Heintz, NOAA

Objective Assess the validity of the herring condition monitoring program through a high temporal and spatial resolution process study

Problem statement

The herring monitoring program is necessarily of coarse temporal and spatial resolution with just two observations per year at narrowly defined sampling sites spread around the large area comprising Prince William Sound (PWS). Data interpretation requires a greater context to impart greater meaning. In the case of temporal variation of herring condition it would be useful to know (1) how sensitive the herring overwinter mortality model is to starting time, and (2) the timing of recovery from winter starvation. The latter is important since the overwinter mortality model predicts that as little as 1 % of the November population would survive to May given a continuation of starvation after March (Kline 2011). PWS herring as late as May have been in very poor condition (Norcross et al. 2001). In the case of spatial variation of herring condition it would be useful to know how sensitive the herring overwinter mortality model is to immigration and emigration from areas immediately adjacent to where herring are sampled at the time of our November and March surveys. The herring population sampled at a given time at a sampling site is defined by the swath of water sampled by the device(s) used (e.g., a net), which is very small compared to the size of the habitat and thus may not be reflective of the local herring population.

Rationale for the experimental design

The experimental design of the ongoing monitoring, i.e., sampling during November and March is a good match with respect to the experimental results used to develop the overwinter mortality model (Kline and Campbell 2011). The overwinter mortality model is based, in part, on a laboratory energy loss experiment that was conducted from 1 December to 25 January (Paul and Paul 1998). Therefore, measuring initial conditions during November is a good match. As well, one Paul and Paul (1998) experiment ended on 1 April, a good match to our field observations made in late March.

The energy value of herring that died during laboratory experiments ranged by 0.8 kJ/g wet mass (Paul and Paul 1998). The monthly (30 days) energy loss rate is very similar at 0.7 kJ/g wet mass suggesting this is a good sampling interval for the planned process study. If for example we sampled at twice per month, the expected energy loss would be $\sim$ 0.3 kJ/g wet mass, much less than this range. Furthermore, with sampling trips possibly taking up to 10 days to complete from planned starting dates due to weather, there could be less than 10 days between samples, resulting in negligible change in measured energy.

Short-term (time intervals of months) increases in fish density previously observed at herring sampling sites suggest the possibility of localized migration (Table 1 in Stokesbury et al. 2002). For example, an undetected movement of the herring population to just outside/inside a given sampling bay prior to a survey would mimic a population loss/gain. If the condition of groups of herring within a bay was heterogeneous such short movements could result in a false apparent change in condition. For example, only those fish with higher condition might have migrated out. To test for this effect during our process study, we will sample more extensively during November and March during the process study year (FFY12). The more extensive area will be sub-divided into five parts with one part corresponding to existing sampling. Therefore only the four additional parts need to be sampled as part of this study. To assess possible effect on the mortality model, the top 20% (the approximate present survival rate between November and March as well as between March and April) of each of the five sub-areas will be compared. Therefore at least 100 herring need to be sampled yielding 20 for this comparison. The mortality model will be run for each of the five sub-areas. The five outcomes will be compared with the five observed March distributions using ANOVA. At the end of the project we will make any necessary recommendations for altering sampling within a bay so as to achieve better representation.

Measurements of energy density can be misleading if the relative concentrations of lipid and protein remain constant when growth resumes. This would translate as a constant energy density leading the mortality model to overestimate mortality due to starvation. Monitoring growth would provide a more direct measure of the onset of feeding. Use of RNA/DNA as an indicator of feeding can be used to indicate the onset of feeding (Sewall et al. 2011). Moreover, RNA/DNA responds more quickly to changes in nutritional status than energy density. Similarly, RNA/DNA could be used to indicate when feeding ceases in fall. When feeding ceases, energy density will remain elevated until fish deplete glycogen reserves and sufficient lipid is catabolized relative to protein to effect a change in energy density. Thus, reliance on energy density can underestimate the period in which feeding ceases. By combining RNA/DNA and energy density analysis the mortality model can provide better estimates of potential mortality.

Experimental Design

We will sample at a single bay, mostly likely Simpson Bay. However, the spatial scope of what is considered Simpson Bay (or other designated bay) will be expanded, at minimal, during the November and March sampling periods. The scope of this expansion is to be determined at a meeting of P.I.'s prior to sampling.

Sampling to increase temporal resolution: We will augment current November and March monitoring by also sampling in October, December, January, April, May, and June as we are presently doing. The target minimum sample size at each time is 100 herring for energetics and 50 fish for RNA/DNA.

Sampling to increase spatial resolution: We will augment current monitoring samples by sampling at four additional sub-areas within the designated expanded bay area during November and March. This will entail dividing the designated expanded bay into five areas and sampling systematically within each area.

Methods

Other than experimental design the methods are the same as described in the accompanying Herring Condition Monitoring project.

Fatty Acid Analysis as Evidence for Winter Migration of Age-0 Herring

Principal Investigators: Ron Heintz and Johanna Vollenweider, NOAA

Ron Heintz and Johanna Vollenweider

PROBLEM: Monitoring of age-0 herring has been suggested as an important component of the Trustee herring program, but the appropriate spatial scale over which they should be monitored is unknown. The current program assumes age-0 herring remain in their nursery bays over winter. If true, then age-0 monitoring can use a series index bays to evaluate the relative health of herring cohorts. Observations of differences among bays in terms of age-0 condition and marine conditions can provide a basis for identifying conditions which lead to improved recruitment to age-1. However, if if age-0 fish move about Prince William Sound in winter, then measurements of fish condition are limited to inter annual variation, severely constraining our ability to identify the conditions leading to the recruitment of large year classes. Thus the current herring monitoring program requires validation of the assumption that age-0 herring remain in their nursery bays over winter.

We propose to test the assumption by monitoring the fatty acid composition of age-0 herring over winter. Herring foraging on different prey fields likely have different fatty acid compositions because the fatty acid composition of depot lipids derives from diets (Budge et al. 2006). Differences in the prey fields in different bays should produce differences in the fatty acid compositions of herring in those bays (Otis et al. 2009). During periods of food deprivation, fish fatty acid compositions are conserved (Figure 1). Therefore, the fatty acid composition of age-0 herring in fall can act as a natural tag for identifying migration. We hypothesize that migration of herring will result in increasing similarity of herring fatty acid compositions. Changes in fatty acid composition due to winter feeding are likely to be minimal because age-0 herring experience energy deficits in winter, proscribing lipid storage. We plan to test this assumption in a laboratory study. Consequently, if the fatty acid composition of age-0 herring in given bays is constant over winter then migration must be limited.

STUDY DESIGN: We propose to repeatedly sample herring from different bays in eastern and western Prince William Sound at the beginning and end of winter. These samples will be collected as part of the current herring monitoring program. Costs for this project are incurred from expanding the analysis of samples we will already be processing.

Ideally our collection will include samples from at least one bay in Port Fidalgo, two bays in Port Gravina, and both arms of Whale Bay. However, we will design the study based on the samples we receive while aiming to maximize our ability to understand the spatial scales for migration. Fatty acids will be analyzed by GC/MS and differences among fish from different locations will be identified by non-parametric multidimensional scaling (Heintz et al. 2010). Field sampling will identify the spatial scale of winter movement by answering the following questions:

1. Do fatty acid compositions differ between bays at the beginning of winter?

2. Are compositional differences between fish from eastern and western PWS conserved over winter?
3. Are compositional differences between fish in two adjacent conserved over winter?
4. Are compositional differences between two adjacent fjord systems (Gravina and Fidalgo) conserved over winter?
5. Are compositional differences between separate bays within a fjord system conserved over winter?

At the same time the assumptions underlying the fatty acid approach will be examined under laboratory conditions by maintaining two populations with distinct fatty acid compositions and fasting them over winter. Each of the populations will have a fasted component and a second component that is periodically offered some prey, but still maintained at an energy deficit. At the end of the lab study it will be possible to determine

1. Are the fatty acid compositions of starving herring conserved over winter?
2. Does winter feeding alter the fatty acid composition of starving herring ?

LOGISTICS: We anticipate that this study can be completely integrated into the existing herring growth study. Samples collected for the herring growth project can be used for the initial and final observations of fish from different bays. For the laboratory study, we propose to use fish collected near our lab in Auke Bay. Fish will be collected by beach seine in late summer, transferred to our lab and divided into two groups. The groups will be fed different diets to create two groups with distinct fatty acid compositions. Fatty acid analysis will take place at the Auke Bay Lab, following established protocols (Heintz et al. 2010).

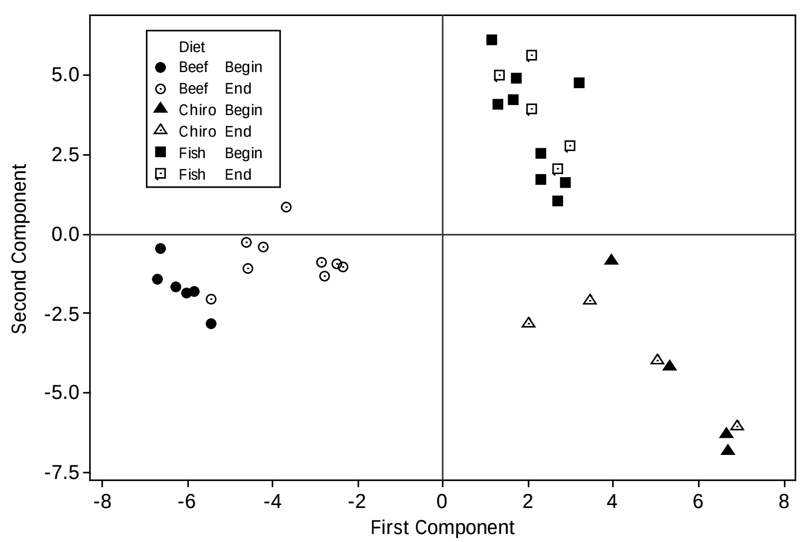

Figure 1. Principle components analysis of the fatty acid composition of coho salmon fed three different diets and fasted under the same conditions for 60 days. All fish came from the same wild population and were fed the different diets for 100 days before fasting commenced. Symbols show component scores for the fatty acid compositions of fish before and after fasting.

Acoustic Consistency: Intensive Surveys of Juvenile Herring

Principal Investigators: Michele Buckhorn and Richard Thorne, PWSSC

Introduction. Hydroacoustic surveys of juvenile herring nursery areas in Prince William Sound have been conducted during fall and late-winter for the last several years. The objectives of this effort have been to improve understanding of habitat utilization by juvenile herring, especially age 0, and to help identify candidate sites that could be potentially used for supplementation efforts. The surveys have also been a focus for other studies on juvenile herring energetics, disease and predation. The number of locations surveyed have varied from 5-9, including the 4 Sound Ecosystem Assessment (SEA) bays. However, each seasonal effort has conducted only a single night survey in each of these locations. Thorne (2010) examined seasonal changes from fall 2006 to spring 2009. He showed that apparent overwinter mortality of age 0 herring appeared to be greatest in Simpson Bay and least in Whale Bay. However, he also pointed out that the differences over winter could also be the result of emigration. Not only might age 0 herring move among bays during the winter, but movement into and out of bays may be progressive during a season. It is possible the overwintering component of age 0 may not be fully recruited into a bay at the time a single fall survey, or may have began spring movement out of bays prior to any given late-winter survey. Another potential source of variability could be the stage of the moon. Ambient light is known to affect fish distributions. On many occasions, age 0 concentrations were readily identified by their distinct distribution: a diffuse layer near surface, near shore and near the heads of bay. On other occasions, this distinctive distribution was absent even though age 0 herring were present. The change might have been the result of different ambient light regimes.

Objectives. The objectives of this study are:

1. to improve the accuracy of both annual and seasonal comparisons from single-night surveys by intensively sampling throughout a fall and spring season
2. estimate the level of immigration and emigration of age 0 herring between bays

Methods. We propose to address these uncertainties with an intensive fall and late winter/spring intensive survey. The fall series will start mid-October 2014 and extend to the first week of December. The late winter/spring series will begin the 3rd week of February 2015, and extend into the 2nd week of April. We propose to conduct the surveys in two bays sufficiently adjacent to cover each bay each night, such as Simpson Bay, Port Gravina, Windy Bay or St. Mathews Bay. We will conduct four surveys per season spaced at 2 week intervals. Each of the two bays will be surveys in three consecutive nights. Such a design will address daily, weekly and monthly variability, including moon phase. In addition to the hydroacoustic surveys, we propose a single night of direct capture effort in each location for each of the survey weeks (See Bishop, this proposal). The survey design will follow the historic zig zag transects run by Thorne since 1993 in order to remain consistent with that sampling design and to put the long term fall and spring surveys into context. Such information is especially critical if hydroacoustic surveys are needed to provide an index of future age 0 herring abundance.

Use of concurrent trawls to validate acoustic surveys for Pacific Herring

Principal Investigator: Mary Anne Bishop, PWSSC

Introduction

Acoustic surveys provide a relatively low-cost, remote sensing tool to estimate species-specific fish biomass and abundance. Interpreting acoustic data requires ground truthing (Simmonds et al. 1992). The main source of information used to validate interpretation of echograms is net catches. Pelagic trawls are the recommended method for validating species composition and for obtaining relatively unbiased information on length frequency distribution, age, and other biological information (Simmonds et al. 1992, McClatchie et al. 2000, Adams et al. 2006).

In Prince William Sound (PWS), juvenile herring acoustic surveys have been conducted at the beginning (November) and end (March) of every winter since March 2007. A variety of methods have been used with limited success to ground truth acoustic surveys in PWS. Small midwater trawls used during fall 2007 and fall 2009 cruises failed to catch fish. In most cases, these trawls were towed 1 day after the acoustic survey and always from a different vessel. Trawling speeds were typically 2-3 knots, producing a high level of net avoidance by the targeted fish.

Variable mesh gill nets as well as cast nets have also been used to validate acoustic surveys. Gillnets, however, select for faster swimming fish (Thorne et al. 1983) and in PWS, gillnet deployments have resulted in very small catch rates of juvenile herring. Cast nets were successful in collecting sufficient numbers of juvenile herring for the fitness and energetics study, but not as a method to validate acoustic data.

Here we propose to use a low-resistance, light-weight midwater trawl capable of increased towing speeds (up to 4 knots) as a method to ground truth acoustic surveys for juvenile and adult herring. These surveys will take place as part of three studies in the herring program: These include: a) juvenile herring biomass estimate (years 2-5); 2) intensive spatial and temporal study of juvenile herring biomass in two select bays (year 3); and, 3) expanded adult herring biomass surveys (years 2-5). In addition to ground truthing acoustic surveys, in year 1 we will use the trawl to collect juvenile herring during the 9-month intensive juvenile herring energetics study.

Objectives

The objectives of our study include:

1) Improve capture methods used for ground truthing acoustic surveys.

2) Increase the sample size for identification, quantification, and measurement of juvenile (0+, 1+, 2+) and adult (3+ and older) herring schools as well as other fish schools in survey areas.

3) Provide data on species composition and length frequency to aid in the interpretation of current and historical acoustic surveys.

4) Provide adult herring samples to Alaska Department of Fish and Game for the adult herring age-structure-analyses model.

5) Provide juvenile herring samples to researchers investigating juvenile herring fitness and disease.

Methods

We will tow a midwater trawl simultaneous with acoustic surveys for herring and from the same research vessel. Our trawl measures 12.8 m in total length and is 7.6 m wide by 9.1 m high under tow. The net is designed to be low-resistance and is constructed of high-tensile, lightweight materials (Innovative Net Systems, Milton LA), Mesh sizes (stretched) taper from 57 mm at the forward end to 38 mm at the cod end. The cod end liner is 12 mm mesh. The net will be fished with Jupiter Aluminum doors weighing 28 kg each. The trawl will be equipped with a Simrad PI50 Catch Monitoring System. This system utilizes wireless, trawl-mounted sensors to transmit real-time data on both trawl depth and net fullness. Average trawling speeds will be 3 to 4 kts.

Validation of acoustic echograms relies on ground truthing species composition and length frequency distribution of ensonified fish (McClatchie et al. 2000). We will tow a subsample of each stratified survey area, as designated by the lead acoustician. For each haul, all catch items will be collected. In the case of large hauls, a random sub-sample of the catch will be collected and measured. Species composition and length frequency will be characterized by identifying all fish to species and measuring individual fork length, standard length, and weight. Juvenile herring of age 0+ and 1+ can be reliably aged based on length (Norcross et al. 2000, Kline unpubl. data), however, herring >150 mm will be aged using scale conventions developed by Alaska Department of Fish and Game (ADF&G). Adult herring captured during expanded spring surveys will be measured, sexed, aged, and assessed for spawning condition. Adult herring samples will be processed in collaboration with the Cordova office of ADF&G so that data can be incorporated into the ADFG herring age-structure-analysis model. All herring scales will be archived with ADF&G.

Tracking Seasonal Movements of Adult Pacific Herring in Prince William Sound

Principal Investigators: Mary Anne Bishop, PWSSC; Sean Powers, University of South Alabama

Introduction

Along the eastern Pacific, adult Pacific herring (*Clupea pallasii*) often overwinter in habitats located in nearshore channels and close to spawning areas (Hay and McCarter 1997). This behavior pattern has been observed in the Prince William Sound (PWS) herring population, where historically large schools both overwintered and spawned around northern Montague and Green Islands. More recently, the major biomass of adult herring during winter has shifted to the northeast and southwest areas of PWS. Currently the largest concentration of adult herring overwinters and spawns around Port Gravina and Port Fidalgo (R. Thorne, PWS Science Center, pers. comm.). Some spring spawning aggregations are not located near known overwintering areas suggesting that: a) some adult herring populations are overwintering in areas outside of PWS; or, b) not all PWS overwintering populations are being detected; or, c) overwintering schools such as those at northeast PWS form smaller schools in spring with some schools moving away from their overwintering area to spawn.

Where PWS adult herring disperse to after spawning is poorly understood. In other parts of its range, it is common for large herring populations to migrate from nearshore spawning areas to coastal shelf areas for summer feeding habitat (Hay and McCarter 1997, Hay et al. 2008). To date, our only information on PWS adult herring movements comes from a study by Brown et al. (2002) that compiled local and traditional knowledge. In that study, fishers reported herring moving in fall up Montague Strait prior to the fall bait fishery while others reported herring moving into PWS in spring through Hinchinbrook Entrance, Montague Strait and the southwest passages of Erlington and LaTouche. These observations suggest that PWS herring are regularly migrating out of PWS and onto the shelf.

Acoustic transmitters make it possible to monitor fish movements both across large distances (Heupel et al. 2006) and in structurally complex habitats like those found in nearshore areas (Bishop et al. 2010). For herring, acoustic tags offer many advantages, including: 1) the potential for multiple data points over time and space for each individual fish; 2) minimal handling - fish are captured and handled only once; 3) transmitters can be implanted quickly, with low mortality and with low tag expulsion; 4) transmitters are programmed for individual identification; and 5) the capability to use portable receivers to monitor spawning schools or large wintering schools of herring regardless of the location (Bishop 2008).

In October 2008 the Pacific Ocean Shelf Tracking Project (POST), PWS Science Center (M.A. Bishop, Co-PI), University of South Alabama (S. Powers, Co-PI) and the PWS Oil Spill Recovery Institute installed across the mouth of Port Gravina the first long-term, large-scale hydroacoustic array in Prince William Sound (Fig. 1). At that same time, Bishop and Powers installed eight portable receivers at pinnacles near the POST array. In September 2010 we installed a new array at the mouth of Zaikof Bay near Hinchinbrook Entrance consisting of six portable receivers. At both Port Gravina and Zaikof Bay, acoustic-tagged lingcod (*Ophiodon elongatus*) are currently being monitored (Bishop et al. 2010).

In summer 2011, PWS Science Center and POST will collaborate with the Ocean Tracking Network (OTN) to install two, large-scale arrays including one across the mouth of Hinchinbrook Entrance and one across Montague Strait, and three, small arrays at the southwest PWS passages of Erlington, LaTouche, and Prince of Whales (Fig. 2). Equipment will be assembled and configured by PWS Science Center personnel in Cordova.

The Herring Marking Workshop sponsored by EVOS in December 2008, reviewed all potential marking methods for herring and stated with regards to acoustic tagging:

A specific recommendation is the conditional endorsement of acoustic tagging, with the caveat that the initial involvement should be limited. Arrays of acoustic receivers have been installed in PWS and there may be opportunities to leverage costs with other organization, so the present time is an excellent opportunity to pursue this approach…. It seems probable that useful information on herring ecology and migratory movements could be revealed by acoustic tagging (source: draft Integrated Herring Restoration Plan 2010, page 134).

Objectives

Here we propose to synergize with efforts of POST and OTN by marking adult Pacific herring with acoustic tags during fall 2011 and 2012. Fish will be tagged in collaboration with Alaska Department of Fish and Game and during their herring surveys. Specifically, the objectives of this project are:

(1) Field test the application of recent advances in acoustic telemetry on wild adult herring.

(2) Elucidate herring movement patterns between overwinter and spawning sites.

(3) Utilize the PWS acoustic arrays to monitor herring migration into and out of PWS.

Materials and Methods

Our tagging efforts will coincide with Alaska Department of Fish & Game (ADFG) surveys for adult herring (known as bait surveys) in November 2011 and November 2012. Following purse-seine capture of adult herring by the ADFG vessel, we will use a dipnet to collect herring then transfer healthy individuals to a 40 gallon aquarium containing aerated, ambient seawater aboard our research vessel. Surgical protocol will follow procedures used for implanting acoustic transmitters into age 2 and 3 Pacific herring (average size 180 mm) and similar sized Pacific salmon smolts (Welch et al. 2007; Seitz et al. 2010). Prior to surgery, individual herring will be transferred to a small, aerated bath containing ambient seawater and buffered tricaine methanesulfonate (MS-222; 60 mg/L), an anesthetic. Following sedation, the fish will be weighed, measured for standard and fork length, then placed on a V-shaped surgery board lined with a disposable surgical mat. During surgery the opercular cavity will be gently irrigated with ambient seawater.

For transmitter insertion, we will make a small incision (11-12 mm) along the ventral midline anterior to the pelvic fins. A Vemco series V9-1L acoustic transmitter (Vemco, Halifax, Nova Scotia) programmed to transmit an individually-encoded signal at 90-270 s random intervals will be inserted into the abdominal cavity. Each transmitter measures 24 x 9 mm and weighs 3.6 g, and has an estimated battery life of 413 d. The incision will be closed with two sutures then swabbed with a broad spectrum antibiotic ointment. The surgical procedure will take less than 2 min per fish. Following surgery, fish will be held for recovery in an aquarium aerated with ambient seawater until equilibrium (upright swimming) and active swimming are observed. Post recovery we will release fish at the capture site.

The first winter we will tag up to 25 herring around Port Gravina and Port Fidalgo. The second winter we will expand our efforts to tag up to 75 herring across multiple overwintering areas seined by ADFG. For 1-2 d after tagging, we will monitor fish using a mobile, omnidirectional VH165 mobile hydrophone. In spring 2012 and 2013 we will use the mobile hydrophone to monitor for tagged fish around Port Gravina and Port Fidalgo spawning areas, as well as spawn areas identified during the expanded adult surveys (2013 only). Data from arrays will be uploaded every 6 to 9 months by the PWS Science Center and University of South Alabama and archived in the POST and OTN data bases, as per their guidelines.

Figure 1. Map of Prince William Sound, Alaska, and acoustic array locations at Zaikof Bay and Port Gravina. Circles indicate the positions of hydro-acoustic receivers. Overwintering adult herring in this area will be captured and tagged during ADFG seine surveys in November 2011 (Port Gravina vicinity) and November 2012 (Port Gravina and additional areas).

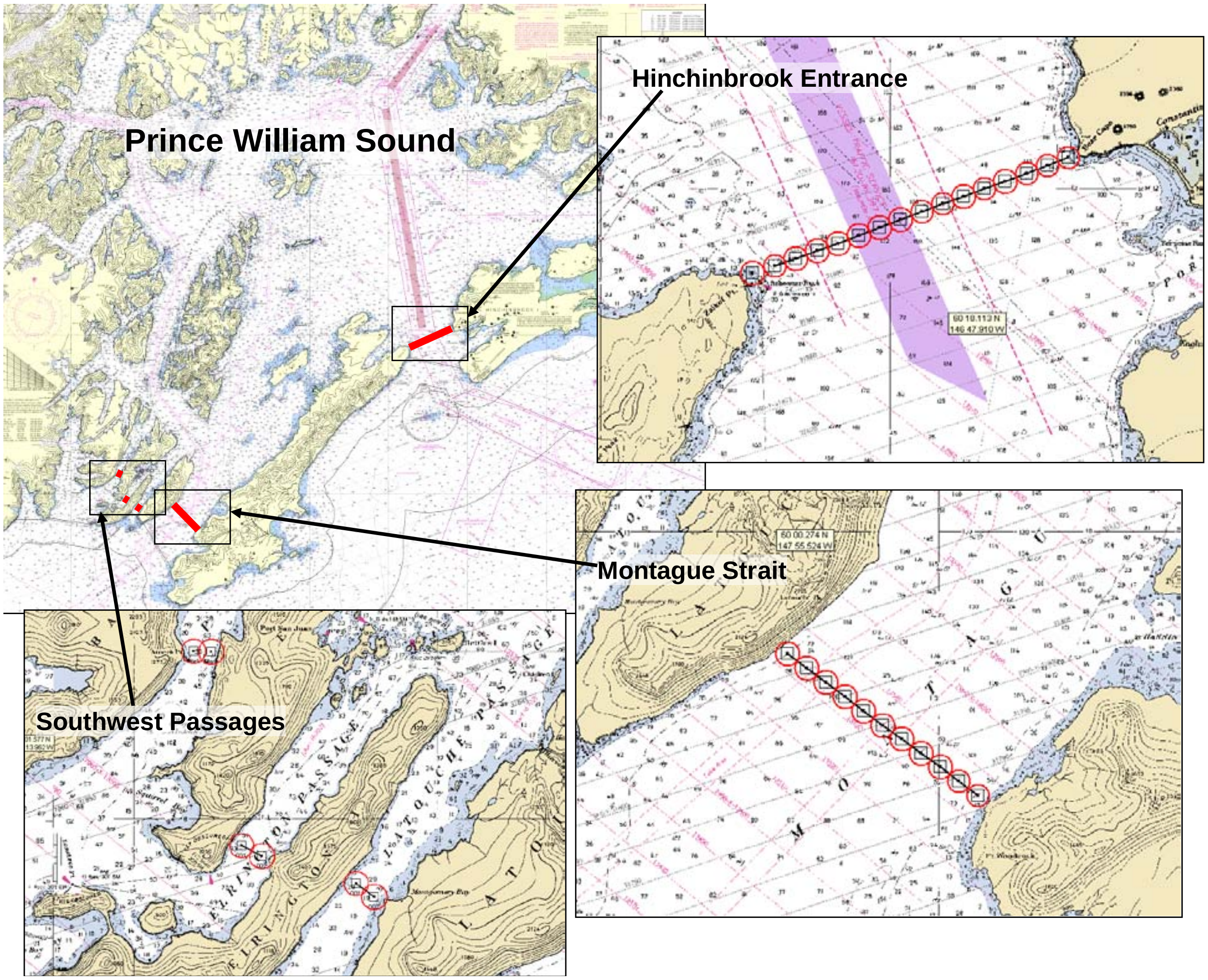

Figure 2. Proposed POST/OTN array locations, scheduled to be installed by PWS Science Center in summer 2011

Non lethal sampling: In situ estimation of juvenile herring sizes

Principal Investigator: Kevin Boswell, LSU

Rationale

A common source of bias in acoustic surveys is proper partitioning of size classes and their respective contribution to biomass estimates (see Simmonds and MacLennan 2005). This is particularly evident when considering the probability of encountering multiple size classes (or age classes) within a given survey region, or even within a large school. Several approaches have been successful in estimating *in situ* size distributions, though many require appropriate light fields to determine target sizes (Foote and Traynor 1988; Gauthier and Rose 2001; Kloser and Horne 2003). Recent application of imaging sonars have proven useful for acquiring high-resolution measurements of target-length distribution, without the need for ambient or external light sources, thereby reducing the potential of behaviorally mediated bias in length estimation. Further, automated analysis software has been refined to rapidly provide length estimates and target tracking parameters, even for tightly schooling fishes.

Recent work by Boswell and others in Southeast Alaska (Lynn Canal) has resulted in the development and successful integration of an imaging sonar and fishery echosounder system to directly compare estimates of biomass derived from traditional echo integration techniques. These traditional measures have been adopted and continue to be used as the baseline for estimating fish biomass, though have no real capacity for determining fish length distributions and their contribution to estimated biomass of PWS herring, as is the need for this research effort. A compelling result from the work conducted in Lynn Canal (Boswell et al., unpub.) was the large variability in estimated biomass from the traditional echo integration techniques as compared to the more direct approach with the imaging sonar. Interestingly, M. Jech (NOAA NEFSC) independently observed the same result with respect to variability in biomass estimates from echo integration and imaging sonar observations from Atlantic herring. Thus in addition to achieving in situ size estimates from the imaging sonar, the simultaneous integration of both sonar systems may enhance resolution of herring biomass estimates as well.

Approach

While conducting surveys using traditional fisheries echosounder equipment (e.g., Simrad Ek60 Split-beam 38 and 120 kHz), a vane or ROV deployment method (see Figure 1) can be utilized opportunistically to acquire both in situ length and density estimates, while simultaneously validating species composition (ROV option). The imaging sonar (DIDSON or ARIS; www.soundmetrics.com) has a down-range resolution of <1cm, depending on range, offering the ability to discriminate among size classes in real time and will serve to quantify differences in length-frequencies among seasons and bay systems. This high-resolution sonar can be mounted onto a vane and deployed at depth or integrated into a towable-ROV designed by Boswell and Seamor Marine with 1200ft fiber optic tether, capable of towing at depth up to 5kts (Figure 1). Depending on vessel capabilities, size and power options, either the vane deployment method or ROV can be utilized. As illustrated in Figure 1, a transducer can be attached to the vane to allow for in situ measures of target strength to compliment echo integration techniques and density estimation; this is not unlike the work previously conducted by Thomas and Thorne in concept. However, in contrast to their work, we would integrate the more contemporary technology by making use of the position and compensation methods offered with split-beam transducers. Ultimately, this would provide an in situ estimate of fish length (via imaging sonar) and target strength (via echosounder) to derive two independent indices of herring size and abundance, while also acquiring information about in situ behavior which can greatly influence acoustic estimates of fish biomass from traditional echo integration techniques.

Figure 1. Deployment options for acquiring in situ estimates of fish length distribution. Left- Remotely controlled vane, comprising of two sonar systems, an imaging sonar (black) and traditional fisheries echosounder (orange) to be deployed at depth into herring schools for *in situ* size and density estimation. Right- ROV with fully articulating camera and imaging sonar, configured to share the same view, both can look forward and completely pan to -90 degrees, simultaneously viewing the same mass of water. The ROV was developed by Boswell and Seamor Marine specifically to integrate the imaging sonar into a towable body to track herring schools at depth in Lynn Canal.

Acoustic data will be processed in both Echoview and Matlab (Boswell et al. 2008; Handegard and Williams 2008), for which algorithms have previously been developed for target identification, tracking, enumeration, and biomass estimation. Length frequency distributions derived from the sonar systems will be compared from direct collection methods (e.g., seines, gill nets, trawls) and offer insight into potential biases among different gear types used to target herring. Moreover, length-frequency estimates can be used as a complimentary tool to enhance current modeling and assessment methods implemented by the ADFG for estimating spawning biomass, juvenile survivorship, and potentially even emigration from coastal bays.

This component will collaboratively and opportunistically compliment work of other investigators (e.g., R Thorne, M. Buckhorn, R. Campbell, J.Vollenweider, J. Moran) involved by providing estimates of juvenile herring size distributions for which several other projects are dependent, and by making more efficient use of ship time and adding new observations at various spatial and temporal resolutions (e.g. seasonal estimates of herring size, behavior in response to predation, variability among different bays). Further, we will be able to address other relevant process-related questions using this approach.

Deliverables

The primary product will be to ground-truth juvenile herring length distributions in the core bays sampled in the monitoring program using a high-resolution imaging sonar. Thus, *in situ* target-length (imaging sonar) and target strength (echo-sounder) distributions will be derived. We will estimate proportional biomass contributions of herring size classes based on *in situ* length and abundance distributions. Additionally, we will evaluate size-based bias in collection methods (e.g., gill nets, trawls, seines, etc.) and extending those biases within the context of population level biomass estimates. An important, yet indirect product will be the estimation of herring sizes targeted by humpback whales during cruises with J. Moran (similar to previous work in Lynn Canal).

Following each survey, data will be assimilated and processed to derive aforementioned metrics and fciliate comparisons among gear types. Results and analyses will be provided to PWSSC researchers for integration into analysis and modeling components and to meet reporting requirements.

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PRINCE WILLIAM SOUND SCIENCE CENTER
CORDOVA, ALASKA

Box 705 Cordova, AK

June 1, 2011

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
441 W. 5th Ave., Suite 500
Anchorage, AK 99501

Please find below the reply to your request for additional information regarding the proposed PWS Herring Research and Monitoring program. In addition to the items included in your April 27th letter, I have added the question regarding data management that was included in the letter to the Long-Term Monitoring team.

Proposal: PWS Herring Research and Monitoring Program
Team Leader: Scott Pegau
Organization/Agency: Prince William Sound Science Center

Request for Additional Information

1. Please provide a detailed budget for the administration of this program.

Please see the Coordination project budget sheet included in the program budget work book. The education and outreach component has a separate budget. Fiscal oversight is provided through the negotiated indirect rate of the Prince William Sound Science Center.

2. Please provide additional information including budgets for each of the projects recommended.

See combined budget sheets and DPDs. The budgets in the Excel workbook (**PWS herring merged.xls**) are provided in thousands of dollars. There is a summary for the entire program, summaries for each organization, and detailed budgets for each project proposed. Budget justifications are provided for each of the detailed budgets (subdirectory). There are occasional small differences between the Budget and Budget Justification that arose because of the need to eliminate rounding errors that were evident in the Budget Excel spreadsheets when the various projects were merged. The differences do not affect the total request or the funding to any organization.

There are differences in the budgets of individual years compared to the original proposal. These changes have been included in Tables 1 and 2 of the main proposal.

Detailed Project Descriptions (subdirectory) are provided in the forms sent to us. The proposal was modified to indicate budget changes, and the increased text concerning project collaboration. Two versions are being provided. The “**herring research and monitoring.doc**” is a clean version of the proposal, the “**herring research and monitoring tc.doc**” has the track changes feature engaged so you can see where changes were made to the proposal.

3. Demonstrate the linkages between the herring projects, for example: currently, more than one team is using acoustics, but there does not appear to be a sharing of the methodologies.

We added the following text in the Coordination section of the proposal text.

> The wide array of projects that make up this program required careful integration to ensure the maximum collaboration between projects. Not all projects are connected directly to each other, but are connected through the objectives of the program. The full benefits of the linkages will be seen at the points where synthesis efforts occur. Direct project overlap occurs in the area of logistics. We intend to have the acoustic surveys, direct capture, and non-lethal collection components sharing a vessel. The direct capture and non-lethal collection are intended to provide validation to the acoustics. The direct capture component will be responsible for providing fish to the RNA condition, energetic condition, disease research, fatty acid indicators, and genetic stock indicator projects. Another direct project overlap occurs between the herring scale analysis and primiparous herring projects, which will share growth information as determined from the scales. The combined efforts will lead to a greater number of scales becoming digitized and improving the statistics for both projects. All projects will also interact with the data management efforts to ensure the data is properly archived and maintained.
>
> Indirect project overlap occurs between projects through the scheduling. Projects like the genetic stock indicators are pushed back in the cycle to ensure that the methodologies used by the direct capture program are mature enough to ensure collection of the required samples. Non-lethal collection is also later in the program to ensure new direct capture techniques are fully tested. Fish collected from the RNA and energetics intensive studies will also be used by the fatty acid indicator project. The acoustic tagging project is early in the program to take advantage of the acoustic receiver array that is in place and has a limited life span. Some projects like the disease research component also start later in the program because of coordination with the existing herring monitoring program. We worked hard to ensure that there isn't duplication between the proposed program and the existing program. One apparent exception is the RNA and energetic condition intensives. By moving these projects early in the program we intend to fill what is seen as a major gap in the existing program and hopefully more quickly resolve the information value that each project provides.

We are a little confused by the reference to the coordination of acoustic techniques we are proposing. There are three acoustic techniques proposed: split beam sonar for surveys, imaging sonar for non-lethal validation, and acoustic tags for fish monitoring. These three systems are extremely different in purpose, equipment, and methodologies. The imaging sonar and survey sonar are intended to be deployed off the same vessel but not on the same platform as they need to be at different depths due to the differences in ranges. Care must be taken to ensure there isn't interference between the two systems. The comment (about coordination of acoustic techniques) may have come about because of the adult and juvenile surveys, but the timing, geographic area, and approach needed for each survey is different, plus it is the same P.I. so it would be hard to integrate them any closer. We anticipate seeing some adults in the juvenile survey and visa versa, but the approaches are different enough not to allow one type of survey to function for both purposes.

4. There was a great deal of interest in the addition of a modeling component to the program. Please provide a proposal would add a modeling component to the program. It is understood that this funding would be in addition to the limits originally set forth in the FY12 Invitation for Proposals.

The lack of a modeling program is a weakness in the proposed integrated herring research program. Successful integrated programs, such as NSF's Globec and NPRB's BSIERP programs have modeling and measurement projects that can inform each other and build from one another. Several of the Science Panel comments of April 4th (e.g. #5, 6 and 7) refer to determining how well existing modeling and measurements are working, and our overall goal is to improve predictive capability, all of which requires bringing in a modeling effort somewhere along the line. As we put the Herring Research and Monitoring proposal together it wasn't clear what the results would be from the EVOSTC sponsored herring modeling project. Discussions with the modeling investigators were extremely beneficial for helping understand modeling gaps and how the measurement program might fit with the modeling. At the same time there is concern that the modeling results have been slow to materialize.

We investigated different approaches (statistical versus deterministic) and groups that we might work with to add a modeling component to the Herring Research and Monitoring program. We want a modeling project that can help prioritize future observation research needs, work with the observation programs to improve modeling of herring life stages, and in the end improve our herring population predictive capability. No one model was seen as the solution to all of these desires. In looking for a potential modeling component there were two groups that rose to the top. The first were the several modeling programs of NOAA and the University of Washington that exist in the Seattle area. The second are the NPRB sponsored Bering Sea and Gulf of Alaska Integrated Ecosystem Research Programs. Based on conversations with the various modelers, we recommend an approach that takes advantage of the wide array of modeling efforts taking place in the Seattle area and therefore worked with Trevor Branch of the University of Washington to provide a proposal for a herring modeling project addition. Please see the attached proposal (modeling subdirectory) for a modeling component that would complement the observation efforts.

5. In light of strong concerns regarding the program's data component, the Council requires the proposers to work with Council staff to produce alternate options for Council to consider.

We worked with the Long-Term Monitoring Program and the EVOSTC staff to investigate how the National Center for Ecological Analysis and Synthesis (NCEAS) might contribute both oversight and delivery of the proposed data management component. NCEAS appeared to be capable of providing some of the proposed services, but not all of the services proposed as part of our data management component. Our interpretation is that they may best contribute to the existing data management structure that the Alaska Ocean Observing System has in place.

I want to provide more information about why we chose the approach we proposed. We proposed working with Axiom Consulting because they are the data managers for the Alaska Ocean Observing

System (AOOS). They are also included in the Long-Term Monitoring program. I also have experience working with Axiom through projects funded by the Oil Spill Recovery Institute and have been pleased with the products they deliver. This combination of factors is important for leverage, integration, and program management.

AOOS invests approximately $500K/year in data management and it has been identified by their governing board as the most critical component to maintain in the future. They have oversight through a data management committee and a backup plan for transferring the information if AOOS loses its funding. Their commitment to data management and plan for transferring the data if their funding ended provided the long-term stability that we were seeking in a data management and archiving system. The funding commitment by AOOS provided an opportunity to develop a data management approach at a much lower funding level than is typically recommended (20-30% of program costs, Mark Schildhauer, NCEAS teleconference May 11, 2011). The use of the AOOS data management system allows us to build upon their funding for data collection efforts and data management oversight.

Data collected for the Long-Term Monitoring (LTM) program is important for understanding the environmental conditions that affect herring survival. Integration of data from the Herring and LTM programs is necessary for both programs to succeed. We need access to the data they collect and recover in their efforts. Using the same data management structure eases the integration of data from the Herring and LTM programs. There is also a financial saving to the programs because we are able to build upon each other's efforts. The difference in the data management proposed in the two programs arises because of the difference in data quantity and availability. The herring program is building upon the EVOSTC funded herring portal that is available through the AOOS website, and the OSRI funded project to build a data management structure for data being collected at the PWSSC (primarily herring related). This allows us to have a limited data recovery aspect to the Herring program data management and a focus on developing tools to improve integration for synthesis efforts. The LTM program will be able to take advantage of these tools and the Herring program will be able to use their environmental data.

The third consideration in our selection is based on program management considerations. There is a very limited budget for coordination in the herring program because the team was selected based on their ability to produce and work together. Because it is an integrated program with a requirement for a single point-of-contact (W. Scott Pegau) for the program. I realize that I am responsible for the performance of all of the investigators included in the program. I therefore chose to work with investigators that I have been able to work with in the past. Since the data management, coordination, and outreach efforts are the only three aspects that touch on all aspects of the program it is imperative that the three be able to readily communicate, which is made much easier by having data management done in Alaska.

When the program was put together we looked at alternative approaches to each project, including data management. Given that we didn't want to spend over 10% of the budget (considerably below what most data managers recommend) on data management we needed to be able to leverage an existing program.

That eliminated approaches such as working with Resource Data, Inc. that would be more expensive and does not do all the types of work we were looking for. We were left with our back up plan being to post data sets from each investigator on the PWSSC website under the herring pages (http://www.pwssc.org/herringsurvey/). We have explored this option and have not tried to implement it as we do not think it is the proper direction to go. The approach would meet the required deliverables in the RFP and our budget, but we would have lost the connection to the LTM program, other data available through AOOS, and the ability to build tools for visualization and synthesis.

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$201.5	$356.3	$556.7	$524.2	$518.0	$2,156.7
Travel	$26.8	$31.0	$47.0	$49.7	$46.6	$201.1
Contractual	$303.1	$409.3	$372.0	$275.5	$266.5	$1,626.4
Commodities	$81.6	$33.7	$104.1	$100.3	$67.1	$386.8
Equipment	$187.2	$0.0	$0.0	$0.0	$0.0	$187.2
Indirect Costs (*will vary by proposer*)	$108.5	$155.1	$171.7	$146.1	$144.4	$725.8
SUBTOTAL	$908.7	$985.4	$1,251.5	$1,095.8	$1,042.6	$5,284.0
General Administration (9% of subtotal)	$81.6	$88.8	$112.8	$98.7	$94.0	$475.9
PROJECT TOTAL	$990.3	$1,074.2	$1,364.3	$1,194.5	$1,136.6	$5,759.9
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: All amounts are give in thousands of dollars.

FY12-16

Program Title: PWS Herring Research and Monitoring
Team Leader: Pegau

SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$142.7	$317.1	$368.8	$320.1	$327.2	$1,475.9
Travel	$19.7	$23.0	$22.7	$19.8	$24.2	$109.4
Contractual	$226.9	$283.9	$285.0	$188.5	$179.5	$1,163.8
Commodities	$67.2	$22.4	$14.5	$17.7	$9.9	$131.7
Equipment	$172.2	$0.0	$0.0	$0.0	$0.0	$172.2
Indirect Costs (*will vary by proposer*)	$108.5	$155.1	$171.7	$146.1	$144.4	$725.8
SUBTOTAL	$737.2	$801.5	$862.7	$692.2	$685.2	$3,778.8
General Administration (9% of subtotal)	$66.2	$72.2	$77.7	$62.4	$61.8	$340.3
PROJECT TOTAL	$803.40	$873.70	$940.40	$754.60	$747.00	$4,119.10
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: All amounts are give in thousands of dollars.

FY12-16

Program Title: PWS Herring Research and Monitoring
Team Leader: Pegau

SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$0.0	$0.0	$17.5	$17.5	$0.0	$35.0
Travel	$6.0	$7.5	$7.3	$12.9	$4.0	$37.7
Contractual	$76.0	$125.4	$75.0	$75.0	$75.0	$426.4
Commodities	$10.4	$11.3	$30.4	$30.4	$5.0	$87.5
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (*will vary by proposer*)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$92.4	$144.2	$130.2	$135.8	$84.0	$586.6
General Administration (9% of subtotal)	$8.3	$13.0	$11.8	$12.2	$7.6	$52.9
PROJECT TOTAL	$100.7	$157.2	$142.0	$148.0	$91.6	$639.5
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: All amounts are give in thousands of dollars.

FY12-16

Program Title: PWS Herring Research and Monitoring
Team Leader: Pegau

SUMMARY

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$58.8	$39.2	$0.0	$0.0	$0.0	$98.0
Travel	$1.1	$0.5	$0.0	$0.0	$0.0	$1.6
Contractual	$0.2	$0.0	$0.0	$0.0	$0.0	$0.2
Commodities	$4.0	$0.0	$13.2	$13.2	$13.2	$43.6
Equipment	$15.0	$0.0	$0.0	$0.0	$0.0	$15.0
Indirect Costs (*will vary by proposer*)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$79.1	$39.7	$13.2	$13.2	$13.2	$158.4
General Administration (9% of subtotal)	$7.1	$3.6	$1.2	$1.2	$1.2	$14.3
PROJECT TOTAL	$86.2	$43.3	$14.4	$14.4	$14.4	$172.7
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: All amounts are give in thousands of dollars.

FY12-16

Program Title: PWS Herring Research and Monitoring
Team Leader: Pegau

SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$0.0	$0.0	$170.4	$186.6	$190.8	$547.8
Travel	$0.0	$0.0	$17.0	$17.0	$18.4	$52.4
Contractual	$0.0	$0.0	$12.0	$12.0	$12.0	$36.0
Commodities	$0.0	$0.0	$46.0	$39.0	$39.0	$124.0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (*will vary by proposer*)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$0.0	$0.0	$245.4	$254.6	$260.2	$760.2
General Administration (9% of subtotal)	$0.0	$0.0	$22.1	$22.9	$23.4	$68.4
PROJECT TOTAL	$0.0	$0.0	$267.5	$277.5	$283.6	$828.6
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: All amounts are give in thousands of dollars.

FY12-16

Program Title: PWS Herring Research and Monitoring
Team Leader: Pegau

SUMMARY

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$19.1	$27.9	$28.7	$20.9	$21.7	$118.3
Travel	$9.5	$4.1	$5.0	$4.0	$8.7	$31.3
Contractual	$183.1	$240.5	$248.1	$152.8	$147.4	$971.9
Commodities	$2.3	$4.0	$2.3	$4.4	$1.0	$14.0
Equipment	$50.5	$0.0	$0.0	$0.0	$0.0	$50.5
Indirect Costs (*30% TDC*)	$35.7	$44.0	$50.0	$36.8	$35.6	$202.1
SUBTOTAL	$300.2	$320.5	$334.1	$218.9	$214.4	$1,388.1
General Administration (9% of subtotal)	$27.00	$28.90	$30.10	$19.70	$19.30	$125.0
PROJECT TOTAL	$327.2	$349.4	$364.2	$238.6	$233.7	$1,513.1
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Pegau	Coordinator	1.0	11.0		11.0
TBD	Assistant	1.0	8.1		8.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	19.1	0.0	
				Personnel Total	$19.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Advisory group travel	0.8	3	2	0.2	2.8
travel for ROV training	1.2	1	5	0.3	2.7
PIs to meet with Long-term Monitoring Investigators	0.4	5	10	0.2	4.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$9.5

FY12

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Information technology (network connection, software)	0.2
printing/mailing/copying	0.3
Communication (phone, fax)	0.1
Vessel charters 25 days at $2500/day	62.5
Data Management (budget provided as separate sheet in this workbook)	120.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$183.1

Commodities Costs: Description	Commodities Sum
misc office supplies	1.0
misc cruise supplies	1.3
Commodities Total	$2.3

FY12

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Remotely Operated Vehicle	1.0	50.5	50.5
			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	$50.5

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Pegau	Coordinator	1.0	11.3		11.3
TBD	Assistant	2.0	8.3		16.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	19.6	0.0	
				Personnel Total	$27.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Advisory group travel	0.8	3	2	0.2	2.8
Marine Science Symposium	0.5	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.1

FY13

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Information technology (Network and software)	0.3
printing/mailing/copying	1.7
Communication (phone, fax)	0.3
CDFU fishing effort	35.0
Vessel charters 32 days at $2600/day	83.2
Data Management	120.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$240.5

Commodities Costs: Description	Commodities Sum
misc office supplies	2.0
misc cruise supplies	2.0
Commodities Total	$4.0

FY13

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Pegau	Coordinator	1.0	11.5		11.5
TBD	Assistant	2.0	8.6		17.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	20.1	0.0	
				Personnel Total	$28.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Advisory group travel	0.8	3	2	0.2	2.8
Marine Science Symposium	0.4	1	4	0.2	1.2
P.I. to EVOSTC meeting	0.4	1	3	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.0

FY14

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Information technology	0.3
printing/mailing/copying	1.0
Communication (phone, fax)	0.3
CDFU fishing effort	35.0
Vessel charters 40 days at $2600/day	104.0
Data Management	20.5
Non-Lethal collection (Boswell)	87.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$248.1

Commodities Costs: Description	Commodities Sum
misc office supplies	1.3
misc cruise supplies	1.0
Commodities Total	$2.3

FY14

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Pegau	Coordinator	1.0	12.0		12.0
TBD	Assistant	1.0	8.9		8.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	20.9	0.0	
				Personnel Total	$20.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Advisory group travel	0.8	3	2	0.2	2.8
Marine Science Symposium	0.4	1	4	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.0

FY15

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Information technology (Network and software)	0.3
printing/mailing/copying	1.0
Communication (phone, fax)	0.4
CDFU fishing effort	38.0
Vessel charters 34 days at $2700/day	91.8
Data management	21.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$152.8

Commodities Costs: Description	Commodities Sum
misc office supplies	2.4
misc cruise supplies	2.0
Commodities Total	$4.4

FY15

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Pegau	Coordinator	1.0	12.4		12.4
TBD	Assistant	1.0	9.3		9.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	21.7	0.0	
				Personnel Total	$21.7

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Advisory group travel	0.8	3	2	0.3	2.9
Marine Science Symposium	0.5	1	4	0.2	1.3
PI meeting with Long-Term Monitoring	0.5	5	10	0.2	4.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8.7

FY16

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Information technology	0.2
printing/mailing/copying	0.5
Communication (phone, fax)	0.3
CDFU fishing effort	38.0
Vessel charters 32 days at $2700/day	86.4
Data Managemetn	22.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$147.4

Commodities Costs: Description	Commodities Sum
misc office supplies	1.0
Commodities Total	$1.0

FY16

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY16

Program Title: PWS herring: Coordination
Team Leader: Pegau

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$2.8	$16.3	$16.8	$18.9	$22.9	$77.7
Travel	$1.4	$1.8	$3.6	$2.5	$2.0	$11.3
Contractual	$0.4	$2.0	$0.8	$2.1	$1.0	$6.3
Commodities	$7.0	$1.4	$1.9	$1.9	$1.1	$13.3
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (30%)	$3.5	$6.5	$6.9	$7.6	$8.1	$32.6
SUBTOTAL	$15.1	$28.0	$30.0	$33.0	$35.1	$141.2
General Administration (9% of subtotal)	$1.4	$2.5	$2.7	$3.0	$3.2	$12.8
PROJECT TOTAL	$16.5	$30.5	$32.7	$36.0	$38.3	$154.0
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Program Title:
Team Leader:

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Lindsay Butters, PI	Education Coordinator	0.5	5.5		2.8
Education Specialist	Education Specialist	0.0	4.7		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	10.2	0.0	
				Personnel Total	$2.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Meeting Travel (Anchorage)	0.4	1	3	0.2	1.0
Education Travel (program delivery outside of Cordova)	0.2	1	2	0.1	0.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.4

FY12

Program Title:
Team Leader:

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Networking ($100/person-month)	0.1
Communications ($100/person-month)	0.1
Printing/shipping	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.4

Commodities Costs: Description	Commodities Sum
Teaching and Outreach Supplies	7.0
Commodities Total	$7.0

FY12	**Program Title:** **Team Leader:**	FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Lindsay Butters, PI	Education Coordinator	2.0	5.7		11.4
Education Specialist	Education Specialist	1.0	4.9		4.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	10.6	0.0	
				Personnel Total	$16.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Meeting Travel (Anchorage)	0.4	1	3	0.2	1.0
Education Travel (program delivery outside of Cordova)	0.2	2	4	0.1	0.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.8

FY13

Program Title:
Team Leader:

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Networking ($100/person-month)	0.3
Communications ($100/person-month)	0.3
Printing/shipping	0.2
Delta Sound Connections publication printing	1.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.0

Commodities Costs: Description	Commodities Sum
Teaching and Outreach Supplies	1.4
Commodities Total	$1.4

FY13

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Lindsay Butters, PI	Education Coordinator	2.0	5.9		11.8
Education Specialist	Education Specialist	1.0	5.0		5.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	10.9	0.0	
				Personnel Total	$16.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Meeting Travel (Anchorage)	0.5	2	6	0.2	2.2
Education Travel (program delivery outside of Cordova)	0.3	2	4	0.2	1.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.6

FY14

Program Title:
Team Leader:

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Networking ($100/person-month)	0.3
Communications ($100/person-month)	0.3
Printing/shipping	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.8

Commodities Costs: Description	Commodities Sum
Teaching and Outreach Supplies	1.9
Commodities Total	$1.9

FY14

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14	**Program Title:** **Team Leader:**	**FORM 3B** **EQUIPMENT DETAIL**

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Lindsay Butters, PI	Education Coordinator	2.1	6.2		13.0
Education Specialist	Education Specialist	1.1	5.3		5.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	11.5	0.0	
				Personnel Total	$18.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Meeting Travel (Anchorage)	0.5	1	3	0.2	1.1
Education Travel (program delivery outside of Cordova)	0.3	2	4	0.2	1.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.5

FY15

Program Title:
Team Leader:

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Networking ($100/person-month)	0.3
Communications ($100/person-month)	0.3
Printing/shipping	0.3
Delta Sound Connections publication printing	1.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.1

Commodities Costs: Description	Commodities Sum
Teaching and Outreach Supplies	1.9
Commodities Total	$1.9

FY15

Program Title:
Team Leader:

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Lindsay Butters, PI	Education Coordinator	2.5	6.5		16.3
Education Specialist	Education Specialist	1.2	5.5		6.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	12.0	0.0	
				Personnel Total	$22.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Meeting Travel (Anchorage)	0.5	1	3	0.2	1.1
Education Travel (program delivery outside of Cordova)	0.3	0	4	0.2	0.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

FY16

Program Title:
Team Leader:

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Networking ($100/person-month)	0.4
Communications ($100/person-month)	0.4
Printing/shipping	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.0

Commodities Costs: Description	Commodities Sum
Teaching and Outreach Supplies	1.1
Commodities Total	$1.1

FY16

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY16

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$0.0	$64.7	$67.3	$70.0	$72.8	$274.8
Travel	$0.0	$3.0	$5.9	$5.9	$6.1	$20.9
Contractual	$0.0	$24.8	$25.6	$26.3	$28.9	$105.6
Commodities	$0.0	$7.5	$5.0	$8.3	$6.7	$27.5
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect @ 30% MTDC	$0.0	$30.0	$31.2	$33.2	$34.4	$128.8
SUBTOTAL	$0.0	$130.0	$135.0	$143.7	$148.9	$557.6
General Administration (9% of subtotal)	$0.0	$11.7	$12.2	$12.9	$13.4	$50.2
PROJECT TOTAL	$0.0	$141.7	$147.2	$156.6	$162.3	$607.8
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	Herring Condition Monitoring		0.0			0.0
Tech to be named	Herring Condition Monitoring		0.0			0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY12

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY12

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	Herring Condition Monitoring		3.0	11.1		33.4
Tech to be named	Herring Condition Monitoring		6.0	5.2		31.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	16.3	0.0	
					Personnel Total	$64.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
January Symposium	0.4	1	4	0.2	1.2
Workshop	1.0	1	4	0.2	1.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.0

FY13

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
PWSSC Network charge 9 @ $100	0.9
Mass spectrometry 800 @ $25	20.0
Freeze drying 800 @ $3	2.4
Printing, copying, shipping	0.5
Communications (fax and phone) 9 @50	0.5
Software	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$24.8

Commodities Costs: Description	Commodities Sum
Office supplies	0.5
Sampling supplies	3.5
Laboratory supplies	3.5
Commodities Total	$7.5

FY13	**Project Title: Herring Condition Monitoring** **Project PI: Kline**	**FORM 3B** **CONTRACTUAL &** **COMMODITIES DETAIL**

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	Herring Condition Monitoring		3.0	11.5		34.4
Tech to be named	Herring Condition Monitoring		6.0	5.5		32.9
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	16.9	0.0	
					Personnel Total	$67.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
January Symposium	0.5	1	4	0.2	1.3
Workshop	1.1	1	4	0.2	1.9
Scientific Meeting	1.5	1	6	0.2	2.7
registration added to ticket cost					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.9

FY14

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
PWSSC Network charge 9 @ $100	0.9
Mass spectrometry 800 @ $26	20.8
Freeze drying 800 @ $3	2.4
Printing, copying, shipping	0.5
Communications (fax and phone) 9 @50	0.5
Software	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$25.6

Commodities Costs: Description	Commodities Sum
Office supplies	0.5
Sampling supplies	2.3
Laboratory supplies	2.2
Commodities Total	$5.0

FY14

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	Herring Condition Monitoring		3.0	11.8		35.4
Tech to be named	Herring Condition Monitoring		6.0	5.8		34.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	17.6	0.0	
					Personnel Total	$70.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
January Symposium	0.4	1	4	0.2	1.2
Workshop	1.2	1	4	0.2	2.0
Scientific Meeting	1.5	1	6	0.2	2.7
registration added to ticket cost					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.9

FY15

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3B
PERSONNEL &
TRAVEL DETAIL

TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
PWSSC Network charge 9 @ $100	0.9
Mass spectrometry 800 @ $27	21.6
Freeze drying 800 @ $3	2.4
Printing, copying, shipping	0.4
Communications (fax and phone) 9 @50	0.5
Software	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$26.3

Commodities Costs: Description	Commodities Sum
Office supplies	3.6
Sampling supplies	2.3
Laboratory supplies	2.4
Commodities Total	$8.3

FY15

Project Title: Herring Condition Monitoring

FORM 3B CONTRACTUAL &

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

FY15

Project PI: Kline

CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Project Title: Herring Condition Monitoring

FORM 3B

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

FY15

Project PI: Kline

EQUIPMENT DETAIL

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	Herring Condition Monitoring		3.0	12.1		36.4
Tech to be named	Herring Condition Monitoring		6.0	6.1		36.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	18.2	0.0	
					Personnel Total	$72.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
January Symposium	0.4	1	4	0.2	1.2
Workshop	1.3	1	4	0.2	2.1
Scientific Meeting	1.6	1	6	0.2	2.8
registration added to ticket cost					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.1

FY16

Project Title: Herring Condition Monitoring

FORM 3B PERSONNEL &

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

FY16 | **Project PI: Kline** | **PERSONNEL & TRAVEL DETAIL**

Contractual Costs: Description	Contract Sum
PWSSC Network charge 9 @ $100	0.8
Mass spectrometry 1000 @ $30	24.0
Freeze drying 1000 @ $3	2.4
Printing, copying, shipping	0.7
Communications (fax and phone) 9 @50	0.5
Software	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$28.9

Commodities Costs: Description	Commodities Sum
Office supplies	0.8
Sampling supplies	3.0
Laboratory supplies	2.9
Commodities Total	$6.7

FORM 3B

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

FY16	**Project Title: Herring Condition Monitoring** **Project PI: Kline**	**FORM 3B** **CONTRACTUAL &** **COMMODITIES DETAIL**

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

FY16	**Project Title: Herring Condition Monitoring** **Project PI: Kline**	**FORM 3B** **EQUIPMENT DETAIL**

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$64.8	$41.2	$13.7	$0.0	$0.0	$119.7
Travel	$2.7	$2.7	$0.0	$0.0	$0.0	$5.4
Contractual	$41.6	$8.5	$0.7	$0.0	$0.0	$50.8
Commodities	$13.9	$2.2	$0.0	$0.0	$0.0	$16.1
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect @ 30% MTDC	$36.9	$16.3	$4.3	$0.0	$0.0	$57.5
SUBTOTAL	$159.9	$70.9	$18.7	$0.0	$0.0	$249.5
General Administration (9% of subtotal)	$14.4	$6.4	$1.7	$0.0	$0.0	$22.5
PROJECT TOTAL	$174.3	$77.3	$20.4	$0.0	$0.0	$272.0
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring program
Project PI:Kline

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	High resolution		3.0	10.8		32.4
Tech to be named	High resolution		6.5	5.0		32.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	15.8	0.0	
					Personnel Total	$64.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Scientific Meeting	1.5	1	6	0.2	2.7
registration in ticket price					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.7

FY12

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring program
Project PI:Kline

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
PWSSC Network charge 9.5 @ $100	1.0
Mass spectrometry 1400 @ $25	35.0
Freeze drying 1400 @ $3	4.2
Printing, copying, shipping	0.5
Communications (fax and phone) 9.5 @50	0.5
Software	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$41.6

Commodities Costs: Description	Commodities Sum
Office supplies	3.9
Sampling supplies	5.0
Laboratory supplies	5.0
Commodities Total	$13.9

FY12

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring program
Project PI:Kline

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring program
Project PI:Kline

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	High resolution		3.0	11.1		33.4
Tech to be named	High resolution		1.5	5.2		7.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	16.3	0.0	
					Personnel Total	$41.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Scientific Meeting	1.5	1	6	0.2	2.7
registration in ticket price					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.7

FY13

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring program
Project PI:Kline

FORM 3B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
PWSSC Network charge 4.5 @ $100	0.5
Mass spectrometry 250 @ $25	6.3
Freeze drying 250 @ $3	0.6
Printing, copying, shipping	0.5
Communications (fax and phone) 4.5 @50	0.2
Software	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$8.5

Commodities Costs: Description	Commodities Sum
Office supplies	0.5
Sampling supplies	0.0
Laboratory supplies	1.7
Commodities Total	$2.2

FY13

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring program

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

Project PI:Kline

COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring program

FORM 3B EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Project PI:Kline

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	High resolution		1.2	11.5		13.7
Tech to be named	High resolution		0.0			0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	11.5	0.0	
					Personnel Total	$13.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY14

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring program

FORM 3B PERSONNEL & TRAVEL DETAIL

TRAVEL DETAIL

Project PI:Kline

Contractual Costs: Description	Contract Sum
PWSSC Network charge 1.2 @ $100	0.1
Printing, copying, shipping	0.0
Communications (fax and phone) 1.2 @50	0.1
Software	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.7

Commodities Costs: Description	Commodities Sum
Office supplies	0.0
Sampling supplies	0.0
Laboratory supplies	0.0
Commodities Total	$0.0

FY14

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring

FORM 3B CONTRACTUAL &

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

FY14	program Project PI:Kline	CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14	Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring	FORM 3B

FY14	program Project PI:Kline	EQUIPMENT DETAIL

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	High resolution		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
						0.0
			Subtotal	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY15	**Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring**	**FORM 3B PERSONNEL &**

FY15

program
Project PI:Kline

PERSONNEL &
TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY15

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring

FORM 3B
CONTRACTUAL &

FY15

program
Project PI:Kline

CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring

FORM 3B

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

FY15	**program** **Project PI:Kline**	**EQUIPMENT DETAIL**

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	High resolution		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
						0.0
			Subtotal	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16	**Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring**	**FORM 3B PERSONNEL &**

FY16	program Project PI:Kline	PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16	**Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring**	**FORM 3B CONTRACTUAL &**

FY16

program
Project PI:Kline

CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

FY16	program Project PI:Kline	EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$32.5	$58.3	$98.1	$95.0	$98.0	$381.9
Travel	$1.0	$1.0	$2.0	$1.2	$1.2	$6.4
Contractual	$0.9	$1.8	$2.6	$2.2	$2.2	$9.7
Commodities	$5.4	$2.8	$1.8	$1.1	$1.1	$12.2
Equipment	$10.7	$0.0	$0.0	$0.0	$0.0	$10.7
Indirect Costs (*30% MTDC*)	$11.9	$19.2	$31.3	$29.9	$30.8	$123.1
SUBTOTAL	$62.4	$83.1	$135.8	$129.4	$133.3	$544.0
General Administration (9% of subtotal)	$5.6	$7.5	$12.2	$11.7	$12.0	$49.0
PROJECT TOTAL	$68.0	$90.6	$148.0	$141.1	$145.3	$593.0
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: Cost of Simraud P150 catch moniitoring system for the midwater trawl is being partially covered out of the expanded adult acoustic survey project

FY12-16

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
J. Watson	Research Assistant-Fisheries	1.5	6.4		9.6
B. Hsu	Research Assistant	1.0	6.4		6.4
M.A. Bishop	Principal Investigator	1.5	11.0		16.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	23.8	0.0	
				Personnel Total	$32.5

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Alaska Marine Symposium	0.3	1	4	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.0

FY12

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
network & software subscriptions $150/staff mo	0.6
communications (phone and fax) $50/staff mo	0.2
printing & copying $25/staff mo	0.1
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.9

Commodities Costs: Description	Commodities Sum
Field, Lab, & office supplies	5.4
Commodities Total	$5.4

FY12

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Simraud P150 Catch Monitoring system (partial cost)	1.0	10.7	10.7
			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	$10.7

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
Midwater Trawl	1	PWSSC

FY12

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Name	Project Title				
J. Watson	Research Assistant-Fisheries	6.0	6.6		39.6
M.A. Bishop	Principal Investigator	1.7	11.3		18.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17.9	0.0	
				Personnel Total	$58.3

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Description					
Alaska Marine Symposium	0.3	1	4	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.0

FY13

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
network & software subscriptions $150/staff mo	1.2
communications (phone and fax) $50/staff mo	0.4
printing & copying $25/staff mo	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.8

Commodities Costs: Description	Commodities Sum
Field, Lab, & Office supplies	2.8
Commodities Total	$2.8

FY13

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
Midwater Trawl	1	PWSSC
Simrad P150 Catch monitoring system	1	PWSSC

FY13

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
J. Watson	Research Assistant-Fisheries	6.0	6.8		40.7
M.A. Bishop	Principal Investigator	4.9	11.7		57.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	18.5	0.0	
				Personnel Total	$98.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Alaska Marine Symposium	0.3	1	4	0.2	1.0
Principal Investigators Meeting - Anchorage	0.3	1	4	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

FY14

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
network & software subscriptions $150/staff mo	1.7
communications (phone and fax) $50/staff mo	0.6
printing & copying $25/staff mo	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.6

Commodities Costs: Description	Commodities Sum
Field, Lab, & Office supplies	1.8
Commodities Total	$1.8

FY14

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
Midwater Trawl	1	PWSSC
Simrad P150 Catch monitoring system	1	PWSSC

FY14

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
J. Watson	Research Assistant-Fisheries	5.0	7.0		35.0
M.A. Bishop	Principal Investigator	5.0	12.0		60.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	19.0	0.0	
				Personnel Total	$95.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Alaska Marine Symposium	0.4	1	4	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.2

FY15

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
network & software subscriptions $150/staff mo	1.5
communications (phone and fax) $50/staff mo	0.5
printing & copying $25/staff mo	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.2

Commodities Costs: Description	Commodities Sum
Field, lab, office supplies	1.1
Commodities Total	$1.1

FY15

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
Midwater Trawl	1	PWSSC
Simrad P150 Catch monitoring system	1	PWSSC

FY15

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
J. Watson	Researh Assistant-Fisheries	5.0	7.2		36.0
M.A. Bishop	Principal Investigator	5.0	12.4		62.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	19.6	0.0	
				Personnel Total	$98.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Alaska Marine Symposium	0.4	1	4	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.2

FY16

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
network & software subscriptions $150/staff mo	1.5
communications (phone and fax) $50/staff mo	0.5
printing & copying $25/staff mo	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.2

Commodities Costs: Description	Commodities Sum
Field, lab, office supplies	1.1
Commodities Total	$1.1

FY16

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
Midwater Trawl	1	PWSSC
Simrad P150 Catch monitoring system	1	PWSSC

FY16

Project Title: PWS Herring Research and Monitoring: Acoustic Survey Validation
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$7.3	$8.9	$11.3	$0.0	$0.0	$27.5
Travel	$5.1	$4.2	$0.0	$0.0	$0.0	$9.3
Contractual	$0.4	$0.3	$1.0	$0.0	$0.0	$1.7
Commodities	$37.1	$0.5	$0.0	$0.0	$0.0	$37.6
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (*will vary by proposer*)	$15.0	$4.2	$3.7			$22.9
SUBTOTAL	$64.9	$18.1	$16.0	$0.0	$0.0	$99.0
General Administration (9% of subtotal)	$5.8	$1.6	$1.4	$0.0	$0.0	$8.8
PROJECT TOTAL	$70.7	$19.7	$17.4	$0.0	$0.0	$107.8
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
B. Reynolds	Research Assistant	0.8	6.4		5.1
M. Bishop	Principal Investigator	0.2	11.0		2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17.4	0.0	
				Personnel Total	$7.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Juneau-Cordova	0.4	1	3	0.2	1.0
Mobile-Cordova	1.1	2	8	0.2	3.8
Subsistence Univ. Alabama			7		0.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.1

FY12

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description		Contract Sum
network & software $150/staff mo		0.2
communications (phone and fax) $50/staff mo		0.1
printing & copying $25/staff mo		0.0
shipping (tags, batteries)		0.1
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$0.4

Commodities Costs: Description		Commodities Sum
Acoustic Tags (100@ $350/ea)		35.0
Tagging Supplies		0.9
Receiver Batteries (30 @ $30/ea)		0.9
Boat groceries, spring monitoring		0.3
	Commodities Total	$37.1

FY12

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
Vemco VR 2 Receivers	8	PWSSC
Vemco VR 3 Receivers (POST Array)	10	POST
Vemco VR2W Receivers (POST Array)	3	POST
Vemco Portable Tracking System	1	PWSSC
Vemco Acoustic Modem	1	PWSSC

FY12

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
B. Reynolds	Research Assistant	1.0	6.6		6.6
M. Bishop	Principal Investigator	0.2	11.3		2.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17.9	0.0	
				Personnel Total	$8.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Mobile-Cordova	1.1	2	8	0.2	3.8
Subsistence Univ. Alabama			10		0.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.2

FY13

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
network & software subscriptions $150/staff mo	0.2
printing & copying $25/staff mo	0.0
communications (phone and fax) $50/staff mo	0.1
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.3

Commodities Costs: Description	Commodities Sum
Tagging Supplies	0.2
Boat groceries, spring monitoring	0.3
Commodities Total	$0.5

FY13

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
Vemco VR 2 Receivers	8	PWSSC
Vemco VR 3 Receivers (POST Array)	10	POST
Vemco VR2W Receivers (POST Array)	3	POST
Vemco Portable Tracking System	1	PWSSC
Vemco Acoustic Modem	1	PWSSC

FY13

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
M. Bishop	Principal Investigator	1.0	11.3		11.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	11.3	0.0	
				Personnel Total	$11.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY14

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
network & software subscriptions $150/staff mo	0.1
printing & copying $25/staff mo	0.0
communications (phone and fax) $50/staff mo	0.1
page charges scientific journal	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY14

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY15

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY15

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY16

Project Title: PWS Herring Research and Monitoring: Movements of Acoustic-tagged Pacific herring
Project PI: Dr. Mary Anne Bishop, PWS Science Center & Dr. Sean Powers, Univ. S. Alabama

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$16.2	$49.9	$40.9	$55.3	$55.9	$218.2
Travel	$0.0	$2.6	$2.6	$2.6	$2.6	$10.4
Contractual	$0.5	$4.0	$1.6	$2.0	$0.0	$8.1
Commodities	$1.5	$0.0	$1.5	$0.0	$0.0	$3.0
Equipment	$59.0	$0.0	$0.0	$0.0	$0.0	$59.0
Indirect Costs (*will vary by proposer*)	$5.5	$17.0	$14.0	$18.0	$17.6	$72.1
SUBTOTAL	$82.7	$73.5	$60.6	$77.9	$76.1	$370.8
General Administration (9% of subtotal)	$7.4	$6.6	$5.5	$7.0	$6.9	$33.4
PROJECT TOTAL	$90.1	$80.1	$66.1	$84.9	$83.0	$404.2
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	2.0	8.1		16.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	8.1	0.0	
				Personnel Total	$16.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY12

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Network, phone ($150/man month)	0.3
Printing	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.5

Commodities Costs: Description	Commodities Sum
Sampling supplies	1.5
Commodities Total	$1.5

FY12

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
120 kHz split-beam hydroacoustic unit	1.0	47.0	47.0
Trawl winch	2.0	6.0	12.0
			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	$59.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	3.0	8.5		25.5
Richard Thorne, PhD	co-PI	0.3	11.4		3.4
James Thorne	acoustics tech	3.0	7.0		21.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	26.9	0.0	
				Personnel Total	$49.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Seattle to Cordova - Richard Thorne	0.7	2			1.4
Cordova to Anchorage -AMSS Richard Thorne	0.6	1	3	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.6

FY13

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Equipment calibration	2.0
Network, phone ($150/man month)	1.0
Printing	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$4.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY13

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	2.5	9.0		22.5
Richard Thorne, PhD	co-PI	0.3	11.4		3.4
James Thorne	acoustics tech	2.0	7.5		15.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	27.9	0.0	
				Personnel Total	$40.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Seattle to Cordova - Richard Thorne	0.7	2			1.4
Cordova to Anchorage AMSS - Richard Thorne	0.6	1	3	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.6

FY14

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Network, phone ($150/man month)	0.8
Printing	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.6

Commodities Costs: Description	Commodities Sum
Sampling supplies	1.5
Commodities Total	$1.5

FY14	**Program Title: Juvenile Herring Abundance Index** **Team Leader: Michele Buckhorn**	**FORM 3B** **CONTRACTUAL &** **COMMODITIES DETAIL**

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	3.0	9.4		28.2
Richard Thorne, PhD	co-PI	0.3	11.4		3.4
James Thorne	acoustics tech	3.0	7.9		23.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	28.7	0.0	
				Personnel Total	$55.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Seattle to Cordova - Richard Thorne	0.7	2			1.4
Cordova to Anchorage AMSS - Richard Thorne	0.6	1	3	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.6

FY15

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Network, phone ($150/man month)	1.0
printing	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY15

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	3.0	9.4		28.2
Richard Thorne, PhD	co-PI	0.3	11.4		3.4
James Thorne	acoustics tech	3.0	8.1		24.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	28.9	0.0	
				Personnel Total	$55.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Seattle to Cordova - Richard Thorne	0.7	2			1.4
Cordova to Anchorage AMSS - Richard Thorne	0.6	1	3	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.6

FY16

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY16

Program Title: Juvenile Herring Abundance Index
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$0.0	$0.0	$51.1	$4.7	$0.0	$55.8
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Contractual	$0.0	$0.0	$1.0	$0.1	$0.0	$1.1
Commodities	$0.0	$0.0	$2.0	$0.0	$0.0	$2.0
Equipment	$46.0	$0.0	$0.0	$0.0	$0.0	$46.0
Indirect Costs (30% PWSSC)	$0.0	$0.0	$15.9	$1.4	$0.0	$17.3
SUBTOTAL	$46.0	$0.0	$70.0	$6.2	$0.0	$122.2
General Administration (9% of subtotal)	$4.1	$0.0	$6.3	$0.6	$0.0	$11.0
PROJECT TOTAL	$50.1	$0.0	$76.3	$6.8	$0.0	$133.2
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY12

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY12

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
ECHOVIEW Acoustic post-processing software (5 modules)	1.0	46.0	46.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$46.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY13

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY13

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	3.0	9.0		27.0
Richard Thorne, PhD	co-PI	0.8	11.4		9.1
James Thorne	acoustics tech	2.0	7.5		15.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	27.9	0.0	
				Personnel Total	$51.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY14

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Network, phone ($150/man month)	0.9
Printing	0.1
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.0

Commodities Costs: Description	Commodities Sum
Sampling supplies	2.0
Commodities Total	$2.0

FY14	**Program Title: Intensive Juvenile Herring Surveys** **Team Leader: Michele Buckhorn**	**FORM 3B** **CONTRACTUAL &** **COMMODITIES DETAIL**

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn	PI	0.5	9.4		4.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	9.4	0.0	
				Personnel Total	$4.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY15

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Network, phone ($150/man month)	0.1
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.1

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY15

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY16

Program Title: Intensive Juvenile Herring Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**

DETAILED BUDGET FORM FY 12-FY16

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$0.0	$49.9	$40.9	$55.3	$55.9	$202.0
Travel	$0.0	$3.6	$3.6	$3.6	$3.6	$14.4
Contractual	$0.0	$2.0	$3.6	$3.0	$0.0	$8.6
Commodities	$0.0	$4.0	$0.0	$2.0	$0.0	$6.0
Equipment	$6.0	$0.0	$0.0	$0.0	$0.0	$6.0
Indirect Costs (*will vary by proposer*)	$0.0	$17.9	$14.4	$19.2	$17.9	$69.4
SUBTOTAL	$6.0	$77.4	$62.5	$83.1	$77.4	$306.4
General Administration (9% of subtotal)	$0.5	$7.0	$5.6	$7.5	$7.0	$27.6
PROJECT TOTAL	$6.5	$84.4	$68.1	$90.6	$84.4	$334.0
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY12

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY12	Program Title: Expanded Adult Surveys Team Leader: Michele Buckhorn	FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Net sounder	0.5	12.0	6.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$6.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	3.0	8.5		25.5
Richard Thorne, PhD	co-PI	0.3	11.4		3.4
James Thorne	acoustics tech	3.0	7.0		21.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	26.9	0.0	
				Personnel Total	$49.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Cordova to Anchorage AMSS - Michele Buckhorn	0.6	1	4	0.2	1.4
Conference travel - Michele Buckhorn	1.2	1	5	0.2	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.6

FY13

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Network, phone ($150/man month)	1.0
printing	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.0

Commodities Costs: Description	Commodities Sum
Sampling supplies	2.5
Acoustic laptop	1.5
Commodities Total	$4.0

FY13

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	2.5	9.0		22.5
Richard Thorne, PhD	co-PI	0.3	11.4		3.4
James Thorne	acoustics tech	2.0	7.5		15.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	27.9	0.0	
				Personnel Total	$40.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Cordova to Anchorage AMSS - Michele Buckhorn	0.6	1	4	0.2	1.4
Conference travel - Michele Buckhorn	1.2	1	5	0.2	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.6

FY14

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
network, phone ($150/man month)	0.8
printing	0.8
equipment calibration	2.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$3.6

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY14

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	3.0	9.4		28.2
Richard Thorne, PhD	co-PI	0.3	11.4		3.4
James Thorne	acoustics tech	3.0	7.9		23.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	28.7	0.0	
				Personnel Total	$55.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Cordova to Anchorage AMSS - Michele Buckhorn	0.6	1	4	0.2	1.4
Conference travel - Michele Buckhorn	1.2	1	5	0.2	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.6

FY15

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Network, phone	1.0
equipment calibration	1.0
printing	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$3.0

Commodities Costs: Description	Commodities Sum
sampling supplies	2.0
Commodities Total	$2.0

FY15

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Michele Buckhorn, PhD	PI	3.0	9.4		28.2
Richard Thorne, PhD	co-PI	0.3	11.4		3.4
James Thorne	acoustics tech	3.0	8.1		24.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	28.9	0.0	
				Personnel Total	$55.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Cordova to Anchorage AMSS - Michele Buckhorn	0.6	1	4	0.2	1.4
Conference travel - Michele Buckhorn	1.2	1	5	0.2	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.6

FY16

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY16

Program Title: Expanded Adult Surveys
Team Leader: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Travel	$2.0	$0.0	$0.0	$0.0	$0.0	$2.0
Contractual	$23.0	$0.0	$0.0	$0.0	$0.0	$23.0
Commodities	$5.0	$0.0	$0.0	$0.0	$0.0	$5.0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$30.0	$0.0	$0.0	$0.0	$0.0	$30.0
General Administration (9% of subtotal)	$2.7	$0.0	$0.0	$0.0	$0.0	$2.7
PROJECT TOTAL	$32.7	$0.0	$0.0	$0.0	$0.0	$32.7
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Program Title:Hi-res condition monitoring Team Leader:Heintz
Agency: NOAA
+D60

FORM 4A
TRUSTEE AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Travel to annual meeting in Cordova (Heintz Vollenweider)	0.4	2	6	0.2	2.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

FY12

Program Title:Hi-res condition monitoring Team Leader:Heintz
Agency: NOAA
+D69

FORM 4B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Contract forRNA/DNA analysis (Sewall)	18.0
Contract for data management	5.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$23.0

Commodities Costs: Description	Commodities Sum
lab supplies, reagents, columns, standards, NIST reference material	5.0
Commodities Total	$5.0

FY12

Program Title:Hi-res condition monitoring Team Leader:Heintz
Agency: NOAA
+D69

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Program Title:Hi-res condition monitoring Team Leader:Heintz
Agency: NOAA
+D60

FORM 4B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY13

Program Title:Hi-res condition monitoring Team Leader:Heintz
Agency: NOAA
+D69

FORM 4B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY13

Program Title:Hi-res condition monitoring Team Leader:Heintz
Agency: NOAA
+D69

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Program Title:Hi-res condition monitoring Team Leader:Heintz
Agency: NOAA
+D69

FORM 4B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY14

Program Title:
Team Leader:
Agency:

FORM 4B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY14

Program Title:
Team Leader:
Agency:

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14

Program Title:
Team Leader:
Agency:

FORM 4B
EQUIPMENT DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY15

Program Title:
Team Leader:
Agency:

FORM 4B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY15

Program Title:
Team Leader:
Agency:

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Program Title:
Team Leader:
Agency:

FORM 4B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Program Title:
Team Leader:
Agency:

FORM 4B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Program Title:
Team Leader:
Agency:

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY16

Program Title:
Team Leader:
Agency:

FORM 4B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15
Personnel	$0.0	$0.0	$17.5	$17.5
Travel	$0.0	$0.0	$3.4	$5.8
Contractual	$0.0	$0.0	$0.0	$0.0
Commodities	$0.0	$0.0	$25.4	$25.4
Equipment	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$0.0	$0.0	$46.3	$48.7
General Administration (9% of subtotal)	$0.0	$0.0	$4.2	$4.4
PROJECT TOTAL	$0.0	$0.0	$50.5	$53.1
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0

FY12-16

Program Title:Genetic Stock Indicators Team
Leader:Guyon and Wildes
Agency: NOAA

Personnel Costs:		Months
Name	Project Title	Budgeted
		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY12

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY12

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes

FY12

Agency: NOAA

New Equipment Purchases:

Description

Existing Equipment Usage:

Description

FY12	Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes Agency: NOAA

Personnel Costs:

Name	Project Title	Months Budgeted

	Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY13

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY13

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA

New Equipment Purchases:

Description

Existing Equipment Usage:

Descriptior

FY13

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA

Personnel Costs:

Name	Project Title	Months Budgeted
Technician	Genetic Stock Inidcators	2.5

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Trips to AMSS (Guyon and Wildes)	0.4	2
Trip to Cordova (Wildes)	0.4	1

FY14

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
Supplies

FY14

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY14

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA

Personnel Costs:		Months Budgeted
Name	Project Title	
TBA	Genetic Stock Indicators	2.5

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Trip to Yakutat (technician and Wildes)	0.4	2
Trip to AMSS (Guyon and Wildes)	0.4	2
Trip to Cordova (Wildes)	0.4	1

FY15

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY15

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY15

Program Title:Genetic Stock Indicators Team Leader: Guyon and Wildes
Agency: NOAA
+A46

Personnel Costs:		Months
Name	Project Title	Budgeted

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY16

Program Title:
Team Leader:
Agency:

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY16

Program Title:
Team Leader:
Agency:

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY16

Program Title:
Team Leader:
Agency:

Proposed FY 16	TOTAL PROPOSED
$0.0	$35.0
$0.0	$9.2
$0.0	$0.0
$0.0	$50.8
$0.0	$0.0
$0.0	$95.0
$0.0	$8.6
$0.0	$103.6
$0.0	$0.0

FORM 4A
TRUSTEE AGENCY
SUMMARY

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum
Commodities Total	$0.0

FORM 4B
CONTRACTUAL &

CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
7.0		17.5
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0

		0.0
		0.0
		0.0
		0.0
7.0	0.0	
	Personnel Total	$17.5

Total Days	Daily Per Diem	Travel Sum
8	0.2	2.4
3	0.2	1.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$3.4

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum
	25.4

Commodities Total	$25.4

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
7.0		17.5
		0.0
		0.0
		0.0
		0.0

		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
7.0	0.0	
	Personnel Total	$17.5

Total Days	Daily Per Diem	Travel Sum
8	0.2	2.4
8	0.2	2.4
3	0.2	1.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$5.8

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum
	25.4

Commodities Total	$25.4

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15
Personnel	$0.0	$0.0	$0.0	$0.0
Travel	$0.0	$4.4	$0.0	$0.0
Contractual	$15.0	$36.0	$0.0	$0.0
Commodities	$1.9	$2.8	$0.0	$0.0
Equipment	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$16.9	$43.2	$0.0	$0.0
General Administration (9% of subtotal)	$1.5	$3.9	$0.0	$0.0
PROJECT TOTAL	$18.4	$47.1	$0.0	$0.0
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0

NOAA contributes salaries for Heintz and Vollenweider for project management

FY12-16

Program Title:Fatty Acids and Winter Migration Team
Leader:Heintz and Vollenweider
Agency: NOAA

Personnel Costs:		Months
Name	Project Title	Budgeted
		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY12	Program Title:Fatty Acids and Winter Migration Team Leader:Heintz and Vollenweider Agency: NOAA

Contractual Costs: Description
Sample prep
Fish culture
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
chem lab supplies

FY12
Program Title:Fatty Acids and Winter Migration Team
Leader:Heintz and Vollenweider

FY12	Leader:Heintz and Vollenweider Agency: NOAA

New Equipment Purchases:

Description

Existing Equipment Usage:

Description

FY12	Program Title:Fatty Acids and Winter Migration Team Leader:Heintz and Vollenweider Agency: NOAA

Personnel Costs:

Name	Project Title	Months Budgeted

	Subtotal

Travel Costs: Description	Ticket Price	Round Trips
2 trips to AMSS (Heintz and Sewall)	0.4	2
2 trip to Cordova for herring meeting (Heintz and Sewall)	0.4	2

FY13

Program Title:Fatty Acids and Winter Migration Team Leader:Heintz and Vollenweider
Agency: NOAA

Contractual Costs: Description
Contract for sample prep
Contract for GC/MS analysis
Contract for data management
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
Sample vials, gases, reagents, fatty acid standards, standard reference materials

FY13	Program Title:Fatty Acids and Winter Migration Team Leader:Heintz and Vollenweider Agency: NOAA

New Equipment Purchases:

Description

Existing Equipment Usage:

Description
Rearing tanks in wet lab
Supercold freezer
gas chromatograph/mass spectrometer
accelerated solvent extractor
computers

FY13	Program Title:Fatty Acids and Winter Migration Team Leader:Heintz and Vollenweider Agency: NOAA

Personnel Costs:

Name	Project Title	Months Budgeted

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY14

Program Title:Fatty Acids and Winter Migration Team Leader:Heintz and Vollenweider
Agency: NOAA

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY14

Program Title:
Team Leader:
Agency:

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY14

Program Title:
Team Leader:
Agency:

Personnel Costs:		Months Budgeted
Name	Project Title	

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY15

Program Title:
Team Leader:
Agency:

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY15

Program Title:
Team Leader:
Agency:

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY15

Program Title:
Team Leader:
Agency:

Personnel Costs:		Months Budgeted
Name	Project Title	

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY16

Program Title:
Team Leader:
Agency:

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY16

Program Title:
Team Leader:
Agency:

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY16

Program Title:
Team Leader:
Agency:

Proposed FY 16	TOTAL PROPOSED
$0.0	$0.0
$0.0	$4.4
$0.0	$51.0
$0.0	$4.7
$0.0	$0.0
$0.0	$60.1
$0.0	$5.4
$0.0	$65.5
$0.0	$0.0

FORM 4A
TRUSTEE AGENCY
SUMMARY

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
	11.0
	4.0
Contractual Total	$15.0

	Commodities Sum
	1.9
Commodities Total	$1.9

FORM 4B
CONTRACTUAL &

CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
8	0.2	2.4
6	0.2	2.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$4.4

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
	17.5
	13.5
	5.0
Contractual Total	$36.0

	Commodities Sum
	2.8

Commodities Total		$2.8

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency
	6	6
	1	1
	1	1
	1	1
	2	2

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15
Personnel	$0.0	$0.0	$0.0	$0.0
Travel	$4.0	$3.1	$0.0	$0.0
Contractual	$38.0	$14.4	$0.0	$0.0
Commodities	$3.5	$2.5	$0.0	$0.0
Equipment	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$45.5	$20.0	$0.0	$0.0
General Administration (9% of subtotal)	$4.1	$1.8	$0.0	$0.0
PROJECT TOTAL	$49.6	$21.8	$0.0	$0.0
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0

FY12-16

Program Title:Age at first spawning Team Leader: Vollenweider
Agency: NOAA

Personnel Costs:		Months
Name	Project Title	Budgeted
		Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Trip to Cordova to collect samples (Vollenweider Sewall)	500.0	2
Trip to AMSS (Vollenweider and Heintz)	450.0	2

FY12

Program Title:Age at first spawning Team Leader: Vollenweider
Agency: NOAA

Contractual Costs: Description
Histological analysis (Gary Marty)
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
formalin, storage bags, sample shipping

FY12

Program Title:Age at first spawning Team Leader: Vollenweider

FY12

Agency: NOAA

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY12

Program Title:Age at first spawning Team Leader: Vollenweider
Agency: NOAA

Personnel Costs:		Months Budgeted
Name	Project Title	

	Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Field trip to Cordova (1) to collect scales	450.0	1
Attend annual herring meeting in Cordova	500.0	1
Attend AMSS in Anchorage	500.0	1

FY13

Program Title:Age at first spawning Team Leader: Vollenweider
Agency: NOAA

Contractual Costs: Description
Scale reading
Contract for data management
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
sample containers, shipping

FY13

Program Title:Hi-res condition monitoring Team Leader:Heintz
Agency: NOAA

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY13

Program Title:Fatty Acids and Winter Migration Team Leader:Heintz and Vollenweider
Agency: NOAA

Personnel Costs:		Months Budgeted
Name	Project Title	

Subtotal		

Travel Costs: Description	Ticket Price	Round Trips

FY14

Program Title:Age at first spawning Team Leader: Vollenweider
Agency: NOAA

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY14

Program Title:Age at first spawning Team Leader: Vollenweider
Agency: NOAA

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY14

Program Title:Age at first spawning Team Leader: Vollenweider
Agency: NOAA

Personnel Costs:		Months Budgeted
Name	Project Title	

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY15

Program Title:Age at first spawning Team Leader: Vollenweider
Agency: NOAA

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY15

Program Title:
Team Leader:
Agency:

New Equipment Purchases:

Description

Existing Equipment Usage:

Description

FY15

Program Title:
Team Leader:
Agency:

Personnel Costs:

Name	Project Title	Months Budgeted

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY16

Program Title:
Team Leader:
Agency:

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY16

Program Title:
Team Leader:
Agency:

New Equipment Purchases:
Description

Existing Equipment Usage:
Descriptior

FY16

Program Title:
Team Leader:
Agency:

Proposed FY 16	TOTAL PROPOSED
$0.0	$0.0
$0.0	$7.1
$0.0	$52.4
$0.0	$6.0
$0.0	$0.0
$0.0	$65.5
$0.0	$5.9
$0.0	$71.4
$0.0	$0.0

FORM 4A
TRUSTEE AGENCY
SUMMARY

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
6	185.0	2.1
6	165.0	1.9
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$4.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
	38.0
Contractual Total	$38.0

	Commodities Sum
	3.5
Commodities Total	$3.5

FORM 4B
CONTRACTUAL &

CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
4	165.0	1.1
3	165.0	1.0
3	165.0	1.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$3.1

FORM 4B
PERSONNEL & TRAVEL
DETAIL

	Contract Sum
	12.0
	2.4
	0.0
Contractual Total	$14.4

	Commodities Sum
	2.5

Commodities Total	$2.5

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL
DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15
Personnel	$0.0	$0.0	$0.0	$0.0
Travel	$0.0	$0.0	$3.9	$7.1
Contractual	$0.0	$75.0	$75.0	$75.0
Commodities	$0.0	$6.0	$5.0	$5.0
Equipment	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$0.0	$81.0	$83.9	$87.1
General Administration (9% of subtotal)	$0.0	$7.3	$7.6	$7.8
PROJECT TOTAL	$0.0	$88.3	$91.5	$94.9
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0

FY12-16

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Personnel Costs:		Months
Name	Project Title	Budgeted
		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY12

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY12

Program Title:Long-term growth monitoring Team Leader:Heintz

FY12

Leader:Heintz
Agency: NOAA

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY12

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Personnel Costs:		Months
Name	Project Title	Budgeted

	Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY13

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Contractual Costs: Description
Contract for RNA/DNA analysis
Contract for lipid analysis
Contract for data consolidation
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
Sample vials, gases, reagents, fatty acid standards, standard reference materials

FY13

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

New Equipment Purchases:

Description

Existing Equipment Usage:

Description

FY13

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Personnel Costs:

Name	Project Title	Months Budgeted

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Travel to annual herring meeting in Cordova	500.0	2
Travel to AMSS in Anchorage	500.0	2

FY14

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Contractual Costs: Description
Contract for RNA/DNA analysis
Contract for lipid analysis
Contract for data consolidation
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
standards, sample vials, pipette tips, reagents, dye

FY14

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY14

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Personnel Costs:		Months Budgeted
Name	Project Title	

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Travel to annual herring meeting in Cordova	500.0	2
Travel to AMSS in Anchorage	500.0	2
Travel to Anchorage for Synthesis meeting	1500.0	2

FY15

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Contractual Costs: Description
Contract for RNA/DNA analysis
Contract for lipid analysis
Contract for data consolidation
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
standards, sample vials, pipette tips, reagents, dye

FY15	**Program Title:Long-term growth monitoring Team Leader:Heintz** **Agency: NOAA**

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY15	**Program Title:Long-term growth monitoring Team Leader:Heintz** **Agency: NOAA**

Personnel Costs:		Months
Name	Project Title	Budgeted

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Travel to annual herring meeting in Cordova	500.0	2
Travel to AMSS in Anchorage	500.0	2
	0	0

FY16

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Contractual Costs: Description
Contract for RNA/DNA analysis
Contract for lipid analysis
Contract for data consolidation
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
standards, sample vials, pipette tips, reagents, dye

FY16

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY16

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

Proposed FY 16	TOTAL PROPOSED
$0.0	$0.0
$4.0	$15.0
$75.0	$300.0
$5.0	$21.0
$0.0	$0.0
$84.0	$336.0
$7.6	$30.3
$91.6	$366.3
$0.0	$0.0

FORM 4A
TRUSTEE AGENCY
SUMMARY

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum
Commodities Total	$0.0

FORM 4B
CONTRACTUAL &

CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

		Contract Sum
		35
		35
		5
	Contractual Total	$75.0

	Commodities Sum
	6.0

Commodities Total	$6.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
4	165.0	1.6
8	165.0	2.3
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$3.9

FORM 4B
PERSONNEL & TRAVEL
DETAIL

		Contract Sum
		35
		35
		5
	Contractual Total	$75.0

	Commodities Sum
	5.0

Commodities Total	$5.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
4	165.0	1.7
8	165.0	2.3
5	185.0	3.1
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$7.1

FORM 4B
PERSONNEL & TRAVEL DETAIL

		Contract Sum
		35
		35
		5
	Contractual Total	$75.0

	Commodities Sum
	5.0

Commodities Total	$5.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
4	165.0	1.7
8	165.0	2.3
0	0	0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$4.0

FORM 4B
PERSONNEL & TRAVEL
DETAIL

		Contract Sum
		35
		35
		5
	Contractual Total	$75.0

	Commodities Sum
	5.0

Commodities Total	$5.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15
Personnel	$58.8	$39.2	$0.0	$0.0
Travel	$1.1	$0.5	$0.0	$0.0
Contractual	$0.2	$0.0	$0.0	$0.0
Commodities	$4.0	$0.0	$0.0	$0.0
Equipment	$15.0	$0.0	$0.0	$0.0
SUBTOTAL	$79.1	$39.7	$0.0	$0.0
General Administration (9% of subtotal)	$7.1	$3.6	$0.0	$0.0
PROJECT TOTAL	$86.2	$43.3	$0.0	$0.0
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directl proposed in this proposal. **Supervision of the project (1.0 months of FB III general funds = $10.5 k), office**

FY12-16

Program Title: Scales as growth history records for Pacific herring.
Team Leader: Steve Moffitt
Agency: Alaska Dept. of Fish and Game

Personnel Costs:		Months
Name	Project Title	Budgeted
FWT II (vacant)	Scales as growth history records for Pacific her	12.0
		Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Travel to Juneau to meet with ADF&G age lab staff using similar equipment	0.4	1
Travel to PI meeting	0.3	1

FY12

Program Title: Scales as growth history records for Pacific herring.
Team Leader: Steve Moffitt
Agency: Alaska Dept. of Fish and Game

Contractual Costs: Description
Retrofit scanner plate to accommimidate herring scales
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
Optimas Image Pro software
External Hard drives for image backup

FY12

Program Title: Scales as growth history records for Pacific herring.

FY12	Team Leader: Steve Moffitt Agency: Alaska Dept. of Fish and Game

New Equipment Purchases:

Description
Indus model 4601-11 with Screen Scan Model PC

Existing Equipment Usage:

Description
Dell desktop computer and monitor

FY12	Program Title: Scales as growth history records for Pacific herring. Team Leader: Steve Moffitt Agency: Alaska Dept. of Fish and Game

Personnel Costs:

Name	Project Title	Months Budgeted
FWT II (vacant)	Scales as growth history records for Pacific herr	8.0

	Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Travel to PI meeting	0.3	1

FY13

Program Title: Scales as growth history records for Pacific herring.
Team Leader: Steve Moffitt
Agency: Alaska Dept. of Fish and Game

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY13

Program Title: Scales as growth history records for Pacific herring.
Team Leader: Steve Moffitt
Agency: Alaska Dept. of Fish and Game

New Equipment Purchases:

Description

Existing Equipment Usage:

Description

FY13

Program Title: Scales as growth history records for Pacific herring.
Team Leader: Steve Moffitt
Agency: Alaska Dept. of Fish and Game

Personnel Costs:

Name	Project Title	Months Budgeted

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY14	**Program Title:** **Team Leader:** **Agency:**

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY14

Program Title:
Team Leader:
Agency:

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY14

Program Title:
Team Leader:
Agency:

Personnel Costs:		Months Budgeted
Name	Project Title	

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY15

Program Title:
Team Leader:
Agency:

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY15	**Program Title:** **Team Leader:** **Agency:**

New Equipment Purchases: Description

Existing Equipment Usage: Description

FY15	**Program Title:** **Team Leader:** **Agency:**

Personnel Costs:		Months
Name	Project Title	Budgeted

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY16

Program Title:
Team Leader:
Agency:

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY16

Program Title:
Team Leader:
Agency:

New Equipment Purchases:
Description

Existing Equipment Usage:
Description

FY16

Program Title:
Team Leader:
Agency:

Proposed FY 16	TOTAL PROPOSED	
$0.0	$98.0	
$0.0	$1.6	
$0.0	$0.2	
$0.0	$4.0	
$0.0	$15.0	
$0.0	$118.8	
$0.0	$10.7	
$0.0	$129.5	
$0.0	$0.0	

in this proposal. List the amount of funds,
ly and specifically related to the work being
space for equipment and personnel.

FORM 4A
TRUSTEE AGENCY
SUMMARY

Monthly Costs	Overtime	Personnel Sum
4.9		58.8
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
4.9	0.0	
	Personnel Total	$58.8

Total Days	Daily Per Diem	Travel Sum
2	0.1	0.6
2	0.1	0.5
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$1.1

FORM 4B
PERSONNEL & TRAVEL
DETAIL

	Contract Sum
	0.2
Contractual Total	$0.2

	Commodities Sum
	3.5
	0.5
Commodities Total	$4.0

FORM 4B
CONTRACTUAL &

CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
1.0	15.0	15.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
New Equipment Total		$15.0

	Number of Units	Inventory Agency
	1	ADF&G

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
4.9		39.2
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0

4.9	0.0	
	Personnel Total	$39.2

Total Days	Daily Per Diem	Travel Sum
2	0.1	0.5
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.5

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15
Personnel	$0.0	$0.0	$170.4	$186.6
Travel	$0.0	$0.0	$17.0	$17.0
Contractual	$0.0	$0.0	$12.0	$12.0
Commodities	$0.0	$0.0	$46.0	$39.0
Equipment	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$0.0	$0.0	$245.4	$254.6
General Administration (9% of subtotal)	$0.0	$0.0	$22.1	$22.9
PROJECT TOTAL	$0.0	$0.0	$267.5	$277.5
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the wo
funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are
work being proposed in this proposal.

FY12-16

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

Personnel Costs:		Months
Name	Project Title	Budgeted
		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY12

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY12

Program Title: Herring Disease
Team Leader: Paul Hershberger

FY12	Agency: USGS

New Equipment Purchases:

Description

Existing Equipment Usage:

Description

FY12	Program Title: Herring Disease Team Leader: Paul Hershberger Agency: USGS

Personnel Costs:

Name	Project Title	Months Budgeted

	Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY13

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

Contractual Costs: Description
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description

FY13

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

New Equipment Purchases:

Description

Existing Equipment Usage:

Description

FY13

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

Personnel Costs:

Name	Project Title	Months Budgeted

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips

FY14

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

Contractual Costs: Description
Subcontract: assistance with laboratory studies
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
Fish food, enrichments, and live feed production for SPF herring
Laboratory supplies (cell culture, histology, molecular biology, parasitology, virology, etc.)
Histology Supplies
Fluorescent in situ hybridization supplies

FY14	Program Title: Herring Disease Team Leader: Paul Hershberger Agency: USGS

New Equipment Purchases:

Description

Existing Equipment Usage:

Description

FY14	Program Title: Herring Disease Team Leader: Paul Hershberger Agency: USGS

Personnel Costs:

Name	Project Title	Months Budgeted
New Hire	GS-7, Step-3 Lab Technician	12.0
New Hire	GS-7, Step-3 Lab Technician for in situ hybridiz	12.0
New Hire	Student Intern (student services contract)	12.0
New Hire	Summer Intern (student services contract)	6.0

		Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Nordland, WA - Anchorage (presentation @ AK marine Science Symp.	1.2	2
Nordland, WA - Cordova (adult and juvenile herring sampling)	1.4	4
Nordland, WA - Sitka (adult herring sampling)	1.2	2
Nordland, WA - Cordova (participate in PI integration meeting)	1.4	1

FY15

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

Contractual Costs: Description
Subcontract: assistance with laboratory studies
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
Fish food, enrichments, and live feed production for SPF herring
Laboratory supplies (cell culture, histology, molecular biology, parasitology, virology, etc.)

FY15	Program Title: Herring Disease Team Leader: Paul Hershberger Agency: USGS

New Equipment Purchases:

Description

Existing Equipment Usage:

Description

FY15	Program Title: Herring Disease Team Leader: Paul Hershberger Agency: USGS

Personnel Costs:		Months
Name	Project Title	Budgeted
New Hire	GS-7, Step-4 Lab Technician (inlcudes benefits	12.0
New Hire	GS-9, Step-1 Post Doc (Inlcudes benefits)	12.0

New Hire	Student Intern (student services contract)	12.0
New Hire	Summer Intern (student services contract)	6.0
		Subtotal

Travel Costs: Description	Ticket Price	Round Trips
Nordland, WA - Anchorage (presentation @ AK marine Science Symp.	1.2	2
Nordland, WA - Cordova (adult and juvenile herring sampling)	1.4	4
Nordland, WA - Sitka (adult herring sampling)	1.2	2
Nordland, WA - Cordova (participate in PI integration meeting)	1.4	1

FY16

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

Contractual Costs: Description
Subcontract: assistance with laboratory studies
If a component of the project will be performed under contract, the 4A and 4B forms are required.

Commodities Costs: Description
Fish food, enrichments, and live feed production for SPF herring
Laboratory supplies (cell culture, histology, molecular biology, parasitology, virology, etc.)

FY16

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

New Equipment Purchases:
Description

FY16

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

Existing Equipment Usage:
Description

Program Title: Herring Disease

FY16	Team Leader: Paul Hershberger Agency: USGS

Personnel Costs:		Months
Name	Project Title	Budgeted
New Hire	GS-8, Step-1 Lab Technician	12.0
New Hire	GS-9, Step-2 Post Doc	12.0
New Hire	Student intern (student services contract)	12.0
New Hire	Summer Intern (student services contract)	6.0
		Subtotal

Travel Costs:	Ticket	Round
Description	Price	Trips
Nordland, WA - Anchorage (presentation @ AK marine Science Symp.	1.2	2
Nordland, WA - Cordova (adult and juvenile herring sampling)	1.4	4
Nordland, WA - Sitka (adult herring sampling)	1.2	2
Nordland, WA - Cordova (participate in PI integration meeting)	1.4	2

Proposed FY 16	TOTAL PROPOSED
$190.8	$547.8
$18.4	$52.4
$12.0	$36.0
$39.0	$124.0
$0.0	$0.0
$260.2	$760.2
$23.4	$68.4
$283.6	$828.6
$0.0	$0.0

rk in this proposal. List the amount of
not directly and specifically related to the

FORM 4A
TRUSTEE AGENCY
SUMMARY

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum
Commodities Total	$0.0

FORM 4B
CONTRACTUAL &

CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
Contractual Total	$0.0

	Commodities Sum

Commodities Total	$0.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
		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	0.0	
	Personnel Total	$0.0

Total Days	Daily Per Diem	Travel Sum
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$0.0

FORM 4B
PERSONNEL & TRAVEL
DETAIL

	Contract Sum
	12.0
Contractual Total	$12.0

	Commodities Sum
	15.0
	20.0
	3.0
	8.0

Commodities Total	$46.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
5.0		60.0
5.0		60.0
3.0		36.0
2.4		14.4
		0.0

		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
15.4	0.0	
	Personnel Total	$170.4

Total Days	Daily Per Diem	Travel Sum
5	0.2	3.4
10	0.2	7.6
4	0.2	3.2
7	0.2	2.8
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$17.0

FORM 4B
PERSONNEL & TRAVEL DETAIL

	Contract Sum
	12.0
Contractual Total	$12.0

	Commodities Sum
	17.0
	22.0

Commodities Total	$39.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
	New Equipment Total	$0.0

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
5.2		62.4
6.0		72.0

3.1		37.2
2.5		15.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
16.8	0.0	
	Personnel Total	$186.6

Total Days	Daily Per Diem	Travel Sum
5	0.2	3.4
10	0.2	7.6
4	0.2	3.2
7	0.2	2.8
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$17.0

FORM 4B
PERSONNEL & TRAVEL
DETAIL

	Contract Sum
	12.0
Contractual Total	$12.0

	Commodities Sum
	17.0
	22.0

Commodities Total	$39.0

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Number of Units	Unit Price	Equipment Sum
		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
New Equipment Total		$0.0

FORM 4B
EQUIPMENT DETAIL

	Number of Units	Inventory Agency

FORM 4B
EQUIPMENT DETAIL

Monthly Costs	Overtime	Personnel Sum
5.3		63.6
6.1		73.2
3.2		38.4
2.6		15.6
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
17.2	0.0	
	Personnel Total	$190.8

Total Days	Daily Per Diem	Travel Sum
5	0.2	3.4
10	0.2	7.6
4	0.2	3.2
7	0.2	4.2
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
		0.0
	Travel Total	$18.4

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commodities	$0.0	$0.0	$13.2	$13.2	$13.2	$39.6
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$0.0	$0.0	$13.2	$13.2	$13.2	$39.6
General Administration (9% of subtotal)	$0.0	$0.0	$1.2	$1.2	$1.2	$3.6
PROJECT TOTAL	$0.0	$0.0	$14.4	$14.4	$14.4	$43.2
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Program Title:
Team Leader:
Agency:

FORM 4A
TRUSTEE AGENCY
SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs: Name	 Project Title	Months Budgeted	Monthly Costs	 Overtime	Personnel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY12

Program Title:
Team Leader:
Agency:

FORM 4B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY12

Program Title:
Team Leader:
Agency:

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Program Title:
Team Leader:
Agency:

FORM 4B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY13

Program Title:
Team Leader:
Agency:

FORM 4B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY13

Program Title:
Team Leader:
Agency:

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Program Title:
Team Leader:
Agency:

FORM 4B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY14

Program Title:
Team Leader:
Agency:

FORM 4B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Laboratory confirmation of infection and disease prevalence in wild PWS and Sitka herring ($31.35 / sample x 420 samples)	13.2
Includes VHSV, VEN, and Ichthyophonus diagnostics	
samples: 180 PWS adults, 180 PWS juveniles, 60 Sitka adults	
Commodities Total	$13.2

FY14

Program Title:
Team Leader:
Agency:

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14

Program Title:
Team Leader:
Agency:

FORM 4B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY15

Program Title:
Team Leader:
Agency:

FORM 4B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Laboratory confirmation of infection and disease prevalence in wild PWS and Sitka herring ($31.35 / sample x 420 samples)	13.2
Includes VHSV, VEN, and Ichthyophonus diagnostics	
samples: 180 PWS adults, 180 PWS juveniles, 60 Sitka adults	
Commodities Total	$13.2

FY15

Program Title:
Team Leader:
Agency:

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Program Title:
Team Leader:
Agency:

FORM 4B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Program Title:
Team Leader:
Agency:

FORM 4B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Laboratory confirmation of infection and disease prevalence in wild PWS and Sitka herring ($31.35 / sample x 420 samples)	13.2
Includes VHSV, VEN, and Ichthyophonus diagnostics	
samples: 180 PWS adults, 180 PWS juveniles, 60 Sitka adults	
Commodities Total	$13.2

FY16	**Program Title:** **Team Leader:** **Agency:**	**FORM 4B CONTRACTUAL & COMMODITIES DETAIL**

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY16

Program Title:
Team Leader:
Agency:

FORM 4B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$94.4	$93.7	$16.7	$17.3	$17.9	$240.0
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commodities	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Equipment	$3.9	$4.8	$0.0	$0.0	$0.0	$8.7
Indirect Costs (*23%*)	$21.7	$21.5	$3.8	$4.0	$4.1	$55.1
SUBTOTAL	$120.0	$120.0	$20.5	$21.3	$22.0	$303.8
General Administration (9% of subtotal)	$10.8	$10.8	$1.9	$1.9	$2.0	$27.4
PROJECT TOTAL	$130.8	$130.8	$22.4	$23.2	$24.0	$331.2
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Shane StClair		2.0	8.4		16.8
Rob Bochenek		1.0	9.2		9.2
Vacant		4.0	7.6		30.4
Vacant		3.5	7.6		26.6
Ross Martin		1.5	7.6		11.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	40.4	0.0	
				Personnel Total	$94.4

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY12

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY12

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Stoarge Expansion for AOOS Disk Array	1.0	3.9	3.9
			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	$3.9

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Shane StClair		1.5	8.7		13.1
Rob Bochenek		1.0	9.5		9.5
Vacant		6.0	7.9		47.4
Ross Martin		3.0	7.9		23.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	34.0	0.0	
				Personnel Total	$93.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY13

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY13

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Server for hosting IHRP data and products	1.0	4.8	4.8
			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			$4.8

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY13

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Shane StClair		0.5	8.7		4.4
Luc Mehl		1.5	8.2		12.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	16.9	0.0	
				Personnel Total	$16.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY14

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY14

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY14

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Shane StClair		0.5	9.0		4.5
Luc Mehl		1.5	8.5		12.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17.5	0.0	
				Personnel Total	$17.3

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY15

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY15

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY15

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Shane StClair		0.5	9.3		4.7
Luc Mehl		1.5	8.8		13.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	18.1	0.0	
				Personnel Total	$17.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY16

Program Title: PWS herring: Data Management
Team Leader: Shane StClair

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$0.0	$0.0	$38.2	$0.0	$0.0	$38.2
Travel	$0.0	$0.0	$17.2	$0.0	$0.0	$17.2
Contractual	$0.0	$0.0	$7.0	$0.0	$0.0	$7.0
Commodities	$0.0	$0.0	$6.7	$0.0	$0.0	$6.7
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect Costs (*will vary by proposer*)			$18.0			$18.0
SUBTOTAL	$0.0	$0.0	$87.1	$0.0	$0.0	$87.1
General Administration (9% of subtotal)	$0.0	$0.0	$7.8	$0.0	$0.0	$7.8
PROJECT TOTAL	$0.0	$0.0	$94.9	$0.0	$0.0	$94.9
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY12-16

Program Title: Non-Lethal Herring Survey
Team Leader: Boswell

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY12

Program Title:
Team Leader:

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY12	**Program Title:** **Team Leader:**	**FORM 3B** **CONTRACTUAL &** **COMMODITIES DETAIL**

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY12

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY13

Program Title:
Team Leader:

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY13

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY13

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Kevin Boswell (plus 31.885 fringe)	PI	3.0	11.0		33.0
Undergraduate Student (plus 0.0033% fringe)	Student	6.0	0.9		5.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	11.9	0.0	
				Personnel Total	$38.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
Marine Science Symposium	1.0	1	4	0.3	2.1
Annual PI Meeting	1.0	1	5	0.2	2.2
Fieldwork (PI and Student)	2.0	3	30	0.2	12.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$17.2

FY14

Program Title: Non-Lethal Herring Survey
Team Leader: Boswell

FORM 3B
PERSONNEL &
TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Ship-time charter for non-lethal component	7.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$7.0

Commodities Costs: Description	Commodities Sum
Supplies, cable and fabrication costs for mounting and deploying DIDSON at depth	3.5
Office supplies, printing costs and data archiving	0.5
Shipping Costs for Equipment (3 trips)	2.7
Commodities Total	$6.7

FY14

Program Title: Non-Lethal Herring Survey
Team Leader: Boswell

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
DIDSON	1	FIU
Remotely controlled sonar motor mount	1	FIU
Seamor ROV with DIDSON - as avaialble	1	FIU

FY14

Program Title: Non-Lethal Herring Survey
Team Leader: Boswell

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY15

Program Title:
Team Leader:

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY15

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY15

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Program Title:
Team Leader:

FORM 3B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

$38,187.16

2120
2150
12900
17170

$17,170.00

$7,000.00

$6,700.00

17954.8615

87012.0211

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Modeling the population dynamics of Prince William Sound herring.

Project Period: October 1, 2011 – September 30, 2016

Primary Investigator(s): Trevor A. Branch

Study Location: School of Aquatic and Fishery Sciences, Box 355020, University of Washington, Seattle WA, 98195, USA.

Abstract:

Estimated Budget:
EVOSTC Funding Requested:
(breakdown by fiscal year and must include 9% GA)

Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date: 1 June 2011

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the Exxon Valdez Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here is a single project that is a part of an integrative program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an improved modeling approach.

II. PROJECT DESIGN

A. Objectives

This project is designed to complement the “PWS Herring Research and Monitoring” proposal submitted by the Prince William Sound Science Center. The objectives of that program are:

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

This modeling program addresses objectives 1, 2 and 3 by examining which data sources provide the most informative inputs to the ASA assessment model, holistically modeling the PWS herring life cycle, identifying possible issues with the assumptions of the measurement program, and examining factors that could determine future herring recruitment.

The specific objectives of this project are to:

a) Determine which datasets provide the most informative information for the ASA model (objective 1).
b) Predict levels of future recruitment, and autocorrelation in recruitment, using information from other herring populations and other species of clupeids (objective 1).
c) Synthesize the data collected from the monitoring program into a holistic model of herring dynamics (objective 2), to determine which life stages the observational program should focus on (objective 3).

B. Procedural and Scientific Methods

Identify the most informative datasets: conduct a management strategy evaluation (e.g. Butterworth & Punt 1999, Sainsbury et al. 2000) to identify which types of data are most informative for the ASA model. This task will comprise developing an operating model (modeling the “truth”) to generate data types used by the ASA model (hydroacoustic survey, surveys of milt production, age composition, etc.), particularly the new time series developed as part of this program. For each model run, one type of data will be omitted, a large number of data sets will be generated (100-1000 depending on the time it takes to run the model), and the ASA model applied to the generated data to produce estimates of abundance. The estimates will then be compared to the underlying “truth” in the operating model to see how well the ASA model performs in the absence of that particular source of data. The end result will be an ordering of input data types from most to least informative, providing critical information to prioritize current and future monitoring efforts.

Predict future levels of recruitment: collate time series of herring abundance and recruitment in Pacific herring stocks, and for stocks of other clupeid species. Conduct a meta-analysis to estimate the average duration that a typical herring stock would be expected to remain at low abundance. Estimate the average level of autocorrelation in herring recruitment from other stocks, to understand how much recruitment covaries from one year to the next. Gather covariates (e.g. length, trophic level, price, latitude, sea surface temperature) to understand which factors influence recruitment in clupeid populations. Much of the data for this task has already been completed in the RAM Legacy stock assessment database (e.g. Branch et al. 2010, 2011, Ricard et al. submitted), but more stocks will be added for the analysis.

Create holistic model of herring dynamics: develop a life stage model to synthesize data from each aspect of the monitoring program, to understand which age groups and sources of mortality are most likely to explain the decline in the abundance of PWS herring. The model will be age-based and include separate terms for each component of mortality. The model will be fitted to time series of abundance at each life history stage and time series of disease prevalence.

These tasks will be conducted on computers by University of Washington students and faculty, who have access to a wide range of in-house fisheries modeling expertise (e.g. faculty members Ray Hilborn, André Punt, Tim Essington). This will allow us to examine statistical modeling, process based modeling, and ecosystem modeling approaches in choosing the best approach for each objective.

C. Data Analysis and Statistical Methods

By working with a well-established measurement program we foresee being able to learn about previous work and have access to historical data more rapidly than if this was a stand-alone project. Thus there will be no need to collect data or analyze data separately from the ongoing efforts of the monitoring program. The only data collection will involve gathering time series of abundance and recruitment for clupeid stocks as described above.

Computer models will be written in a combination of R, a high level language such as C++ or Fortran, and AD Model Builder (ADMB Project 2010) software which can rapidly and efficiently fit models to data.

D. Description of Study Area

The study area includes all of Prince William Sound (N, E, S, and W boundaries of respectively, ~ 61, -145.5. 60, and -149°). However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 2). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question “What is the appropriate sampling distribution?” as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

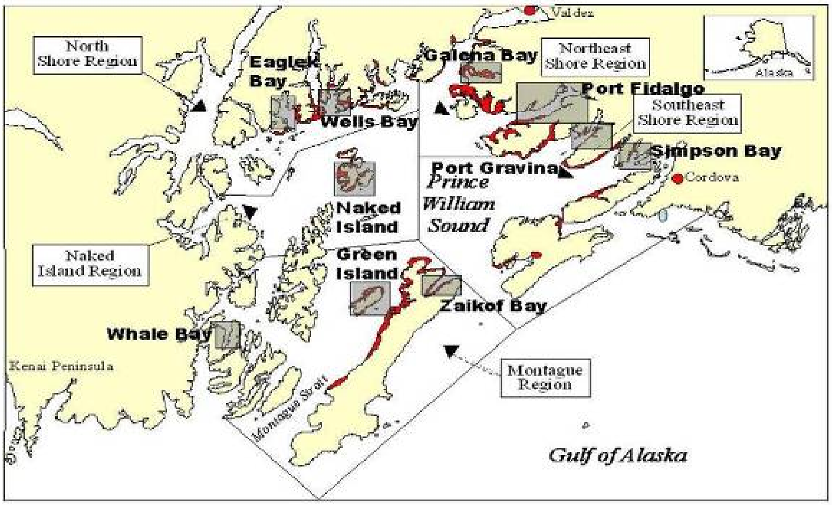

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is structured to be part of a collaborative programmatic effort being led by the Prince William Sound Science Center. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Pegau will act as the program team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program.

There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year’s work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermens United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

The wide array of projects that make up this program required careful integration to ensure the maximum collaboration between projects. Not all observation projects are directly connected to each other, but are connected through the objectives of the program. The full benefits of the linkages will be seen at the points where synthesis efforts occur. As the modeling component to this program the proposed project is one of the main tools for synthesizing the different observation program. It is designed to utilize data from the observation programs and help guide future sampling efforts to maximize the likelihood of achieving the program objectives.

Direct overlap between observation projects occurs in the area of logistics. We intend to have the acoustic surveys, direct capture, and non-lethal collection components sharing a vessel. The direct capture and non-lethal collection are intended to provide validation to the acoustics. The direct capture component will be responsible for providing fish to the RNA condition, energetic condition, disease research, fatty acid indicators, and genetic stock indicator projects. Another direct project overlap occurs between the herring scale analysis and primiparous herring projects, which will share growth information as determined from the scales. The combined efforts will lead to a greater number of scales becoming digitized and improving the statistics for both projects. All projects will also interact with the data management efforts to ensure the data is properly archived and maintained.

Indirect project overlap occurs between projects through the scheduling. Projects like the genetic stock indicators are pushed back in the cycle to ensure that the methodologies used by the direct capture program are mature enough to ensure collection of the required samples. Non-lethal collection is also later in the program to ensure new direct capture techniques are fully tested. Fish collected from the RNA and energetics intensive studies will also be used by the fatty acid indicator project. The acoustic tagging project is early in the program to take advantage of the acoustic receiver array that is in place and has a limited life span. Some projects like the disease research component also start later in the program because of coordination with the existing herring monitoring program. We worked hard to ensure that there isn't duplication between the proposed program and the existing program. One apparent exception is the RNA and energetic condition intensives. By moving these projects early in the program we intend to fill what is seen as a major gap in the existing program and hopefully more quickly resolve the information value that each project provides.

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydroacoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

Other important programs for coordinating with are the existing PWS herring survey program and existing ADF&G herring research. This program has been developed with input from both of these programs and the focus of this proposal is extending the interpretation of the data from those two programs. The Herring Survey program will still be operating in FY12 and FY13. There are field observations scheduled in FY12 and in FY13 funds are strictly for analysis and report writing. Included in the report writing is a synthesis of previous and current research. This report will be finished in FY13 and be the basis for the synthesis required under this request for proposals.

III. SCHEDULE
A. Project Milestones

All projects will be conducted simultaneously and are interlinked. The dates given are the expected dates of submission of scientific papers, but preliminary results will be used to improve the monitoring efforts as they are generated.

Objective 1. Create life history model of herring dynamics.
To be met by September 2014

Objective 2. Identify the most informative datasets using management strategy evaluation.
To be met by September 2015

Objective 3. Predict future levels of recruitment from other herring and clupeid stocks.
To be met by September 2016

B. Measurable Project Tasks

Specify, by each quarter of each fiscal year, when critical project tasks (for example, sample collection, data analysis, manuscript submittal, etc.) will be completed. This information will be the basis for the quarterly project progress reports that are submitted to the Trustee Council Office. Please format your schedule like the following example.

FY12, 1st quarter (October 1, 2013-December 31, 2013)
December 31: Advertise position to potential graduate students

FY12, 2nd quarter
March 31: Offer graduate student place in SAFS program

FY12, 3rd quarter
May: Annual Cordova meeting with broader project PIs

FY12, 4th quarter
August Annual report: summary of data available for modeling, preliminary model development

FY13, 1st quarter
October Student registers, begins quantitative training and coursework

FY13, 2nd quarter
January Annual Marine Science Symposium, Anchorage

FY13, 3rd quarter
May Annual Cordova meeting with broader project PIs

FY13, 4th quarter
August Annual report: preliminary life-history model
December Student completes required modeling and quantitative courses

FY14, 1st quarter (October 1, 2013-December 31, 2013)

September	Preliminary examination of most informative datasets

FY14, 2nd quarter

January	Annual Marine Science Symposium, Anchorage
March	Draft manuscript: life history model of herring dynamics

FY14, 3rd quarter

May	Annual Cordova meeting with broader project PIs
June	Student completes all required coursework and milestones

FY14, 4th quarter

August	Annual report
September	Manuscript submission: life history model of herring dynamics

FY15, 1st quarter (October 1, 2014-December 31, 2014)

December	Finalize gathering of time series of abundance and recruitment for herring stocks and other clupeids

FY15, 2nd quarter

January	Annual Marine Science Symposium, Anchorage
March	Draft manuscript: identification of most informative datasets using management strategy evaluation

FY15, 3rd quarter

May	Annual Cordova meeting with broader project PIs

FY15, 4th quarter

September	Manuscript submission: identification of most informative datasets using management strategy evaluation

FY16, 1st quarter (October 1, 2015-December 31, 2015)

FY16, 2nd quarter

January	Annual Marine Science Symposium, Anchorage
March	Draft manuscript: predictions of herring recruitment and autocorrelation in herring recruitment

FY16, 3rd quarter

May	Annual Cordova meeting with broader project PIs

FY16, 4th quarter

August	Final project report
September	Manuscript submission: predictions of herring recruitment and autocorrelation in herring recruitment

References

Branch, T. A., R. Watson, E. A. Fulton, S. Jennings, C. R. McGilliard, G. T. Pablico, D. Ricard, and S. R. Tracey. 2010. The trophic fingerprint of marine fisheries. Nature 468:431-435.

Branch, T. A., O. P. Jensen, D. Ricard, Y. Ye, and R. Hilborn. 2011. Contrasting global trends in marine fishery status obtained from catches and from stock assessments. Conservation Biology doi: 10.1111/j.1523-1739.2011.01687.x.

Butterworth, D. S. and A. E. Punt. 1999. Experiences in the evaluation and implementation of management procedures. ICES Journal of Marine Science 56:985-998.

Ricard, D., C. Minto, J. K. Baum, and O. P. Jensen. Submitted. RAM Legacy: a new global stock assessment database for exploited marine species. Fish and Fisheries.

Sainsbury, K. J., A. E. Punt, and A. D. M. Smith. 2000. Design of operational management strategies for achieving fishery ecosystem objectives. ICES Journal of Marine Science 57:731-741.

III. BUDGET NARRATIVE

Funds are requested for FY12-FY16, but most of the costs are in FY13-FY16 when the graduate student is hired. Indirect costs are 54.5%.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$20,734.0	$34,445.7	$35,823.5	$37,256.4	$38,746.7	$167,006.3
Travel	$982.0	$3,636.0	$8,194.0	$7,812.0	$8,508.0	$29,132.0
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commodities	$200.0	$16,884.0	$20,552.4	$21,286.5	$22,050.0	$80,972.9
Equipment	$0.0	$4,000.0	$0.0	$0.0	$0.0	$4,000.0
Indirect Costs (*will vary by proposer*)	$11,944.2	$20,863.5	$25,188.5	$25,761.3	$26,952.8	$110,710.4
SUBTOTAL	$33,860.2	$79,829.2	$89,758.4	$92,116.2	$96,257.5	$391,821.6
General Administration (9% of subtotal)	$3,047.4	$7,184.6	$8,078.3	$8,290.5	$8,663.2	$35,263.9
PROJECT TOTAL	$36,907.6	$87,013.8	$97,836.7	$100,406.7	$104,920.6	$427,085.5
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

FY12 Justification:

Personnel ($20,734):

Two months for Branch to review literature, compile data, conduct preliminary data analysis, and develop preliminary models of Prince William Sound herring. Since it is too late to identify and admit a graduate student in September 2011, Branch will conduct analyses in FY12 and then train the graduate student to complete and extend the analyses in subsequent years. Tow months at monthly salary of $8150 per month, plus 27.2% benefits, assuming no cost-of-living increase from FY11 salary ($20,734).

Travel ($982):

Travel funds for Branch to attend annual PI meeting in Cordova in May 2012.

Commodities ($200):
Long distance phone calls, photocopying, printer cartridges etc. ($200).

FY13 Justification:
Personnel ($34,446):
One month for Branch to supervise graduate student and for modeling (monthly salary $8,476, plus 27.2% benefits, includes 4% cost-of-living increase from FY12).
Twelve months of PhD student research assistant support to conduct research (monthly salary $1972, plus 16.2% benefits, includes 4% cost-of-living increase from FY12).

Travel ($3636):
Travel funds for Branch and graduate student to attend annual PI meeting in Cordova in May 2012 ($1964).
Travel funds for graduate student to attend Annual Marine Science Symposium in Anchorage ($1672).

Commodities ($16,884):
Long distance phone calls, photocopying, printer cartridges etc. ($200).
Tuition for graduate student, assuming 16% increase in tuition over FY12 ($16,684). Increase assumed to be the same as increase from FY11 to FY12 (due to budget cuts in Washington State).

New Equipment ($4000):
Laptop computer, monitor, associated software for graduate student ($2000).
High speed desktop computer for running lengthy simulations, monitor, to be shared between student and Branch ($2000).
Equipment costing more than $2000 is not subject to University of Washington indirect costs of 54.5%.

FY14 Justification:
Personnel ($35,824):
One month for Branch, 12 months of PhD student, justification as in FY13 except including 4% cost-of-living increase.

Travel ($8194):
Travel funds for Branch and graduate student to attend annual PI meeting in Cordova in May 2012 ($1964).
Travel funds for Branch and graduate student to attend Annual Marine Science Symposium in Anchorage ($3344).
Travel funds for Branch and graduate student to attend American Fisheries Society conference in Little Rock Arkansas ($2886).

Commodities ($20,552):
Publication charges for papers (page charges, color page charges, open access charges). ($2000).
Long distance phone calls, photocopying, printer cartridges etc. ($200).
Tuition for graduate student, assuming 10% increase in tuition over FY13 ($18,352).

FY15 Justification:
Personnel ($37,256):
One month for Branch, 12 months of PhD student, justification as in FY14 except including 4% cost-of-living increase.

Travel ($7812):
Travel funds for Branch and graduate student to attend annual PI meeting in Cordova in May 2012 ($1964).
Travel funds for Branch and graduate student to attend Annual Marine Science Symposium in Anchorage ($3344).
Travel funds for Branch and graduate student to attend Mote Marine Symposium in Sarasota Florida to present results ($2504).

Commodities ($21,287):
Publication charges for papers (page charges, color page charges, open access charges). ($2000).
Long distance phone calls, photocopying, printer cartridges etc. ($200).
Tuition for graduate student, assuming 5% increase in tuition over FY14 ($19,086).

FY16 Justification:
Personnel ($38,747):
One month for Branch, 12 months of PhD student, justification as in FY15 except including 4% cost-of-living increase.

Travel ($8508):
Travel funds for Branch and graduate student to attend annual PI meeting in Cordova in May 2012 ($1964).
Travel funds for Branch and graduate student to attend Annual Marine Science Symposium in Anchorage ($3344).
Travel funds for Branch and graduate student to attend American Fisheries Society annual meeting, venue to be arranged ($3200).

Commodities ($22,050):
Publication charges for papers (page charges, color page charges, open access charges). ($2000).
Long distance phone calls, photocopying, printer cartridges etc. ($200).
Tuition for graduate student, assuming 5% increase in tuition over FY15 ($19,850).

Indirect costs (54.5%)
Federal cost recovery at the University of Washington has been set at 54.5%, and is assumed to remain at this level throughout the grant. Indirect is not applied to tuition or to capital equipment expenses.

Trevor A. Branch

(Principal Investigator)
Address: School of Aquatic and Fishery Sciences, Box 355020, University of Washington, Seattle, WA, 98195
Telephone: 206-221-0776, Fax: 206-685-7471
Email address: tbranch@uw.edu

Education

University of Cape Town	Zoology and Computer Science	B.Sc.	1994
University of Cape Town	Zoology	B.Sc.(Hons)	1995
University of Cape Town	Conservation Biology	M.Sc.	1998
University of Washington	Aquatic and Fishery Sciences	Ph.D.	2004

Employment (Position, institution, start and end year):

2010–present	Assistant Professor, School of Aquatic and Fishery Sciences, Univ. of Washington
2006–2010	Research Scientist, School of Aquatic and Fishery Sciences, Univ. of Washington
2005–2006	Research Officer, Marine Resource Assessment and Management Group, Department of Mathematics and Applied Mathematics, University of Cape Town

Professional Recognition (Societies, honors and awards):

Associate Editor for Animal Conservation, 2011-present.

Invited participant to Scientific Committee meetings of the International Whaling Commission, 2000–2008, advising on abundance, current status, and trends of Antarctic minke whales, Antarctic blue whales and other large cetaceans.

Consultant to Independent Scientific Advisory Panel for Commission for Conservation of Southern Bluefin Tuna, 2004–present.

Young Investigator award for best oral presentation at the Mote Symposium, November 2004.

Faculty merit award for best PhD student, School of Aquatic and Fishery Sciences, University of Washington, 2004.

Reviewer for 22 journals including Science, Canadian Journal of Fisheries and Aquatic Sciences, Proceedings of the Royal Society B, Fisheries Research, ICES Journal of Marine Science, Fish and Fisheries, Ecology, and Marine Ecology Progress Series.

Graduate students and post-doctorates supervised:

M.S. Advisor, Cole Monnahan (2011-present), Quantitative Ecology and Resource Management (QERM) interdisciplinary program.

Ph.D. committee member: Kotaro Ono (2011-present), School of Aquatic and Fishery Sciences, University of Washington.

M.S. Committee member: Curry Cunningham (2011-present), School of Aquatic and Fishery Sciences, University of Washington.

Selected publications since 2009 (total = 34):

Branch, T.A., Watson, R., Fulton, E.A., Jennings, S., McGilliard, C.R., Pablico, G.T., Ricard, D., & Tracey, S.R. 2010. The trophic fingerprint of marine fisheries. Nature. 468:431-435.

Worm, B., Hilborn R., Baum, J.K., **Branch, T.A.**, Collie, J.S., Costello, C., Fogarty, M.J., Fulton, E.A., Hutchings, J.A., Jennings, S., Jensen, O.P., Lotze, H.K., Mace, P.M., McClanahan, T.R., Minto, C., Palumbi, S.R., Parma, A.M., Ricard, D., Rosenberg, A.A., Watson, R. & Zeller, D. 2009. Rebuilding global fisheries. Science. 325:578-585.

Sethi, S. A., **Branch, T.A.** & Watson, R. 2010. Fishery development patterns are driven by profit but not trophic level. Proceedings of the National Academy of Sciences U.S.A. 107:12163-12167.

Branch, T.A., Jensen, O.P., Ricard, D., Ye, Y. & Hilborn, R. 2011 Contrasting global trends in marine fishery status obtained from catches and from stock assessments. Conservation Biology. doi: 10.1111/j.1523-1739.2011.01687.x

Froese, R., **Branch, T.A.**, Proelβ, A., Quaas, M., Sainsbury, K. & Zimmermann, C. 2011. Generic harvest control rules for European fisheries. Fish and Fisheries. doi: 10.1111/j.1467-2979.2010.00387.x

Branch, T.A. & Hilborn, R. 2010. A general model for reconstructing salmon runs. Canadian Journal of Fisheries and Aquatic Sciences. 67:886-904. doi: 10.1139/F10-032

Branch, T.A. 2009a. How do individual transferable quotas affect marine ecosystems? Fish and Fisheries. 10:39-57.

Branch, T.A. 2009b. Differences in predicted catch composition between two widely used catch equation formulations. Canadian Journal of Fisheries and Aquatic Sciences. 66: 126-132. doi:10.1139/F08-196

Collaborators and co-editors in the last 48 months

Abbott, J. (Arizona State University), Abubaker, E.M.N. (Sudan), Allison, C. (IWC, U.K.), A'Mar, Z.T. (UW), Anderson, R.C. (Maldives), Ashe, E., (U.K.), Baker, A.N. (New Zealand), Baker, M.R. (UW), Bannister, J.L. (W. Australian Museum) , Baum, J.K. (Scripps Inst. Oceanography), Best, P.B. (South African Museum), Borsa, P. (New Caledonia), Bravington, M. (CSIRO, Australia), Brownell Jr, R.L. (NOAA), Burton, C.L.K. (private, Australia), Butterworth, D.S. (Univ. Cape Town, South Africa), Cabrera, E. (Centro de Conservacion Cetacea, Chile), Carlson, C.A. (College of the Atlantic), Childerhouse, S. (Department of Conservation, New Zealand), Clarke, E. (NOAA), Clark, S. (Sea World), Collie, J.S. (Univ. Rhode Island), Costello, C. (UC Santa Barbara), Essington, T.E. (UW), Findlay, K.P. (Univ. Cape Town, South Africa), Fogarty, M.J. (NOAA), Froese, R. (Leibniz Inst. Mar. Sci., Germany), Fulton, E.A. (CSIRO, Australia), Galletti Vernazzani, B. (Centro de Conservacion Cetacea, Chile), Gerrodette, T. (NOAA), Gill, P.C. (Blue Whale Study, Australia), Haynie, A.C. (NOAA), Hammond, P. (U.K.), Hedley, S. (U.K.), Hilborn R. (UW), Hollowed, A. (NOAA), Holland, D.S. (NOAA), Holtgrieve, G.W. (UW) , Hucke-Gaete, R. (Universidad Austral de Chile), Hoyt, E. (Whale & Dolphin Cons. Soc.), Hutchings, J.A. (Dalhousie Univ., Canada), Ianelli, J. (NOAA), Ilangakoon, A.D. (Sri Lanka), Jannot, J. (NOAA), Jenner, K.C.S. (Centre for Whale Research, Australia), Jenner, M.-N.M. (Ctr. Whale Res, Australia), Jennings, S. (Ctr. Env. Fish. Aqu. Res., U.K.), Jensen, O.P. (Univ. Rutgers), Joergensen, M. (Denmark), Kahn, B. (Indonesia), Kato, H. (Tokyo Univ. Mar. Sci. Tech., Japan), Kendall, N.W. (UW), Krkošek, M. (New Zealand), Ljungblad, D.K. (private), Lotze, H.K. (Dalhousie Univ., Canada), Mace, P.M. (Min. Fisheries, New Zealand), Matsuoka, K. (Inst. Cet. Res., Japan), Maughan, B. (U.K.), McCauley, R.D. (Curtin Univ., Australia), McClanahan, T.R. (Wildlife Cons. Soc., Kenya), McGilliard, C.R. (UW), McKay, S. (Deakin Univ., Australia), Melvin, E. (UW), Mikhalev, Y.A. (South-Ukrainian Pedagogical Univ.), Minto, C. (Dalhousie Univ., Canada), Miyashita, T. (Natl Res. Inst. Far Seas Fish., Japan), Mkango, S. (Univ. Cape Town, South Africa), Morrice, M.G. (Deakin Univ., Australia), Nishiwaki, S. (Inst. Cet. Res., Japan), Noren, D. (NOAA), Norris, T.F. (private), Pablico, G. (WorldFish Cntr., Philippines), Palacios, D.M. (NOAA), Palumbi, S.R. (Stanford Univ.), Parma, A.M. (Centro Nacional Patagónico, Argentina), Proelβ, A. (Germany), Quaas, M. (Germany), Quinn, T.P. (UW), Ranjan, R. (UW), Rankin, S. (NOAA), Ricard, D. (Dalhousie Univ., Canada), Rosen, D. (UBC, Canada), Rosenberg, A.A. (Univ. New Hampshire), Sainsbury, K. (Australia), Samaran, F. (Cntr. d'Etudes Biol. Chize, France), Schindler, D.E. (UW), Sethi, S.A. (UW), Stafford, K.M. (UW), Sturrock, V.J. (Australia), Thiele, D. (Deakin Univ. Australia), Tormosov, D. (Russia), Tracey, S.R. (Univ. Tasmania), Van Waerebeek, K. (Peruvian Cntr. Cet. Res.), Warneke, R.M. (Australia), Watson, R. (Univ. British Columbia), Williams, R. (Canada), Worm, B. (Dalhousie Univ., Canada), Ye, Y. (FAO, Italy), Zeller, D. (Univ. British Columbia), Zerbini, A.N. (NOAA), Zimmermann, C. (Germany).

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	$20,734.0	$34,445.7	$35,824	$37,256.4	$38,746.7	$167,006.3
Travel	$982.0	$3,636.0	$8,194.0	$7,812.0	$8,508.0	$29,132.0
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commodities	$200.0	$16,884.0	$20,552.4	$21,286.5	$22,050.0	$80,972.9
Equipment	$0.0	$4,000.0	$0.0	$0.0	$0.0	$4,000.0
Indirect Costs (*will vary by proposer*)	$11,944.2	$20,863.5	$25,188.5	$25,761.3	$26,952.8	$110,710.4
SUBTOTAL	$33,860.2	$79,829.2	$89,758.4	$92,116.2	$96,257.5	$391,821.6
General Administration (9% of subtotal)	$3,047.4	$7,184.6	$8,078.3	$8,290.5	$8,663.2	$35,263.9
PROJECT TOTAL	$36,907.6	$87,013.8	$97,836.7	$100,406.7	$104,920.6	$427,085.5
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the

FY12-16

Program Title: Modeling the population dynamics of Prince William Sound herring
Team Leader: Trevor A. Branch

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor A. Branch	Assistant Professor	2.0	10367.0		20,734.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	10367.0	0.0	
				Personnel Total	$20,734.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Travel Seattle to Cordova, annual PI meeting	307.0	1	3	225.0	982.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$982.0

FY12

Program Title:
Team Leader:

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Long distance telephone, photocopying, printer cartridges etc.	200.0
Commodities Total	$200.0

FY12

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY13

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor A. Branch	Assistant Professor	1.0	10781.7		10,781.7
To be arranged	Research Assistant	12.0	1972.0		23,664.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	12753.7	0.0	
				Personnel Total	$34,445.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Travel Seattle to Cordova, annual PI meeting	307.0	2	6	225.0	1,964.0
Marine Science Symposium	307.0	1	7	195.0	1,672.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3,636.0

FY13

Program Title:
Team Leader:

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Tuition for graduate student	16,684.0
Long distance telephone, photocopying, printer cartridges etc.	200.0
Commodities Total	$16,884.0

FY13

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Laptop computer, monitor, associated software	1.0	2,000.0	2,000.0
High speed desktop computer, monitor, for simulations	1.0	2,000.0	2,000.0
			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	$4,000.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY14

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor A. Branch	Assistant Professor	1.0	11212.9		11,212.9
To be arranged	Research Assistant	12.0	2050.9		24,610.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	13263.8	0.0	
				Personnel Total	$35,823.5

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Travel Seattle to Cordova, annual PI meeting	307.0	2	6	225.0	1,964.0
Marine Science Symposium	307.0	2	14	195.0	3,344.0
AFS symposium, Little Rock Arkansas	400.0	2	14	149.0	2,886.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8,194.0

FY14

Program Title:
Team Leader:

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Publication charges for scientific papers, page charges and color page charges	2,000.0
Tuition for graduate student	18,352.4
Long distance telephone, photocopying, printer cartridges etc.	200.0
Commodities Total	$20,552.4

FY14

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY15

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor A. Branch	Assistant Professor	1.0	11661.5		11,661.5
To be arranged	Research Assistant	12.0	2132.9		25,595.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	13794.4	0.0	
				Personnel Total	$37,256.4

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Travel Seattle to Cordova, annual PI meeting	307.0	2	6	225.0	1,964.0
Marine Science Symposium, Anchorage	307.0	2	14	195.0	3,344.0
Mote Marine Symposium, Sarasota	400.0	2	12	142.0	2,504.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7,812.0

FY15

Program Title:
Team Leader:

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Publication charges for scientific papers, page charges and color page charges	2,000.0
Tuition for graduate student	19,086
Long distance telephone, photocopying, printer cartridges etc.	200.0
Commodities Total	$21,286.5

FY15

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor A. Branch	Assistant Professor	1.0	12127.9		12,127.9
To be arranged	Research Assistant	12.0	2218.2		26,618.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	14346.2	0.0	
				Personnel Total	$38,746.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Travel Seattle to Cordova, annual PI meeting	307.0	2	6	225.0	1,964.0
Marine Science Symposium	307.0	2	14	195.0	3,344.0
AFS meeting, venue to be arranged	400.0	2	12	200.0	3,200.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8,508.0

FY16

Program Title:
Team Leader:

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Publication charges for scientific papers, page charges and color page charges	2,000.0
Tuition for graduate student	19,850.0
Long distance telephone, photocopying, printer cartridges etc.	200.0
Commodities Total	$22,050.0

FY16

Program Title:
Team Leader:

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Program Title:
Team Leader:

FORM 3B
EQUIPMENT DETAIL

FY12 INVITATION

PROPOSAL SUMMARY PAGE

Project Title: PWS Herring Research and Monitoring Validation of Acoustic Surveys for Pacific Herring Using Direct Capture

Project Period: October 1, 2011 – September 30, 2016

Primary Investigator(s): Mary Anne Bishop, Ph.D., Prince William Sound Science Center, Cordova

Study Location: Prince William Sound

Abstract: Acoustic surveys provide a relatively low-cost, remote sensing tool to estimate species-specific fish biomass and abundance. Interpreting acoustic data requires accurate ground truthing. In Prince William Sound, juvenile herring acoustic surveys have been conducted at the beginning (November) and end (March) of every winter since March 2007. Until now, a variety of methods have been used with limited success to ground truth these surveys.

Pelagic trawls are the recommended method for validating species composition and for obtaining relatively unbiased information on length frequency distribution, age, and other biological information. Here we propose to use a low-resistance, light-weight midwater trawl capable of increased towing speeds (up to 4 knots) as a method to ground truth acoustic surveys for juvenile and adult herring. Our pelagic trawl surveys will take place in conjunction with and onboard the same vessel as three studies in the *PWS Herring Research and Monitoring* program: a) *Juvenile Herring Abundance Index* (years 2-5); b) *Acoustic Consistency: Intensive Surveys of Juvenile Herring* (year 3); and, c) *Expanded Adult Herring Surveys* (years 2-5). In year 1 we will also use the trawl to collect juvenile herring during the 9-month intensive *Study to Validate the Separate Herring Condition Monitoring Programs*. Our project will provide data on species composition and length frequency to aid in the interpretation of current and historical acoustic surveys. In addition it will provide adult herring samples to Alaska Department of Fish and Game for the adult herring age-structure-analyses model and will provide juvenile herring samples to researchers investigating juvenile herring fitness and disease. Our trawls will also provide fishery-independent surveys for non-herring species, thus increasing our knowledge of pelagic fishes in Prince William Sound.

Estimated Budget:

EVOSTC Funding Requested: *(breakdown by fiscal year and must include 9% GA)*

FY 12	FY 13	FY 14	FY 15	FY 16
$68,000	$90,600	$148,000	$141,000	$145,300

Non-EVOSTC Funds to be used:

Date: May 25, 2011

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here are projects for a single project that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

II. PROJECT DESIGN

A. Background:

Pacific herring (*Clupea pallasii*) has a distribution in the eastern Pacific from the Beaufort Sea to Baja California, Mexico. They are pelagic forage fish that provide an important transfer of energy from phyto- and zooplankton to a suite of larger predators such as other fish, marine mammals, and birds. For more than 1500 years, herring species from around the world have been captured by subsistence and commercial fisheries for reduction to fish meal, consumption of meat and eggs, and bait for predatory sport fishes (Hay et al. 2001). Many herring stocks have experienced collapses, but unlike other fish species that decline due to fishing, herring are more likely to recover after reduced or zero levels of harvest (Hutchings 2000). In spite of repeated closures of the fishery in PWS the herring population has not recovered to pre-1993 numbers. While research over the last 16 years has been conducted to help pinpoint the cause(s) of the collapse and the lack of recovery, the conclusions are complex and at times conflicting. The mandate set by the EVOSTC is clear, that regardless of the cause of the decline it is imperative to work towards restoration of this important ecological and commercial fisheries stock.

As a forage fish, herring experience high levels of mortality at all life history stages, but certain stages may represent significant population-limiting bottlenecks that determine year class strength. Previous research (Sound Ecosystem Assessment (SEA)project; see (Cooney et al. 2001)) indicated that a population-limiting bottleneck in PWS herring may include mortality that occurs during the overwintering period among age-0 cohorts; consequently, this life stage represents the basis for the current EVOSTC herring research (Project 10100132 A-I).

Every winter, herring enter a starvation period in which they rely on their energy stores to survive through winter. Age-0 herring may be at a disadvantage compared to the older cohorts that are able to start feeding and building energy stores during the period when age-0 herring are eggs and then larvae. The age-0 cohort relies on energy stores for overwinter survival as zooplankton biomass decreases during the fall. Larger Age-1 and older herring tend to have a higher whole-body energy density (WBED) going into winter. Age-0 herring have lower WBEDs (~5.7 kj/g wet) heading into winter than age-1 herring (~8.0 kj/g wet) and age-2 herring (~9.4 kj/g wet), but age-0 herring also have a lower decrease of WBED during winter compared to older age classes (Paul et al. 1998). Larger age-0 herring may have higher survival due to higher WBED and higher assimilation rates (Foy and Paul 1999). Gut content analysis indicate that age-0 herring prey items varied among seasons and among bays (Foy and Norcross 1999). Zooplankton samples were not collected during that study so it is difficult to determine if prey consumption was based upon preference or availability. However, they did find that the spatial and temporal variation in diet composition accounted for the differences in condition of age-0 herring sampled. The compromised overwinter survival among age-0 herring resulting from decreased energy content is further exacerbated by endemic diseases, which add additional bioenergetic demands. For example, *Ichthyophonus*-infected herring demonstrate a 30% reduction in total energy content compared to uninfected cohorts (Vollenweider et al. In press).

The overwintering survival of age-0 herring is just one of the potential factors limiting recruitment. Large gaps remain in our understanding of herring life history that we must fill if we are to better predict herring recovery. The EVOSTC website lists 174 projects intended to address factors contributing to the decline and failed recovery of PWS herring. This number is misleading in that many of these are the same project over several different years and others were part of large programs, such as the Apex Predator Experiment that had components related to herring, but were not focused on herring. There still remain many herring focused research projects, some of which are included in the current PWS Herring Survey program that includes a coordinated set of ten individual research projects. The program proposed here builds upon the needs identified in the EVOSTC Integrated Herring Restoration Program and is designed to complement previous research to improve our understanding of PWS herring stock.

B. Goal and Objectives

Goal: Improve predictive models of herring stocks through observations and research.

This is the long-term goal of an anticipated twenty year program. The general approach will be to conduct monitoring of a limited number of variables combined with process study research. We will break the process study efforts into five-year increments. Within each increment we will focus on particular aspects of the herring life cycle to better predict how factors affecting that life stage influence overall herring stocks. We have identified several areas that require attention such as the larval life stage (least amount of existing information), stock structure (from modeling efforts), context of existing measurements (from synthesis), along with predation and competition questions. By no means is this list meant to be comprehensive. We will rely on a scientific advisory group (described later) to guide the efforts of each five-year effort and to recommend modifications during a five-year period if needed. The remainder of the discussion in this proposal is focused on the proposed efforts between FY12 and FY16.

We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

Objectives

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

This study, *Validation of Acoustic Surveys for Pacific Herring Using Direct Capture,* is a process study that addresses **objective 3** of the *PWS Herring Research and Monitoring**: to address assumptions in the current measurements***. Our study will provide the ability to rapidly improve our understanding of the herring population in PWS. This effort will allow the design of the most accurate and efficient monitoring program.

Objectives specific to the *Direct Capture* study include:

1) Improve capture methods used for ground truthing acoustic surveys.

2) Increase the sample size for identification, quantification, and measurement of juvenile (0+, 1+, 2+) and adult (3+ and older) herring schools as well as other fish schools in survey areas.

3) Provide data on species composition and length frequency to aid in the interpretation of current and historical acoustic surveys.

4) Provide adult herring samples to Alaska Department of Fish and Game for the adult herring age-structure-analyses model.

5) Provide juvenile herring samples to researchers investigating juvenile herring fitness and disease.

In addition, to providing better information on acoustic targets. this study will bolster the current understanding of pelagic species composition and abundance in PWS.

C. Procedural and Scientific Methods

We recognize that a major deficit in the existing *PWS Herring Survey* program is the lack of an effective means of validating the hydroacoustic signal. Fortunately, if we can establish through direct capture of ensonified fish that certain patterns in echograms can be interpreted as different year classes of herring, then we may be able to reanalyze historical acoustic measurements to better understand changes in juvenile herring populations.

In Prince William Sound, juvenile herring acoustic surveys have been conducted at the beginning (November) and end (March) of every winter since March 2007. A variety of methods have been used with limited success to ground truth these surveys. Small mid-water trawls used during fall 2007 and fall 2009 cruises failed to catch fish. In most cases, these trawls were towed 1 day after the acoustic survey and always from a different vessel. Trawling speeds were typically 2-3 knots, producing a high level of net avoidance by the targeted fish. Variable mesh gill nets have also been used to validate acoustic surveys; however, gillnets select for faster swimming fish (Thorne et al. 1983) and in PWS, gillnet deployments have resulted in very small catch rates of juvenile herring.

Pelagic trawls are the recommended method for validating species composition and for obtaining relatively unbiased information on length frequency distribution, age, and other biological information (Simmonds et al. 1992, McClatchie et al. 2000, Adams et al. 2006, NOAA 2009). In the proposed program we plan to use a low-resistance, light-weight mid-water trawl capable of increased towing speeds (3-4 knots) as a direct capture method for collecting the number of fish necessary to provide validation. These surveys will take place as part of three studies in the *PWS Herring Research and Monitoring*: These include: a) *Juvenile Herring Abundance Index* (years 2-5); b) *Acoustic Consistency: Intensive Surveys of Juvenile Herring* (year 3); and, c) *Expanded Adult Herring Surveys* (years 2-5). Principal Investigators for these three studies are Buckhorn and Thorne. In addition to ground truthing acoustic surveys, in year 1 we will use the trawl along with cast nets to collect juvenile herring during the 9-month intensive A *High-Temporal & Spatial Resolution Study to Validate the Separate Herring Condition Monitoring Programs* (Principal Investigators Kline and Heintz).

Table 1. Schedule of PWS herring cruises that require collections by this study. Except for year 1 herring condition collections, all cruises will share the same vessel platform as hydroacoustic component.

Year	High Res Herring Condition	Juvenile Herring Abundance Index	Expanded Adult Herring Surveys	Intensive Juvenile Herring Sureys
1 FY 2012	No acoustics; Oct-Jun collections			
2 FY 2013		Nov	Mar/Apr	
3 FY 2014		Nov	Mar/Apr	Oct-Dec; Feb-Apr
4 FY 2015		Nov	Mar/Apr	
5 FY 2016		Nov	Mar/Apr	

Field Collections and Laboratory Methods

In order to provide accurate data on ensonified fish, the trawl will be towed simultaneous with acoustic surveys for herring and from the same research vessel. Our trawl measures 12.8 m in total length and is 7.6 m wide by 9.1 m high under tow. The net is designed to be low-resistance and is constructed of high-tensile, lightweight materials (Innovative Net Systems, Milton LA), Mesh sizes (stretched) taper from 57 mm at the forward end to 38 mm at the cod end. The cod end liner is 12 mm mesh. The net will be fished with Jupiter Aluminum doors weighing 28 kg each. The trawl will be equipped with a Simrad PI50 Catch Monitoring System. This system utilizes wireless, trawl-mounted sensors to transmit real-time data on both trawl depth and net fullness. Average trawling speeds will be 3 to 4 kts.

Validation of acoustic echograms relies on ground truthing species composition and length frequency distribution of ensonified fish (McClatchie et al. 2000). We will tow a subsample of each stratified survey area, as designated by the lead acoustician. For each haul, all catch items will be collected. In the case of large hauls, a random sub-sample of the catch will be collected and measured.

Species composition and length frequency will be characterized by identifying all fish to species and measuring individual fork length, standard length, and weight. Juvenile herring of age 0+ and 1+ can be reliably aged based on length (Norcross et al. 2000, Kline unpubl. data), however, herring >150 mm will be aged using scale conventions developed by Alaska Department of Fish and Game (ADF&G). Adult herring captured during expanded spring surveys will be measured, sexed, aged, and assessed for spawning condition. Adult herring samples will be processed in collaboration with the Cordova office of ADF&G so that data can be incorporated into the ADFG herring age-structure-analysis model. All herring scales will be archived with ADF&G.

D. Data Analysis and Statistical Methods

Acoustic-based estimates of fish abundance rely on unique target strengths obtained for each fish species according to fishes' behaviors, physiologies, anatomies and morphologies, in addition to physical characteristics of the surveyed environment (Hazen and Horne, 2003). In most cases, the target strength obtained from hydroacoustic surveys is best described by the equation:

$$TS = m \log L + b + \varepsilon$$

where TS is the target strength, m and b are species specific coefficients, ε is an error term and L is the mean fish length for the school (McClatchie et al., 1996, Stokesbury et al. 2000). Thus in order to validate acoustic signals, the aforementioned trawls will provide requisite species and length data necessary to obtain values of m, b and L. Trawl data will be compiled for such validation analysis by Dr. Buckhorn. See Buckhorn and Thorne proposal for details on echo integration and acoustic surveys.

In addition to facilitating the validation of acoustic survey data, the proposed trawls will provide valuable fishery independent data on non-herring species and size composition (length and weight) for multiple bays throughout Prince William Sound. For a subset of non-herring species, otoliths will be collected, providing additional age data. These data will improve upon a scarce body of knowledge of pelagic fishes and populations, providing novel baseline data.

E. Description of Study Area

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

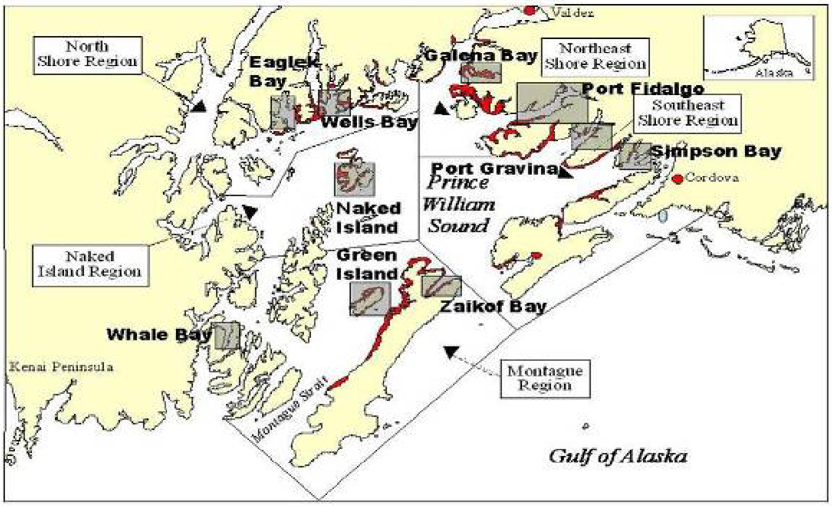

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

F. Coordination and Collaboration

This proposal is part of the integrated "*PWS Herring Research and Monitoring*" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the *Long-Term Monitoring* proposal submitted by the Alaska Ocean Observing System.

This proposal is structured to be a collaborative effort being led by the Prince William Sound Science Center. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Pegau will act as the team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program. He will also be responsible for outreach and public input efforts.

Dr. Pegau currently is the coordinator of the existing EVOSTC funding PWS Herring Survey program. This program consists of ten individual projects that provide a coordinated examination of juvenile herring in Prince William Sound. This proposal is heavily influenced by the early findings from that effort. Dr. Pegau also serves as the Research Program Manager for the Oil Spill Recovery Institute (OSRI). In that capacity he is responsible for developing annual work plans, ensuring proper reporting, making reports available, developing partnerships to leverage funding, and to ensure outreach of OSRI activities. All activities that provide experience delivering the team leader duties outline in the request for proposals.

One of his duties is to ensure proper scientific oversight of the research programs. To accomplish this we will be setting up a four-person scientific oversight panel that will help guide the program and ensure the research is relevant to the long-term goal. The team will consist of people representing Alaska Department of Fish and Game, the National Oceanic and Atmospheric Administration, academia, and the local fishing community. There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year's work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermens United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydroacoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

Other important programs for coordinating with are the existing PWS herring survey program and existing ADF&G herring research. This program has been developed with input from both of these programs and the focus of this proposal is extending the interpretation of the data from those two programs. The Herring Survey program will still be operating in FY12 and FY13. There are field observations scheduled in FY12 and in FY13 funds are strictly for analysis and report writing. Included in the report writing is a synthesis of previous and current research. This report will be finished in FY13 and be the basis for the synthesis required under this request for proposals.

Dr. Mary Anne Bishop (PWSSC) will lead the direct capture efforts needed for validation of hydroacoustic measurements and disease and condition studies. Bishop will oversee the project and coordinate with other studies that are part of the *PWS Herring Research & Monitoring* program. Specifically, the *Validation of Acoustic Surveys for Pacific Herring Using Direct*

Capture project will be providing samples for projects by Drs. Kline and Heintz (herring condition) Dr. Hershberger (herring disease), Moffitt (herring scales), and Drs. Buckhorn and Thorne (juvenile herring index and intensive surveys; expanded adult herring surveys). In addition, Bishop will have primary responsibility for field work (fish capture), data integration, and completion of final products for *PWS Herring Research & Monitoring* synthesis. She will supervise the research assistant. She will be responsible for project design, statistical analyses and data interpretation and preparation of a manuscript and contributing to the *PWS Herring Research & Monitoring* synthesis.

III. SCHEDULE

A. Milestones

1) Improve capture methods used for ground truthing acoustic surveys. *Field work completed April 2016. Synthesis evaluating techniques, August 2016.*

2) Increase the sample size for identification, quantification, and measurement of juvenile (0+, 1+, 2+) and adult (3+ and older) herring schools as well as other fish schools in survey areas. *Completed April 2016.*

3) Provide data on species composition and length frequency to aid in the interpretation of current and historical acoustic surveys. *Sampling completed April 2016. Data synthesis completed August 2016*.

4) Provide adult herring samples to Alaska Department of Fish and Game for the adult herring age-structure-analyses model. *Completed April 2016.*

5) Provide juvenile herring samples to researchers investigating juvenile herring fitness and disease. *Completed November 2015.*

B. Measurable Project Tasks

<u>FY 12, 1st quarter</u> (October 1, 2011-December 31, 2011)
- Oct Secure Trustee Council funding approval & purchase trawl sensors
- Oct-Dec Monthly cruise: juvenile herring collections for *High-Resolution Condition Study*.

<u>FY 12, 2nd quarter</u> (January 1, 2012-March 31, 2012)
- Jan Alaska Marine Symposium
- Jan-Mar Monthly cruise: juvenile herring collections for *High-Resolution Condition Study*

<u>FY 12, 3rd quarter</u> (April 1, 2012-June 30, 2012)
- Apr-Jun Monthly cruise: juvenile herring collections for *High-Resolution Condition Study*
- May Annual PI meeting
- June Submit FY13 work plan for review

<u>FY 12, 4th quarter</u> (July 1, 2012-September 30, 2012)
- Jul - Sep 30 Analyze data
- Aug Submit Annual Report

<u>FY 13, 1st quarter</u> (October 1, 2012-December 31, 2012)

Nov Field cruise: *Juvenile herring abundance index* with hydroacoustic & validation surveys; disease & energetics collections

Dec Process fish samples

FY 13, 2nd quarter (January 1, 2013-March 31, 2013)

Jan Alaska Marine Symposium

Jan-Mar Process fish samples

Mar Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

FY:13, 3rd quarter (April 1, 2013-June 30, 2013)

Apr Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

Apr-Jun Process fish and analyze data

May Annual PI meeting

Jun Submit FY14 work plan for review

FY 13, 4th quarter (July 1, 2013-September 30, 2013)

Jul - Sep 30 Analyze data

Aug Submit Annual Report

FY 14, 1st quarter (October 1, 2013-December 31, 2013)

Oct-Dec Biweekly *Juvenile Herring Intensive Acoustic & Validation Surveys*

Nov Field cruise: *Juvenile herring abundance index* with hydroacoustic & validation surveys; disease & energetics collections

Dec Process fish samples

FY 14, 2nd quarter (January 1, 2014-March 31, 2014)

Jan Alaska Marine Symposium

Jan-Mar Process fish samples

Feb-Mar Biweekly *Juvenile Herring Intensive Acoustic & Validation Surveys*

Mar Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

Winter EVOS sponsored workshop with Herring and Long-term monitoring programs

FY 14, 3rd quarter (April 1, 2014-June 30, 2014)

Apr Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

Apr-Jun Process fish & analyze data

May Annual PI meeting

Jun Submit FY15 work plan for review

FY 14, 4th quarter (July 1, 2014-September 30, 2014)

Jul - Sep 30 Analyze data

Aug Submit Annual Report

FY 15, 1st quarter (October 1, 2014-December 31, 2014)

Nov Field cruise: *Juvenile herring abundance index* with hydroacoustic & validation surveys; disease & energetics collections

Dec Process fish samples

FY 15, 2nd quarter (January 1, 2015-March 31, 2015)

Jan Alaska Marine Symposium

Jan-Mar Process fish samples

Mar Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

FY 15, 3rd quarter (April 1, 2015-June 30, 2015)

Apr Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

Apr-Jun Process fish & analyze data

May Annual PI meeting

Jun Submit FY15 work plan for review

FY 15, 4th quarter (July 1, 2015-September 30, 2015)

Jul - Sep 30 Analyze data

Aug Submit Annual Report

FY 16, 1st quarter (October 1, 2015-December 31, 2015)

Nov *Juvenile herring abundance index* Juvenile herring field cruise: hydroacoustic & validation surveys; disease & energetics collections

Dec Process fish samples

FY 16, 2nd quarter (January 1, 2016-March 31, 2016)

Jan Alaska Marine Symposium

Jan-Mar Process fish samples

Mar Field cruise: *Expanded Adult Herring Survey* Adult herring survey with hydroacoustic & validation surveys

FY 16, 3rd quarter (April 1, 2016-June 30, 2016)

Apr Field cruise: *Expanded Adult Herring Survey* Adult herring survey with hydroacoustic & validation surveys

Apr-Jun Process fish & analyze data

May Annual PI meeting

June Submit work plan for FY17

FY 16, 4th quarter (July 1, 2016-September 30, 2016)

Jul - Sep 30 Analyze data

Sep 1 Submit Final Report on first 5 years of validation surveys

IV. REFERENCES

Adams, J,V., R.L. Argyle, G.W. Fleischer, G.L. Curtis, and R.G. Stickel. 2006. Improving the design of acoustic and midwater trawl surveys through stratification, with an application to Lake Michigan prey fishes. North American Journal of Fisheries Management 26:612–621.

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Stokesbury, K.D.E., J. Kirsch, E.D. Brown, G.L. Thomas and B.L. Norcross. 2000. Spatial Distributions of Pacific herring and walleye pollock in Prince William Sound, Alaska. Fish Bull. 98:400-409.

Thorne, R.E., Trumble, R., Lemberg, N., Blankenbeckler, D., 1983. Hydroacoustic assessment and management of herring fisheries in Washington and south-eastern Alaska. Fisheries Report, Vol.300. FAO, pp. 217-222.

PWS Herring Research and Monitoring:

Validation of Acoustic Surveys for Pacific Herring Using Direct Capture

PRINCE WILLIAM SOUND SCIENCE CENTER

PWSSC Personnel Salaries & Fringe Benefits
Yr 1 = $32.5, Yr 2 = $58.3, Yr 3 = $98.1, Yr 4 = $95.0, Yr 5 = $98.0
Research Assistant Watson Yr 1=1.5 mo @ $6.4, Yrs 2 = 6.0 mo @ $6.6, Yr 3 = 6.0 mo @ $6.8; Yr 4 = 5.0 mo @ $7.0, Yr 5 = 5.0 mo @$7.2. Watson will conduct fish capture operations for energetic intensive surveys (yr 1), expanded adult surveys (yrs 2-5), juvenile acoustic intensive surveys (yr 3). He will assist with data collection for other projects while on cruises (e.g. disease sampling). He will also process captured fish. maintain the database, conduct preliminary analyses, and assist with preparation of annual reports and work plans.
Research Assistant Hsu, Yr 1 = 1.0 mo @ $6.4. Hsu will assist with fish capture operations for the energetic intensive surveys.
Principal Investigator Bishop Yr 1 = 1.5 mo @ $11.0, Yr 2 = 1.7 mo @ $11.3, Yr 3 = 4.9 mo @ $11.7, Yr 4 = 5.0 mo @ $12.0, Yr 5 = 5.0 mo @ $12.4.
For this project Bishop will oversee the project and coordinate with other studies that are part of the *PWS Herring Research & Monitoring* program. She will have primary responsibility for field work (fish capture), data integration, and completion of final products for *PWS Herring Research & Monitoring* synthesis. She will supervise the research assistant. She will be responsible for project design, statistical analyses and data interpretation and preparation of a manuscript and contributing to the *PWS Herring Research & Monitoring* synthesis.

<u>PWSSC Travel</u>
Yrs 1 & 2 = $1.0/yr, Yr 3 = $2.0, Yrs 4 &.5 = $1.2/yr
Principal Investigator Bishop, Cordova-Anchorage: Ticket price $0.3 (Yrs 1-3) and $0.35 (Yrs 4-5). One 4d trip/yr @ $0.18/d per diem to attend Alaska Marine Symposium all 5 years; and Yr 3 one trip to Anchorage for a Principal Investigators Meeting.

<u>PWSSC Contractual</u>
Yr 1 = $0.9, Yr 2 = $1.8, Yr 3 = $2.6, Yrs 4 & 5 = $2.2/yr
Yrs 1-5 Computer network & software subscriptions, direct cost based on $0.15/mo x staff mo
Yrs 1-5 Communications (Phone & Fax) direct cost based on $0.05/mo x staff mo
Yrs 1-5 Printing & copying direct cost based on $0.025/mo x staff mo

<u>PWSSC Commodities</u>
Yr 1 = $5.4, Yr 2 = $2.8, Yr 3 = $1.8, Yr 4 -=$1.1, Yr 5 = $1.1
Supplies (Field, office, & lab) Includes fishing trawl gear set up including lines, fasteners, buoys, and replacement parts for the trawl and Simraud catch monitoring system, display monitor for catch monitoring system, gps, cast nets, jigs, scales, fish boards, fish sampling table, log books, knives, plastic bags, plastic buckets, personnel rain gear, rubber boots, gloves, field notebooks, office supplies, computer hardware, coolers, ice, whirl paks, formalin, gas for truck).

PWSSC Equipment

Yr 1 = $10.7, Yrs 2-5 = 0
In Year 1, this project will purchase a Simraud P150 Catch Monitoring system. The $10.7 covers a portion of the total cost, with the remainder covered by the Expanded Adult Survey Project (M. Buckhorn, Principal Investigator).

PWSSC INDIRECT COSTS
Yrs 1-5 MTID is estimated at 30%, pending negotiations & and approval by NOAA.

Note: all vessel charter costs for years 1-5 are included under proposal by W.S. Pegau, *PWS Herring Research & Monitoring*

FY12 INVITATION

PROPOSAL SUMMARY PAGE

Project Title: PWS Herring Research and Monitoring Tracking Seasonal Movements of Adult Pacific Herring in Prince William Sound

Project Period: October 1, 2011 – September 30, 2014

Primary Investigator(s):
Dr. Mary Anne Bishop, Prince William Sound Science Center, Cordova , mbishop@pwssc.org
Dr. Sean Powers, University of South Alabama & Dauphin Island Sea Lab, spowers@disl.org
Collaborators: S. Moffitt, Alaska Dept. Fish Game; J. Eiler, Auke Bay Lab, NOAA; Dr. Andy Seitz, Univ. Alaska Fairbanks

Study Location: Prince William Sound

Abstract:
Knowledge of fish movements and migrations are critical to understanding fish population dynamics. In Prince William Sound (PWS) adult herring disperse after spawning, however their movement patterns are poorly understood. Currently the only information on adult herring movements are a small number of observations from fishers that suggest PWS herring are regularly migrating out of PWS and onto the shelf. This proposal focuses on verifying adult Pacific herring movements using detections of tagged fish. The Herring Marking Workshop sponsored by EVOS in December 2008, reviewed all potential marking methods for herring and conditionally endorsed acoustic tagging as a method for determining herring movements. This pilot project will acoustic tag adult herring during November around Port Gravina, a spring spawning area. During the second season a small sample of adult herring will be tagged during spring at other spawning areas. We will then examine detections from two, established Pacific Ocean Shelf Tracking (POST) Project's acoustic arrays as well as new arrays to be deployed at the major entrances and passages to Prince William Sound. These acoustic arrays will enable us to determine seasonal movement patterns within and out of Prince William Sound. The proposed project builds on our previous and current research on acoustic-tagged fishes. This project will synergize with efforts of POST and the Ocean Tracking Network (OTN). The ability to track herring is critical to answer many questions including those about stock structure, migration habits, and the occurrence of skip-spawning. Determining the capabilities of this technology will help guide our choice of future research emphasis.

Estimated Budget:
EVOSTC Funding Requested: *(breakdown by fiscal year and must include 9% GA)*

FY12	FY13	FY14
$79,700	19,700	17,400

Non-EVOSTC Funds to be used:

Date: May 25, 2011

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here are projects for a single project that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

II. PROJECT DESIGN

A. Background for the Adult Seasonal Movement Study:

Adult Pacific herring (*Clupea pallasii*) along the eastern Pacific Ocean often overwinter close to spawning areas and in nearshore channels (Hay and McCarter 1997). This behavior has also been observed in PWS herring populations, where historically large schools both overwintered and spawned around northern Montague and Green Islands. More recently however, the major biomass of adult herring during winter has shifted to the northeast and southwest areas of PWS. Currently the largest concentration of adult herring overwinters and spawns around Port Gravina and Port Fidalgo (R. Thorne, PWS Science Center, pers. comm.). Some spring spawning aggregations are not located near known overwintering areas suggesting that: (a) some adult herring populations are overwintering outside of PWS; (b) not all PWS overwintering populations are being detected; or, (c) overwintering schools such as those in northeast PWS break into smaller schools in spring with some schools moving away from their overwintering area to spawn.

Post-spawning behavior of adult PWS herring is poorly understood. Elsewhere, it is common for large herring populations to migrate from nearshore spawning areas to coastal shelf areas for summer feeding habitat (Hay and McCarter 1997, Hay et al. 2008). To date, our only information on adult PWS herring movements comes from a study by Brown et al. (2002) that compiled local and traditional knowledge. In that study, fishers reported herring moving in fall north through Montague Strait prior to the fall bait fishery while whose observations suggest others reported herring moving into PWS in spring through Hinchinbrook Entrance, Montague Strait and the southwest passages of Erlington and LaTouche. These observations suggest that PWS herring are regularly migrating out of PWS and onto the shelf.

Acoustic transmitters make it possible to monitor fish movements both across large distances (Heupel et al. 2006) and in structurally complex habitats like those found in nearshore areas (Bishop et al. 2010). Acoustic tags offer many additional advantages, including: 1) the potential for multiple data points over time and space for each individual fish; 2) minimal handling - fish are captured and handled only once; 3) transmitters can be implanted quickly, with low mortality and with low tag expulsion; 4) transmitters are programmed for individual identification; and 5) the capability to use portable receivers to monitor spawning schools or large wintering schools of herring regardless of the location (Bishop 2008).

In October 2008 the Pacific Ocean Shelf Tracking Project (POST), PWS Science Center (M.A. Bishop, Co-PI), University of South Alabama (S. Powers, Co-PI) and the PWS Oil Spill Recovery Institute installed across the mouth of Port Gravina the first long-term, large-scale hydroacoustic array in Prince William Sound. At that same time, Bishop and Powers installed eight portable receivers at pinnacles near the POST array. In September 2010 we installed a new array at the mouth of Zaikof Bay near Hinchinbrook Entrance consisting of six portable receivers. At both Port Gravina and Zaikof Bay, acoustic-tagged lingcod (*Ophiodon elongatus*) are currently being monitored (Bishop et al. 2010; Fig. 1).

In fall 2011, PWS Science Center and POST will collaborate with the Ocean Tracking Network (OTN) to install two, large-scale arrays including one across the mouth of Hinchinbrook Entrance and one across Montague Strait, and three small arrays at the southwest PWS passages of Erlington, LaTouche, and Prince of Whales (Fig. 2). Equipment will be assembled and configured by PWS Science Center personnel in Cordova.

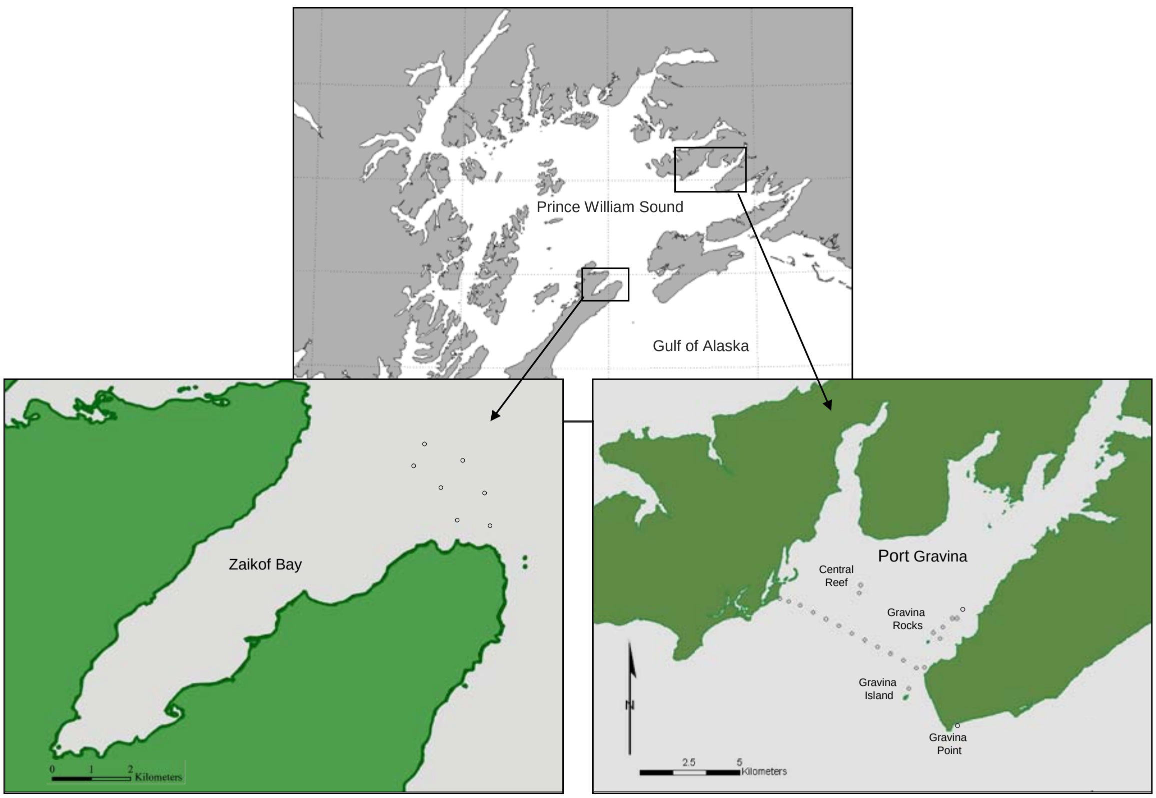

Figure 1. Map of Prince William Sound, Alaska, and acoustic array locations at Zaikof Bay and Port Gravina. Circles indicate the positions of hydro-acoustic receivers. Overwintering adult herring in this area will be captured and tagged during ADFG seine surveys in November 2011 (Port Gravina vicinity) and November 2012 (Port Gravina and additional areas).

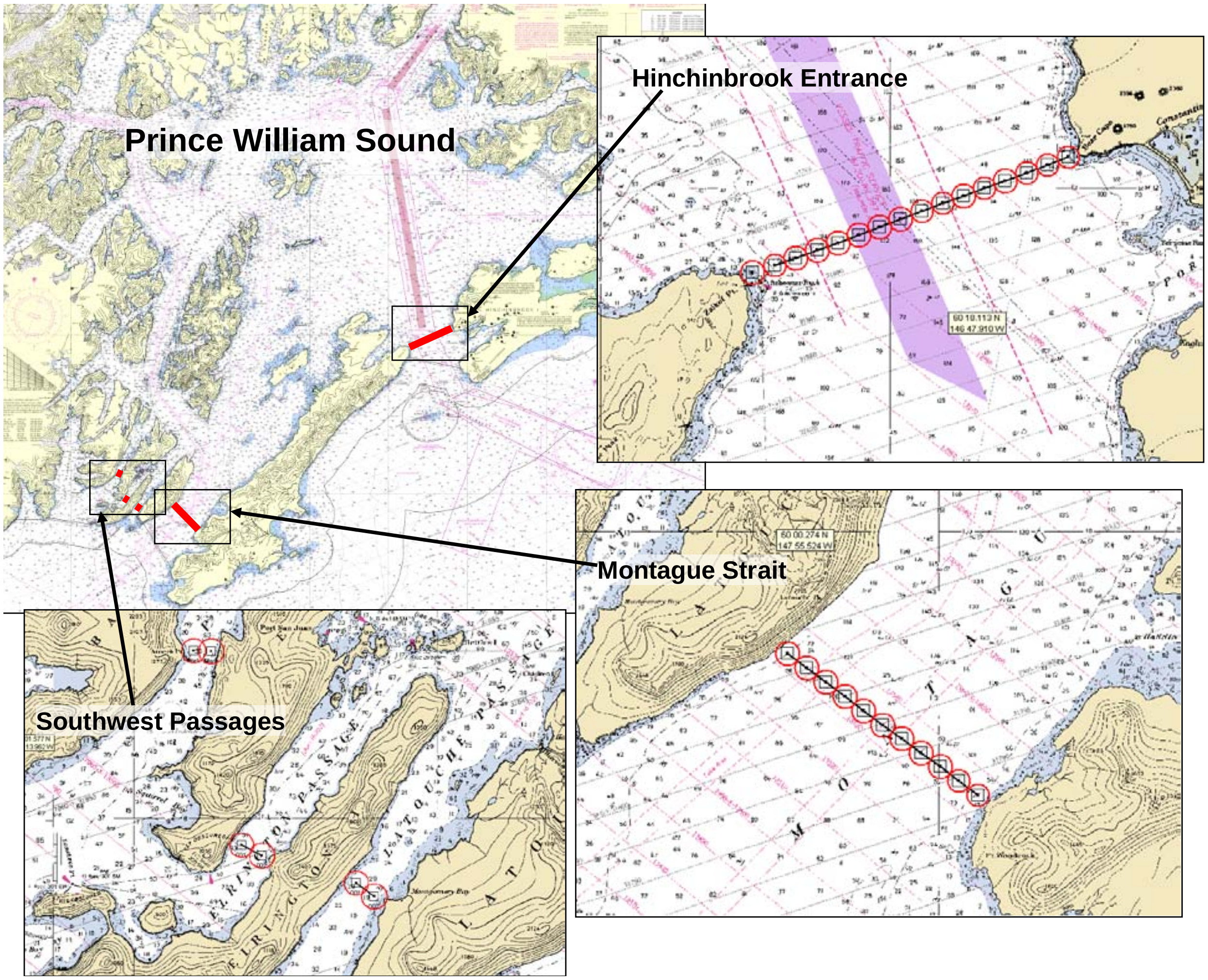

Figure 2. Proposed POST/OTN array locations, scheduled to be installed by PWS Science Center in fall 2011

## *B.	Goal and Objectives*

Goal: <u>Improve predictive models of herring stocks through observations and research</u>.

This is the long-term goal of an anticipated twenty year program. The general approach will be to conduct monitoring of a limited number of variables combined with process study research. We will break the process study efforts into five-year increments. Within each increment we will focus on particular aspects of the herring life cycle to better predict how factors affecting that life stage influence overall herring stocks. We have identified several areas that require attention such as the larval life stage (least amount of existing information), stock structure (from modeling efforts), context of existing measurements (from synthesis), along with predation and competition questions. By no means is this list meant to be comprehensive. We will rely on a scientific advisory group (described later) to guide the efforts of each five-year effort and to recommend modifications during a five-year period if needed. The remainder of the discussion in this proposal is focused on the proposed efforts between FY12 and FY16.

We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

Objectives

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

This study, *Tracking Seasonal Movements of Adult Pacific Herring in Prince William Sound*, is a process study that addresses **objective 4** of the *PWS Herring Research and Monitoring**: develop new approaches to monitoring***. Our study will provide the ability to rapidly improve our understanding of herring populations in PWS. This effort will allow the design of the most accurate and efficient monitoring program.

Objectives specific to the *Seasonal Movements of Adult Herring* study include:

(1) Field test the application of recent advances in acoustic telemetry on wild adult herring.

(2) Elucidate herring movement patterns between overwinter and spawning sites.

(3) Utilize the PWS acoustic arrays to monitor herring migration into and out of PWS.

This project will use the preferred marking method for herring. The Herring Marking Workshop sponsored by EVOS in December 2008, reviewed all potential marking methods for herring and stated with regards to acoustic tagging:

> A specific recommendation is the conditional endorsement of acoustic tagging, with the caveat that the initial involvement should be limited. Arrays of acoustic receivers have been installed in PWS and there may be opportunities to leverage costs with other organizations, so the present time is an excellent opportunity to pursue this approach…. It seems probable that useful information on herring ecology and migratory movements could be revealed by acoustic tagging (source: draft Integrated Herring Restoration Plan 2010, page 134).

C. Procedural and Scientific Methods

Here we propose to synergize with efforts of POST and OTN by undertaking a pilot study to mark adult Pacific herring with acoustic tags during fall 2011 and 2012. Our tagging efforts will coincide with Alaska Department of Fish & Game (ADFG) surveys for adult herring (known as bait surveys) in November 2011 and November 2012. Following purse-seine capture of adult herring by the ADFG vessel, we will use a dipnet to collect herring and then transfer healthy individuals to a 40 gallon aquarium containing aerated, ambient seawater aboard our research vessel. Surgical protocol will follow procedures used for implanting acoustic transmitters into age 2 and 3 Pacific herring (average size 180 mm) and similar sized Pacific salmon smolts (Welch et al. 2007; Seitz et al. 2010). Prior to surgery, individual herring will be transferred to a small, aerated bath containing ambient seawater and buffered tricaine methanesulfonate (MS-222; 60 mg/L), an anesthetic. Following sedation, the fish will be weighed, measured for standard and fork length, then placed on a V-shaped surgery board lined with a disposable surgical mat. During surgery the opercular cavity will be gently irrigated with ambient seawater.

For transmitter insertion, we will make a small incision (11-12 mm) along the ventral midline anterior to the pelvic fins. A Vemco series V9-1L acoustic transmitter (Vemco, Halifax, Nova Scotia) programmed to transmit an individually-encoded signal at 90-270 s random intervals will be inserted into the abdominal cavity. Each transmitter measures 24 x 9 mm and weighs 3.6 g, and has an estimated battery life of 413 d. The incision will be closed with two sutures then swabbed with a broad spectrum antibiotic ointment. The surgical procedure will take less than 2 min per fish. Following surgery, fish will be held for recovery in an aquarium aerated with ambient seawater until equilibrium (upright swimming) and active swimming are observed. Post recovery we will release fish at the capture site.

The first winter we will tag up to 25 herring around Port Gravina and Port Fidalgo. The second winter we will expand our efforts to tag up to 75 herring across multiple overwintering areas seined by ADFG. For 1-2 d after tagging, we will monitor fish using a mobile, omnidirectional VH165 mobile hydrophone. In spring 2012 and 2013 we will use the mobile hydrophone to monitor for tagged fish around Port Gravina and Port Fidalgo spawning areas, as well as spawn areas identified during the expanded adult surveys (2013 only). Data from arrays will be uploaded every 6 to 9 months by the PWS Science Center and University of South Alabama and archived in the POST and OTN data bases, as per their guidelines.

D. Data Analysis and Statistical Methods

Prior to analyses, we will assume a fish was detected only when there are at least two detections of a transmitter at an array during a 24h period. In order to test whether herring are detected more frequently based on size, month of capture, or location, we will calculate the detectability of each herring following a methodology similar to that outlined by Andrews et al. (2010). With this method, we will divide the number of days a herring was detected by the life span of the tag. We will then use detectability as the dependent variable in a linear mixed model.

We will consider a herring as having departed from the Sound if it is detected at one of the arrays at the PWS entrances or passages. Similarly, if that fish is later detected at one of these arrays, it will be considered having returned to PWS. Detections occurring at Zaikof Bay and detections either from the mobile receiver or at the arrays in Port Gravina will be examined to determine the amount of time spent in an area.

E. Description of Study Area

The study area for *PWS Herring Research and Monitoring* includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question “What is the appropriate sampling distribution?” as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

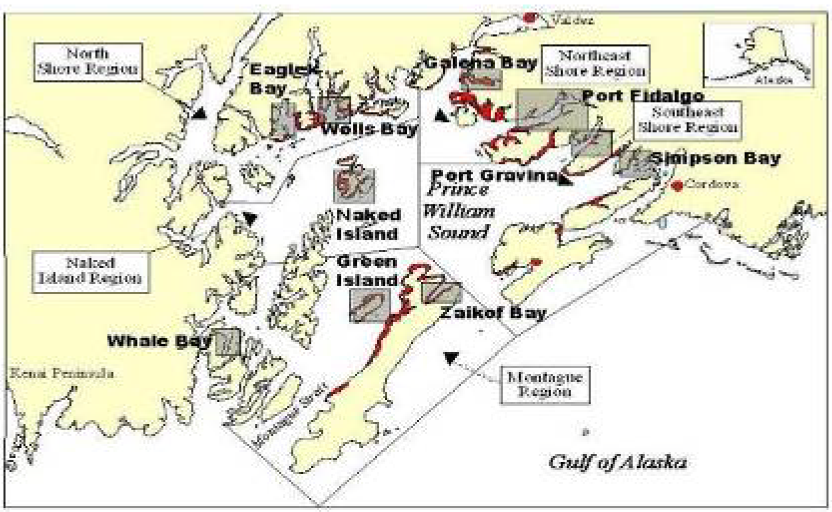

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

F. Coordination and Collaboration

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

This proposal is structured to be a collaborative effort being led by the Prince William Sound Science Center. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Pegau will act as the team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program. He will also be responsible for outreach and public input efforts.

Dr. Pegau currently is the coordinator of the existing EVOSTC funding PWS Herring Survey program. This program consists of ten individual projects that provide a coordinated examination of juvenile herring in Prince William Sound. This proposal is heavily influenced by the early findings from that effort. Dr. Pegau also serves as the Research Program Manager for the Oil Spill Recovery Institute (OSRI). In that capacity he is responsible for developing annual work plans, ensuring proper reporting, making reports available, developing partnerships to leverage funding, and to ensure outreach of OSRI activities. All activities that provide experience delivering the team leader duties outline in the request for proposals.

One of his duties is to ensure proper scientific oversight of the research programs. To accomplish this we will be setting up a four-person scientific oversight panel that will help guide the program and ensure the research is relevant to the long-term goal. The team will consist of people representing Alaska Department of Fish and Game, the National Oceanic and Atmospheric Administration, academia, and the local fishing community. There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year's work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermens United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydroacoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

Other important programs for coordinating with are the existing PWS herring survey program and existing ADF&G herring research. This program has been developed with input from both of these programs and the focus of this proposal is extending the interpretation of the data from those two programs. The Herring Survey program will still be operating in FY12 and FY13. There are field observations scheduled in FY12 and in FY13 funds are strictly for analysis and report writing. Included in the report writing is a synthesis of previous and current research. This report will be finished in FY13 and be the basis for the synthesis required under this request for proposals.

Dr. Mary Anne Bishop (PWSSC) will oversee the seasonal movements study and will coordinate with other studies that are part of the *PWS Herring Research & Monitoring* program as well as our collaborators. She will have primary responsibility for field work (fish tagging) data integration, and completion of final products for *PWS Herring Research & Monitoring* synthesis. Along with Co-Principal Investigator Dr. Sean Powers she will be responsible for project design, statistical analyses and data interpretation and preparation of a manuscript and contributing to the *PWS Herring Research & Monitoring* synthesis.

This project will rely on obtaining data from the existing POST Port Gravina acoustic array as well as arrays maintained by PWSSC near Gravina Rocks and at Zaikof Bay. In addition, data will be obtained from the POST/OTN arrays proposed to be installed at major entrances to Prince William Sound in fall 2011.

We will also be collaborating with Alaska Department of Fish and Game for our tagging efforts, that are scheduled to coincide with their fall herring bait surveys. Mr. John Eiler from NOAA Auke Bay Lab will also provide technical advice for our initial tagging efforts. And, Dr. Andy Seitz has indicated that he is interested in deploying an Automated Underwater Vehicle during our spring monitoring efforts.

III. SCHEDULE

A. Milestones

1) Field test the application of recent advances in acoustic telemetry on wild adult herring.
Completed July 2014.

(3) Utilize the PWS acoustic arrays to monitor herring migration into and out of PWS.
Completed July 2014.

(2) Elucidate herring movement patterns between overwinter and spawning sites.
Completed September 2014.

B. Measurable Project Tasks

FY 12, 1st quarter (October 1, 2011-December 31, 2011)

- Oct Secure Trustee Council funding approval;
- Oct Purchase acoustic tags
- Nov Tag and monitor adult herring at Port Gravina/Port Fidalgo herring in conjunction with ADFG bait surveys

FY 12, 2nd quarter (January 1, 2012-March 31, 2012)

- Jan Alaska Marine Symposium
- Feb Upload data and change batteries on VR2W receivers in Port Gravina arrays
- Mar Monitor for tagged fish around spawning aggregations at Port Gravina & Port Fidalgo

FY 12, 3rd quarter (April 1, 2012-June 30, 2012)

- Apr Monitor for tagged fish around spawning aggregations at Port Gravina & Port Fidalgo
- May PI Meeting
- Jun Upload data from Port Gravina arrays
- Jun Submit FY 13 work plan for review

FY 12, 4th quarter (July 1, 2012-September 30, 2012)

- Jul–Sep Analyze data uploaded from POST arrays and PWSSC receivers
- Aug Submit Annual Report
- Sep Purchase acoustic tags

FY 13, 1st quarter (October 1, 2012-December 31, 2012)

- Nov Tag adult herring in cooperation with ADFG bait surveys in Prince William Sound

FY 13, 2nd quarter (January 1, 2013-March 31, 2013)

- Jan Alaska Marine Symposium
- Mar Monitor for tagged fish around spawning aggregations at Port Gravina & Port Fidalgo

FY 13, 3rd quarter (April 1, 2013-June 30, 2013)

- Apr Monitor for tagged fish around spawning aggregations at Port Gravina & Port Fidalgo; upload data and change batteries on VR2W receivers in arrays
- May PI Meeting
- Jun Prepare and submit work plan for FY14

FY 13, 4th quarter (July 1, 2013-September 30, 2013)

- Jul - Sep 30 Analyze data uploaded from POST arrays and PWSSC receivers
- Aug Submit Annual Report

FY 14, 1st quarter (October 1, 2013-December 31, 2013)

Oct-Dec analyze data

FY 14, 2nd quarter (January 1, 2014-March 31, 2014)

Jan Alaska Marine Symposium & PI meeting

Sep Submit final report

Winter EVOS sponsored workshop with Herring and Long-term monitoring programs

FY 14, 3rd quarter (April 1, 2014-June 30, 2014)

Apr-Jun Process & analyze data

May Annual PI meeting

FY 14, 4th quarter (July 1, 2014-September 30, 2014)

September Submit Final Report

IV. Literature Cited

Bishop, MA. 2008. Acoustic tags and POST arrays in PWS: a timely and unique opportunity for marking herring in PWS. Unpubl. rpt. submitted to Exxon Valdez Oil Spill Trustee Council. 2 pp.

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Seitz AC, BL Norcoss, JC Payne, AN Kagley, B Meloy, JL Gregg, and PK Hershberger. 2010. Feasibility of surgically implanting acoustic tags into Pacific herring. Trans Am Fish Soc 139: 1288–1291.

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PWS Herring Research and Monitoring: Tracking Seasonal Movements of Adult Pacific Herring in Prince William Sound

PRINCE WILLIAM SOUND SCIENCE CENTER &
UNIVERSITY OF SOUTH ALABAMA DAUPHIN ISLAND SEA LAB

PWSSC Personnel Salaries & Fringe Benefits
Yr 1 = $7.3, Yr 2 = $8.9, Yr 3 = $11.3
Co-Principal (Lead) Investigator Bishop Yr 1 = 0.2 mo @ $11.0/mo; Yr 2 = 0.2 mo @ 11.3/mo; Yr 3 = 1.0 mo @ $11.3/mo (includes vessel time yrs 1 & 2)
For this project Bishop will oversee the project and coordinate with other studies that are part of the *PWS Herring Research & Monitoring* program. She will have primary responsibility for field work (fish tagging) data integration, and completion of final products for *PWS Herring Research & Monitoring* synthesis. She will supervise the research assistant. Along with Powers she will be responsible for project design, statistical analyses and data interpretation and preparation of a manuscript and contributing to the *PWS Herring Research & Monitoring* synthesis.
Research Assistant Reynolds: Yr 1 = 0.8 mo @ $6.4/mo; Yr 2 = 1.0mo @ 6.6/mo (includes vessel time Yrs 1 & 2). Reynolds will conduct fish tagging operations, fish monitoring in spring, and data retrieval from acoustic receivers, and will process acoustic tag data.

PWSSC Travel
Yr 1 = $5.1, Yr 2 = $4.2, Yr 3 = $0
Yr 1: J. Eiler, NOAA Juneau, Juneau-Cordova, 1 rt. Ticket price $0.4 ea; per diem $0.18/d for 3d. To assist with Nov 2011 tagging effort.
Yrs 1 & 2: Univ. South Alabama personnel, Mobile –Cordova, 2 rt/year (fall, spring) to assist with field work (Nov & Mar). (airfare $1.1 ea; subsistence while on boat 7d =$0.3 Yr 1; 10 d subsistence =$0.4 Yr 2; per diem while in Cordova $0.18/d for 8d/yr. .

PWSSC Contractual
Yr 1 = $0.4, Yr 2 = $0.3, Yr 3 = $1.0
Yrs 1-3 Computer network & software subscriptions, direct cost based on $0.15/mo x staff mo
Yrs 1-3 Communications (Phone & Fax) direct cost based on $0.05/mo x staff mo
Yrs 1-3 Printing & copying direct cost based on $0.025/mo x staff mo
Yr 1 Mail/freight Charges; ship tags & batteries direct cost based on use only estimated at $0.1
Yr 3 Page charges for manuscript publication in scientific journal, estimated at $0.8.

PWSSC Commodities
Yr 1 = $37.1, Yr 2 = $0.5, Yr 3 = $0
Yr 1: Vemco Acoustic Tags (100@ $0.35/ea); Tagging Supplies $0.9; Acoustic Receiver Lithium Batteries (30 @ $0.03/ea); Boat groceries, spring monitoring $0.3.
Yr 2 Tagging Supplies $0.2, Boat groceries, spring monitoring $0.3.

PWSSC Equipment No equipment purchases are anticipated

PWSSC will be utilizing PWSSC acoustic array at Port Gravina (consisting of VR2 and VR2W receivers) & the Port Gravina Pacific Ocean Shelf Tracking Project's array (consisting of VR2 and VR3 receivers). PWSSC will also be using its Vemco portable tracking system and Vemco acoustic modem. .

PWSSC INDIRECT COSTS

Yrs 1-3 MTID is estimated at 30%, pending negotiations & and approval by NOAA.

Note: all vessel charter costs for years 1-2 are included under proposal by W.S. Pegau, *PWS Herring Research & Monitoring*

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Data Management Support for the Integrated Herring Research Program

Project Period: FY12-FY16

Primary Investigator(s): Rob Bochenek, Alaska Ocean Observing System

Study Location: General Spill Affected Area

Abstract: This project supports the EVOS Integrated Herring Research Program with critical data management support to assist study teams in efficiently meeting their objectives and ensuring data produced or consolidated through the effort is organized, documented and available to be utilized by a wide array of technical and non technical users. This effort leverages, coordinates and cost shares with a series of existing data management projects, cyber-infrastructure and partnerships which contribute capacity and information to this effort. During year one and two, this project would focus on providing informatics support to streamline the transfer of information between various study teams and isolate and standardize historic data sets in the general spill affected area for use in retrospective analysis, synthesis and model development. This work would scale down in year three thru five to provide support for general project level data management and archival.

Estimated Budget:
EVOSTC Funding Requested:
FY12-120K, FY13-120K, FY14-20.5K, FY15-21.2K, FY16-22.0K
Non-EVOSTC Funds to be used:
FY12-683K, FY13-640K, FY14-620K, FY15-500K, FY16-500K

Date: 5-25-2011

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here is the data management component of the PWS Herring Research and Monitoring Program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

Managing oceanographic data is particularly challenging due to the variety of data collection protocols and the vast range of oceanographic variables studied. Data may derive from automated real-time sensors, remote sensing satellite/observational platforms, field/cruise observations, model outputs, and various other sources. Variables can range from mesoscale ocean dynamics to microscale zooplankton counts. The resulting datasets are packaged and stored in advanced formats, and describe a wide spectrum of scientific observations and metrics. Due to the complexity of the data, developing data management strategies to securely organize and disseminate information is also technically challenging. Distilling the underlying information into usable products for various user groups requires a cohesive, end-to-end approach in addition to a fundamental understanding of the needs and requirements of the user groups and stakeholders.

Data management activities for oceanographic information occur in isolated, physically distributed agencies, leading to low cross-agency utilization of data. Technical barriers, complex data formats, a lack of standardization and missing metadata have limited access to data and made the utilization of available scientific information cumbersome and daunting. As a consequence, existing data is underutilized and often has not undergone quality assurance.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.
Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

II. PROJECT DESIGN
A. Objectives

1) Provide data management oversight and services for EVOS IHRP project team data centric activities which include data structure optimization, metadata generation, and transfer of data between project teams.

2) Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.

3) Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long term storage and public use.

The specific objectives of this proposed effort will directly support the overall objectives of the combined PWS Herring Research and Monitoring proposal which are listed below.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for

estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Providing a framework for efficiently managing data produced or consolidated by this effort will enable the information to be used to improve the ASA model, inform and facilitate the planned synthesis efforts, address assumptions in the current measurements and develop new approaches to monitoring. Data management activities are critical for the overall success of the IHRP program in addition to the integration of data sets and information transfer between study groups and research team leads.

B. Procedural and Scientific Methods

Objective 1. Provide data management oversight and services for EVOS IHRP project team data centric activities which include data structure optimization, metadata generation, and transfer of data between project teams.

AOOS data management staff will work with EVOS IHRP investigators to assess the types of data which will be collected during sampling efforts, assess Standard Operating Procedures (SOPs) for data collection to create metadata templates in addition to gauging general data management needs of PIs. This assessment is critical to identify the data management needs and the types of tools needed by researchers to increase their abilities to manage their data in an automated, standard fashion.

The AOOS data management group is currently developing a web base platform for PIs to manage project level data sets and author metadata. System development is currently supported through internal AOOS funds in additional to dedicated funding from the Prince William Sound Science Center. The AOOS Ocean Workspace will provide a web based platform for PIs to post and share data sets and rapidly author metadata. The system will be enabled with security authentication in order to limit access to IHRP investigators, project managers and administrators. The system will also provide PIs with tools to generate metadata profiles which comply with national standards. Initially, this system will focus on authoring FGDC metadata formats including tools for authoring the biological extension for taxonomic classifications and measurements. The software development phase of this application was initiated in March 2011. An initial beta release/testing of this system will commence in August 2011 with a planned release date of October 1st, 2011. This platform will provide IHRP investigators and project managers with a transparent view of data collection and metadata authoring progress in addition to providing a framework for data integration. It is envisioned that this platform will function as the primary vehicle to facilitate data transfer, metadata generation and archiving for the entire IHRP project data management lifecycle. This proposed effort will provide a user base and focused environment for the expansion and refinement of this project level data management tool.

Objective 2. Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.

This task will involve isolating and standardizing historic data sets deemed necessary for retrospective analysis by EVOS IHRP synthesis efforts. Early in the effort the EVOS IHRP researcher team will be engaged to prioritize sources of relevant data deemed of high value for the synthesis effort. Data will be prioritized by several metrics including length of time series, scientific importance, and quality and precision of the data storage format. All data acquired through efforts of this project will be merged into the AOOS data system for long term archival and access. Many herring related data sets not easily accessible to restoration researchers and managers have been standardized and made available through the actions of the PWS Herring Portal (EVOS Project 070822, 080822 and 090822). This proposed project would expand the geographic and programmatic scope of this work to include datasets in Lower Cook Inlet and potentially Kodiak regions.

Building upon results of the PWS Herring Portal Project, investigators will expand their efforts to additional project level data sets, long term time series produced from sensor platforms, remote sensing/satellite imagery data products, oceanographic/atmospheric/ecological model outputs and relevant GIS data layers. The AOOS data system currently has the capacity to manage all of these data types except for project level data. AOOS will be deploying a project level data management system in the fall of 2011 to address this need. This is the same system referenced in methods of objective 1. Data analysts preparing and salvaging historic project level datasets will leverage this system to consolidate, centralize and document data resources so that IHRP investigators can access these data as they are discovered, processed and made available for use.

Additionally, data management staff will leverage existing data management efforts and data sets currently under the stewardship of AOOS in this activity. These resources and efforts are detailed more fully in the "Coordination and Collaboration with Other Efforts" section of this proposal. These existing data resources include a wide array of physical and biological data sets in the general spill affected areas. These resources can be reviewer at http://data.aoos.org.

Potential Data Sources for this Effort

Lower Cook Inlet

The Alaska Department of Fish and Game in Homer (ADF&G-Homer) has flown aerial surveys to assess Pacific herring abundance trends in Lower Cook Inlet (LCI) since 1978 (Otis et al. 1998). An uninterrupted time series (1978-2008) of aerial survey data is available for the Kamishak and Southern (i.e., Kachemak Bay) districts and discontinuous data sets are available for the Outer and Eastern districts. The Outer/Eastern districts are oceanographically downstream of PWS. Embayments along the outer coast of the Kenai Peninsula may function as juvenile rearing areas for herring larvae advected from PWS via Montague Strait. Lower Cook Inlet's most comprehensive herring data set is for Kamishak Bay, where commercial sac-roe herring harvests occurred from 1974-1979, and from 1985-1998. The fishery is currently closed while the stock rebuilds, but ADF&G continues to fly aerial surveys and conduct vessel surveys to assess herring abundance and ASL composition of the spawning biomass. Through a previous NOAA grant funded project (Otis and Spahn 2003), the great majority of the Kamishak herring data set has already been digitized into a spatial database (ADF&G 2002), which can be readily ingested into the data management system for this project. However, herring survey and ASL data for the Southern, Outer, and Eastern districts of LCI remain spatially disabled and would require staff time to digitize and spatially reference them. Table 1 documents the type and current status of available herring data from LCI.

Kodiak

The Alaska Department of Fish and Game in Kodiak (ADF&G-Kodiak) has been monitoring herring population and fishery parameters since the 1930's. Herring distribution and abundance trends have been assessed using a combination of aerial and acoustic surveys periodically since the mid-1980's. Spawn observations have been documented consistently since the 1970's and herring age, sex, length (ASL) data have been collected annually since 1967. Fishery performance and harvest data have been maintained since the 1970's and early fishery observations exist back to the 1930's. Marine mammal sightings and herring disease data are also available for recent years. Most of these valuable, historical data sets exist only in hard copy format and need to be digitized and spatially enabled to realize their full worth. Table 2 documents the type and current status of available herring related data from the Kodiak region.

PWS-ADF&G

The Alaska Department of Fish and Game in Cordova (ADF&G-Cordova) has flown aerial surveys in Prince William Sound since 1973. Population trends were initially monitored with aerial surveys to estimate biomass and the linear extent of beach used for spawning (Brady 1987), and have continued almost without interruption. Age, sex, and size data h as been collected from most fisheries and spawning aggregations since 1973 (e.g., Baker et al. 1991; Biggs et al. 1992). Dive surveys to estimate spawning biomass began with feasibility studies in 1983 and 1984 and continued in 1988-1992 and 1994-1997 (e.g., Willette et al. 1999). In 1993, ADF&G in cooperation with the Prince William Sound Science Center began fall acoustics surveys. Spring (March/April) acoustics surveys have been conducted during 1995-2009. Age structured models have been used since 1993 to estimate historical population parameters and project future biomass, recruitment, and abundance (Funk 1994). Disease assessments (1993-2002) indicate viral hemorrhagic septicemia virus (VHSV) and associated ulcers were related to population declines in 1993/1994 and 1998; and *Ichthyophonus hoferi* was related to a population decline in 2001 (Marty et al. 2004). Additional disease sampling to index the prevalence of VHSV and *I. hoferi* (2003-2006) and measure the prevalence (2006-2009) have been funded by the Department of Fish and Game and the EVOS Trustee Council. Previous funding by the EVOS Trustee Council has allowed the digitizing and publishing of the majority of the aerial survey linear extent of spawn and biomass data; and age, sex, and size in addition to the commercial harvest data. (http://dev.axiomalaska.com/pwsherringportal/) and digitizing most of the commercial harvest and spawn deposition survey data. Table 3 documents the type and current status of available herring related data from the PWS region.

PWS-PWSSC
The Prince William Sound Science Center (PWSSC) has been collecting biological and physical measurements in Prince William Sound which are critical to understanding herring population dynamics back to the early 1990s. The data includes herring acoustic data (e.g., Thomas and Thorne 2003), herring nursery bay and larger PWS oceanographic conditions, zooplankton abundance, herring energetic, and seabird predation datasets for juvenile and adult herring. The data at PWSSC must be standardized, documented and up scaled into a geospatial database. Table 4 documents the type and current status of available herring related data from the PWS region stewarded by the Prince William Sound Science Center.

Objective 3. Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long term storage and public use.

The ultimate goal of this project is to provide services to assist in the organization, documentation and structuring of data collected and made available via EVOS IHRP project activities so that it can be transferred efficiently to long term data archive and storage centers and made available for future use by researchers and other user groups. This task will leverage the AOOS cyber infrastructure, long term funding and other active data management projects being undertaken by that organization. Data sets produced from the integrated research effort will be served to users by extending existing data access, analysis and visualization interfaces currently supported and under development by the AOOS data management team.

Figure 1 below provides screen captures of existing AOOS data portals which provide access to data management systems that manage sensors, models/remote sensing and GIS data layers. These portals can be accessed off the AOOS website at http://data.aoos.org/.

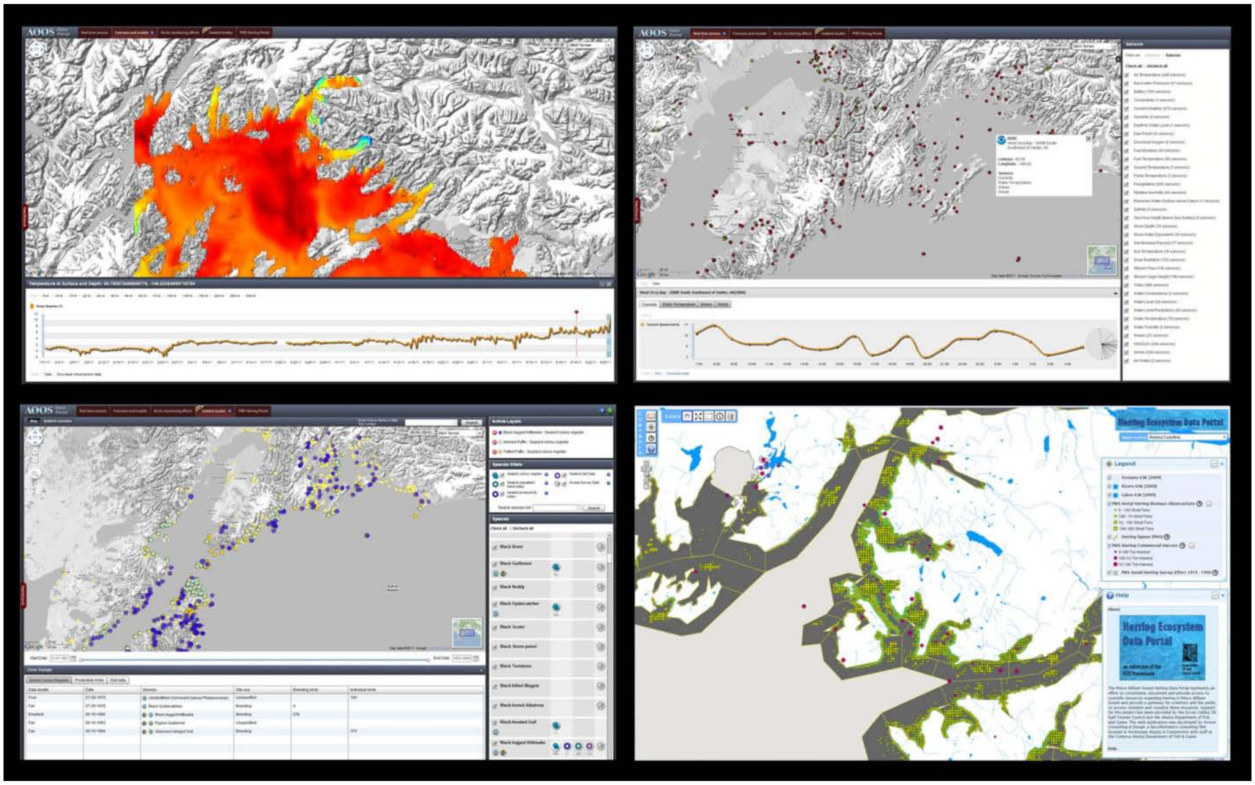

Figure 1. Screenshots of existing AOOS data management and visualization systems which are available at http://data.aoos.org. At the top left is a screenshot of the AOOS model explorer displaying a ROMS circulation model of Prince William Sound and an ocean temperature point source time series extraction near Port Fidalgo. On the top right of the figure is a screen capture of the AOOS real time sensor portal. On the bottom of the figure from the left to right are screenshots of the North Pacific Seabird Portal and the PWS Herring Portal.

C. Data Analysis and Statistical Methods

The overarching strategic plan for the AOOS data system involves implementing an end-to-end technological solution which allows data and information to be channeled and distilled into user-friendly products while simultaneously enabling the underlying data to be assimilated and used by the emerging external data assembly systems. The following diagram (Figure 2) details the four logical technical tiers of the approach. At the base (Tier 1) of the pyramid lie the source data produced by researchers, instruments, models, and remote sensing platforms which are stored as files or loaded within geospatial databases. Interoperability systems (Tier 2), such as Web Map Services (WMS) and Web Coverage Services (WCS), are then implemented and connected to these underlying data sources. The asset catalogue (Tier 3) connects to internal interoperability systems in addition to known external sources of interoperable data and populates a database describing the dimensional characteristics (space, time, measured parameter, and taxonomy) of each data resource. Also in this third tier are web services which provide access to the descriptive information contained in the asset catalogue database so that applications can more easily utilize data from multiple sources, formats, and types. The final technical level (Tier 4) is composed of the web based applications and tools which provide users access to data and products. Users sit at the top of the pyramid with all underlying systems working together to create a powerful and intuitive user experience. The intended result is the facilitation of rapid data discovery, improved data access, understanding, and the development of knowledge about the physical and biological marine environment.

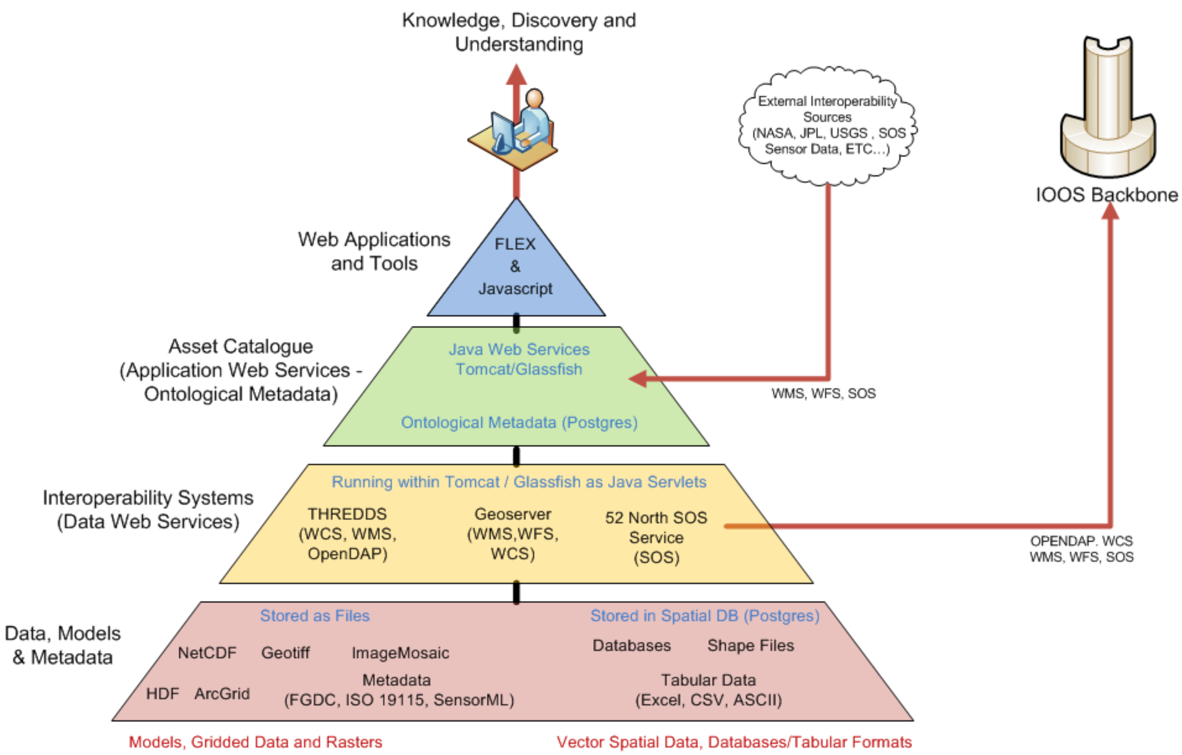

Figure 2. Data knowledge pyramid detailing the flow of data through logical technology tiers so that it can be consumed by users to enable discovery and understanding about the ocean environment.

Tiers are discussed in technical detail below.

- **Tier 1 (Data, Models and Metadata)** – At the base of the proposed data management framework are the datasets, metadata, and model outputs that provide the foundation for applications and user tools. These resources can be stored either in native formats or spatially enabled databases. The decision to choose one method over the other is dictated by the requirements of the interoperability system which will be serving the data. Data which has a tabular or vector form (Shapefiles, databases, Excel spreadsheets, comma separated values (CSV) text files, etc.) will be loaded into a PostgreSQL database and spatially indexed. GeoServer, an open source geospatial data server, will then connect to the PostgreSQL database and serve the data via WFS and WMS protocols. Imagery, raster, and model data will be stored in a file server in their native file formats. THREDDS and/or ncWMS will be used to serve NetCDF and HDF files which may contain two, three, four or higher dimensional gridded datasets. GeoServer or other OGC compliant mapping servers will be utilized to serve GeoTIFF, ArcGrid, ImageMosaic and other two dimensional imagery/raster data.

- **Tier 2 (Interoperability Systems) –** Various interoperability servers (GeoServer, THREDDS, ncWMS, 52 North SOS, etc.) will be implemented on top of source data. By design, these servers will expose a powerful set of interfaces for other computing systems and humans to extract, query, and visualize the underlying source data. These systems will facilitate all aspects of data delivery to users in addition to providing the muscle for the machine-to-machine data transfer to national data assembly systems as required. Because these systems have been developed using the Java programming language, they will run within a servlet container such as Tomcat or Glassfish.

- **Tier 3 (Asset Catalogue, Ontological Metadata and Services) –** The asset catalogue provides a description of known internal and external available data resources, access protocols for these resources (interoperability services, raw file download, etc.), and directives on how to ultimately utilize these data resources in applications. Because documentation and access methods vary widely between data sources, a system which catalogs data sources and reconciles these inconsistencies must be implemented if the data are to be used in an efficient manner.

  In addition to managing information about data availability and access methods, the asset catalogue will also contain an ontology that maps source data descriptions and metadata to a common set of internally stored terms with strict definitions. This mapping will allow users to easily locate related sets of information without having explicit knowledge of the internal naming conventions of each data-providing agency. The development of an internal ontology will also enable future endeavors to connect the asset catalogue to global ontologies in the semantic web. The following dimensions are to be stored in the database for mapping the heterogeneous characteristics of source data to common metrics:

  - **Source –** Service URLs and methods of interaction for these services.
  - **Data formats and return types –** Data format returned by the service and how data can be equated between various formats.
  - **Space (x, y, z) –** Spatial dimensions of dataset (1D, 2D, 3D). Upper and lower spatial bounds (bounding box or cube) stored in common projection (EPSG 4326).
  - **Time (t) –** For data resources with a time component: document time span, whether time corresponds to a single moment or if it is representative of a time period. If data is in discrete periods, document individual available periods.
  - **Taxonomy –** Taxonomic data mapped to International Taxonomic Information System (ITIS) codes.
  - **Parameter –** Parameter(s) and units in the data resource and how they map to internally defined universal terms. For example: Datasets SST, AVHRR, and Sea_Surface all contain parameters that map to internal universal term Sea Surface Temperature.

  Web services written in the Java programming language will be developed to connect to the asset catalogue and provide applications with access to the underlying descriptions of all known data sources. Because the asset catalogue contains a structured ontological definition of data sources and maps all known data sources to a common definition, applications can be developed which connect users to vast arrays of data through simple but powerful interfaces. The following is a list of example functionality that is possible utilizing this methodology:

- Users can load multiple data layers (potentially existing in different physical locations and being served by different systems) onto a single web based map. Users can also filter all layers simultaneously by time or request spatial and temporal subsamples of data that can be pulled from multiple sources and automatically packaged into a single download.
- All real time sensor feeds can be accessed and visualized on a single uniform user interface by parameter even though the sources of the sensor feeds may exist in a wide array of formats and service protocols.
- Users can query the asset catalogue to discover which data is available for an area, time period, parameter, and species.

- **Tier 4 (User Applications) –** Users interface with web based applications that bring together combinations of underlying data and allow users to make discoveries, improve understanding, and develop knowledge through visualization and data access. These types of applications would most likely be interactive map based data portals. Applications will also be developed which provide specific targeted functionality. These focused applications could include marine spatial planning tools, emergency response applications, and educational/outreach portals. Developed tools are designed to meet user needs and thus require user input into their initial design and periodic feedback to direct functional improvements for future design iterations.

D. Description of Study Area

The majority of this project will involve consolidating existing data, metadata, and other electronic resources related to herring in Spill Affected Area. Specific areas of focus include those areas in PWS, Lower Cook Inlet, and Kodiak where herring fisheries currently do, or historically did occur. The north, east, south, and west bounding coordinates of this area are 59.767, -145.837, 61.834, and -154.334

E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System. This project is also highly coupled with the proposed data management component of the EVOS Long Term Monitoring program.

AOOS brings a significant level of leveraged resources, infrastructure, regional data management projects and partnerships to this proposed effort. The data management effort for the LTM and herring projects could not be accomplished for the budgeted amount by a team without these leveraged resources.

1. AOOS – (500k to AOOS DM) Alaska oceanographic data management effort. Supports open source, standards based data system that serves up and archives real-time sensor feeds, models & remote sensing applications, GIS data layers, and historical datasets. Data system developed on interoperability concepts and meets NOAA Integrated Ocean Observing System standards and protocols for streaming data feeds to national data assimilation sensors. Data Management Committee chaired by Dr. Phil Mundy provides ongoing advice, prioritization and direction to the team at Axiom Consulting & Design. AOOS board is made up of federal and state agencies, and major marine research institutions in the state that have committed to data sharing. The AOOS board has committed to supporting a statewide data system for as long as AOOS exists. Federal funding is stable, although we would like to see it increase. In the event AOOS was to end, all data and data products would be transferred to the University of Alaska.
2. PWSSC – PWSSC Data Management Project ($50K to AOOS DM).– Project involves the creation of a prototype data management system for use by PWSSC staff to manage, track, document via metadata and visualize oceanographic and biological data being collected at the center. Project will utilize a stack of open source technologies and protocols with the overall goal of creating a packaged solution for research organizations to better manage and document their data resources. This project is to function as the pilot application for the AOOS project level data management system.
3. Northern Forum/USFWS Seabird Data System – ($50K)Project involves the creation and population of a series of new seabird metric databases (diet and productivity) and integrating these new databases with legacy seabird databases (species distribution and abundance at seabird colonies, pelagic species distribution and abundance, USGS seabird monitoring databases and NPRB's North Pacific Seabird Diet Database). Modern spatially explicit, web based data entry interfaces have and continue to be developed to assist researchers existing in distributed agencies to contribute their historic and current seabird metric data into standard data structures. Project will result in vastly increasing the amount and quality of seabird species distribution, diet and other seabird data available for use in retrospective analysis and management. Though data includes areas around all of Alaska, most available data is located in GOA and PWS.
4. AOOS – 3-year funded partnership (~$200K to ADF&G) with ADF&G Division of Commercial Fisheries to develop data sharing and transfer to make commercial fisheries data more accessible, and to allow ADF&G researchers greater access to oceanographic data. Project builds upon an effort funded by the Moore foundation to develop improved data management capacity and salmon fishery management tools for the PWS fisheries.
5. AOOS – collaborator with Alaska Data Integration Working Group – an initiative with the Alaska Climate Change Executive Roundtable – to develop protocols for serving up project data to increase data sharing among federal and state agencies.
6. AOOS and NOAA – initiatives to develop data sharing agreements with private sector, including oil & gas companies.

7. Cook Inlet Regional Citizens Advisory Council (27K) – contract with Axiom to develop a data management system for their oceanographic and contaminants data in Cook Inlet.

III. SCHEDULE

A. Project Milestones

Objective 1. Provide data management oversight and services for EVOS IHRP project team data centric activities which include data structure optimization, metadata generation, and transfer of data between project teams.

This objective will be addressed throughout the entire span of the project and will follow the annual cycle of field data collection and analysis by principal investigators. Investigators will be engaged before each field season to ensure that preparations have been made to stage data collected by the project so that other members of the IHRP project can access the data produced by project participants.

Objective 2. Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.

This objective will be met by the fourth quarter of year two of the effort (September 2013).

Objective 3. Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long term storage and public use.

This objective will be addressed throughout the entire span of the project. The AOOS data system is to serve as the vessel to capture all project level data produced through this effort in addition to those datasets salvaged to inform the historic synthesis effort. This task will be ongoing as long as the program is producing or acquiring additional data.

B. Measurable Project Tasks

FY12 1st Quarter (October 1, 11 to December 31, 11)

October	Project authorized by trustee council
October	Release AOOS Ocean Workbench (Project DM System)
November	Set up user profiles for PIs in Ocean Workbench
November	Initialize historic data salvage effort
December	Draft historic data set manifest

FY12 2nd Quarter

January	Annual Marine Science Symposium
January	Prioritize historic datasets for inclusion into synthesis effort
February	Adjust historic data aggregation effort and AOOS integration

FY12 3rd Quarter

April	Prepare for FY12 field season
May	Participate in annual PI meeting
June	Submit FY13 work plan for review

FY12 4th Quarter

August	Submit annual report

FY13 1st Quarter (October 1, 12 to December 31, 12)

October	Assess year 1 datasets and metadata submitted through Ocean Workbench

FY13 2nd Quarter

January	Annual Marine Science Symposium
January	Release updated Ocean Workbench tool

FY13 3rd Quarter

May	Participate annual PI meeting
June	Submit FY14 work plan for review
June	Complete integration of data salvaged into AOOS DM System

FY13 4th Quarter

August	Submit annual report
January	Annual Marine Science Symposium

FY14 1st Quarter (October 1, 13 to December 31, 13)

October	Assess year 2 datasets and metadata submitted through Ocean Workbench

FY14 2nd Quarter

January	Annual Marine Science Symposium
Winter	EVOS workshop with Herring and Long-term monitoring programs

FY14 3rd Quarter

May	Participate in annual PI meeting
June	Submit FY15 work plan for review

FY14 4th Quarter

August	Submit annual report

FY15 1st Quarter (October 1, 14 to December 31, 14)

October	Assess year 3 datasets and metadata submitted through Ocean Workbench

FY15 2nd Quarter

January	Annual Marine Science Symposium

FY15 3rd Quarter

May	Participate in annual PI meeting
May	Submit five-year plan for FY17-22 and work plan for FY16

FY15 4th Quarter

FY16 1st Quarter (October 1, 15 to December 31, 15)

October	Assess year 4 datasets and metadata submitted through Ocean Workbench

FY16 2nd Quarter

January	Annual Marine Science Symposium

FY16 3rd Quarter

June	Submit work plan for FY17

FY16 4th Quarter

August	Submit annual report

Table 1. Data type and current status of herring related survey data collected from Lower Cook Inlet, 1971-present.

Data Type	District	Years	Current Status	Comments
Herring School Observations	Kamishak	1978-present	ESRI .shp files with accompanying attribute tables (.dbf)	
(timing, location, est. biomass)	Southern	1978-present	Hard copy survey maps; Excel files w daily biomass est.	Handwritten biomass observations by bay
(from aerial/vessel surveys)	Outer/Eastern	1978-1992	Hard copy survey maps	Handwritten biomass observations by bay
Herring Spawn Observations	Kamishak	1978-present	ESRI .shp files with accompanying attribute tables (.dbf)	
(timing, location, magnitude)	Southern	1978-present	Hard copy survey maps	Very few spawning events documented
(from aerial/vessel surveys)	Outer/Eastern	1978-1992	Hard copy survey maps	Very few spawning events documented
Herring ASL Data	Kamishak	~1974-present	Hard copy data (74-87), ascii .txt (88-02), Excel (03-Present)	Continuous
(age, sex, length, weight)	Southern	~1973-present	Hard copy data (73-87), ascii .txt (88-02), Excel (03-Present)	Intermittent
	Outer/Eastern	~1971-1991	Hard copy data (71-87), ascii .txt (88-91)	Intermittent
Commercial Fishery Data	Kamishak	~1974-1998[1]	ADF&G Herring Fish Ticket Database (SQL)	Confidentiality rules apply when fewer than 4 permits fished
(commercial openings and	Southern	~1974-1989[1]	ADF&G Herring Fish Ticket Database (SQL)	Confidentiality rules apply when fewer than 4 permits fished
harvest by date and stat area)	Outer/Eastern	~1974-1987[1]	ADF&G Herring Fish Ticket Database (SQL)	Confidentiality rules apply when fewer than 4 permits fished
Marine Mammal Observations	Kamishak	1978-present	ESRI .shp files with accompanying attribute tables (.dbf)	
(timing, location, est. number)	Southern	1978-present	Hard copy survey maps	Very few marine mammal sightings documented
(from aerial/vessel surveys)	Outer/Eastern	1978-1992	Hard copy survey maps	Very few marine mammal sightings documented
Seabird Observations	Kamishak	1978-present	ESRI .shp files with accompanying attribute tables (.dbf)	
(timing, location, est. number)	Southern	1978-present	Hard copy survey maps	Very few seabird sightings documented
(from aerial/vessel surveys)	Outer/Eastern	1978-1992	Hard copy survey maps	Very few seabird sightings documented
Disease Data	Kamishak	2002-2007	.pdf files	Pathology reports
Management Boundaries	Kamishak	current	ESRI .shp files with accompanying attribute tables (.dbf)	Herring mgt areas, stat areas, aerial survey index areas, etc.
Photo Links	Kamishak	misc.	.tiff and .jpg images	Historical photos of fishery, vessels, landmarks, etc.
Water Temperature	Kamishak	1999-present	electronic files (Excel)	Thermographs deployed 2 m below surface at Nordyke I. and Iniskin Bay
Aerial Survey Trackline	Kamishak	1978-present	ESRI .shp files with accompanying attribute tables (.dbf)	generalized track line for standard survey flight
Vessel Survey Tracklines	Kamishak	1999-2007	ESRI .shp files with accompanying attribute tables (.dbf)	daily tracklines for chartered survey vessels collecting ASL samples
Misc. Fisheries Information	Lower Cook Inle	1973-present	Hard copy and electronic reports	AMR's, RIR's, Conference Proceedings, etc.

[1] *The Kamishak, Southern and Outer/Eastern district sac roe herring fisheries have been closed since 1998, 1989, and 1987, respectively.*

Table 2. Data type and current status of herring related survey data collected from the Kodiak district.

Data Type	Years	Current Status	Comments
Herring Spawn Maps	1977-1989	Hard copy	
Spawn Observations	1970's-present	Hard copy, various notes	
Herring ASL Data	~1967- present	1967-1984, hard copy	
		1985-present, database	
Shelikof Biomass Estimates	1986, 1989-1990	Digital hydroacoustic tapes, notes	
Aerial Surveys	~1970-present	Hard copy	Variable data through range of dates
Commercial Fishery Data	~1970-present	~1970-1984, hard copy	Daily harvest
		1985-present, digital	Daily harvest
Acoustic Survey (Research)	2002-present	Electronic (quantitative)	Excel
Acoustic Survey (Management)	~1985-present	Hard copy (qualitative)	Intermittent through range of dates
Disease Data	2007-present	Hard copy	
Marine Mammal Sightings	2002-present	Hard copy	
Misc. Field Notes	1960's-present	Hard copy	Various notes and years
Misc. Fisheries Data	1930's-present	Hard copy AMR's	

Table 3. Data type and current status of herring related survey data collected from the PWS district (ADF&G).

Data Type	Years	Current Status	Comments
Spawn Deposition Transects	1977-1989	Excel, GIS (5/15/2009)	
Egg Loss Transects	1970's-present	Excel	
Herring ASL Data	1969-2009	Visualizations Online/Data Ready	
Aerial Surveys Linear Spawn	1973-2006	Online now	
Aerial Surveys Linear Spawn	2007-2009	Ready	
Aerial Surveys Track Lines	1973-2007	Online now	
Aerial Surveys Track Lines	2008-2009	Ready	
Aerial Survey Biomass Estimates	1973-2007	Online now	
Aerial Survey Biomass Estimates	2007-2009	Ready	
Commercial Fisheries Data	~1973-present	Ready	Harvest, EO's, Effort
Acoustic Survey Tracks/Data	1997-2007	Electronic (quantitative)	Excel
Disease Data	2007-present	Hard copy	
Marine Mammal Sightings	2002-present	Hard copy	
Forecast Data	1993-2009	Ready	

Table 4. Data type and current status of herring related survey data collected from the PWS district (Science Center).

Data Type	Years	Source	Comments
Herring Acoustic Data	1993-2009	Dick Thorne	
Herring Nursery Bay Oceanographic	1995-1998	Shelton Gay	SEA Project
PWS Oceanography	1995-2009	Scott Pegau, Mark Halverson	
Zooplankton Abundance	2004-2009	Rob Campbell	
Herring Energetics	1995-1999, 2006-2009	Tom Kline	
Seabird Predation on Spawning Herring	1994-1996	Mary Anne Bishop	EVOS Project 95320Q
Seabird Predation in Herring Juvenile Bays	2006-2009	Mary Anne Bishop	
Herring Diet	1996-1997	Mary Anne Bishop	NVP Data EVOS Project 97025

BUDGET JUSTIFICATION: Fiscal Year: 2012

Personnel:
Funds are requested ($94.4K) to support a Senior Software Engineer (2 months), Software Engineer (1.5 months), Information Architect (1 month), and two data analysts (2 staff for a total of 7.5 months) in the AOOS data management unit. The software Engineers and Information Architect will supervise and direct data processing activities of the data analysts. These lead staff members will also assists in developing data management plans for projects and support the AOOS Ocean Workbench project level data management system. The data analysts will focus their activities on acquiring, accessing, documenting and loading data sets deemed important to the IHRP effort into the AOOS data system for use in synthesis efforts.

Equipment:
A disk array will be procured (3.9K) in FY12 to increase storage capacity of the AOOS data system.

Indirect:
AOOS's indirect Rate is 23% (21.7 K) and has been figured into the AOOS budget. This covers expenses for software, telecommunications and other operating expenses.

BUDGET JUSTIFICATION: Fiscal Year: 2013

Personnel:
Funds are requested ($93.7K) to support a Senior Software Engineer (1.5 months), Information Architect (1 month), software engineer (3 months) and data analyst (6 months) in the AOOS data management unit. The Senior Software Engineer and Information Architect will supervise and direct data processing activities of the data analysts and data system development of the software engineer. These lead staff members will also assists in developing data management plans for projects. The data analyst will focus activities on acquiring, accessing, documenting and loading data sets deemed important to the IHRP effort into the AOOS data system for use in synthesis. The software engineer will work developing web based pathways (extend the AOOS Ocean Workspace) for data sharing, discovery and visualization by researchers and others.

Equipment:
A disk array will be procured (3.9K) in FY12 to increase storage capacity of the AOOS data system.

Indirect:
AOOS's indirect Rate is 23% (21.7 K) and has been figured into the AOOS budget. This covers expenses for software, telecommunications and other operating expenses.

BUDGET JUSTIFICATION: Fiscal Year: 2014

Personnel:
Funds are requested ($16.7) to support a Senior Software Engineer (0.5 month) and a Data Analyst (1.5 months) in the AOOS data management unit. The Software Engineer and data analyst will work with PIs to develop and implement data management plans and load data sets into the AOOS data system.

Indirect:

AOOS's indirect Rate is 23% (3.8 K) and has been figured into the AOOS budget. This covers expenses for software, telecommunications and other operating expenses.

BUDGET JUSTIFICATION: Fiscal Year: 2015

Personnel:
Funds are requested ($17.3) to support a Senior Software Engineer (0.5 month) and a Data Analyst (1.5 months) in the AOOS data management unit. The Software Engineer and data analyst will work with PIs to develop and implement data management plans and load data sets into the AOOS data system.

Indirect:
AOOS's indirect Rate is 23% (4.0 K) and has been figured into the AOOS budget. This covers expenses for software, telecommunications and other operating expenses.

BUDGET JUSTIFICATION: Fiscal Year: 2016

Personnel:
Funds are requested ($17.9) to support a Senior Software Engineer (0.5 month) and a Data Analyst (1.5 months) in the AOOS data management unit. The Software Engineer and data analyst will work with PIs to develop and implement data management plans and load data sets into the AOOS data system.

Indirect:
AOOS's indirect Rate is 23% (4.1 K) and has been figured into the AOOS budget. This covers expenses for software, telecommunications and other operating expenses.

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: **Non lethal sampling: In situ estimation of juvenile herring sizes**

Project Period: October 2014-September 2015

Primary Investigator(s): Kevin M. Boswell; Louisiana State University, Baton Rouge, LA, 70803

Study Location: Prince William Sound

Abstract: A common source of bias in acoustic surveys is proper partitioning of size classes and their respective contribution to biomass estimates (see Simmonds and MacLennan 2005). This is particularly evident when considering the probability of encountering multiple size classes (or age classes) within a given survey region, or even within a large school. Several approaches have been successful in estimating *in situ* size distributions, though many require appropriate light fields to determine target sizes (Foote and Traynor 1988; Gauthier and Rose 2001; Kloser and Horne 2003). Recent application of imaging sonars have proven useful for acquiring high-resolution measurements of target-length distribution, without the need for ambient or external light sources, thereby reducing the potential of behaviorally mediated bias in length estimation. Further, automated analysis software has been refined to rapidly provide length estimates and target tracking parameters, even for tightly schooling fishes.

Estimated Budget:
EVOSTC Funding Requested:
(breakdown by fiscal year and must include 9% GA)
$94,900
Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date:
5/23/2011

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PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

A common source of bias in acoustic surveys is proper partitioning of size classes and their respective contribution to biomass estimates (see Simmonds and MacLennan 2005). This is particularly evident when considering the probability of encountering multiple size classes (or age classes) within a given survey region, or even within a large school. Several approaches have been successful in estimating *in situ* size distributions, though many require appropriate light fields to determine target sizes (Foote and Traynor 1988; Gauthier and Rose 2001; Kloser and Horne 2003). Recent application of imaging sonars have proven useful for acquiring high-resolution measurements of target-length distribution, without the need for ambient or external light sources, thereby reducing the potential of behaviorally mediated bias in length estimation. Further, automated analysis software has been refined to rapidly provide length estimates and target tracking parameters, even for tightly schooling fishes.

Recent work by Boswell and others in Southeast Alaska (Lynn Canal) has resulted in the development and successful integration of an imaging sonar and fishery echosounder system to directly compare estimates of biomass derived from traditional echo integration techniques. These traditional measures have been adopted and continue to be used as the baseline for estimating fish biomass, though have no real capacity for determining fish length distributions and their contribution to estimated biomass of PWS herring, as is the need for this research effort. A compelling result from the work conducted in Lynn Canal (Boswell et al., unpub.) was the large variability in estimated biomass from the traditional echo integration techniques as compared to the more direct approach with the imaging sonar. Interestingly, M. Jech (NOAA NEFSC) independently observed the same result with respect to variability in biomass estimates from echo integration and imaging sonar observations from Atlantic herring. Thus in addition to achieving in situ size estimates from the imaging sonar, the simultaneous integration of both sonar systems may enhance resolution of herring biomass estimates as well.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

By applying non-lethal approaches with under water remote sensing technologies, we are adhering to the principles set forth in the 1994 Restoration Plan. This project will evaluate the potential to apply advanced technologies to estimate the abundance and length distributions of herring in concert with direct collection methods.

II. PROJECT DESIGN

A. Objectives

Objective 1- Apply non-invasive techniques to estimate the *in situ* distribution (size, abundance, behavior, orientation) of herring.

Objective 2- Directly compare the abundance, size, and density estimates of herring derived from direct capture methods, fisheries echosounder data and *in situ* measurements.

Objective 3- Use data from in situ methods to evaluate biases with direct collection methods and estimates of abundance derived from traditional fisheries echosounder data.

Given that the condition of the herring population is of great concern the ability to estimate the in situ abundance, density and length distributions of herring is paramount. Moreover, by developing a method to acquire these metrics in a non-invasive manner, we will be better able to interpret the fisheries acoustic data collected and move beyond relying on intensive direct capture techniques.

B. Procedural and Scientific Methods

A multibeam imaging sonar and an ROV will be used to derive in situ estimates of herring size, abundance, behavior, and orientation to compare with direct capture methods and traditional fisheries echosounder data. We propose to augment surveys using traditional fisheries echosounder equipment (e.g., Simrad Ek60 Split-beam 38 and 120 kHz), with a vane or ROV deployment approach (see Figure 1) to opportunistically acquire both in situ length and density estimates, while simultaneously validating species composition (ROV). The imaging sonar (DIDSON or ARIS; www.soundmetrics.com) has a down-range resolution of <1cm, depending on range, offering the ability to discriminate among size classes in real time and will serve to quantify differences in length-frequencies among seasons and bay systems. This high-resolution sonar can be mounted onto a vane and deployed at depth or integrated into a towable-ROV designed by Boswell and Seamor Marine with 1200ft fiber optic tether, capable of towing at depth up to 5kts (Figure 1). Depending on vessel capabilities, size and power options, either the vane deployment method or ROV can be utilized. As illustrated in Figure 1, a transducer can be attached to the vane to allow for in situ measures of target strength to compliment echo integration techniques and density estimation; this is not unlike the work previously conducted by Thomas and Thorne in concept. However, in contrast to their work, we would integrate the more contemporary technology by making use of the position and compensation methods offered with split-beam transducers. Ultimately, this would provide an in situ estimate of fish length (via imaging sonar) and target strength (via echosounder) to derive two independent indices of herring size and abundance, while also acquiring information about in situ behavior which can greatly influence acoustic estimates of fish biomass from traditional echo integration techniques.

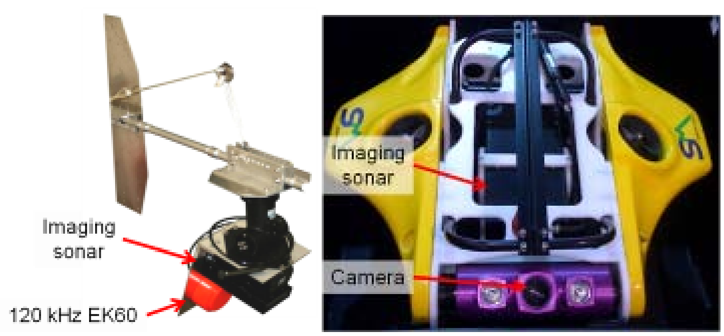

Figure 1. Deployment options for acquiring in situ estimates of fish length distribution. Left-Remotely controlled vane, comprising of two sonar systems, an imaging sonar (black) and traditional fisheries echosounder (orange) to be deployed at depth into herring schools for *in situ*

size and density estimation. Right- ROV with fully articulating camera and imaging sonar, configured to share the same view, both can look forward and completely pan to -90 degrees, simultaneously viewing the same mass of water. The ROV was developed by Boswell and Seamor Marine specifically to integrate the imaging sonar into a towable body to track herring schools at depth in Lynn Canal.

I

C. Data Analysis and Statistical Methods

Acoustic data will be processed in both Echoview and Matlab (Boswell et al. 2008; Handegard and Williams 2008), for which algorithms have previously been developed for target identification, tracking, enumeration, and biomass estimation. Length frequency distributions derived from the sonar systems will be compared from direct collection methods (e.g., seines, gill nets, trawls) and offer insight into potential biases among different gear types used to target herring. Additionally, estimates of density and abundance derived form in situ methods will be compared with those derived by both direct capture and fisheries echosounder techniques. Specifically, the metrics derived from the imaging sonar (length, abundance, density) will be compared with the echointegrated estimate of density and abundance indices derived from the fisheries echosounder and direct capture methods, respectively. In addition, length-frequency estimates will be derived from all techniques and the distributions will be compared to identify potential sampling biases among gear types. Finally, these distributions will be available for use as a complimentary tool to enhance current modeling and assessment methods implemented by the ADFG for estimating spawning biomass, juvenile survivorship, and potentially even emigration from coastal bays.

The primary product will be to ground-truth juvenile herring length distributions in the core bays sampled in the monitoring program using a high-resolution imaging sonar. Thus, *in situ* target-length (imaging sonar) and target strength (echo-sounder) distributions will be derived. We will estimate proportional biomass contributions of herring size classes based on *in situ* length and abundance distributions. Additionally, we will evaluate size-based bias in collection methods (e.g., gill nets, trawls, seines, etc.) and extending those biases within the context of population level biomass estimates. An important, yet indirect product will be the estimation of herring sizes targeted by humpback whales during cruises with J. Moran (similar to previous work in Lynn Canal).

Following each survey, data will be assimilated and processed to derive aforementioned metrics and facilitate comparisons among gear types. Results and analyses will be provided to PWSSC researchers for integration into analysis and modeling components and to meet reporting requirements.

D. Description of Study Area

As this is a complimentary component to other proposed projects (listed below), the time frame for this proposed work will be dependent upon the finalized sampling program schedule developed throughout the first few fiscal years.

Juvenile Herring Abundance Index
Expanded Adult Herring Surveys

Acoustic Consistency: Intensive Surveys of Juvenile Herring
Use of concurrent trawls to validate acoustic surveys for Pacific Herring

E. Coordination and Collaboration with Other Efforts
This component will collaboratively and opportunistically compliment work of other investigators (e.g., MA Bishop, R Thorne, M. Buckhorn, J. Moran) involved by providing estimates of juvenile herring size distributions for which several other projects are dependent, and by making more efficient use of ship time and adding new observations at various spatial and temporal resolutions (e.g. seasonal estimates of herring size, behavior in response to predation, variability among different bays). Further, we will be able to address other relevant process-related questions using this approach (e.g., predation or mortality rates imposed by humpback whales).

III. SCHEDULE
A. Project Milestones

Objective 1. Apply non-invasive techniques to estimate the *in situ* distribution (size, abundance, behavior, orientation) of herring.
Data collection and analysis will be completed by January 2015

Objective 2- Directly compare the abundance, size, and density estimates of herring derived from direct capture methods, fisheries echosounder data and *in situ* measurements.
Statistical analyses completed by March 2015

Objective 3- Use data from *in situ* methods to evaluate biases with direct collection methods and estimates of abundance derived from traditional fisheries echosounder data.
To be completed by June 2015

B. Measurable Project Tasks

FFY 14, 1st quarter (October 1, 2014-December 31, 2014)
November 15: *Final collection and begin analysis for Objective 1*

FFY 14, 2nd quarter (January 1, 2015-March 31, 2015)
January 18: *Annual Marine Science Symposium*
March 31: *Completion of analyses of Objective 2*

FFY 14, 3rd quarter (April 1, 2015-June 30, 2015)
June 30: *Complete analyses for Objective 3*

FFY 14, 4rd quarter (July 1, 2015-September 30, 2015)
August 1 *Submit final report. This will consist of a draft manuscript for publication to the Trustee Council Office.*

Budget Justification- FY14

Salaries and Wages: Approximately 3 months of salary (at $8333 per month) are requested for PI Boswell who will oversee all components of the Non-lethal Herring evaluation study to include actively participating in field surveys, PI meetings, the Alaska Marine Science Symposium (AMSS) and all analyses, reporting and manuscript preparation. In addition, funds are requested for an undergraduate student worker (approximately 6 months, at $866.67 per month) whose responsibilities will be to participate in field work, data processing and report/manuscript preparation. Fringe Benefits: Fringe rates are included in the budget sheet and are applied to salaries at 31.88% for PI Boswell and 0.0033% for the participating undergraduate student.

Domestic Travel: Funds are requested to travel to participate in the PI meeting during FY14, the AMSS and three field surveys. Funds are requested for travel for both PI Boswell (all activities) and an undergraduate student (field work only). Travel expenses are estimated and include airfare, lodging and per diem during travel periods.

Contractual Costs: Funds are requested for ship time charter support during field surveys in Prince William Sound and will serve to extend the cruises for which the Non-lethal Herring Evaluation study will participate ($7,000).

Commodities Costs: Funds for three categories of commodities costs are requested to support both field collection and data processing needs and include: 1) expendable supplies for field deployments; cable material for data transfer between sonar, motor and computer; and material costs for designing and fabricating device to mounting and deploying DIDSON and motor assembly at depth; 2) office supplies, printing costs and data archiving devices; 3) shipping costs for equipment transport and insurance for 3 trips during FY 14.

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: PWS Herring Research and Monitoring: Expanded Adult Herring Surveys

Project Period: October 1, 2011 – September 30, 2016

Primary Investigator(s): Michele Buckhorn, PhD; Richard Thorne, PhD; Prince William Sound Science Center, Cordova, AK

Study Location: Prince William Sound, AK

Abstract: Prince William Sound herring stock biomass estimates from hydroacoustic surveys provide a direct measure of the stock abundance and are also a primary input into the age-structured assessment (ASA) model that is the forecasting tool used for managment. Prior to 2001, the hydroacoustic surveys were conducted exclusively by the Prince William Sound Science Center (PWSSC). Since 2001, the effort has been shared between PWSSC and the Cordova office of Alaska Department of Fish and Game (ADF&G). While the ADF&G considers the hydroacoustic surveys to be critical (Steve Moffitt, personal communication) the lack of a commercial herring fishery in PWS since 1998 has reduced management priorities for herring. Thus the PWSSC contribution has become critically important for the long-term, especially if a future fishery appears only a remote possibility. With the level of effort available over the past several years, PWSSC and ADF&G individually have achieved herring biomass estimates with a precision of about ±30%, which is insufficient for management purposes. However, the combined effort currently meets management requirements for precision. Current stock assessment efforts by ADF&G resource managers in PWS focus on the largest spawning aggregations. The objective of this study is to increase the current survey area of adult spawning beyond the Port Gravina and Fidalgo areas to provide a more precise estimate of spawning biomass. We propose to extend the PWSSC acoustic surveys to help identify the relative contributions of additional spawning aggregations over temporal and spatial scales. This will help establish more accurate estimates of the total herring biomass in PWS and provide an alert to changes in biomass in different regions. Beginning in FY2013 and continuing until 2016, hydroacoustic surveys will be conducted in late spring (April-May) to assess adult spawning biomass. ADF&G will continue to conduct direct sampling for age/length/weight. Additional direct capture will be conducted using a midwater trawl at adult spawning sites (See Bishop proposal).

Estimated Budget:
EVOSTC Funding Requested: $335.9
(breakdown by fiscal year and must include 9% GA))

FY 12	FY 13	FY 14	FY 15	FY 16
$6,500	$84,400	$68,100	$90,600	$84,400

Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date: 5/19/2011

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PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here are projects for a program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

The current management of the Prince William Sound (PWS) herring stock by the Alaska Department of Fish and Game (ADF&G) depends heavily on hydroacoustic surveys. Biomass estimates from these surveys provide a direct measure of the stock abundance and are also a primary input into the age-structured assessment (ASA) model that is the primary forecasting tool. The hydroacoustic surveys were initiated in 1993 when fishers were unable to locate concentrations of herring despite a forecast for high abundance. The high forecast was based on an ASA model that relied on age-structure information alone. The hydroacoustic survey revealed that the population had collapsed. March 2011 will mark the 19th consecutive annual survey using hydroacoustic surveys. Over this time period the hydroacoustic survey has shown to be an early and accurate measure of the herring stock abundance and compares well with the recent ASA model estimates that now incorporate hydroacoustic survey information as well as an index of male spawning abundance.

Prior to 2001, the hydroacoustic surveys were conducted exclusively by the Prince William Sound Science Center (PWSSC). Since 2001, the effort has been shared between PWSSC and the Cordova office of Alaska Department of Fish and Game. Over the past 3 years, the PWSSC effort has been supported by EVOS TC. The cooperative effort has been critical since both PWSSC and ADF&G have limited resources for this effort. While ADF&G considers the hydroacoustic surveys to be critical (Steve Moffitt, personal communication) the lack of a commercial herring fishery in PWS since 1998 has reduced management priorities for herring during a time of overall limited funding for the state agency. Thus the PWSSC contribution has become critically important for the long-term, especially if a future fishery appears only a remote possibility.

With the level of effort available over the past several years, PWSSC has achieved herring biomass estimates with a precision of about ±30%. This level of precision is insufficient for management purposes. The level of effort available to ADF&G is similarly insufficient. However, the combined effort currently meets management requirements for precision. There is concern that some concentrations of fish are not located and surveyed under current levels, in which case the estimate is biased, a factor not incorporated into variance calculations for precision.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

II. PROJECT DESIGN

A. Objectives

Program objectives:

We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

Project Objective #1:
This project will address Program Objective #1 - *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The objective of this study is to increase the current survey area of adult spawning beyond the Port Gravina and Fidalgo areas to provide a more precise estimate of spawning biomass.

B. Procedural and Scientific Methods

Current stock assessment efforts by ADF&G resource managers in PWS focus on the largest spawning aggregations. Additional spawning aggregations exist, but are not regularly surveyed by ADF&G because of funding and personnel limitations; therefore, their relative contributions to the biomass of the PWS metapopulation remain poorly understood. The Prince William Sound Science Center (PWSSC) has also conducted acoustic biomass surveys for the past two decades. We propose to extend the PWSSC acoustic surveys to help identify the relative contributions of these additional spawning aggregations over temporal and spatial scales. This will help establish more accurate estimates of the total herring biomass in PWS and provide an alert to changes in biomass in different regions. The PWSSC survey will overlap with the ADF&G survey to provide a comparative measure between the two studies and to improve the precision of the estimate.

In this proposal for expanded adult herring surveys, we propose an effort level that will meet management needs for precision when combined with the ADF&G effort, and will also reduce current levels of uncertainty with regard to adequate geographic coverage. Beginning in FY2013 and continuing until 2016, hydroacoustic surveys will be conducted in late spring (April-May) to assess adult spawning biomass. Based on an exhaustive review of historic survey coverage, we have determined the effort required to be eight days of vessel survey for PWSSC in addition to that available to ADF&G. ADF&G will continue to conduct direct sampling for age/length/weight, primarily with a 17 FA purse seine, including concentrations located by the PWSSC effort. PWSSC effort will emphasize search for and surveys of concentrations outside the Port Gravina/Port Fidalgo area where the herring have been concentrated during the past several years. Direct capture will be conducted using a midwater trawl at adult spawning sites (See Bishop proposal). As has been the case previously, the search effort will utilize all information available including historical records of sighting of both adults and spawn, reports of marine mammal/bird concentrations and some aerial survey effort as well as high speed vessel surveys.

C. Data Analysis and Statistical Methods

There are well-developed protocols for hydroacoustic data analysis. Basic analysis is done using echo integration techniques (Thorne 1983a,b; McLennon and Simmonds 1992). We will be using to ECHOVIEW post processing software for the echo integration and analysis. Specific analysis of schools or layers requires a bounding process to limit analysis to a specific school or layer (Fig 8). Target strength characteristics of herring as well as several other common fishes are well documented (Thorne 1983b; Traynor 1998; Thomas et al. 2002). The acoustic analysis determines the biomass density of the fish. The biomass estimates use scaling factors that are size and species specific, but are relatively insensitive to these variables (Thorne 1983b). These densities are extrapolated to the appropriate area based on the GPS information that is automatically written to the acoustic data files. Conversion of biomass to numerical values is more sensitive to species/size information. For adults and age 0 herring this information is typically available. Some assumptions are required for other species and these assumptions are dependent on the direct capture information.

D. Description of Study Area

This project will take place in the northeastern region of Prince William Sound (60.841056, -146.128239, 60.864482, -147.345965, 60.622618, -147.382919, 60.609086, -146.018257).

E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

III. SCHEDULE

A. Project Milestones

Project Objective #1: to increase the current survey area of adult spawning beyond the Port Gravina and Fidalgo areas to provide a more precise estimate of spawning biomass.

Surveys to be met by May of each year 2013-2016

Analysis of each year's survey to be met by October of each year 2013-2016

B. Measurable Project Tasks

FY12 1st Quarter (October 1, 11 to December 31, 11)

October	Begin funding

FY12 2nd Quarter

January	Annual Marine Science Symposium

March	Complete ordering equipment

FY12 3rd Quarter
May	Annual PI meeting

FY12 4th Quarter
August	Submit annual report

FY13 1st Quarter (October 1, 12 to December 31, 12)

FY13 2nd Quarter
January	Annual Marine Science Symposium

FY13 3rd Quarter
May	Conduct annual PI meeting
June	Submit FY14 work plan for review
FY13 4th Quarter
August	Submit annual report
September	Complete fatty acid analysis, complete scale analysis

FY14 1st Quarter (October 1, 13 to December 31, 13)

FY14 2nd Quarter
January	Annual Marine Science Symposium
Winter	EVOS sponsored workshop with Herring and Long-term monitoring programs

FY14 3rd Quarter
April	Conduct extended adult biomass cruise, collect samples for genetics
May	Conduct annual PI meeting
June	Submit FY15 work plan for review

FY14 4th Quarter
August	Submit annual report

FY15 1st Quarter (October 1, 14 to December 31, 14)
October	Complete adult survey analysis

FY15 2nd Quarter
January	Annual Marine Science Symposium

FY15 3rd Quarter
April	Conduct extended adult biomass cruise
May	Conduct annual PI meeting

FY15 4th Quarter

August	Submit annual report

FY16 1st Quarter (October 1, 15 to December 31, 15)

October	Complete adult survery analysis

FY16 2nd Quarter

January	Annual Marine Science Symposium

FY16 3rd Quarter

April	Conduct extended adult biomass cruise
May	Conduct annual PI meeting
June	Submit work plan for FY17

FY16 4th Quarter

August	Submit annual report

PWS Herring Research and Monitoring: Expanded Adult Surveys
PRINCE WILLIAM SOUND SCIENCE CENTER

Personnel
All salaries for this project begin in FY13. Three months' salary is requested in each year (FY13-FY16) for Dr. Buckhorn to act as lead Principle Investigator. Dr. Buckhorn will oversee the project and coordinate with the other projects in this program. She will have primary responsibility for project design, field work, data collection, analysis and completion of final products. She will supervise the acoustics technician.
Three months' salary is requested in each year (FY13-16) for James Thorne, the acoustics technician. He will assist with data collection and is responsible for maintenance of acoustic equipment.
One-third month salary is requested in each year (FY13-16) for Dr. Thorne. He will provide technical consulting and support.

Travel
In each year travel is requested for Dr. Buckhorn for the attendance of two scientific conferences; AMSS and one of the following appropriate associations: American Fisheries Society, American Society of Ichthyologists and Herpetologists, Western Society of Naturalists.

Contractual
Each year funds are requested for Information Technology, which includes $100/person month for network connections and costs associated with software license renewals or purchases. Funds are requested each year for printing/mailing/copying. The request is based on historic and anticipated usage. Funds are also requested each year for communications, which includes $50/person month for phone, plus additional funds for long distance and fax costs.

Commodities
In each year funds are requested for office supplies (paper, pens, printers, etc.) that are typically consumed in association with the project. Additional funds are requested for miscellaneous cruise supplies (lines, nets, totes, etc.).

Equipment
Funds are requested in year one towards the purchase of a net sounder and catch monitor to monitor net depth and catch in the trawl that will be used for validation. This equipment will allow us to know where the net is sampling in relation to the acoustic data and to ensure we stay well within ADF&G permit limits. This cost is split with Bishop.

INDIRECT COSTS
The PWSSC indirect rate is estimated at 30% based on our currently negotiated rate.

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: **PWS Herring Research and Monitoring: Juvenile Herring Abundance Index**

Project Period: October 1, 2011 – September 30, 2016

Primary Investigator(s): Michele Buckhorn, PhD (Lead PI)
Richard Thorne, PhD (co-PI); Prince William Sound Science Center, Cordova, AK

Study Location: Prince William Sound, AK

Abstract: Management of the Pacific herring stock in Prince William Sound (PWS), Alaska, is based primarily on an age-structured-assessment (ASA) model. The current model, developed in 2005, incorporates both hydroacoustic estimates of the adult herring biomass and an index of the male spawning, called the "mile-days of spawn". Unfortunately, the forecast is based on measurements from the previous year and does not have a direct measure of future age 3 recruitment. Current knowledge suggests that most mortality occurs during the first winter of life, so the relative recruitment may be fixed by the end of the first year. Consequently, estimates of relative abundance of age 1 and age 2 fish should provide an index of future recruitment. An index of age 0 fish would also provide a forecast of recruitment if additional information were available on the magnitude of the first year mortality. We will conduct annual fall surveys (FY2013-2016) of 8 bays; four of which will be the Sound Ecosystem Assessment (SEA) bays (Cooney et al. 2001). This will maintain a continual database from these locations. The other 4 bays will be selected based upon the survey results of the current EVOSTC FY10 Herring Survey Project (# 10100132). Surveys will be conducted using 120 kHz split-beam hydroacoustic unit in a stratified systematic survey design (Adams et al. 2006). For this study, direct capture will be directed to size and species composition. A midwater trawl will be used to sample randomized transects within each strata.

Estimated Budget:
EVOSTC Funding Requested: 404.1
(breakdown by fiscal year and must include 9% GA)

FY 12	FY 13	FY 14	FY 15	FY 16
$90,100	$80,100	$66,100	$84,900	82,900

Non-EVOSTC Funds to be used: 0
(breakdown by fiscal year)

Date:

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Management of the Pacific herring stock in Prince William Sound (PWS), Alaska, is based primarily on an age-structured-assessment (ASA) model. The current model, developed in 2005, incorporates both hydroacoustic estimates of the adult herring biomass and an index of the male spawning, called the "mile-days of spawn". Evidence suggests that the current model performs adequately. Unfortunately, the forecast is based on measurements from the previous year and does not have a direct measure of future recruitment. Since herring are a relatively short-lived fish, this uncertain recruitment can be a substantial component of the forecast abundance.

Herring recruit primarily as age 3. Current knowledge suggests that most mortality occurs during the first winter of life, so the relative recruitment may be fixed by the end of the first year. Consequently, estimates of relative abundance of age 1 and age 2 fish should provide an index of future recruitment. An index of age 0 fish would also provide a forecast of recruitment if additional information were available on the magnitude of the first year mortality.

Hydroacoustic surveys of juvenile herring abundance have been conducted over the past 4 years. These surveys have been conducted in both fall and late winter. The focus has been on age 0 herring, driven by interest in the extent of the critical first overwinter mortality, and has included energetics and disease research as well as research on sources of predation mortality

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

II. PROJECT DESIGN

A. Objectives

Program objectives:

We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

This project will contribute to Program Objective #1: *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.*

Project Objectives:

1. Conduct annual surveys of juvenile herring to create an index of future recruitment
2. Validate species and size composition of fish ensonified during acoustic transects (See Bishop proposal).

B. Procedural and Scientific Methods

Objective 1: Conduct annual surveys of juvenile herring to create an index of future recruitment

We will conduct annual fall surveys (FY2013-2016) of 8 bays; four of which will be the Sound Ecosystem Assessment (SEA) bays (Cooney et al. 2001). This will maintain a continual database from these locations. The other 4 bays will be selected based upon the survey results of the current EVOSTC FY10 Herring Survey Project (# 10100132).

Surveys will be conducted using 120 kHz split-beam hydroacoustic unit in a stratified systematic survey design (Adams et al. 2006). Bays will be stratified as MOUTH, MIDDLE, and HEAD. The areal extent of each strata will be based upon the variance of mean densities from previous surveys in order to reduce overall variance in abundance estimates (Simmonds et al. 1992, Adams et al. 2006).

Objective 2: Validate species and size composition of fish ensonified during acoustic transects (See Bishop proposal).

Historically, direct capture has been oriented to maximize age 0 captures in support of disease and energetics research. For this study, direct capture will be directed to size and species composition. Gill nets have been only been moderately effective in catching juvenile herring during previous surveys and tend to select for faster moving fishes (Thorne et al. 1983, McClatchie et al. 2000). A midwater trawl will be used to sample randomized transects within each strata (See Bishop, this proposal).

We propose to sample during fall rather than spring despite uncertainty about overwinter mortality. Previous experience suggests that the fall period provides better assessment conditions: less ice coverage and better weather. It is anticipated that the results of previous research will allow overwinter mortality to be factored into the juvenile index.

C. Data Analysis and Statistical Methods

There are well-developed protocols for hydroacoustic data analysis. Basic analysis is done using echo integration techniques (Thorne 1983a,b; McLennon and Simmonds 1992). We will be using to ECHOVIEW post processing software for the echo integration and analysis. Specific analysis of schools or layers requires a bounding process to limit analysis to a specific school or layer (Fig 8). Target strength characteristics of herring as well as several other common fishes are well documented (Thorne 1983b; Traynor 1998; Thomas et al. 2002). The acoustic analysis determines the biomass density of the fish. The biomass estimates use scaling factors that are size and species specific, but are relatively insensitive to these variables (Thorne 1983b). These densities are extrapolated to the appropriate area based on the GPS information that is automatically written to the acoustic data files. Conversion of biomass to numerical values is more sensitive to species/size information. For adults and age 0 herring this information is typically available. Some assumptions are required for other species and these assumptions are dependent on the direct capture information.

D. Description of Study Area

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

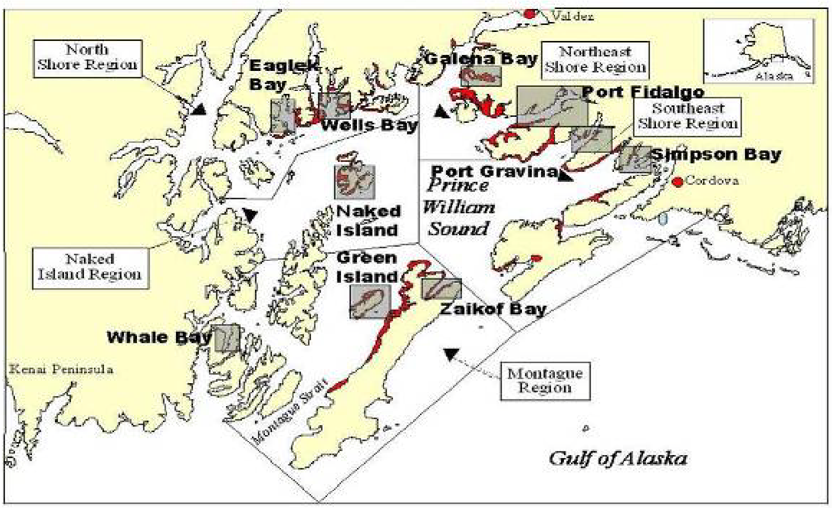

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

III. SCHEDULE

A. Project Milestones

Objective 1: Conduct annual surveys of juvenile herring to create an index of future recruitment. *Will be conducted every November FY2013-2016.*

Objective 2: Validate species and size composition of fish ensonified during acoustic transects (See Bishop proposal). *Will be conducted every November FY2013-2016.*

B. Measurable Project Tasks

FY12 1st Quarter (October 1, 11 to December 31, 11)
October Begin funding

FY12 2nd Quarter
January Annual Marine Science Symposium
March Complete ordering equipment

FY12 3rd Quarter
May Conduct annual PI meeting
June Submit FY13 work plan for review

FY12 4th Quarter
August Submit annual report

FY13 1st Quarter (October 1, 12 to December 31, 12)
November Conduct juvenile index survey

FY13 2nd Quarter
January Annual Marine Science Symposium

FY13 3rd Quarter
May Conduct annual PI meeting

FY13 4th Quarter
August Submit annual report
FY14 1st Quarter (October 1, 13 to December 31, 13)
November Conduct juvenile index survey, test non-lethal sampling systems

FY14 2nd Quarter
January Annual Marine Science Symposium
Winter EVOS sponsored workshop with Herring and Long-term monitoring programs

FY14 3rd Quarter
May Conduct annual PI meeting
June Submit FY15 work plan for review

FY14 4th Quarter
August Submit annual report

FY15 1st Quarter (October 1, 14 to December 31, 14)
November Conduct juvenile index survey

FY15 2nd Quarter
January Annual Marine Science Symposium

FY15 3rd Quarter

May	Conduct annual PI meeting
May	Submit five-year plan for FY17-22 and work plan for FY16

FY15 4th Quarter

August	Submit annual report

FY16 1st Quarter (October 1, 15 to December 31, 15)

November	Conduct juvenile index survey

FY16 2nd Quarter

January	Annual Marine Science Symposium

FY16 3rd Quarter

May	Conduct annual PI meeting
June	Submit work plan for FY17

FY16 4th Quarter

August	Submit annual report

Literature Cited.

Adams, J. V., R. L. Argyle, G. W. Fleischer, G. L. Curtis, and R. G. Stickel. 2006. Improving the design of acoustic and midwater trawl surveys through stratification, with an application to lake Michigan prey fishes. North American Journal of Fisheries Management **26**:612-621.

Cooney, R. T., J. R. Allen, M. A. Bishop, D. L. Eslinger, T. Kline, B. L. Norcross, C. P. McRoy, J. Milton, J. Olsen, V. Patrick, A. J. Paul, D. Salmon, D. Scheel, G. L. Thomas, S. L. Vaughan, and T. M. Willette. 2001. Ecosystem control of pink salmon (Oncorhynchus gorbuscha) and Pacific herring (Clupea pallasi) populations in Prince William Sound, Alaska. Fisheries Oceanography **10**:1-13.

McClatchie, S., R. E. Thorne, P. Grimes, and S. Hanchet. 2000. Ground truth and target identification for fisheries acoustics. Fisheries Research **47**:173-191.

Simmonds, E. J., N. J. Williamson, F. Gerlotto, and A. Aglen. 1992. Acoustic Survey design and analysis procedure: a comprehensive review of current practice., ICES, Copenhagen, Denmark.

Thorne, R. E., R. J. Trumble, N. A. Lemberg, and D. Blankenbeckler. 1983. Hydroacoustic assessment and management of herring fisheries in Washington and southeastern Alaska. FAO, Rome Italy.

PWS Herring Research and Monitoring: Juvenile Herring Abundance Index
PRINCE WILLIAM SOUND SCIENCE CENTER

Personnel
Two months' salary is requested in year one and three months in subsequent years for Dr. Buckhorn to act as lead Principle Investigator. Dr. Buckhorn will oversee the project and coordinate with the other projects in this program. She will have primary responsibility for project design, field work, data collection, analysis and completion of final products. She will supervise the acoustics technician.
Beginning in FY13, three months' salary is requested in year two, 2 months in year three, three months in year four and five for James Thorne, the acoustics technician. He will assist with data collection and is responsible for maintenance of acoustic equipment.
One-third month salary is requested in each year for Dr. Thorne. He will provide technical consulting and support.

Travel
Beginning in FY13 travel is requested each year for Dr. Thorne to travel from Seattle to Cordova and for the attendance at AMSS.

Contractual
Each year funds are requested for Information Technology, which includes $100/person month for network connections and costs associated with software license renewals or purchases. Funds are requested each year for printing/mailing/copying. The request is based on historic and anticipated usage. Funds are also requested each year for communications, which includes $50/person month for phone, plus additional funds for long distance and fax costs.

Commodities
In each year funds are requested for office supplies (paper, pens, printers, etc.) that are typically consumed in association with the project. Additional funds are requested for miscellaneous cruise supplies (lines, nets, totes, etc.).

Equipment
Funds are requested in year one to purchase a 120 kHz split-beam hydroacoustic unit. The Science Center currently has 70 khz single beam transducers. This is an opportunity to upgrade this equipment to a higher frequency split-beam which more accurately measures target strength, especially for smaller size fish species.

INDIRECT COSTS
The PWSSC indirect rate is estimated at 30% based on our currently negotiated rate.

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: **PWS Herring Research and Monitoring: Intensive surveys of juvenile herring**

Project Period: October 1, 2011 – September 30, 2016

Primary Investigator(s): Michele Buckhorn, PhD (Lead PI)
Richard Thorne, PhD (co-PI); Prince William Sound Science Center, Cordova, AK

Study Location: Prince William Sound, AK

Abstract: Hydroacoustic surveys of juvenile herring nursery areas in Prince William Sound have been conducted during fall and late-winter for the last several years. The number of locations surveyed have varied from 5-9, including the 4 Sound Ecosystem Assessment (SEA) bays. However, each seasonal effort has conducted only a single night survey in each of these locations. Thorne (2010) examined seasonal changes from fall 2006 to spring 2009. He showed that apparent overwinter mortality of age 0 herring appeared to be greatest in Simpson Bay and least in Whale Bay. However, the differences in seasonal abundance could be attributed to mortality, emigration, or changes in ambient light. We propose to address these uncertainties with an intensive fall and late winter/spring intensive survey. The fall series will start mid-October 2014 and extend to the first week of December. The late winter/spring series will begin the 3rd week of February 2015, and extend into the 2nd week of April. We propose to conduct the surveys in two bays sufficiently adjacent to cover each bay each night, such as Simpson Bay, Port Gravina, Windy Bay or St. Mathews Bay. In addition to the hydroacoustic surveys, we propose a single night of direct capture effort in each location for each of the survey weeks (See Bishop, this proposal). The survey design will follow the historic zig zag transects run by Thorne since 1993 in order to remain consistent with that sampling design and to put the long term fall and spring surveys into context.

Estimated Budget:
EVOSTC Funding Requested:

(breakdown by fiscal year and must include 9% GA)

FY 12	FY 13	FY 14	FY 15	FY 16
$50,100	$0	$76,300	$6,800	$0

Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date: May 24, 2010

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Hydroacoustic surveys of juvenile herring nursery areas in Prince William Sound have been conducted during fall and late-winter for the last several years. The objectives of this effort have been to improve understanding of habitat utilization by juvenile herring, especially age 0, and to help identify candidate sites that could be potentially used for supplementation efforts. The surveys have also been a focus for other studies on juvenile herring energetics, disease and predation. The number of locations surveyed have varied from 5-9, including the 4 Sound Ecosystem Assessment (SEA) bays. However, each seasonal effort has conducted only a single night survey in each of these locations. Thorne (2010) examined seasonal changes from fall 2006 to spring 2009. He showed that apparent overwinter mortality of age 0 herring appeared to be greatest in Simpson Bay and least in Whale Bay. However, he also pointed out that the differences over winter could also be the result of emigration. Not only might age 0 herring move among bays during the winter, but movement into and out of bays may be progressive during a season. It is possible the overwintering component of age 0 may not be fully recruited into a bay at the time a single fall survey, or may have began spring movement out of bays prior to any given late-winter survey. Another potential source of variability could be the stage of the moon. Ambient light is known to affect fish distributions. On many occasions, age 0 concentrations were readily identified by their distinct distribution: a diffuse layer near surface, near shore and near the heads of bay. On other occasions, this distinctive distribution was absent even though age 0 herring were present. The change might have been the result of different ambient light regimes.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to “Conduct research to find out why Pacific herring are not recovering” and “Monitor recovery”, listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

II. PROJECT DESIGN

A. Objectives

Program objectives:
We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

Project Objectives. This project addresses Program Objective #3: *Address assumptions in the current measurements.* It will put current single season measurements of juvenile herring into a temporal context to address estimates of mortality and immigration/emigration.
The objectives of this study are:

1. to improve the accuracy of both annual and seasonal comparisons from single-night surveys by intensively sampling throughout a fall and spring season

2. estimate the level of immigration and emigration of age 0 herring between bays

B. Procedural and Scientific Methods

We propose to address these uncertainties with an intensive fall and late winter/spring intensive survey. The fall series will start mid-October 2014 and extend to the first week of December. The late winter/spring series will begin the 3rd week of February 2015, and extend into the 2nd week of April. We propose to conduct the surveys in two bays sufficiently adjacent to cover each bay each night, such as Simpson Bay, Port Gravina, Windy Bay or St. Mathews Bay. We will conduct four surveys per season spaced at 2 week intervals. Each of the two bays will be surveys in three consecutive nights. Such a design will address daily, weekly and monthly variability, including moon phase. In addition to the hydroacoustic surveys, we propose a single night of direct capture effort in each location for each of the survey weeks (See Bishop, this proposal). The survey design will follow the historic zig zag transects run by Thorne since 1993 in order to remain consistent with that sampling design and to put the long term fall and spring surveys into context. Such information is especially critical if hydroacoustic surveys are needed to provide an index of future age 0 herring abundance.

C. Data Analysis and Statistical Methods

There are well-developed protocols for hydroacoustic data analysis. Basic analysis is done using echo integration techniques (Thorne 1983a,b; McLennon and Simmonds 1992). We will be using to ECHOVIEW post processing software for the echo integration and analysis. Specific analysis of schools or layers requires a bounding process to limit analysis to a specific school or layer (Fig 8). Target strength characteristics of herring as well as several other common fishes are well documented (Thorne 1983b; Traynor 1998; Thomas et al. 2002). The acoustic analysis determines the biomass density of the fish. The biomass estimates use scaling factors that are size and species specific, but are relatively insensitive to these variables (Thorne 1983b). These densities are extrapolated to the appropriate area based on the GPS information that is automatically written to the acoustic data files. Conversion of biomass to numerical values is more sensitive to species/size information. For adults and age 0 herring this information is typically available. Some assumptions are required for other species and these assumptions are dependent on the direct capture information.

D. Description of Study Area

This project will take place in the northeastern region of Prince William Sound (60.841056, -146.128239, 60.864482, -147.345965, 60.622618, -147.382919, 60.609086, -146.018257).

E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated “PWS Herring Research and Monitoring” proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

III. SCHEDULE

A. Project Milestones

For each project objective listed above (II.A.), specify when critical project tasks will be completed. Project reviewers will use this information in conjunction with annual project reports to assess whether projects are meeting their objectives and are suitable for continued funding. Please format your information like the following example.

Objective 1: to improve the accuracy of both annual and seasonal comparisons from single-night surveys by intensively sampling throughout a fall and spring season. *This will be met by July 2015.*
Objective 2: estimate the level of immigration and emigration of age 0 herring between bays. *This will be met by August 2015.*

B. Measurable Project Tasks

FY12 1st Quarter (October 1, 11 to December 31, 11)
October		Begin funding

FY12 2nd Quarter
January		Annual Marine Science Symposium

FY12 3rd Quarter
May		Conduct annual PI meeting

FY13 1st Quarter (October 1, 12 to December 31, 12)

FY13 2nd Quarter
January		Annual Marine Science Symposium

FY13 3rd Quarter
May		Conduct annual PI meeting
June		Submit FY14 work plan for review

FY13 4th Quarter
August		Submit annual report

FY14 1st Quarter (October 1, 13 to December 31, 13)
October		Begin acoustic intensive study

FY14 2nd Quarter
January		Annual Marine Science Symposium
Winter		EVOS sponsored workshop with Herring and Long-term monitoring programs
Winter		Continue with intensive study

FY14 3rd Quarter
May		Conduct annual PI meeting
May		Complete intensive study

FY14 4th Quarter

July	Data analysis
August	Submit annual report

FY15 1st Quarter (October 1, 14 to December 31, 14)

FY15 2nd Quarter

January	Annual Marine Science Symposium

FY15 3rd Quarter

May	Conduct annual PI meeting

FY15 4th Quarter

August	Submit annual report

FY16 1st Quarter (October 1, 15 to December 31, 15)

FY16 2nd Quarter

January	Annual Marine Science Symposium

FY16 3rd Quarter

May	Conduct annual PI meeting

FY16 4th Quarter

August	Submit annual report

References Cited

Thorne, R. E. 2010. Trends in Adult and Juvenile Herring Distribution and Abundance in Prince William Sound. Prince William Sound Science Center, Cordova, AK.

PWS Herring Research and Monitoring: Juvenile Herring Abundance Index
PRINCE WILLIAM SOUND SCIENCE CENTER

Personnel
This intensive survey project will take only take place in FY14. Three months' salary is requested in FY14 to conduct the surveys and ½ months' salary in FY15 to complete analysis. Dr. Buckhorn will act as lead Principle Investigator. Dr. Buckhorn will oversee the project and coordinate with the other projects in this program. She will have primary responsibility for project design, field work, data collection, analysis and completion of final products. She will supervise the acoustics technician.
Two months' salary is requested in FY14 for James Thorne, the acoustics technician. He will assist with data collection and is responsible for maintenance of acoustic equipment. One-third month salary is requested in FY14 for Dr. Thorne. He will provide technical consulting and support.

Travel
No travel is requested in this proposal (covered in other hydroacoustic budgets).

Contractual
For FY14 and FY15 funds are requested for Information Technology, which includes $100/person month for network connections and costs associated with software license renewals or purchases. Funds are requested each year for printing/mailing/copying. The request is based on historic and anticipated usage. Funds are also requested each year for communications, which includes $50/person month for phone, plus additional funds for long distance and fax costs.

Commodities
In FY14 funds are requested for office supplies (paper, pens, printers, etc.) that are typically consumed in association with the project. Additional funds are requested for miscellaneous cruise supplies (lines, nets, totes, etc.).

Equipment
In FY12 funds are requested to purchase ECHOVIEW hydroacoustic post-processing software. The specific module necessary for fish school analysis has 4 pre-requisite modules in order to work. ECHOVIEW is a much more powerful program than we are currently using and will allow us to integrate fish abundances with bird activity (FY10 project) and will also integrate with the DIDSON data collection for the non-lethal data collection experiment.

INDIRECT COSTS
The PWSSC indirect rate is estimated at 30% based on our currently negotiated rate.

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: *PWS Herring Research and Monitoring: Outreach & Education*

Project Period: October 1, 2011-September 30, 2016

Primary Investigator(s): Lindsay Butters, Education Coordinator, PWS Science Center (PWSSC)

Study Location: Prince William Sound (PWS)

Abstract:
The *Outreach & Education* project is designed to enhance the PWS Herring Program research activities by showcasing their relevancy, broadening their applicability and extending their impact to people in the community. PWSSC educators will work with PWS Herring Research and Monitoring principal investigators (PI) and project collaborators to prepare public education materials that communicate the purpose, goals and results of the research program to "non-scientist" audiences and stakeholders in communities in and beyond the spill affected area.

Outreach and education products will extend and transfer Pacific herring and marine ecosystem information to inform the public of local research activities and improve their ecological and ocean science literacy.

The specific objectives of this proposal, which includes the outreach and education components of the PWS Herring Research and Monitoring Program, are to:

1) Disseminate PWS herring research information and lessons learned in this program to individuals, groups, policy makers, resource managers and institutions in PWS, including the effected fishing community.

2) Extend and transfer PWS herring research-based outreach and education products to general audiences in and beyond the spill affected areas of PWS.

3) Integrate community involvement into the planning and sampling programs through citizen science opportunities and public workshops

Estimated Budget: $153,900
EVOSTC Funding Requested: *(breakdown by fiscal year and must include 9% GA)*

FY 12	FY13	FY14	FY15	FY16
$16,500	$30,500	$32,700	$35,900	$38,300

Non-EVOSTC Funds to be used: *(breakdown by fiscal year)* $0

Date: May 27, 2011

PROJECT PLAN

I. NEED FOR THE PROJECT
A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here are projects for a program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

II. PROJECT DESIGN
A. Objectives

Program Objectives:

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

Outreach and Education Project Objectives:

The specific objectives of this proposal, which includes the outreach and education components of the PWS Herring Research and Monitoring Program, are to:

4) Disseminate PWS herring research information and lessons learned in this program to individuals, groups, policy makers, resource managers and institutions in PWS, including the effected fishing community.

5) Extend and transfer PWS herring research-based outreach and education products to general audiences in and beyond the spill affected areas of PWS.

6) Integrate community involvement into the planning and sampling programs through citizen science opportunities and public workshops.

The **Outreach & Education** project is designed to enhance the PWS herring research activities by showcasing their relevancy, broadening their applicability and extending their impact to people in communities in and beyond the spill affected areas of PWS. Outreach products and education activities will extend and transfer herring and ecosystem information to inform the public of local research activities and improve their ecological and ocean science literacy. Both formal and informal approaches to science education are used.

The PWSSC education group has experience developing and implementing a diverse array of public outreach and educational activities through its ***Science of the Sound*** program. Educators will work closely with PWS herring research principal investigators and project collaborators to prepare and distribute public education materials that communicate the purpose, goals and results of the research program to "non-scientist" audiences and stakeholders in communities in and beyond the spill affected area.

B. Procedural and Scientific Methods

Approach: Our iterative approach to addressing the long-term goal of this program "**to improve predictive models of herring stocks through observations and research"** involves testing the relative importance of factors that may be preventing the recovery of PWS herring. The relative importance of these factors will be identified through an integrated set of studies that include monitoring efforts, shorter field-based process studies focusing on particular aspects of the herring life cycle, and controlled laboratory-based studies intended to determine cause-and effect relationships. When combined, this approach is intended to inform more directed herring monitoring and modeling efforts by focusing on important population-limiting factors and providing empirical data for the current ASA model. The work outlined here will be informed by projects outlined in a separate long-term monitoring program, such as monitoring of basic oceanographic conditions, food availability, and predator populations. It also builds upon the existing EVOSTC funded PWS Herring Survey research program. The team lead (W. Scott Pegau) on the proposed work is the same team leader as on the PWS Herring Survey program, which allows the proposed work to be fully integrated with the existing work without unnecessary duplication.

C. Data Analysis and Statistical Methods

Not applicable.

D. Description of Study Area

The *PWS Herring Research and Monitoring* program study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

PWS Herring Research and Monitoring: Outreach & Education activities will primarily occur in PWS communities, and some communities outside of the spill affected region.

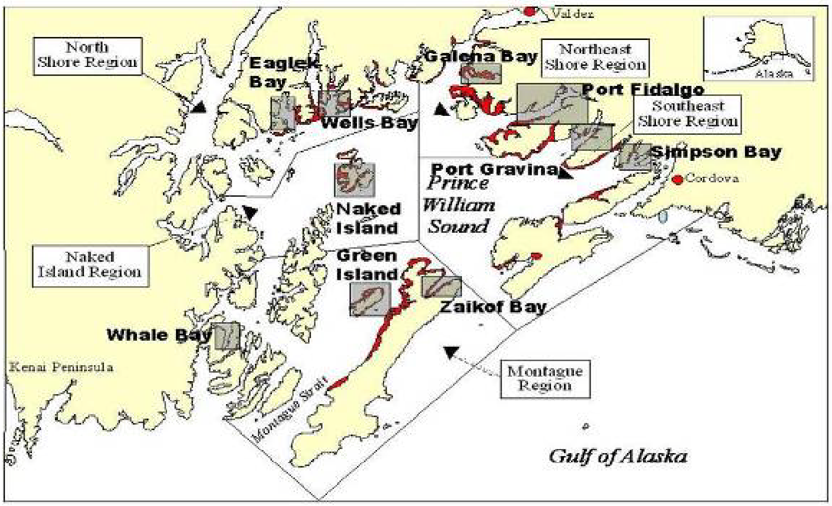

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

III. SCHEDULE

A. Project Milestones

Objective 1. Disseminate PWS herring research information and lessons learned in this program to individuals, groups, policy makers, resource managers and institutions in PWS, including the effected fishing community.

Objective 2. Extend and transfer PWS herring research-based outreach and education products to general audiences in and beyond the spill affected areas of PWS.

Objective 3. Integrate community involvement into the planning and sampling programs through citizen science opportunities and public workshops

To meet the objectives outlined above, PWSSC educators will produce the public outreach and education materials/programs identified in Table 1.

Table 1. The informal or formal education approaches (**bold**) used to meet objectives, specific products (*italics*), and schedule and frequency/number of outreach and education products developed/delivered by our staff.

1. Written project profiles and articles for pubic information and use; appropriate for lay audiences for inclusion in newsletters or other science/education publications.		
Delta Sound Connections	20,000 copies distributed annually to residents and visitors to PWS	Contribution of articles by herring researchers FY12-16. Sponsorship and herring program feature FY13 & FY15
PWSSC Breakwater *newsletter*	Mailed to 325 households/businesses in and outside of Alaska	One herring article per newsletter publication 2-3 time per year FY12-16
Project Profiles	Distribution points: PWSSC, CDFU, Cordova harbor, Chamber of commerce, public locations, Community Education email list-350 subscribers	Three profiles per year developed or updated FY12-16
2. Public presentations to general public audiences.		
Community Lecture Series	(live in Cordova, broadcast to Valdez)	Three presentations delivered by Herring researchers per year FY12-16
Field Notes radio program	(aired and archived KCHU public radio)	Three radio programs produced based on Herring projects per year FY12-16
3. Advertise and involve community members in opportunities to participate in herring research as "citizen scientists."		
Citizen Science Opportunities	Provide and promote opportunities for the public to become involved in research project activities	Citizen science opportunities promoted on web and during community presentations
4. Develop and advertise web-based materials to communicate the basis, goals and results of the herring research project, and provide access to outreach and education products.		
Herring Program webpage: http://www.pwssc.org/herringsurvey	Basic information about each herring project can be found and links to the annual reports on the EVOSTC website.	Continue to use this as a place to make documents associated with the herring program accessible FY12-16
Herring Program Facebook page: http://www.facebook.com/pages/ PWS-Juvenile-Herring Research/ 187859711248910	Project photos, news and updates, administered by PWSSC & CDFU	Continue to use popular social media to outreach information associated with the herring program FY12-16

PWSSC YouTube channel: http://www.youtube.com/user/PWSSC	Podcasts (based on *Field Notes* radio programs) and video clips posted on YouTube	Continue to use popular social media to outreach information associated with the herring program FY12-16
5. Educate targeted groups in the application of research information and sampling methods.		
Discovery Room	5th Grade Oceanography and Herring curriculum	6 2-hour classroom sessions/monitoring field trips delivered Oct-Apr FY12-16
Outreach Discovery	Stand-alone, hands-on herring and ocean science education programs for students in grades 3-12	1 program delivered to school group outside of Cordova per year FY12-16
Summer Field Programs	Field-based, hands-on herring and ocean science activities for participants in science and environmental camps and day programs	1 program delivered in PWSSC or partner summer program per year FY12-16

The first year (FY12) of this project overlaps with the existing PWS Herring Survey Program. PWSSC educators will use the overlap period to focus increasing capacity to expand the impact and geographic scope of outreach and education efforts. The intention is to provide activities that groups outside our delivery area will utilize without direct funding from this program. To increase the geographic impact of the programs, we propose to modify the current oceanography and herring *Discovery Room*, *Outreach Discovery* and *Summer Education* activities so that the instructional focus is on how a fishery (PWS herring) is affected by changes in the ecosystem. The resultant activities will focus on the ecosystem, which is more transferable, than on a particular fish population. At the same time it will continue to use PWS herring as the central example, which maintains its relevance to this program. The second activity that will take place in the first year is to market the revised programs to other marine education programs in the state. It is important to actively market the activities if we expect them to be utilized by other groups.

B. Measurable Project Tasks

FFY 12 1st Quarter (October 1, 11 to December 31, 11)

October	Begin revising/implementing oceanography and herring *Discovery Room* (overlap with current EVOSTC funded PWS Herring Survey program)
December	Develop *Field Notes* radio program based on fall surveys

FFY12 2nd Quarter (January 1, 12 to March 31, 12)

January	Annual Marine Science Symposium
March	Develop/update *Project Profiles* based on surveys & herring data analysis

FFY12 3rd Quarter (April 1, 12 to June 30, 12)

May	Evaluate oceanography and herring *Discovery Room* program
	Participation in Principal Investigator update and outreach meeting
	Delivery of *Community Lectures* and *Field Notes* complete for FY12
	Written outreach materials complete for FY12 (*Delta Sound Connections*, *Breakwater* newsletter articles, *Project Profiles*)

FFY12 4th Quarter (July 1, 12 to September 30, 12)

July	Market revised herring education programs to other marine education programs in Alaska.
August	Deliver *Summer Field Program*
August	Submit Annual Report
September	Delivery of *Outreach Discovery* program complete for FY12

FFY13 1st Quarter (October 1, 12 to December 31, 12)

October	Begin implementing oceanography and herring *Discovery Room*
December	Develop *Field Notes* radio program based on fall surveys

FFY13 2nd Quarter (January 1, 13 to March 31, 13)

January	Annual Marine Science Symposium
March	Develop/update *Project Profiles* based on surveys & herring data analysis

FFY13 3rd Quarter (April 1, 13 to June 30, 13)

May	Evaluate oceanography and herring *Discovery Room* program
	Participate in Principal Investigator update and outreach meeting
	Delivery of *Community Lectures* and *Field Notes* complete for FY13
	Written outreach materials complete for FY13 (*Delta Sound Connections*, *Breakwater* newsletter articles, *Project Profiles*)

FFY13 4th Quarter (July 1, 13 to September 30, 13)

August	Deliver *Summer Field Program*
August	Submit Annual Report
September	Delivery of *Outreach Discovery* program complete for FY13

FFY14 1st Quarter (October 1, 13 to December 31, 13)

October	Begin implementing oceanography and herring *Discovery Room*
December	Develop *Field Notes* radio program based on fall surveys

FFY14 2nd Quarter (January 1, 14 to March 31, 14)

January	Annual Marine Science Symposium

FFY14 3rd Quarter (April 1, 14 to June 30, 14)

May	Evaluate oceanography and herring *Discovery Room* program
	Participate in Principal Investigator update and outreach meeting
	Delivery of *Community Lectures* and *Field Notes* complete for FY14

Written outreach materials complete for FY14 (*Delta Sound Connections*, *Breakwater* newsletter articles, *Project Profiles*)

FFY14 4th Quarter (July 1, 14 to September 30, 14)

August	Deliver *Summer Field Program*
August	Submit Project Annual Report
September	Delivery of *Outreach Discovery* program complete for FY14

FFY15 1st Quarter (October 1, 14 to December 31, 14)

October	Begin implementing oceanography and herring *Discovery Room*
December	Develop *Field Notes* radio program based on fall surveys

FFY15 2nd Quarter (January 1, 15 to March 31, 15)

January	Alaska Marine Science Symposium
March	Develop/update *Project Profiles* based on surveys & herring data analysis

FFY15 3rd Quarter (April 1, 15 to June 30, 15)

May	Evaluate oceanography and herring *Discovery Room* program
	Participate in Principal Investigator update and outreach meeting
	Delivery of *Community Lectures* and *Field Notes* complete for FY15
	Written outreach materials complete for FY15 (*Delta Sound Connections*, *Breakwater* newsletter articles, *Project Profiles*)

FFY15 4th Quarter (July 1, 15 to September 30, 15)

August	Deliver *Summer Field Program*
August	Submit Project Annual Report
September	Delivery of *Outreach Discovery* program complete for FY15

FFY16 1st quarter (October 1, 15 to December 31, 15)

October	Begin implementing oceanography and herring *Discovery Room*
December	Develop *Field Notes* radio program based on fall surveys

FFY16 2nd quarter (January 1, 16 to March 31, 16)

January	Alaska Marine Science Symposium
March	Develop/update *Project Profiles* based on surveys & herring data analysis

FFY16 3rd quarter (April 1, 16-June 30, 16)

May	Evaluate oceanography and herring *Discovery Room* program
	Participate in Principal Investigator update and outreach meeting
	Delivery of *Community Lectures* and *Field Notes* complete for FY16
	Written outreach materials complete for FY16 (*Delta Sound Connections*, *Breakwater* newsletter articles, *Project Profiles*)

FFY16 4th quarter (July 1, 16 to September 30, 16)

July	Secure final approval, acceptance of final report
August	Deliver *Summer Field Program*

September	Delivery of *Outreach Discovery* program complete for FY16
September	Publication of final report complete, delivered to ARLIS

PWS Herring Research and Monitoring: Outreach & Education
PRINCE WILLIAM SOUND SCIENCE CENTER

Personnel
Year 1: 0.5 months of salary for Lindsay Butters, PI, is requested to develop the necessary infrastructure to implement outreach and education projects in Years 2-5 of the project, to attend the AK Marine Science Symposium in Anchorage, and to deliver herring education programs in communities outside of Cordova.

Comment [L1]: Is this too vague? Just vague enough? I will just need time to research and acquire the necessary infrastructure for program delivery, attend the meetings, and deliver a program during an Outreach Discovery trip.

Years 2 & 3: 2.0 months of salary for Lindsay Butters and 1.0 months of salary for a PWSSC Education Specialist to plan an implement herring outreach and education programs, including youth hands-on science programs, community lectures, radio programs and written publications, and to attend the AK Marine Science Symposium.

Year 4: 2.1 months of salary for Lindsay Butters and 1.1 months of salary for a PWSSC Education Specialist to plan an implement herring outreach and education programs as described above, and to attend the AK Marine Science Symposium.

Year 5: 2.5 months of salary for Lindsay Butters and 1.1 months of salary for a PWSSC Education Specialist to plan an implement herring outreach and education programs as described above, and to attend the AK Marine Science Symposium.

Travel
In years 1-5 travel to the Alaska Marine Science Symposium is requested. In years 1-5 travel to deliver herring education & outreach programs in communities outside of Cordova is requested. In year 3 funds are requested to travel to an EVOSTC review of the Herring and Long-Term Monitoring programs as outlined in the RFP.

Contractual
Each year funds are requested for Information Technology, which includes $100/person month for network connections and costs associated with software license renewals or purchases. Funds are requested each year for printing/mailing. The request is based on historic and anticipated usage. Funds are also requested each year for communications, which includes $100/person month for phone, plus additional funds for long distance and fax costs. In years 2 and 4 funds are requested to support the printing and distribution of the Prince William Sound Science Center's annual "Delta Sound Connections" science and natural history publication. The publication will be used to outreach PWS Herring Program information and results to at least 18,000 visitors and residents of the Prince William Sound and South-central Alaska regions.

Commodities
In each year funds are requested for miscellaneous teaching and outreach supplies, and office supplies (paper, pens, printer ink, computer, educational aids etc.) that are typically consumed or utilized in association with the project. In Year 1, funds are requested to acquire items necessary to develop infrastructure and increase capacity to deliver

outreach and education programs, such as computers, audio recorders, digital cameras/camcorders and microfiche readers.

Equipment
No equipment funds are requested.

INDIRECT COSTS
The PWSSC indirect rate is estimated at 30% based on our currently negotiated rate.

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: PWS Herring Research and Monitoring **-** Fatty Acid Analysis as Evidence for Winter Migration of Age-0 Herring in Prince William Sound

Project Period: October 1, 2011 – September 30, 2016

Primary Investigator(s): Ron Heintz & Johanna Vollenweider
Co-operating Investigator:

Study Location: Prince William Sound

Abstract: This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et al. Monitoring of age-0 herring should be an important component of the Trustee herring program, but the appropriate spatial scale for monitoring is unknown. The current program assumes age-0 herring remain in their nursery bays over winter. If true, observations of differences among bays in terms of age-0 condition and marine conditions will allow for identifying conditions that lead to improved recruitment to age-1. We propose to test the assumption by monitoring the fatty acid (FA) composition of age-0 herring over winter. The FA composition of depot lipids derives from diets (Budge et al. 2006), so differences in the prey fields in different bays should produce differences in the FA compositions of herring in those bays (Otis et al. 2009). Therefore, the FA composition of age-0 herring in fall can act as a natural tag for identifying migration. Changes in FA composition due to winter feeding are likely to be minimal because age-0 herring experience energy deficits in winter, proscribing lipid storage. We plan to test this assumption in a laboratory study. We hypothesize that migration of herring will result in increasing similarity of herring FA compositions over winter. Alternatively, if the FA composition of age-0 herring in given bays remains constant over winter then migration must be limited.

Estimated Budget:
EVOSTC Funding Requested:
(breakdown by fiscal year and must include 9% GA)

FY 12	FY13
$18,400	$47,100

Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date: May 18, 2011

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring populations, suitable for exploitation by commercial roe fisheries are typically sustained by periodic recruitment of strong year classes into the adult spawning population; however, the Prince William Sound herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound (PWS) requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

What is described here are a series of projects that make up a program that enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we don't anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular it addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery," listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop, or test, biological and physical models of herring growth and recruitment rather than relying on empirical models.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS from the effects of EVOS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring lifecycle necessary to move us from an empirical modeling approach towards an analytical modeling approach.

II. PROJECT DESIGN

A. Objectives

The Herring Monitoring Program goal is to improve predictive models of herring stocks through observations and research. To meet this goal we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass. The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies were put together based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Monitoring age-0 herring should be an important component of the herring program, but the appropriate spatial scale over which they should be monitored is unknown. If age-0 herring remain in their nursery bays over winter, then age-0 monitoring can use a series of index bays to evaluate the relative health of herring cohorts. Observations of differences among bays in terms of age-0 condition and marine conditions can provide a basis for identifying conditions which lead to improved recruitment to age-1. However, if age-0 fish move about Prince William Sound in winter, then measurements of fish condition are limited to inter annual variation, severely constraining our ability to identify the conditions leading to the recruitment of large year classes. Thus the current herring monitoring program requires validation of the assumption that age-0 herring remain in their nursery bays over winter.

In support of program goal #3, the goal of this study is to test the assumption in the current studies that age-0 herring remain in their nursery bays over winter by monitoring the fatty acid (FA) composition of age-0 herring over winter. Herring foraging on different prey fields likely have different FA compositions because the FA composition of depot lipids derives from diets (Budge et al. 2006). Differences in the prey fields in different bays should produce differences in the FA compositions of herring in those bays (Otis et al. 2009). Therefore, the FA composition of age-0 herring in fall can act as a natural tag for identifying migration during winter. During periods of food deprivation, fish FA compositions are conserved (Figure 1). Changes in FA composition due to winter feeding are likely to be minimal because age-0 herring experience energy deficits in winter, proscribing lipid storage. We hypothesize that migration of herring will result in increasing similarity of herring FA compositions. Alternatively, if the FA composition of age-0 herring in given bays is constant over winter then migration must be limited.

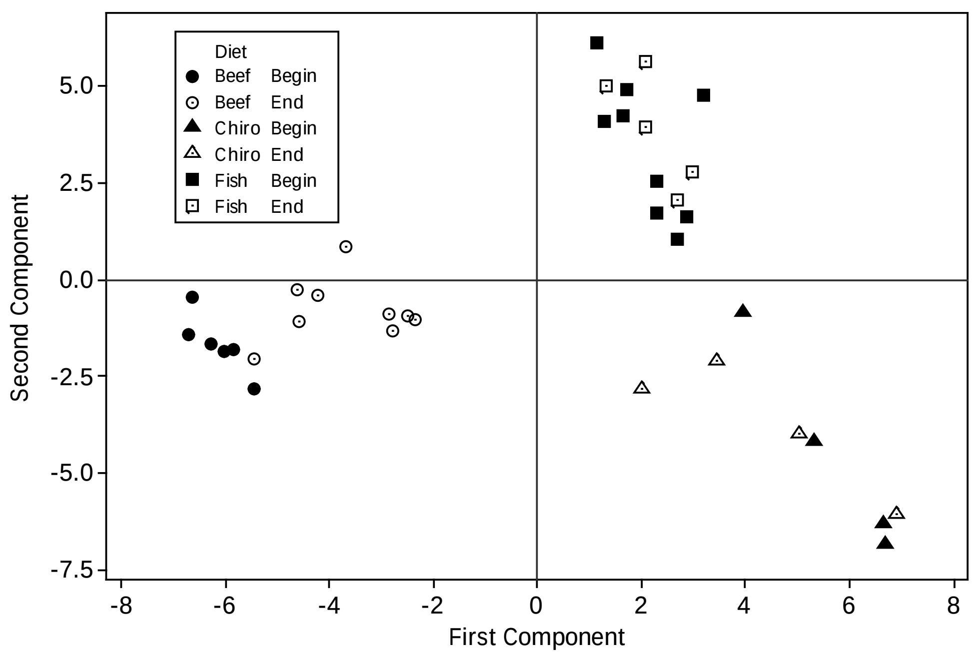

Figure 1. Principle components analysis of the fatty acid composition of coho salmon fed three different diets and fasted under the same conditions for 60 days. All fish came from the same wild population and were fed the different diets for 100 days before fasting commenced. Symbols show component scores for the fatty acid compositions of fish before and after fasting.

Field sampling and FA analysis will identify the spatial scale of winter movement by addressing the following questions:

1. Do FA compositions differ between bays at the beginning of winter?
2. Are FA compositional differences between fish from eastern (e.g., Port Gravina, Port Fidalgo) and western PWS (e.g., Whale Bay) conserved over winter?

3. Are FA compositional differences between fish in two adjacent bays conserved over winter?
4. Are FA compositional differences between two adjacent fjord systems (Port Gravina and Port Fidalgo) conserved over winter?
5. Are FA compositional differences between separate bays within a fjord system conserved over winter?

The assumptions underlying the FA approach used in this study will be examined under laboratory conditions to determine:

6 Are the FA compositions of starving herring conserved over winter?
7 Does winter feeding alter the FA composition of starving herring?

B. Procedural and Scientific Methods

Field sampling:
We anticipate that this study can be completely integrated into the proposed monitoring program. Samples collected during the intensive survey proposed by Kline and Heintz will provide samples to answer question 5. Samples collected under the long term monitoring program will answer questions 1 through 4. The laboratory study will answer questions 6 and 7. Under the intensive monitoring study we propose to sample fish from Simpson and Windy Bays in November and March. These bays are roughly adjacent in Orca Bay. Under the monitoring program we propose to sample herring from various bays in eastern and western Prince William Sound in early winter and repeating these at the end of winter. Ideally our collection will include samples from one of each of the SEA bays. However, we will modify the study design as necessary based on the samples collected as part of the current herring monitoring program, while aiming to maximize our ability to understand the spatial scales of age-0 herring movement over winter (e.g., between adjacent bays, between fjords, or across the sound).

Lab rearing:
For the laboratory component testing the validity of the FA approach, we propose to use fish collected near our lab in Auke Bay. Fish will be collected by beach seine in late summer, transferred to our lab and divided into two groups. The groups will be fed different diets to create two groups with distinct fatty acid compositions. Each of the groups will have a fasted component and a second component that is periodically offered some prey, but still maintained at an energy deficit

Fatty acid analysis:
FA compositions will be determined by gas chromatography and mass spectrophotometry at the Auke Bay Lab, following established protocols (Heintz et al. 2010). Concentrations of 32 fatty acids will be reported as percentages of the observed total mass of fatty acids.

C. Data Analysis and Statistical Methods

Differences in FA compositions among fish from different locations will be identified by non-metric multidimensional scaling and analysis of similarities (Heintz et al. 2010). Differences between bays or logical groups will be tested by ANOSIM.

D. Description of Study Area

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

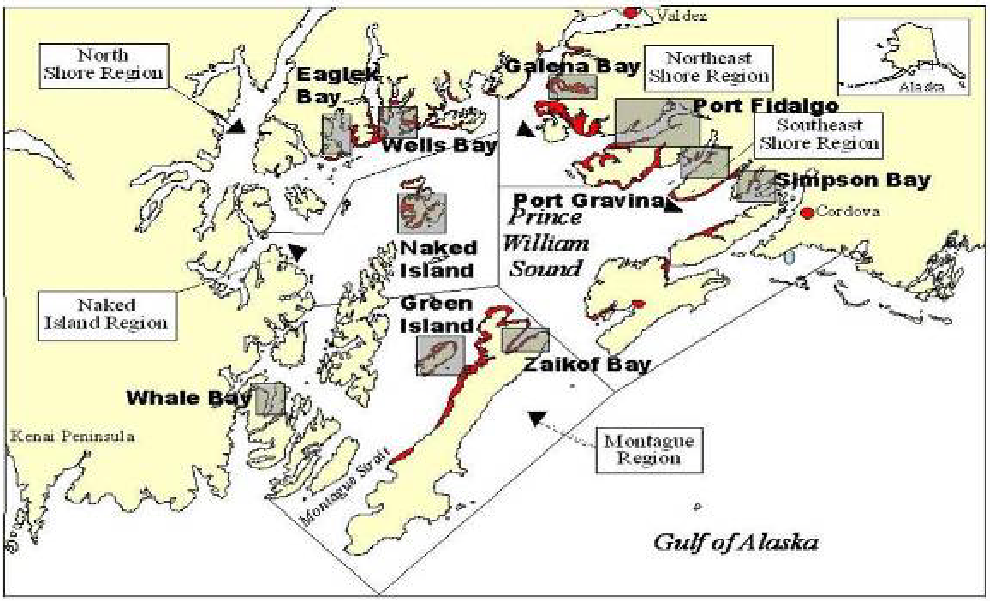

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

III. SCHEDULE

A. Project Milestones

October 2011:	Receive funding, acquire wild fish near Juneau for lab study
January 2012:	Begin fasting herring in laboratory
March 2012:	Acquire spring herring samples from intensive study , end fasting study
January 2013:	Report preliminary results at AMSS

March 2013: Complete acquisition of herring from monitoring program
September 2013: Complete chemistry
April 2014: Submit final report

B. Measurable Project Tasks

FY 12, 1st quarter (October 1, 2011-December 31, 2011)
September Collect herring for laboratory study by beach seining (Auke Bay)
Maintain herring in laboratory in preparation for experimental trials

FY 12, 2nd quarter (January 1, 2012-March 31, 2012)
January Begin laboratory study, receive first set of samples from intensive surveys in PWS
March Receive rest of field samples from intensive study, end lab study

FY 12, 3rd quarter (April 1, 2012-June 30, 2012)
April Begin analyzing samples
May Attend annual herring meeting Cordova

FY 12, 4th quarter (July 1, 2012- September 30, 2012)
September Complete analysis of samples from first year

FY 13, 2nd quarter (January 1, 2013-March 31, 2013)
January Attend AK Marine Science Symposium
March Acquire samples from monitoring program

FY 13, 3rd quarter (April 1, 2013-June 30, 2013)
April Begin sample analysis of fish from monitoring project
May Attend annual herring meeting Cordova

FY 13, 4th quarter (July 1, 2013-September 30, 2013)
September Finish analysis of samples

FY 14, 2nd quarter (January 1, 2014-March 31, 2014)
January Attend AMSS report preliminary results

FY 14, 2nd quarter (Jan 1, 2014- April 30, 2014)
April Submit final report

IV. BUDGET

Below is the budget for the project. Funds are requested for only two years, outlying years are not shown as they incur no cost to the Trustee Council.

Budget Category:	Proposed FY 12	Proposed FY 13	TOTAL PROPOSED
Personnel	$0.0	$0.0	$0.0
Travel	$0.0	$3,970.0	$3,970.0
Contractual	$15,000.0	$36,000.0	$51,000.0
Commodities	$2,000.0	$3,185	$5,185.0
Equipment	$0.0	$0.0	$0.0
TOTAL	$17,000.0	$43,155	$60,155

Budget Justification:

FY12

Personnnel:

No funds requested

Travel:

No funds requested

Conractual : Request contracts for:

Processing ($15/sample), lipid extraction ($50/sample) and transesterification of samples ($35/sample) collected during the monitoring survey and lab studies conducted in FY12.
110 samples x $100/sample = $11,000

Fish culture (200 hours x $20/hour) = $4,000

Commodities:

Sample collection and preparation : vials, lables, bags
$3.00 per sample x 110 samples = $330
Lipid extraction : solvents, hydromatrix, vials, sand, nitrogen, machine time
$10.20 per sample x 110 samples = $1120
Transesterification: nitrogen, pipettes, solvents, reagents, vials, caps, misc. supplies
$5.00 per sample x 110 samples = $550

Equipment:

No funds requested

FY13

Personnnel:
No funds requested

Travel:
Funds are requested for Heintz and Sewall to travel to the 2013 AMSS meeting in Anchorage.
Funds are requested for Heintz and Sewall to travel to the annual herring meeting in Cordova

Conractual :
Request contracts for:

Processing ($15/sample), lipid extraction ($50/sample) and transesterification of samples ($35/sample) collected during the monitoring survey and lab studies conducted in FY13.
175 samples x $100/sample = $17,500

Process transesterified samples by GC/MS
$35/sample x 385 samples (285 fish + 100 QA) = $13,500

Data management contract $5,000

Commodities:

Sample collection and preparation: vials, labels, bags
$3.00 per sample x 175 samples = $525
Lipid extraction : solvents, hydromatrix, vials, sand, nitrogen, machine time
$10.20 per sample x 175 samples = $1785
Transesterification: nitrogen, pipettes, solvents, reagents, vials, caps, misc. supplies
$5.00 per sample x 175 samples = $875

Equipment:

No funds requested

LITERATURE CITED

Budge, S. M., S. J. Iverson and H.N. Koopman. Studying trophic ecology in marine ecosystems using fatty acids: a Primer on analysis and interpretation. Marine Mammal Science 22(4):759-801.

Heintz, R. A., M. S. Wipfli and J.P. Hudson. 2010. Identification of marine-derived lipid in juvenile coho salmon and aquatic insects through fatty acid analysis. Transactions of the American Fisheries Society 139:840-854.

Otis, E.O., R. Heintz, and J. Maselko. 2010. Investigation of Pacific herring (Clupea pallasii) stock structure in Alaska using otolith microchemistry and heart tissue fatty acid composition. Exxon Valdez Oil Spill Restoration Project Final Report (Restoration Project 070769), Alaska Department of Fish and Game, Division of Commercial Fisheries, Homer, Alaska.

IV. BUDGET

Below is the budget for the project. Funds are requested for only two years, outlying years are not shown as they incur no cost to the Trustee Council.

Budget Category:	Proposed FY 12	Proposed FY 13	TOTAL PROPOSED
Personnel	$0.0	$0.0	$0.0
Travel	$0.0	$3,970.0	$3,970.0
Contractual	$15,000.0	$36,000.0	$51,000.0
Commodities	$2,000.0	$3,185	$5,185.0
Equipment	$0.0	$0.0	$0.0
TOTAL	$17,000.0	$43,155	$60,155

Budget Justification:
FY12
Personnnel:
No funds requested

Travel:
No funds requested

Conractual : Request contracts for:
Processing ($15/sample), lipid extraction ($50/sample) and transesterification of samples ($35/sample) collected during the monitoring survey and lab studies conducted in FY12.
110 samples x $100/sample = $11,000

Fish culture (200 hours x $20/hour) = $4,000

Commodities:
Sample collection and preparation : vials, lables, bags
$3.00 per sample x 110 samples = $330
Lipid extraction : solvents, hydromatrix, vials, sand, nitrogen, machine time
$10.20 per sample x 110 samples = $1120
Transesterification: nitrogen, pipettes, solvents, reagents, vials, caps, misc. supplies
$5.00 per sample x 110 samples = $550

Equipment:
No funds requested

FY13
Personnnel:
No funds requested

Travel:

Funds are requested for Heintz and Sewall to travel to the 2013 AMSS meeting in Anchorage.
Funds are requested for Heintz and Sewall to travel to the annual herring meeting in Cordova

Conractual :
Request contracts for:

Processing ($15/sample), lipid extraction ($50/sample) and transesterification of samples ($35/sample) collected during the monitoring survey and lab studies conducted in FY13.
175 samples x $100/sample = $17,500

Process transesterified samples by GC/MS
$35/sample x 385 samples (285 fish + 100 QA) = $13,500

Data management contract $5,000

Commodities:

Sample collection and preparation: vials, labels, bags
$3.00 per sample x 175 samples = $525

Lipid extraction : solvents, hydromatrix, vials, sand, nitrogen, machine time
$10.20 per sample x 175 samples = $1785

Transesterification: nitrogen, pipettes, solvents, reagents, vials, caps, misc. supplies
$5.00 per sample x 175 samples = $875

Equipment:

No funds requested

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: PWS Herring Research and Monitoring **– What is the age at first spawning for female herring in PWS?**

Project Period: October 1, 2011 – September 30, 2016

Primary Investigator(s): JJ Vollenweider, Dr. Ron Heintz
Co-operating Investigator: Dr. Gary Marty, Rich Brenner

Study Location: Prince William Sound

Abstract: The predictive capabilities of current population models of herring in Prince William Sound may be improved by validating the estimated proportions of fish in each age class that spawn and knowing the proportions of primiparous individuals in each age class. Determination of age at first spawn has been accomplished via 1) analysis of differential growth increments on scales, 2) histological analysis of egg development in ovaries. While the histological method provides direct observation of the spawning history of individuals it is unlikely that developing oocytes can be observed among spawners. Hence the histological analysis must occur some months after spawning. We propose to examine scales of female herring collected from spawning aggregates in PWS to identify the spawning history of each year class. We will also validate the scale technique by comparing the results of scale analysis with that of histological analysis of oocyte development. The validation will likely be used on fish sampled some time after spawning. In order to identify the optimal time we will iteratively sample ovaries in fish held in the lab after spawning. Estimates of the proportion of primiparous fish in the spawning population will provide a means for adjusting estimates of the total post-spawning biomass in the ASA by indicating proportion of each age class that was not on the spawning grounds in the previous year. This study will consequently serve to develop an inexpensive method for improving the accuracy of spawning stock biomass estimates.

Estimated Budget:
EVOSTC Funding Requested:
(breakdown by fiscal year and must include 9% GA)

Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date: May 18, 2011

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT
A. Statement of Problem

Robust Pacific herring populations, suitable for exploitation by commercial row fisheries are typically sustained by periodic recruitment of strong year classes into the adult spawning population; however, the Prince William Sound herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound (PWS) requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

What is described here are a series of projects that make up a program that enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we don't anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities
The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular it addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop, or test, biological and physical models of herring growth and recruitment rather than relying on empirical models.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS from the effects of EVOS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring lifecycle necessary to move us from an empirical modeling approach towards an analytical modeling approach.

II. PROJECT DESIGN

A. Objectives

The Herring Monitoring Program goal is to improve predictive models of herring stcks through observations and research. To meet this goal we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass. The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies were put together based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

The goal of this study is to determine the age when herring first spawn in Prince William Sound. The goals of this study support the program goal #1, by evaluating the assumption of the ASA model that herring first spawn at age three. The predictive capabilities of current population models of herring in Prince William Sound may be improved by validating the estimated proportions of fish in each age class that spawn and knowing the proportions of primiparous individuals in each age class. This latter number provides a means for adjusting estimates of the total post-spawning biomass in the ASA by estimating the proportion of each age class that was not on the spawning grounds in the previous year. Data regarding the proportions of spawners by age class would improve the accuracy of model estimates of spawning stock biomass.

B. Procedural and Scientific Methods

Determination of age at first spawn has been accomplished via 1) analysis of differential growth increments on scales, and 2) histological analysis of egg development in ovaries. Herring lay down annual growth rings on their scales. In Atlantic herring, growth ring width can be used to differentiate years in which the fish did or did not spawn, where growth rings are relatively wider prior to their first spawning event (and during years of skip-spawn), and are narrower for years in which they spawn (Engelhard & Heino 2005). Thus scales provide a spawning history for an individual fish. The presence of post-ovulatory follicles (POV) after spawning indicates an individual fish has recently spawned while oocyte maturation identifies individuals about to spawn. By sampling at a time when both POV and maturing oocytes are present it is possible to discern immature, primiparous and repeat spawning individuals. While the histological method provides direct observation of the spawning history of individuals it is unlikely that developing oocytes can be observed among spawners. Hence the histological analysis must occur some months after spawning (Saborido-Rey & Junquera 1998).

We propose to examine scales of female herring collected from spawning aggregates in PWS to identify the spawning history of each year class. We will also validate the scale technique by comparing the results of scale analysis with that of histological analysis of oocyte development. The validation will likely be used on fish sampled some time after spawning. In order to identify the optimal time we will iteratively sample ovaries in fish held in the lab after spawning. If scale analysis proves to be a viable means to assess age at first spawn and spawning frequency, it would be a relatively inexpensive monitoring tool that could be used to adjust the ASA model in real time.

OBJECTIVES:

1. Determine the optimal time window (likely a summer month) in which histological analysis can be employed to determine spawning history of Pacific herring using a captive population.
2. Sample fish for scale and histological analysis at the optimal time to determine the age at first spawn for a group of PWS herring. Compare estimates of spawning history obtained from scales and histology.
3. The following spring, use scale analysis to identify the age at first spawn of 500 female herring caught during the 2012 spawning period in PWS.

STUDY DESIGN:

<u>Lab Study</u>: *determine field sampling schedule*

Live adult herring will be collected from Lynn Canal spawning aggregations in May 2011 and maintained at Auke Bay Laboratories for up to a year. Monthly collections (n=15) will be taken for histological examination of ovaries. Our objective is to identify the optimal time in which histological analysis can distinguish immature, recruit and repeat spawners, as has been done in Atlantic cod (Saborido-Rey & Junquera 1998). Immature females will be identified when all the oocytes are in the primary growth stage. Recruit females will be identified as those with developing oocytes but no post-ovulatory follicles. Repeat females will be identified as those individuals simultaneously having physiological evidence of prior spawning (post-ovulatory follicles) and new oocyte development. Histological samples will preserved and sent to Dr. Gary Marty for analysis beginning in FY12.

<u>Field Collections:</u>

1. *Summer 2012: Histological assessment of age at first spawn*
   In order to validate the use of scales for detecting age at first spawn, the age of females will be identified and compared with the results of a histological analysis of their ovaries. Wild adult herring will be collected from PWS according to the timeline of female maturation determined in the lab study. Individuals will be classified according to their current maturation state: immature, primiparous or repeat spawner. An immature is regarded as a fish that does not show any sign of imminent or previous maturation, a primiparous fish shows no sign of recent spawning but has developing oocytes, a repeat spawner has post-ovulatory follicles and developing oocytes. The proportion of each state will be recorded for each age class. Note that immature and primiparous fish were all immature during the previous spawning event. Ages will be constrained to 2-5 year-olds based on the assumption that all primiparous females will occur in this age range.

   At the same time, spawning histories will also be examined from scale growth patterns. Based on the developmental state ascertained with histological analysis females will be identified as being mature or immature the previous spawning event. Scale growth patterns will be examined to determine the proportion of fish that were mature or immature during the last spawning event. We will compare the maturation histories obtained by both methods. We recognize that this comparison only verifies that scales can be used to identify fish that have recently spawned. However, the scale method is based on changes in the growth increment during the year previous to spawning. If scales reliably identify individuals that have spawned then it should be possible to use the growth pattern to project entire spawning history of the fish.

2. *Spring 2013: Scale analysis to detect age at first spawn*
   Pending the outcome of the first field study, 500 female spawning herring will be collected in the spring of 2013 in PWS for scale analysis. At this time, spawning history for the spawning cohorts will be constructed from the scale growth patterns. At this time fish will have completed laying down an annulus, so we will be able to identify those individuals that were spawning for the first time in addition to repeat spawners. The proportion of primiparous fish identified in each age class will be compared with the proportions determined from the histological analysis the previous summer.

   Samples will be collected during the ADF&G vessel-based spawning survey. All fish will be measured for length, mass, gonadosomatic index (GSI), and gonad development stage (Modified Hjort scale), and scales will be preserved for microscopic analysis. Aging of scales will be conducted by ADF&G, Cordova for consistency with current aging protocols. Growth increments of scales will be measured by Auke Bay Labs using Nikon NIS-Elements imaging software.

C. Data Analysis and Statistical Methods

Lab Study: A minimum of 500 herring will be collected from the wild and transferred live and held captive in tanks at NOAA's facility in Juneau, Alaska. A sample size 20 females will be analyzed each week for 10 weeks (n=200) after spawning to determine the time window during which there is histological evidence of prior spawning. Dr. Gary Marty, a histology expert, recommended this sampling schedule based on previous experience with Pacific herring histology. Histological evidence of spawning (presence or absence) in samples will be quantified as a percentage of the 20 samples assessed each week.

Field Collections: Approximately 4000 herring will be collected from each field collection, of which approximately 1,600 of which are expected to be females (ADF&G AWL data). Of the 1,600, approximately 800 are expected to be within the targeted age group of 2-5 year olds (ADF&G AWL data). Of the 800 fish, expected sample sizes by age are: 100 age-2's, 224 age-3's, 244 age-4's, 232 age 5's. One hundred fish from each age group will be used for comparison of histological indices of spawning to evidence of spawning in the scales.

D. Description of Study Area

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

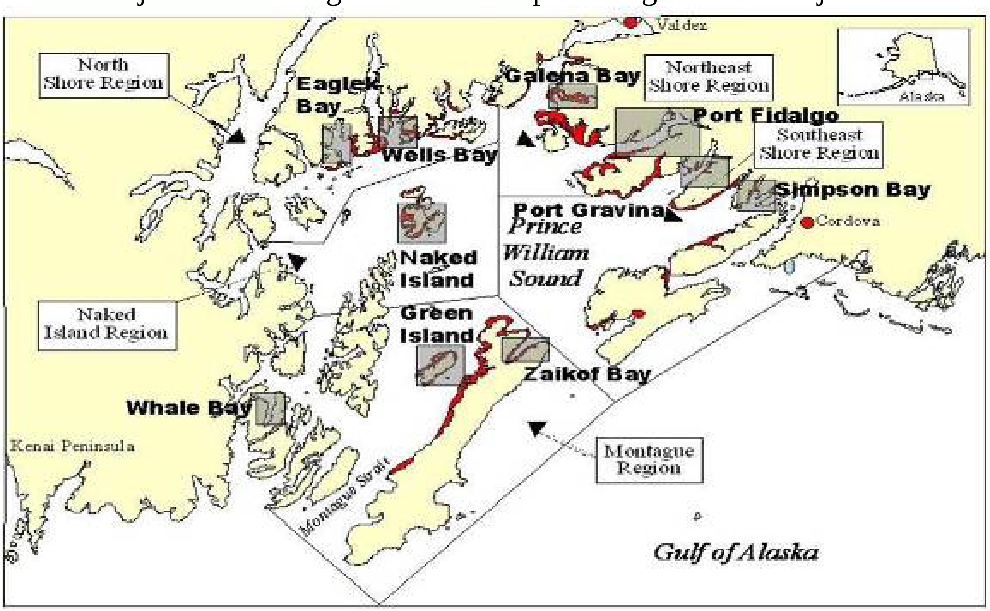

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

III. SCHEDULE

A. Project Milestones

May 2011:	Obtain herring for laboratory study
October 2011:	Receive funding, begin analysis of laboratory samples
June 2012:	Collect scale and histology samples from PWS females (timing depends on results of laboratory study)
January 2013:	Initial results at Alaska Marine Sciences Symposium
March 2013:	Collect scales from spawning herring
January 2014:	Final results at Alaska Marine Sciences Symposium\
March 2014:	Submit final report

B. Measurable Project Tasks

2011	
3rd Quarter (Apr – Jun)	• Collect live herring from Lynn Canal and commence lab study at Auke Bay Labs (In-kind contribution) • Collect monthly samples from lab study
4th Quarter (Jul – Sept)	• Collect monthly samples from lab study
2012	
1st Quarter (Oct – Dec)	• Histological examination of lab samples
2nd Quarter (Jan – March)	• Histological examination of lab samples
3rd Quarter (Apr – Jun)	• Field collections for histological analysis (charter)
4th Quarter (Jul – Sept)	• Histological & scale examination of field collections
2013	
1st Quarter (Oct – Dec)	• Histological & scale examination of field collections
2nd Quarter (Jan – March)	• Collect spawning PWS herring for scale analysis (ADF&G *R/V* Solstice)
3rd Quarter (Apr – Jun)	• Age scales and measure growth increments • Data analysis
4th Quarter (Jul – Sept)	• Data analysis • Submit final report

LITERATURE CITED

Engelhard, G.H. and M. Heino. 2005. Scale analysis suggests frequent skipping of the second reproductive season in Atlantic herring. Biology Letters **1**:172–175.

Junquera, S. and F. Saborido-Rey. 1996. Histological assessment of sexual maturity of the Flemish Cap cod in 1995. NAFO Scientific Council Studies 27:63-67.

III. BUDGET NARRATIVE

Funds are requested for only two years; outlying years are not shown as they incur no cost to the Trustee Council.

Budget Category:	Proposed FY 12	Proposed FY 13	TOTAL PROPOSED
Personnel	$0.0	$0.0	$0.0
Travel	$4,000.0	$3,100.0	$7,100.0
Contractual	$38,000.0	$14,400.0	$52,400.0
Commodities	$3,500.0	$2,500.0	$6,000.0
Equipment	$0.0	$0.0	$0.0
TOTAL	$31,500.0	$20,000.0	$65,500.0

Budget Justification:

FY12

Personnnel ($0):

No funds requested

Travel ($4,000.0):

Funds are requested for Vollenweider and Sewall to travel to Cordova for sample collection trip ($2,110.0).

Funds are requested for Vollenweider and Heintz to travel to the 2013 AMSS meeting in Anchorage ($1,890.0).

Contractual ($38,000.0):

Funds are requested for a contract to Dr. Gary Marty for 3.0 months of scientific consultation ($19,200), travel to Alaska (two trips = $2,400) and analysis of histological samples ($13.50/sample x (1000 field samples + 200 laboratory samples) = $16,200).

Commodities ($3,500.0):

Sample preservation supplies: formalin, storage bags, shipping ($3,500.0)

Equipment ($0):

No funds requested

FY13

Personnnel ($0):

No funds requested

Travel ($3,100.0):

Funds are requested for Vollenweider travel to Cordova for sample collection ($1,110.0).

Funds are requested for Vollenweider to travel to the annual herring meeting in Cordova ($995.0).

Funds are requested for Vollenweider to travel to the 2013 AMSS meeting in Anchorage ($995.0).

Contractual ($14,400.0):

Funds are requested for a contract for scale reading and scanning ($12,000.0)
Funds are requested for a contract for data consolidation ($2,400.0)

Commodities ($2,500.0):

Sample preservation supplies: formalin, storage bags, shipping ($2,500.0)

Equipment ($0):

No funds requested

III. BUDGET NARRATIVE

Funds are requested for only two years; outlying years are not shown as they incur no cost to the Trustee Council.

Budget Category:	Proposed FY 12	Proposed FY 13	TOTAL PROPOSED
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Sample preservation supplies: formalin, storage bags, shipping ($3,500.0)

Equipment ($0):

No funds requested

FY13
Personnnel ($0):
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Funds are requested for a contract for data consolidation ($2,400.0)

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Sample preservation supplies: formalin, storage bags, shipping ($2,500.0)

Equipment ($0):

No funds requested

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 March 17, 2008) and reporting requirements (Procedures for the Preparation and Distribution of Reports**, adopted June 27, 2007).

PROJECT TITLE: **PWS Herring Research and Monitoring: Herring Disease Program (HDP)**

Printed Name of PI **Paul Hershberger, Ph.D.**

Email: **phershberger@usgs.gov**

Mailing Address **USGS – Marrowstone Marine Field Station**
616 Marrowstone Point Road

City, State, Zip **Nordland, WA, 98358**

Phone: **(360) 385-1007, Ext. 225**

Signature of PI: ______________________ Date: ______________

Printed Name of PI ______________________

Email: ______________________

Mailing Address ______________________

City, State, Zip ______________________

Phone: ______________________

Signature of PI: ______________________ Date: ______________

Printed Name of PI ______________________

Email: ______________________

Mailing Address ______________________

City, State, Zip ______________________

Phone: ______________________

Signature of PI: ______________________ Date: ______________

* www.evostc.state.ak.us/Policies/data.cfm
** www.evostc.state.ak.us/Policies/reporting.cfm

FY10 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: PWS Herring Research and Monitoring: Herring Disease Program (HDP)

Project Period: October 1, 2011 – September 30, 2016

Primary Investigator(s): Paul K. Hershberger, USGS – Marrowstone Marine Field Station

Study Location: Field components will be performed in Prince William Sound (adult herring spawning aggregations and juvenile rearing bays), Sitka Sound (adult spawning aggregations), and Puget Sound (adult spawning aggregations). Laboratory components will be performed at the USGS – Marrowstone Marine Field Station.

Abstract:
The *Herring Disease Program (HDP)* is part of a larger integrated effort, Prince William Sound Research and Monitoring (outlined in a separated proposal by Dr. Scott Pegau). Within this integrated effort, the *HDP* is intended to evaluate the impact of infectious and parasitic diseases on the failed recovery of the PWS herring population. The framework for the 2012 – 2016 *HDP* involves a combination of field surveillance efforts, field-based disease process studies, and laboratory-based controlled studies. Field surveillance efforts will provide continued and expanded infection and disease prevalence data for herring populations in Prince William Sound (PWS), Sitka Sound, and Puget Sound. Additionally, samples from field surveillance efforts will be processed using newly developed disease forecasting tools to provide annual risk assessments that quantify the potential for future disease epizootics. Laboratory-based empirical studies will provide an understanding of cause-and effect epidemiological relationships between the host, pathogen, and environment; understanding of these relationships represents a first step towards developing additional disease forecasting tools. Specific emphasis will be placed on refining our understanding disease processes specific to viral hemorrhagic septicemia (VHS) and ichthyophoniasis, two primary diseases of herring in PWS. Additionally, a novel diagnostic tool for Ichthyophonus, a fluorescent in situ hybridization (FISH) probe, will be developed.

Estimated Budget:
EVOS Funding Requested *(must include 9% GA)*

FY12	FY13	FY14	FY15	FY16	Total
$0 K	$0 K	$267.5K K	277.5K	$283.6K	$828.6 K

(NOT TO EXCEED ONE PAGE)

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here are projects for a program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

II. PROJECT DESIGN

A. Objectives

During FY 2012-2016, the Herring Disease Program (HDP) will address the following objectives:

- Provision of disease prevalence data necessary for the ASA herring model
- Provision of disease process studies intended to investigate the seasonality of herring diseases in PWS
- Collection of novel disease forecasting data
- Production of Specific Pathogen-Free Pacific herring intended as laboratory hosts for controlled experiments intended to determine cause-and-effect disease relationships
- Development of a novel diagnostic technique (fluorescent in situ hybridization) intended to provide confirmatory diagnosis of *Ichthyophonus* from histology sections.

B. Procedural and Scientific Methods

Provision of disease prevalence data necessary for the ASA herring model

Disease is now a component in the Age-Structure-Analysis model for Prince William Sound; however, it is not part of the ADF&G sponsored surveys. We will provide the disease information for the ASA model by determining annual prevalence and intensity data for the most virulent pathogens that are currently endemic in the PWS herring populations, including viral hemorrhagic septicemia (VHS), viral erythrocytic necrosis (VEN), and ichthyophoniasis. Monitoring efforts will consist of the annual collection and processing of sixty adult and sixty juvenile herring per site from three sites in PWS to test for disease. Diagnostic techniques for these pathogens will follow standard procedures described in the "Blue Book: Standard procedures for the detection and identification of select fish and shellfish pathogens (American Fisheries Society)." We will also examine efficacy of newly-developed procedures that may forecast the potential for future disease mortalities and simplify the disease surveillance efforts.

Provision of disease process studies intended to investigate the seasonality of herring diseases in PWS

Mortality from infectious and parasitic diseases has been identified as a leading hypothesis accounting for the decline and failed recovery of PWS herring (Marty et al. 1998; Marty et al. 2003; Marty et al. 2010); unfortunately, the location and timing of the acute and / or chronic mortalities remain unaddressed because of difficulties inherent to sampling in marine systems. However, recent empirical studies provide insights into seasonal periods that are critical to disease processes, based on water temperatures and herring behavioral patterns. For example, the probability of viral hemorrhagic septicemia (VHS) epizootics increase as water temperature decreases, because virulence, magnitude and duration of viral shedding, and VHSV persistence in infected hosts increase as the temperature decreases (Hershberger unpublished data). Similarly, the infectivity of *Ichthyophonus* to Pacific herring is inversely related to temperature, with infection prevalence decreasing from 76%, 54%, and 24% at temperatures of 9.3°C, 12°C, and 15.3°C, respectively (Gregg et al 2011).

In association with sampling from other components of this program, we will investigate the seasonality of these diseases by focusing disease surveys during the coldest periods of the year, when *Ichthyophonus* infectivity is highest and VHS is likely to have its greatest impacts. An additional risk factor for VHS mortality includes periods of high aggregation when effective fish-to-fish transmission is most likely to occur (Hershberger et al. 2010; Hershberger et al. submitted); this risk factor is enhanced during cold water periods, when viral shedding from carrier individuals is greatest. Therefore, field disease surveillance efforts will be focused on the overwinter and spring-spawning periods. Additionally, controlled laboratory studies will be performed to further understand cause-and-effect disease relationships and to further develop predictive tools that forecast the potential for disease-related mortality.

Collection of novel disease forecasting data
High-throughput techniques intended to forecast the potential for future herring mortalities caused by viral hemorrhagic septicemia are currently being developed, optimized, and validated. The techniques are based on the well-demonstrated concept that survivors of prior VHS exposure demonstrate resistance to the disease after subsequent exposure to the virus. Therefore, the potential for future VHS epizootics and resulting fish kills can be enumerated if we can determine the prior exposure history and subsequent levels of herd immunity conferred to wild herring populations; whereby previously-exposed populations would have high immunity and a resulting low potential for future VHS impacts. We have successfully developed an enzyme-linked immunosorbent assay (ELISA) that quantifies the prior exposure history of herring populations by detecting levels of circulating antibodies that are specific to VHSV. We are in the final phases of ELISA optimization and validation. This tool will be incorporated into the annual herring assessments to determine the potential for future VHS epizootics in the PWS populations. Additionally, we will continue to develop further disease forecasting tools for VHS and other primary diseases of PWS herring, including ichthyophoniasis and viral erythrocytic necrosis.

Production of Specific Pathogen-Free Pacific herring intended as laboratory hosts for controlled experiments intended to determine cause-and-effect disease relationships
A critical component of both the field surveillance efforts and the empirical disease process studies involves the availability of laboratory host animals with known exposure and disease histories. We have developed techniques to rear specific pathogen-free (SPF) herring and we currently maintain thousands of SPF herring in each of 4 age classes (age 0, 1, and 5 and 6 yr) for use as experimental animals. These laboratory animals are the only SPF herring known to exist and are offered as an in-kind contribution to the proposed project. Additional colonies need to be developed and maintained to satisfy the needs described in this proposal.

Colonies of specific pathogen-free (SPF) Pacific herring will be reared at the USGS - Marrowstone Marine Field Station each year, taking special precautions to prevent their exposure to marine pathogens or antigens of marine pathogens through the rearing water or feed. As a source of SPF Pacific herring, naturally deposited herring eggs attached to submerged macrophytes will be collected from locations in Puget Sound, WA. Herring eggs and associated macrophytes will be transported to the USGS, Marrowstone Marine Field Station, where they will be incubated in 260 L tanks supplied with single-pass, processed seawater. Ambient seawater will be processed by double sand-filtration, 100 µm particle filtration, and double UV-irradiation prior to delivery to culture facilities where SPF herring will be reared and live feeds will be produced. Submerged macrophytes will be removed from the tanks after yolk sac larvae have emerged. Early larvae will be fed live rotifers (*Brachionus plicatilis*) and later weaned to

Artemia nauplii (*Artemia franciscana*, instar 1-2). Live rotifer colonies will be maintained on concentrated algae, (*Isochrysis* sp., *Nannochloropsis* sp.) and Artemia will be hatched daily from chlorine-decapsulated cysts; both live feed items will be enriched with Super Selco® (INVE Aquaculture; Dendermonde, Belgium), Protein HUFA (Salt Creek Inc., Salt Lake City, Utah), or Algamac 3050 (Aquafauna Bio-Marine, Hawthorne, California) for 12 hr prior to use. The enrichments will be rotated daily. Herring larvae will later be weaned onto Cyclop-eeze™, a product of frozen copepods harvested from a freshwater Arctic lake (Argent Laboratories, Redmond, WA).

Development of a novel diagnostic technique (fluorescent in situ hybridization) intended to provide confirmatory diagnosis of Ichthyophonus from histology sections.
Fluorescent *in situ* hybridization (FISH) allows specific nucleic acid sequences to be identified in morphologically preserved cells or tissues. FISH is often used for specific identification of a pathogen in host tissues, but has also been used for a wide range other applications, including the identification (using epifluorescence microscopy) or quantification (using flow cytometry) of microbial and fungal communities in aquatic environments (Amann and Fuchs 2008; Jobard, Rasconi et al. 2010). The most common nucleic acid targets are regions within the ribosomal gene complex; this gene region is widely used for phylogenetic analyses. The fluorescently-labeled oligonucleotide probes diffuse into permeabilized cells and hybridize to homologous DNA or RNA sequences. A major drawback of the technique can be low sensitivity due to the ribosome content in the cells or high background due to autofluorescence (Jobard, Rasconi et al. 2010). However, assay sensitivity can be improved using probes labeled with horseradish peroxidase (HRP) which catalyze multiple fluorescent labeled tyramides (Catalyzed reporter deposition (CARD)-FISH) (Schmidt, Chao et al. 1997).

There are currently no FISH assays available for the detection of *Ichthyophonus* but methods have been developed for other members of the Class Mesomycetozoea. ISH has been used to successfully to identify *Rhinosporidium seeberi* in human tissues and lake water (Fredericks, Jolley et al. 2000; Kaluarachchi, Sumathipala et al. 2008) and *Anurofeca richardsi* spores in frog feces (Baker, Beebee et al. 1999),

Ichthyophonus-specific oligonucleotide probes will be designed to conserved portions of the 18S small subunit (SSU) ribosomal gene; the SSU gene has been sequenced in a range of *Ichthyophonus* isolates (Criscione, Watral et al. 2002; Rasmussen, Purcell et al. 2010). Heart and skeletal muscle tissue from *Ichthyophonus* infected herring will subjected to routine processing and paraffin embedding using published procedures (Garver, Conway et al. 2005). Serial 5 µm tissue sections will be subjected to ISH using previously described methods (Carnegie, Meyer et al. 2003) (Fredericks, Jolley et al. 2000). Briefly, fluorescently-labeled oligonucleotide probes will be purchased commercially. Sections will de-paraffinized, re-hydrated and digested with proteinase K and/or lysozyme. Probes will be hybridized to the sections, washed and slides will be examined by epifluorescence microscopy. A variety of parameters will be evaluated for optimal assay performance, including (1) probe design, (2) fluorochrome choice, (3) tissue fixation procedures, (4) hybridization conditions and (5) use of tyramide signal amplification (CARD-FISH) to enhance sensitivity.

Assay development and validation will be performed using tissues sampled from laboratory-challenged Pacific herring and *Ichthyophonus* culture. Assay sensitivity will be compared to tissue explant culture and histopathological examination. Specificity will be tested using fish infected with the freshwater form of *Ichthyophonus* (Hershberger, Pacheco et al. 2008; Rasmussen, Purcell et al. 2010) as well as tissue samples infected with other mesomycetozoeans (obtained from various collaborators).

C. Data Analysis and Statistical Methods

Standard statistical comparisons for pathogen virulence studies will be employed in all experiments. For example, percent cumulative mortalities in replicate tanks / aquaria will be arc sin transformed and transformed means from all groups will be statistically compared using Student's T-test (1-tailed) or ANOVA followed by the Tukey test for multiple comparisons. In non-replicated tanks, percent mortality in control and treatment groups will be statistically compared using the Chi Square statistic (χ^2). Statistical significance will be assigned to all comparisons with $p \leq 0.05$. Prevalences of infection and disease in wild populations from Prince William Sound, Sitka Sound, and Puget Sound will be based on minimum sample sizes of 60 fish, sufficient to detect 5% population prevalence with 95% confidence.

D. Description of Study Area

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

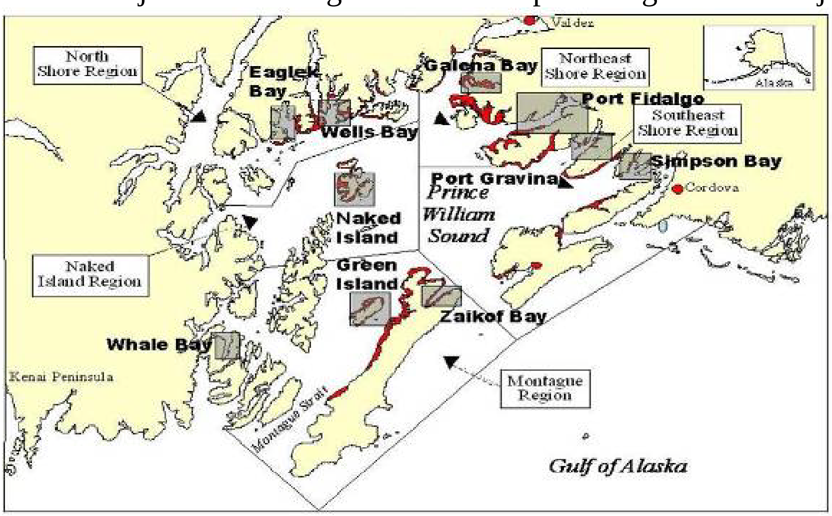

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

Herring collection sites in Sitka Sound and Puget Sound will be determined by the respective management authority in each region (ADF&G and WDF&W, respectively), but are likely to include locations similar to those described in Table 1.

Laboratory studies described in this proposal will be conducted at the USGS-Marrowstone Marine Field Station, and USGS-Western Fisheries Research Center where facilities ideally designed to safely and responsibly conduct experiments using endemic fish pathogens. The Marrowstone Marine Field Station represents the sole seawater-based biological research facility for the USGS. Facilities include three large wet laboratory buildings with approximately 10,000 square feet of wet laboratory space, replicated with approximately 60,000 liter tank capacity, and supplied with 400 gpm of high quality filtered and UV irradiated seawater. Back-up, redundant water treatment systems are incorporated into the supply water for each wet laboratory. Separate laboratory buildings are designated as specific pathogen-free nursery zones and experimental pathogen manipulation zones. Laboratory effluent water is disinfected with chlorine and treated to insure safe and responsible handling of endemic pathogens. The Western Fisheries Research Center (WFRC) is recognized as an international leader in fish health research. The WFRC maintains fish health laboratory facilities which are among the newest and best in the nation. The facility operates a state-of-the-art fresh water wet laboratory that is completely climate controlled and automated for disease challenges and studies in physiology and pathology. The nation's only Biosafety Level III disease containment wet laboratory for fish is also part of this facility. Additionally, the Center maintains fully equipped laboratories for molecular biology, virology, bacteriology, immunology, and histopathology.

III. SCHEDULE

A. Project Milestones

- ***Provision of disease prevalence data necessary for the ASA herring model***
  To be met by June 30 each year.
- ***Provision of disease process studies intended to investigate the seasonality of herring diseases in PWS***
  Laboratory diagnostics will be completed <8 weeks after sample collections in the field
- ***Collection of novel disease forecasting data***
  Laboratory diagnostics will be completed <4 weeks after the sample collections in the field
- ***Production of Specific Pathogen-Free Pacific herring intended as laboratory hosts for controlled experiments intended to determine cause-and-effect disease relationships***
  SPF juveniles will be produced by July 15 each year
- ***Development of a novel diagnostic technique (fluorescent in situ hybridization) intended to provide confirmatory diagnosis of Ichthyophonus from histology sections.***
  Will be developed by Sept 30, 2014.

B. Measurable Project Tasks

Every Fiscal Year (FY 2014 - 2016)

1st Quarter (October 1-December 31)

- Project funding approved by TC
- Perform empirical disease studies in the laboratory

2nd Quarter (January 1-March 31)

- Attend Alaska Marine Science Symposium and present results

- Collect herring eggs for rearing SPF colonies
- Begin collecting adult herring to determine infection and disease prevalence
- Perform empirical disease studies in the laboratory

3rd Quarter (April 1-June 30)
- Finish collecting and processing spring adult herring to determine infection and disease prevalence.
- Participate in PI meeting in Cordova
- Perform empirical disease studies in the laboratory

4th Quarter (July 1- Sept. 30)
- Perform empirical disease studies in the laboratory

Additional Quarterly Tasks

FY14, 1st quarter (October-December 31, 2013)
- Begin FISH development

FY14, 4th quarter (July 1 – Sept 30, 2014)
- Complete FISH development

FY16, 1st quarter (October 1 - December 31, 2015)
- Start drafting final report
- Participate in 1st PI integration meeting

FY16, 2nd quarter (January 1 - March 31, 2016)
- Participate in 2nd PI integration meeting

FY16, 4th quarter (July - September 30, 2016)
- Respond to peer review comments, acceptance and publication of final report

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ABBREVIATED RESUME

Paul K. Hershberger, Ph.D.
Marrowstone Marine Field Station, USGS-BRD
616 Marrowstone Point Road, Nordland, WA 98358
Telephone: (360) 385-1007, Ext 225, Email: phershberger@usgs.gov

Professional Interests

Disease ecology and processes affecting the health and survival of wild fishes
Effects of multiple stressors on the health and survival of wild fishes
Climatic/oceanic factors affecting populations of wild fishes

Membership in Professional Organizations

American Fisheries Society (AFS), and Fish Health Section (FHS)
International Society of Aquatic Animal Epidemiology (ISAAE)
Pacific Northwest Society of Environmental Toxicology and Chemistry (PNW SETAC)

Recent Positions

2004 – Present: Affiliate Assistant Professor: School of Aquatic and Fishery Sciences, University of Washington.
2003 – Present: Research Fishery Biologist and Station Leader: USGS- BRD, Marrowstone Marine Field Station
1999-2003: Faculty Research Associate - University of Washington
2003: Co-Instructor, UW – Friday Harbor Labs: FISH-499B "Emerging Diseases and Latent Infections in Aquatic Organisms"
2001: Instructor, UW – School of Aquatic and Fishery Sciences: FISH 404 "Diseases of Aquatic Organisms"
2001: Co-Instructor, UW – Friday Harbor Labs: FISH 499B: "Latent Viruses in Marine Fish,"
2000: Co-Instructor, UW – Friday Harbor Labs: FISH-499B: "Marine Fish Disease Research"

Education:

Ph.D. Fisheries, University of Washington 1998
M.S. Fisheries, University of Washington 1995
B.S. Chemistry & Biology, Northland College (Manga Cum Laude) 1993

Recent Awards and Honors:

2008: USGS STAR Award
2004: USGS Exemplary Act Award
2004: USGS STAR Award
2001: Most significant paper of the year 2001: Journal of Aquatic Animal Health

Five Selected Publications Relevant to this Proposal:

Vollenweider, J.J., J. Gregg, R.A. Heintz, P.K. Hershberger. 2011. Energetic cost of *Ichthyophonus* infection in juvenile Pacific herring (*Clupea pallasii*). Journal of Parasitology Research.doi:1155/2011/926812, 10 pp

Gregg J, J Vollenweider, C Grady, R Heintz, P Hershberger. 2011. Effects of environmental temperature on the dynamics of ichthyophoniasis in juvenile Pacific herring (*Clupea pallasii*). Journal of Parasitology Research. doi: 10.1155/2011/563412, 9pp.

Grady, C.A., J.L. Gregg, R.M. Collins, P.K. Hershberger. 2011. Viral Replication in Excised Fin Tissues (VREFT) corresponds with prior exposure of Pacific herring, *Clupea pallasii* (Valenciennes), to *viral haemorrhagic septicaemia virus* (VHSV). Journal of Fish Diseases 34: 34:-12.

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Five Additional Selected Publications

Kocan R, H Dolan, P Hershberger. 2011. Diagnostic methodology is critical for accurately determining the prevalence of *Ichthyophonus* infections in wild fish populations. Journal of Parasitology 97: 344-348.

Hart L, GS Traxler, KA Garver, J Richard, JL Gregg, CA Grady, G Kurath, PK Hershberger. 2011. Larval and juvenile Pacific herring *Clupea pallasii* are not susceptible to infectious hematopoietic necrosis under laboratory conditions. Diseases of Aquatic Organisms 93: 105-110.

Hershberger, P.K., B.K. van der Leeuw, J.L. Gregg, C.A. Grady, K. Lujan, S. Gutenberger, M. Purcell, J.C. Woodson, J.R. Winton, M. Parsley. 2010. Amplification and transport of an endemic fish disease by an invasive species. Biological Invasions 12: 3665-3675.

Hershberger PK, JL Gregg, CA Grady, RM Collins, JR Winton. 2010. Susceptibility of three stocks of Pacific herring to viral hemorrhagic septicemia. Journal of Aquatic Animal Health 22: 1-7.

Kocan, R. M., J. L. Gregg, P. K. Hershberger. 2010. Release of infectious cells from epidermal ulcers in *Ichthyophonus* sp. – infected Pacific herring (*Clupea pallasii*): evidence for multiple mechanisms of transmission. Journal of Parasitology 96: 348-352.

Recent Collaborators and Co-Authors:

W. Batts (USGS-WFRC), B. Bui (UW-FHL), E. Emmenegger (USGS), N. Elder (USGS), D. Elliott (USGS), J. Gregg (USGS), J. Hansen (USGS), R. Kocan (UW-SAFS), G. Kurath (USGS), S. LaPatra (Clear Springs Foods), M. Purcell (USGS), J. Richard (DFO), N. Sholtz (NMFS – NW Center), K. Stick (WDFW), G. Traxler (DFO), N. Van der Straaten (UW-FHL)

<u>Budget Justification</u>

Personnel Costs = $382.8K

FY12 ($0)
None requested: personnel are provided in the currently funded HDP.

FY13 ($0)
None requested: personnel are provided in the currently funded HDP.

FY14 ($170.4K)
Funding is requested to support a GS-7 laboratory technician ($60 K) at the Marrowstone Marine Field Station to perform laboratory studies, process samples from laboratory studies, perform predictive disease assays, and process Puget Sound herring survey samples. Funding is also requested to support a GS-7 laboratory technician ($60K) at the Western Fisheries Research Center, where development of the FISH will occur. Funding is also requested for student interns ($50.4K total) who will assist with the rearing of larval herring and with empirical studies.

FY15 ($186.6K)
Continued funding is requested to support a GS-7 laboratory technician ($62.4 K) at the Marrowstone Marine Field Station. A GS-9 post doc ($72.0 K) will be hired to assist with empirical laboratory studies. Funding is also requested for student interns ($52.2K total) who will assist with the rearing of larval herring and with empirical studies.

FY16 ($190.8)
Continued funding is requested to support a GS-8 laboratory technician ($63.6 K) and a GS-9 post doc ($73.2K) at the Marrowstone Marine Field Station; responsibilities will be the same as the previous year. Funding is also requested for student interns ($54.0K total) who will assist with the rearing of larval herring and with empirical studies.

Travel Costs = $37.0 K

FY12 ($0)
None requested: travel costs are provided in the currently funded HDP.

FY13 ($0)
None requested: travel costs are provided in the currently funded HDP.

FY14 ($ 17.0 K)
Round trip travel costs from Nordland, WA are requested for two pathologists to perform field sampling in PWS ($7.6K), perform Sitka field sampling ($3.2K K), present at the annual Marine Science Symposium ($3.4K). Additional travel support is requested (2.8K) for the PI to participate in the annual herring integration meeting in Cordova.

FY15 ($17.0 K)

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FY16 ($18.4 K)
Round trip travel costs from Nordland, WA are requested for two pathologists to perform field sampling in PWS ($7.6K), perform Sitka field sampling ($3.2K K), present at the annual Marine Science Symposium ($3.4K). Additional travel support is requested (4.2K) for the PI to participate in the annual herring integration meeting in Cordova.

Contractual Costs = $236.6K

FY ’12 ($0 K)
None Requested.

FY ‘13 ($0 K)
None Requested

FY ‘14 ($12.0 K)
Funding for a subcontract ($12.0K), administered through WFRC, is requested to include two months salary for a fish health professional with expertise working with VHS and *Ichthophonus*.

FY’15 ($12.0 K)
Funding for a subcontract ($12.0K), administered through WFRC, is requested to include two months salary for a fish health professional with expertise working with VHS and *Ichthophonus*.
.
FY’16 ($12.0 K)
Funding for a subcontract ($12.0K), administered through WFRC, is requested to include two months salary for a fish health professional with expertise working with VHS and *Ichthophonus*.

Commodities = $124.0 K

Commodities for FY 2014-2016 include laboratory supplies for the Marrowstone Marine Station ($15.0-17.0K/yr for fish food, $20.0 -22.0K for dry lab supplies). Separate funding ($13.2 K/ yr) is requested for ADF&G Pathology Laboratory in Juneau to process PWS and Juneau herring samples.

New Equipment / Existing Equipment Usage: $0
No new equipment with a life span of more than one year and a unit value greater than $1,000 is needed or requested for this project.

Data Management and Quality Assurance / Quality Control (QA/QC) Statement:
The USGS, Marrowstone Marine Field Station and Western Fisheries Research Center comply with all data management and QA/QC policies described in the USGS-Survey Manual describing Fundamental Science Practices, particularly:
- SM 502.1, Fundamental Science Practices Foundation Practices, http://www.usgs.gov/usgs-manual/500/502-1.html
- 502.2 - Fundamental Science Practices: Planning and Conducting Data Collection and Research, http://www.usgs.gov/usgs-manual/500/502-2.html
- 502.3 - Fundamental Science Practices: Peer Review, http://www.usgs.gov/usgs-manual/500/502-3.html
- 502.4 - Fundamental Science Practices: Review, Approval, and Release of Information Products, http://www.usgs.gov/usgs-manual/500/502-4.html
- 205.18 - Authority to Approve Information Products, http://www.usgs.gov/usgs-manual/200/205-18.html
- Part 1100 – Publishing, http://www.usgs.gov/usgs-manual/t500.html#pubs

Additionally, both laboratories maintain accreditation with the Association for Assessment of Laboratory Animal Care (AALAC) through semiannual inspections and certifications with the University of Washington Institutional Animal Care and Use Committee (IACUC), overseeing laboratory animal welfare and human health issues associated with utilizing live animals for experimental purposes.

The USGS Marrowstone Marine Field Station and Western Fisheries Research Center maintain semiannual certification with the University of Washington Institutional Animal Care and Use Committee that oversees both laboratory animal welfare and human health issues associated with utilizing live animals for experimental purposes. Additionally, both facilities are inspected twice annually by an internal Institutional Animal Care and Use Committee, and both laboratories conform to Title 21 Code of Federal Regulations: Good Laboratory Practice for Nonclinical Laboratory Studies.

Budget Justification

Personnel Costs = $382.8K

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None requested: personnel are provided in the currently funded HDP.

FY13 ($0)
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Travel Costs = $37.0 K

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None requested: travel costs are provided in the currently funded HDP.

FY13 ($0)
None requested: travel costs are provided in the currently funded HDP.

FY14 ($ 17.0 K)
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Contractual Costs = $236.6K

FY ’12 ($0 K)
None Requested.

FY ‘13 ($0 K)
None Requested

FY ‘14 ($12.0 K)
Funding for a subcontract ($12.0K), administered through WFRC, is requested to include two months salary for a fish health professional with expertise working with VHS and *Ichthophonus*.

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FY’16 ($12.0 K)
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Commodities = $124.0 K

Commodities for FY 2014-2016 include laboratory supplies for the Marrowstone Marine Station ($15.0-17.0K/yr for fish food, $20.0 -22.0K for dry lab supplies). Separate funding ($13.2 K/ yr) is requested for ADF&G Pathology Laboratory in Juneau to process PWS and Juneau herring samples.

New Equipment / Existing Equipment Usage: $0
No new equipment with a life span of more than one year and a unit value greater than $1,000 is needed or requested for this project.

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Herring Condition Monitoring

Project Period: federal fiscal years of 2013 to 2016 (October 1, 2012 – September 30, 2016)

Primary Investigator(s): Thomas C. Kline, Jr., Ph. D., Prince William Sound Science Center
Ron Heintz, Ph. D., National Oceanic and Atmospheric Administration (NOAA) Alaska Fisheries Science Center (AFSC) Auke Bay Laboratories (ABL)

Study Location: Prince William Sound

Abstract:
Outlined here is a single herring monitoring project that is a part of an integrative program that will enhance the current herring monitoring efforts and examine aspects of particular life stages to allow better modeling of Prince William Sound herring populations. The long-term goal of the program is to improve predictive models of herring stocks through observations and research.

This project will be furthering the development of a herring overwintering mortality model that began with an ongoing monitoring project that began in 2007 and incorporates results from Prince William Sound herring research dating as far back as the 1990's. The model runs by applying herring condition observations made before and after winter. Accordingly, herring are sampled in November and the following March. Present sampling will end in March 2012. Proposed sampling will commence in November 2012 and end in March 2016. A future project is expected to continue the time series beginning in November 2016. The purpose of the time series is to relate overwinter mortality to herring recruitment.

This project will be furthering the development of a herring overwintering mortality model with additional data types as well energy levels per se. The goal is use physiological indicators to realistically modify the daily energy loss rate in the overwintering model. The results of model improvement will be tested using the March data model validation approach begun during the project that began in 2007.

Additionally, we will be assessing effects of competition of other juvenile fishes on condition of age-0 herring using stable isotope analysis on an opportunistic basis.

Estimated Budget:
EVOSTC Funding Requested:
To PWSSC: 141.7K (FY13), 147.1K (FY14), 156.7K (FY15), 162.3K (FY16)
To NOAA: 81K (FY13), 83.9K (FY14), 87.1K (FY15), 84K (FY16)
Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date: 1 June 2011

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the Exxon Valdez Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here is a single project that is a part of an integrative program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. The long-term goal of the program is to improve predictive models of herring stocks through observations and research. While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

Studies conducted since the 1990's suggest that age-0 PWS herring begin winter deficient in energy, which leads to significant overwinter mortality. Starvation was confirmed by using RNA/DNA as a physiological indicator. It is hypothesized that when these constraints are relaxed, first winter survival is much greater and this leads to a good recruitment.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach. This particular project falls into the monitoring study category.

II. PROJECT DESIGN

A. Objectives

We have sought input for the design of the first five-year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

Objectives specific to this project:

Objective 1. Monitor juvenile herring condition by sampling in November
Objective 2. Monitor juvenile herring condition by sampling in March
Objective 3. Apply resultant observations from objectives 1 and 2 to continue refining an overwintering mortality model with the addition of physiological indicators
Objective 4. Assess competition interactions with fishes using stable isotope analysis

B. Procedural and Scientific Methods

Overwinter energy loss based mortality modeling

Each year the Herring Condition Monitoring (HCM) project will make a prediction using an HCM overwinter mortality model (**Objective 3**), which will use the energy density observed in November

(**Objective 1**) as model initial conditions. In addition to predicting mortality, the model predicts the frequency distribution of the population's March energy density assuming that there was no energy intake during winter. The difference between predicted and observed March distribution (**Objective 2**), which is currently very small, may lead to better forecasting if starvation is what is driving recruitment. The long-term goal is to develop a time series of these differences (each year being one difference, i.e. one data point, when considering the PWS as a whole) and correlate it to the resultant recruitment to test this hypothesis.

The initial overwinter mortality model and the methods used to obtain energy density are as described in Kline and Campbell (2010). Briefly, age-0 herring will be sampled in select Prince William Sound herring nursery bays in November and the following March (**Objectives 1 and 2**). By using energy density mortality criteria based on the experimental work of Paul and Paul (1998), the HCM overwinter mortality model is presently an improvement over the overwinter mortality model of Kline and Campbell (2010), which used a single "knife-edge" mortality criterion. This improved model predicted a March energy density frequency distribution that was much closer to that actually observed (Kline 2011). It remained skewed reflecting energy uptake by a small fraction of the population.

The next step is to incorporate physiological parameters (**Objective 3**). This is important because there are two ways in which starvation-related herring mortality might be reduced during winter, one is to begin winter with higher energy density (which can be observed directly) and second, by feeding during winter. A portion of the herring that have been sampled had non-empty stomachs. However, using that information is problematic because of sampling bias and possible sampling artifacts; physiological indicators are expected to more quantitatively reflect a herring population's foraging status.

The HCM overwinter mortality model assumes a winter fast. If fasting extends into starvation then mortality can be expected to occur. Use of proximate analysis and RNA/DNA can indicate the nutritional state and feeding status of fish (Sewall et al. 2011). By contrasting the relative contributions of lipid and protein to overwinter energy loss we can establish the proportion of fish found starving at the end of winter. Similarly, by comparing the RNA/DNA levels with levels known from starving and fed fish we can determine if fish in the field are actively feeding. Hence, combining proximate analysis, RNA/DNA and energy density analysis will enable the mortality model to provide better estimates of potential mortality.

Competition assessment

Other small fishes are routinely sampled alongside age-0 herring. These are assumed to be sympatric with herring and are important as potential competitors (Kline and Campbell 2010). Their presence and competition with herring may be driving the observed low herring energy density and consequent mortality. We may gain insight if for example we observed that herring were in better condition when there was reduced competition. Competitors may gain energy, or at least break even, at the expense of herring (Paul et al. 1998). Their interaction with age-0 herring has varied over time (Kline and Campbell 2010). We therefore need an index of competition that could be incorporated into the HCM overwinter mortality model. The mass spectrometric method used to obtain C/N ratio used to calculate energy density also provides natural stable isotope abundance, which is used to assess species interaction (**Objective 4**; e.g., Kline and Campbell 2010). We can thus add a sympatric species interaction component to the HCM model at the relatively low cost of the additional analyses of the sympatric species (N ~ 100 to 200 per year according to actual catch).

C. Data Analysis and Statistical Methods

Experimental Design

Sampling will continue to follow the present experimental design (Kline and Campbell 2010). Sampling occurs during November and March and is focused on four reference bays, known as the SEA bays since they were established as reference sites during the SEA project of the 1990's (Norcross et al. 2001). As well, approximately two other bays will be selected according to observations of herring distribution made by acoustics surveys and available cruise time, which is generally weather-dictated. The size distribution of age-0 herring can vary considerable by bay dictating that sampling additional bays is prudent. A goal of the synthesis will be to assess the effects of sampling in order to improve long-term monitoring.

Sample sizing is based on recent past history of herring sampling in PWS (Kline and Campbell 2010). Relatively large samples are needed to initialize the HCM overwinter mortality model. Because of the high mortality between November and March, the effective sample size after mortality is accounted for is only about 20% of the starting number (Kline and Campbell 2010). Because the model simulates overwinter mortality, those herring expected to die are subtracted from the simulated population like those from the actual population. For example, with a starting number of 100 herring in a given bay, there will be about 20 left in March to compare with observed March data. This is an absolute minimal amount for comparing frequency distributions in March. As part of the synthesis we will evaluate the effect of sample size on the model and make recommendations for future sampling. Sample size evaluation will involve simulating larger sample sizes, which will be done by data aggregation, such as pooling data across bays within one year or across years for one bay. This necessarily requires multiple years of data collected in the same way, which will be achieved by this project.

Time series approach

This project is, in part, a continuation of herring energy level monitoring in November and March that began in 2007. One goal is to observe one or more year classes that recruit well. For example, in the decade prior to the *Exxon Valdez* oil spill, there were several good recruitments; these numbered on the order of one billion herring at age three (Funk 2007). In recent years, herring recruitment has been on the order of tens of millions or only about one per cent of a good recruitment. Strong recruitments may occur again. If this should happen, a goal will be to assess what the condition of those herring were when they were at age-0. This will only be possible if the data are on hand. Furthermore, the poor recruitment years, such as we have been experiencing, will provide context (i.e., baseline values) for comparing with strongly recruiting cohorts. The time series will provide both before and after winter baseline values, making it possible to assess if strong year classes are determined prior to winter such as by having much higher November values (relative to the baseline) or if strong year classes are determined during winter such as my having much higher values in March without also having higher November values.

Table of time series of herring energy observations (by year and month of sampling) resulting from a past, ongoing, and future projects. Year classes recruiting in their third year from sampled age-0 cohorts as indicated. HFC = Herring Forage Contingency project, HERF = PWS Survey: Herring Energy Recruitment project, HCM = Herring Condition Monitoring project (this proposal).

Calendar Year	Sampling Period	Recruiting Year Class	Project doing the sampling
2007	March	2009	HFC
	November	2010	HFC
2008	March		HFC
	November	2011	HFC
2009	March		HFC
	November	2012	HERF
2010	March		HERF
	November	2013	HERF
2011	March		HERF
	November	2014	HERF
2012	March		HERF
	November	2015	HCM
2013	March		HCM
	November	2016	HCM
2014	March		HCM
	November	2017	HCM
2015	March		HCM
	November	2018	HCM
2016	March		HCM
	November	2019	future project
2017	March		future project
	November	2020	future project
2018	March		future project
	November	2021	future project
2019	March		future project
	November	2022	future project
2020	March		future project
	November	2023	future project
2021	March		future project

Data analysis

Herring will be measured for wet mass, dry mass, and length (fork and standard). Water content is calculated from these data. Samples will be ground to a fine power and analyzed for C/N ratio using an Elemental Analyzer mated to a Continuous Flow Isotope Ratio Mass Spectrometer. Energy density will be calculated from these data (Arrhenius and Hanson 1996, Paul et al. 2001, Kline and Campbell 2010). Energy density data are applied to the HCM overwinter mortality model as model initial conditions and for comparison with model predictions made for March (this ending time was selected to match our March observations; other ending times are also possible). Energy density will also be measured using bomb calorimetry on ten percent of the samples. This dual approach is used for quality control - quality assessment; it provides the means for assessing systematic error (Kline and Campbell 2010).

D. Description of Study Area

The study area includes all of Prince William Sound (N, E, S, and W boundaries of respectively, ~ 61, -145.5. 60, and -149°). However, most of the project will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment (SEA) and PWS Herring Survey programs (Figure 2). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question “What is the appropriate sampling distribution?” as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

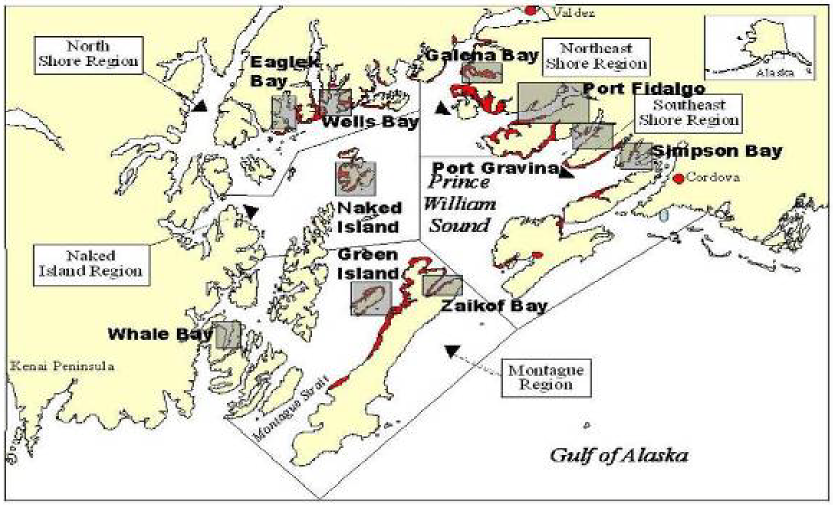

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is structured to be part of a collaborative programmatic effort being led by the Prince William Sound Science Center. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Scott Pegau will act as the program team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program. He will also be responsible for outreach and public input efforts.

Dr. Pegau currently is the coordinator of the existing EVOSTC funding PWS Herring Survey program. This program consists of ten individual projects that provide a coordinated examination of juvenile herring in Prince William Sound. This proposal is heavily influenced by the early findings from that effort. Dr. Pegau also serves as the Research Program Manager for the Oil Spill Recovery Institute (OSRI). In that capacity he is responsible for developing annual work plans, ensuring proper reporting, making reports available, developing partnerships to leverage funding, and to ensure outreach of OSRI activities. All activities that provide experience delivering the team leader duties outline in the request for proposals.

One of his duties is to ensure proper scientific oversight of the research programs. To accomplish this we will be setting up a four-person scientific oversight panel that will help guide the program and ensure the research is relevant to the long-term goal. The team will consist of people representing Alaska Department of Fish and Game, the National Oceanic and Atmospheric Administration, academia, and the local fishing community. There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year's work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermen United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydro-acoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

Other important programs for coordinating with are the existing PWS herring survey program and existing ADF&G herring research. This program has been developed with input from both of these programs and the focus of this proposal is extending the interpretation of the data from those two programs. The Herring Survey program will still be operating in FY12 and FY13. There are field observations scheduled in FY12 and in FY13 funds are strictly for analysis and report writing. Included in the report writing is a synthesis of previous and current research. This report will be finished in FY13 and be the basis for the synthesis required under this request for proposals.

Lead Principal Investigator Dr. Thomas C. Kline, Jr. will be responsible for the execution of project's energy observations and energy modeling and oversight of the proposed project. Dr. Kline is a world-leader in applying natural stable isotope abundance to fish ecology problems. Dr. Kline has been a research scientist at the Prince William Sound Science Center (PWSSC) since 1995. During this time he has led numerous projects on the oceanography of Prince William Sound and adjacent Gulf of Alaska. He has published numerous research papers based on the resulting data.

Dr. Kline is currently the principal investigator of the *Exxon Valdez* Oil Spill Trustee Council project 'Prince William Sound Herring Survey: Pacific Herring Energetic Recruitment Factors**'** that is investigating the role of food sources and energy status of herring for recruitment. He was the principal investigator of several previous *Exxon Valdez* Oil Spill Trustee Council projects that had a herring focus. These included Herring Forage Contingency (2007-9), Productivity Dependencies: Stable Isotopes (1998-9), and Sound Ecosystem Assessment: Conforming Food Webs of Fishes with Stable Isotope Tracers (1995-8). Results of these projects have been incorporated into approximately two-dozen scientific publications. The data from the existing project and past projects will synergize with this proposed project.

Co-Principal Investigator Dr. Ron Heintz will be responsible for the execution of the RNA/DNA aspects of the proposed project. Heintz has been involved in Trustee herring studies aimed at contrasting energy loss rates of herring in different stocks (Project 100806) and examining the impacts of humpback whale predation on herring (Project 100804). In addition, Heintz is leading a study of RNA/DNA as a predictive tool for age-0 survival in PWS (10100132-D). In addition this study will contribute samples to the study proposed by Heintz and Sewall titled *"Fatty Acid Analysis as Evidence for Winter Migration of Age-0 Herring"*. A subset of the samples collected for RNA/DNA will be used for the fatty acid analysis.

Both investigators are also investigators of ongoing herring condition monitoring projects that are part of the herring program as well as a separate process study proposal assessing fine scale temporal and spatial variation at one site. This multiple project role will facilitate near real-time integration of project results. Both investigators will contribute to programmatic synthesis scheduled to take place in FY14.

The effectiveness of collaboration is often inversely proportional to the number of people gathered together. Therefore, as well as participating with the collective program, the investigators will be collaborating more closely together and with smaller groups of the other investigators within the program. This is necessary for focused work on model refinement and for writing reports and scientific publications. While much of this collaboration will be done using long-distance communication such as email, there is also a need a for face to face meetings, which will be done opportunistically during larger meetings (such as the January symposium) and on trips dedicated to this purpose.

As part of the integrated herring program, this project will be interacting with virtually all other aspects of the program. Personnel from multiple projects will be working in cooperation. This project will furnish one field technician for field sampling. This technician will be expected to cooperate with other projects during this sampling. For example, Dr. Kline's current technician has been simultaneously collecting, sorting, and preparing samples for multiple investigators such as Dr. Hershberger's disease samples as part of research cruise duties. Field sampling is being conducted on shared research vessels, with funding for vessel charter time outside the scope of this project.

The following table summarizes project tasks with responsible investigator indicated by initials:

1. (TK) Systematically assess energy levels of age-0 herring before and after winter (November and March).

2. (TK) Use stable isotope data that is a by-product of the energy analysis to assess changes in competition for food resources with sympatric species over time.

3. (TK) Model overwintering mortality using data from (1) and evaluate year-to-year mortality change in the context of (2) and (4) through collaborating with Heintz.

4. (RH) Systematically assess RNA/DNA and proximate composition of age-0 herring before and after winter.

5. (RH) Collaborate with Kline per (3).

6. Both P.I.'s will contribute to the synthesis effort in 2013 and workshop in 2014.

III. SCHEDULE
A. Project Milestones

Objective 1. **Monitor juvenile herring condition by sampling in November**
Sampling to be met by November 2015, analysis of samples collected through November 2014 by November 2015, incorporation of data generated through November 2015 into project synthesis by March 2016, and incorporated into herring program by August 2016

Objective 2. **Monitor juvenile herring condition by sampling in March**
Sampling to be met by March 2016, analysis of samples collected through March 2015 by March 2016, incorporation of data generated through March 2015 into project synthesis by April 2016, and incorporated into herring program by August 2016

Objective 3. **Apply resultant observations from 1 and 2 to and continue refining an overwintering mortality model using these observations**.
To be met by April 2016

Objective 4. **Assess competition interactions with fishes using stable isotope analysis**
To be met by April 2016 using data reflecting the same time frames as Objectives 1-3

B. Measurable Project Tasks

FY12 1st Quarter (October 1, 11 to December 31, 11)
October Continuation of existing monitoring project

FY12 2nd Quarter
January Continuation of existing monitoring project
January Annual Marine Science Symposium

FY12 3rd Quarter
April Continuation of existing monitoring project
May Annual PI meeting

FY12 4th Quarter
August Continuation of existing monitoring project

FY13 1st Quarter (October 1, 12 to December 31, 12)
October Project begins
November Conduct November juvenile collection

FY13 2nd Quarter
January Annual Marine Science Symposium
March Conduct March juvenile collection

FY13 3rd Quarter
May Annual PI meeting
June Submit FY14 work plan for review

FY13 4th Quarter
August Submit annual report

FY14 1st Quarter (October 1, 13 to December 31, 13)
October Collaborate to synthesis for EVOS science council
November Conduct November juvenile collection

FY14 2nd Quarter
January Annual Marine Science Symposium
March Conduct March juvenile collection
Winter ` EVOS sponsored workshop with Herring and Long-term monitoring programs

FY14 3rd Quarter
May Annual PI meeting
June Submit FY15 work plan for review

FY14 4th Quarter
August		Submit annual report

FY15 1st Quarter (October 1, 14 to December 31, 14)
November	Conduct November juvenile collection

FY15 2nd Quarter
January		Annual Marine Science Symposium
March		Conduct March juvenile collection

FY15 3rd Quarter
May		Annual PI meeting
May		Submit five-year plan for FY17-22 and work plan for FY16

FY15 4th Quarter
August		Submit annual report

FY16 1st Quarter (October 1, 15 to December 31, 15)
November	Conduct November juvenile collection (data processing to be completed in subsequent project)

FY16 2nd Quarter
January		Annual Marine Science Symposium
March		Conduct March juvenile collection (sample and data processing to be completed in subsequent project)

FY16 3rd Quarter
May		Annual PI meeting
June		Submit work plan for FY17

FY16 4th Quarter
August		Submit final report

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Budget Justification

Project:

Herring Condition Monitoring

P.I.: T. Kline

Personnel

Dr. T. C. Kline, Lead Principal Investigator (P.I.). The Lead P.I.'s job and therefore responsibility is the administration of the project including report writing, supervision of personnel, and interpretation of the results. The purpose of these activities is dictated by the funding agency (e.g., report writing) and the needs of the research (e.g., data interpretation). The P.I. expects to dedicate 3 months of his time to this project in FY13; 3 months in FY14, 3 months in FY15, and 3 months in FY16.

Technician (to be named). One technician will be needed to accomplish the laboratory tasks and to lead in field sampling. Accordingly, The technician will be expected to dedicate 6 months of time in FY13, 6 months of time in FY14, 6 months of time in FY15, and 6 months of time in FY16.

Fringe benefit. It is the PWSSC's usual accounting practice that contributions to employee benefits (social security, retirement, etc.) are treated as direct costs. Workman's compensation for anticipated sea-days varies per year according to the anticipated number of cruise days. Included are anticipated modest benefit cost increases of 3% and 5% each year, respectively for the P.I. and technician, based on recent experience.

Travel

Travel is budgeted each year (FY13 to FY16) to attend the Alaska Marine Symposium in Anchorage. Travel is budgeted to enable workshops with individual or small groups of program investigators each year during FY14 to FY16 to facilitate integration and synthesis. The P.I. will attend and participate in workshops, special symposia, and town meetings at national and international conferences. The P.I. tentatively plans on attending a workshop and participate in symposia at the 2013 PICES Annual meeting, which is scheduled to be in Canada, likely cities are Victoria and Sidney. The P.I. tentatively plans on attending the 2014 and 2016 Ocean Sciences Meetings (location unknown), and 2015 Aquatic Sciences Meeting (location unknown). Symposia sponsored by PICES and AFS may be attended instead of these or in other years according to the details of the symposia content. Symposia registration fees run $300 to $500 and are incorporated as part of the ticket cost in the EVOS budget form. Emphasis will be symposia where methods used by the P.I. or herring are the focus. Air travel is based on the current cost of round-trip, economy airfare. Travel will be by US-flag carriers, if available.

Supplies

Field supplies: Ice, coolers, cast nets, gill nets, floats, lead lines, rope, sampling bags, foul-weather gear, and other items as determined by project needs (such as replacement items).

Laboratory supplies: LSC vials, vacuum pump oil, chemicals, grinder components, forceps, lab safety equipment and apparel, notebooks, bags, boxes, bulbs, and other items as determined by project needs (such as replacement items).

Experience dictates that about $3000 is spent per year for lab supplies and the same for field supplies. Bulk quantities of certain items such as case lots of vials will be purchased in FY12 where possible to save funds for this relatively long-term project. Accordingly the FY13 amount is higher at $3500 per category while FY14 is less at $2300 per category. It is expected that large lot purchases made early in the project will be depleted by FY15 and FY16 so these years are budgeted accordingly, $2400 per category in FY15 and $3000 per category in FY16.

Office supplies: Paper, folders, pens, pencils, and computer accessories as needed. Experience dictates that about $500 will be spent in FY13 and FY14, $600 in FY15 and $800 in FY16. A laptop computer ($3K) will be used to facilitate computer use and data transport to and from workshops. Experience dictates that after two-three years of daily use a laptop will cease to function or have significant problems and thus in need of replacement. Accordingly a laptop is budgeted for in FY15 to replace one to be purchased on another project in FY12.

Equipment

None

Contractual

It is the practice to charge a per use fee for photocopies, printing, and shipping to a project. The annualized total is estimated at $500. There is a base phone fee of $50 per person-month.

PWSSC Network charge (computer-months): The PWSSC presently must levy a $100 per person-month network charge to offset this cost.

Mass Spectrometry Elemental Analysis (EA): This is the actual mass spectrometric analysis of samples, which is outsourced to the UAF Stable Isotope Facility at $25 in FY13, $26 in FY14, $27 in FY15, and $30 in FY16 per sample. Budgeted cost increases, which can suddenly surge, are based on experience.

Lyophilizer usage (LU): This is a PWSSC-mandated cost for the operation of this equipment at $3 each.

EA and LU costs are based upon analyzing 800 samples per year with an additional 200 samples in the project’s final year to address data gaps.

Software: word processing, spreadsheet, email, operating system (OS), presentation, scientific graphing, statistical updates as needed (virtually annually) due to OS updates and fixes. Experience dictates that about $500 will be needed per year.

Indirect Costs:

The Prince William Sound Science Center has a federally approved indirect rate of 30% on modified total direct costs (excluding equipment, subawards in excess of $25,000, and tuition). Please contact the financial officer, Penelope Oswalt, for further information.

Below is the NOAA budget for the project. Funds are requested for only years 2-5, no costs will be incurred in year 1.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0
Travel	$0.0	$0.0	$3.9	$7.1	$4.0
Contractual	$0.0	$75.0	$75.0	$75.0	$75.0
Commodities	$0.0	$6.0	$5.0	$5.0	$5.0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0

Budget Justification:

FY13

Personnnel:

No funds requested

Travel:

No travel funds are requested

Contractual :

Request contracts for:

RNA/DNA analysis:

Processing ($15/sample), nucleotide extraction, staining, digestion and fluorometry ($25/sample)

300 samples x $50/sample = $15,000

Proximate analysis:

Lipid extraction ($50/sample), ash and moisture content ($15/sample), protein analysis ($35/sample)

300 samples x $100/sample = $30,000

Stomach analysis:

Initial sample processing, stomach removal, content identification, weighing and archiving

300 samples x $100/sample = $30,000

Data consolidation contract $5,000

Commodities:

Sample collection and preparation : vials, lables, bags

$3.00 per sample x 450 samples = $1.3 K

Nucleic acid isolation : reagents, ethidium bromide, enzymes, multiplates

$6.75 per sample x 450 samples = $3.1K

Shipping: $0.6K

Equipment:

No funds requested

FY14:

Personnel:

No funds requested

Travel:

Funds are requested for Heintz and Vollenweider to travel to the 2014 AMSS meeting in Anchorage.

Funds are requested for Heintz and Vollenweider to travel to the annual herring meeting in Cordova

Contractual :

Request contracts for:

RNA/DNA analysis:
Processing ($15/sample), nucleotide extraction, staining, digestion and fluorometry ($25/sample)
300 samples x $50/sample = $15,000

Proximate analysis:
Lipid extraction ($50/sample), ash and moisture content ($15/sample), protein analysis ($35/sample)
300 samples x $100/sample = $30,000

Stomach analysis:
Initial sample processing, stomach removal, content identification, weighing and archiving
300 samples x $100/sample = $30,000

Data consolidation contract $5,000

Commodities:

Sample collection and preparation : vials, lables, bags
$3.00 per sample x 450 samples = $1.3 K
Nucleic acid isolation : reagents, ethidium bromide, enzymes, multiplates
$6.75 per sample x 450 samples = $3.1K
Shipping: $0.6K

Equipment:

No funds requested

FY15:

Personnel:

No funds requested

Travel:

Funds are requested for Heintz and Vollenweider to travel to the 2015 AMSS meeting in Anchorage.

Funds are requested for Heintz and Vollenweider to travel to the annual herring meeting in Cordova

Funds are requested for Heintz and Vollenweider to travel to the synthesis meeting.

Contractual :

Request contracts for:

RNA/DNA analysis:
Processing ($15/sample), nucleotide extraction, staining, digestion and fluorometry ($25/sample)

300 samples x $50/sample = $15,000

Proximate analysis:
Lipid extraction ($50/sample), ash and moisture content ($15/sample), protein analysis ($35/sample)
300 samples x $100/sample = $30,000

Stomach analysis:
Initial sample processing, stomach removal, content identification, weighing and archiving
300 samples x $100/sample = $30,000

Data consolidation contract $5,000

Commodities:
Sample collection and preparation : vials, lables, bags
$3.00 per sample x 450 samples = $1.3 K
Nucleic acid isolation : reagents, ethidium bromide, enzymes, multiplates
$6.75 per sample x 450 samples = $3.1K
Shipping: $0.6K
Equipment:
No funds requested

FY16:
Personnel:
No funds requested

Travel:
Funds are requested for Heintz and Vollenweider to travel to the 2016 AMSS meeting in Anchorage.

Funds are requested for Heintz and Vollenweider to travel to the annual herring meeting in Cordova

Funds are requested for Heintz and Vollenweider to travel to the synthesis meeting.

Contractual :
Request contracts for:
RNA/DNA analysis:
Processing ($15/sample), nucleotide extraction, staining, digestion and fluorometry ($25/sample)
300 samples x $50/sample = $15,000

Proximate analysis:
Lipid extraction ($50/sample), ash and moisture content ($15/sample), protein analysis ($35/sample)
300 samples x $100/sample = $30,000

Stomach analysis:
Initial sample processing, stomach removal, content identification, weighing and archiving
300 samples x $100/sample = $30,000

Data consolidation contract $5,000

Commodities:

Sample collection and preparation : vials, lables, bags

$3.00 per sample x 450 samples = $1.3 K

Nucleic acid isolation : reagents, ethidium bromide, enzymes, multiplates

$6.75 per sample x 450 samples = $3.1K

Shipping: $0.6K

Equipment:

No funds requested

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: A high temporal and spatial resolution study to validate the separate herring condition monitoring program.

Project Period: federal fiscal years of 2012 to 2014 (October 1, 2011 – September 30, 2014)

Primary Investigator(s): Thomas C. Kline, Jr., Ph. D., Prince William Sound Science Center
Ron Heintz, Ph. D., National Oceanic and Atmospheric Administration (NOAA) Alaska Fisheries Science Center (AFSC) Auke Bay Laboratories (ABL)

Study Location: Prince William Sound

Abstract:

Described here is a single process study project that is a part of an integrative program that will enhance the current monitoring efforts, and examine aspects of particular life stages to allow better modeling of Prince William Sound herring populations. The long-term goal of the program is to improve predictive models of herring stocks through observations and research. The herring monitoring program is necessarily of coarse temporal and spatial resolution with just two observations per year at narrowly defined sampling sites spread around the large area comprising Prince William Sound. Data interpretation requires a greater context to impart greater meaning. In the case of temporal variation of herring condition it would be useful to know (1) how sensitive the herring overwinter mortality model is to starting time, and (2) the timing of recovery from winter starvation. In the case of spatial variation of herring condition it would be useful to know how sensitive the herring overwinter mortality model is to immigration and emigration from areas immediately adjacent to where herring are sampled at the time of our November and March surveys.

Fine-scale temporal and spatial variability at designated herring monitoring sites has never been characterized and therefore remains a data gap with potential ramifications for interpreting observed variation of herring condition that is part of the herring monitoring program as well as the aforementioned modeling. This will be addressed by sampling at Simpson Bay, which has been a key monitoring site for juvenile herring since the 1990's. Energy content and RNA/DNA will be measured monthly from September 2011 until June 2012 to assess fine-scale temporal variability. Fine-scale spatial variability will be assessed by sampling in November and March five separate sub-areas of a more extensive Simpson Bay than what is typically done during surveys. The results of the analysis will be contributed to the herring synthesis effort that will take place in FY14.

Estimated Budget:
EVOSTC Funding Requested:
To PWSSC: 174.2K (FY12), 77.3K (FY13), 20.4K (FY14)
To NOAA:
Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date: 1 June 2011

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the Exxon Valdez Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here is a single project that is a part of an integrative program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. The long-term goal of the program is to improve predictive models of herring stocks through observations and research. While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

The herring monitoring program is necessarily of coarse temporal and spatial resolution with just two observations per year at narrowly defined sampling sites spread around the large area comprising Prince William Sound (PWS). Data interpretation requires a greater context to impart greater meaning. In the case of temporal variation of herring condition it would be useful to know (1) how sensitive the herring overwinter mortality model is to starting time, and (2) the timing of recovery from winter starvation. The latter is important since the overwinter mortality model predicts that as little as 1 % of the November population would survive to May given a continuation of starvation after March (Kline 2011). PWS herring as late as May have been in very poor condition (Norcross et al. 2001). In the case of spatial variation of herring condition it would be useful to know how sensitive the herring overwinter mortality model is to immigration and emigration from areas immediately adjacent to where herring are sampled at the time of our November and March surveys. The herring population sampled at a given time at a sampling site is defined by the swath of water sampled by the device(s) used (e.g., a net), which is very small compared to the size of the habitat and thus may not be reflective of the local herring population.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program ~~described below~~ aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach. This particular project falls into the process study category.

II. PROJECT DESIGN

A. Objectives

We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

Objectives specific to this project:

1. Expanded area Simpson Bay sampling in November 2011 and March 2012
2. Sample Simpson Bay monthly from September 2011 to June 2012

B. Procedural and Scientific Methods

We will sample at a single bay, Simpson Bay. However, the spatial scope of what is considered Simpson Bay will be expanded during the November and March sampling periods. The scope of this expansion (Fig. 1) is based on a combination of where herring have been previously sampled and where herring have been observed acoustically (R. Thorne. Pers. comm.).

Sampling to increase spatial resolution (objective 1): For this project we will augment current monitoring samples by sampling Simpson Bay as an aggregate of five sub-areas within the designated expanded bay area during November and March (Fig. 1). This entails dividing the designated expanded Simpson Bay into five sub-areas and sampling systematically within each area rather than just one location (the expansion per se is thus for four additional Simpson sites).

Sampling to increase temporal resolution (objective 2): For this project we will augment current November and March monitoring by also sampling Simpson Bay in September, October, December, January, April, May, and June as we are presently doing (sampling limited to either sub-areas 1 or 2 in Fig. 1 according to greatest fish abundance). The target minimum sample size at each time is 100 herring for energetics and 50 fish for RNA/DNA.

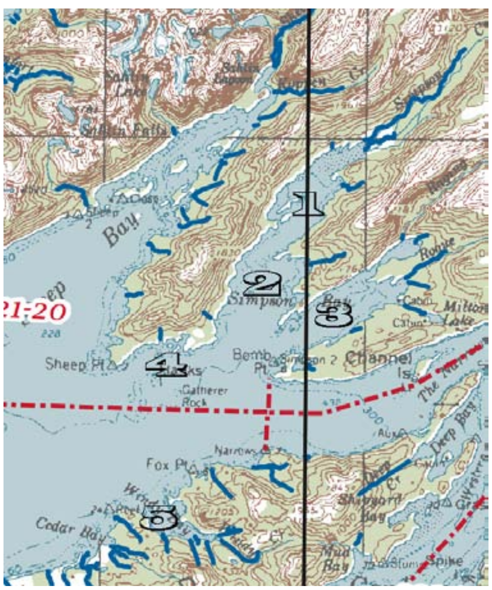

Figure 1. Map of Simpson Bay and surrounding waters showing five sampling areas.

The experimental design of the ongoing monitoring, i.e., sampling during November and March is a good match with respect to the experimental results used to develop the overwinter mortality model (Kline and Campbell 2011). The overwinter mortality model is based, in part, on a laboratory energy loss experiment that was conducted from 1 December to 25 January (Paul and Paul 1998). Therefore, measuring initial conditions during November is a good match. As well, one Paul and Paul (1998) experiment ended on 1 April, a good match to our field observations made in late March.

The energy value of herring that died during laboratory experiments ranged by 0.8 kJ/g wet mass (Paul and Paul 1998). The monthly (30 days) energy loss rate is very similar at 0.7 kJ/g wet mass suggesting this is a good sampling interval for the planned process study. If for example we sampled at twice per month, the expected energy loss would be ~ 0.3 kJ/g wet mass, much less than this range. Furthermore, with sampling trips possibly taking up to 10 days to complete from planned starting dates due to weather, there could be less than 10 days between samples, resulting in negligible change in measured energy.

Short-term (time intervals of months) increases in fish density previously observed at herring sampling sites suggest the possibility of localized migration (Table 1 in Stokesbury et al. 2002). For example, an undetected movement of the herring population to just outside/inside a given sampling bay prior to a survey would mimic a population loss/gain. If the condition of groups of herring within a bay was heterogeneous such short movements could result in a false apparent change in condition. For example, only those fish with higher condition might have migrated out. To test for this effect during our process study, we will sample more extensively during November and March during the process study year (late summer 2011 to spring 2012). The more extensive area comprising Simpson Bay will be sub-divided into five parts with one part corresponding to existing sampling. Therefore only the four additional parts need to be sampled as part of this study. To assess possible effect on the mortality model, the top 20% (the approximate present survival rate between November and March as well as between March and April) of each of the five sub-areas will be compared. Therefore at least 100 herring need to be sampled yielding 20 for this comparison. The mortality model will be run for each of the five sub-areas. The five outcomes will be compared with the five observed March distributions using ANOVA. At the end of the project we will make any necessary recommendations for altering sampling within a bay so as to achieve better representation.

Measurements of energy density can be misleading if the relative concentrations of lipid and protein remain constant when growth resumes. This would translate as a constant energy density leading the mortality model to overestimate mortality due to starvation. Monitoring growth would provide a more direct measure of the onset of feeding. Use of RNA/DNA as an indicator of feeding can be used to indicate the onset of feeding (Sewall et al. 2011). Moreover, RNA/DNA responds more quickly to changes in nutritional status than energy density. Similarly, RNA/DNA could be used to indicate when feeding ceases in fall. When feeding ceases, energy density will remain elevated until fish deplete glycogen reserves and sufficient lipid is catabolized relative to protein to effect a change in energy density. Thus, reliance on energy density can underestimate the period in which feeding ceases. By combining RNA/DNA and energy density analysis the mortality model can provide better estimates of potential mortality.

C. Data Analysis and Statistical Methods

Other than tests specific to the experimental design aspects unique to this project (section B), the data analysis and statistical methods are the same as described in the accompanying Herring Condition Monitoring project. Energy measurement techniques will be done consistent with previous Prince William Sound herring studies dating as far back as the 1990's (Kline and Campbell 2011).

The null hypothesis for the higher spatial resolution sampling is that the five sub-areas of Simpson Bay have the same value for each of the parameters being measured. This will be tested using ANOVA. For example, the whole body energy density should not vary spatially within the greater Simpson Bay. If this is so then small scale migration (within this area) should not be a concern.

The expectation for the monthly observations is that they will follow a consistent pattern over the course of the observation period. An inconsistent pattern would be if the values of a given parameter shifted erratically rather than with a consistent pattern. For example, energy values decreased, then increased, then decreased, etc. Evidence of immigration would be supported by a combination of erratic variation and a systematic relationship among shifting values consistent with two more populations mixing. The differences corresponding to these hypothetical populations would have to be consistent with the differences among the five sub-areas sampled in November and March to suggest shifting around of sub-populations (e.g., the herring residing in each of the five sub-areas at a given time) from nearby.

However, if the de-trended monthly differences exceeded the differences from within the five sub-areas, it would suggest immigration/emigration from a greater space domain than that reflected by the expanded Simpson Bay sampling scheme of this project. If this is the case we may need to adjust the herring monitoring sampling strategy.

D. Description of Study Area

The study area includes all of Prince William Sound (N, E, S, and W boundaries of respectively, ~ 61, -145.5. 60, and -149°). However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 2). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

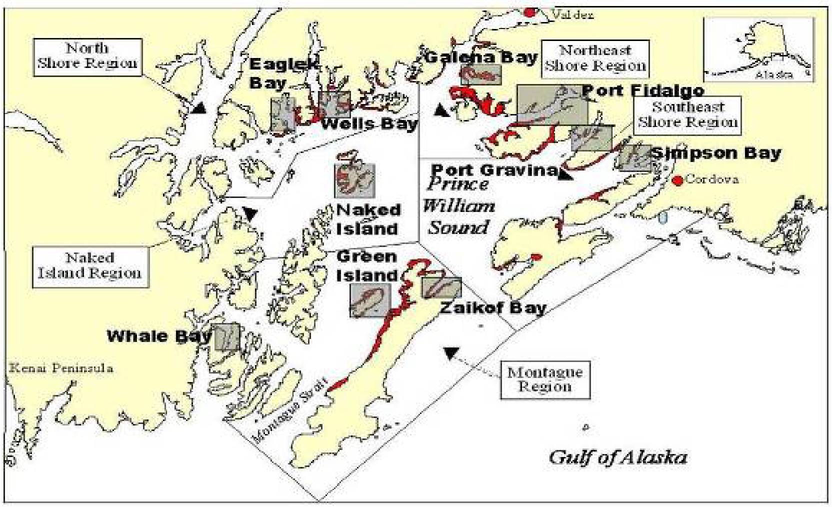

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is structured to be part of a collaborative programmatic effort being led by the Prince William Sound Science Center. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Pegau will act as the program team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program. He will also be responsible for outreach and public input efforts.

Dr. Pegau currently is the coordinator of the existing EVOSTC funding PWS Herring Survey program. This program consists of ten individual projects that provide a coordinated examination of juvenile herring in Prince William Sound. This proposal is heavily influenced by the early findings from that effort. Dr. Pegau also serves as the Research Program Manager for the Oil Spill Recovery Institute (OSRI). In that capacity he is responsible for developing annual work plans, ensuring proper reporting, making reports available, developing partnerships to leverage funding, and to ensure outreach of OSRI activities. All activities that provide experience delivering the team leader duties outline in the request for proposals.

One of his duties is to ensure proper scientific oversight of the research programs. To accomplish this we will be setting up a four-person scientific oversight panel that will help guide the program and ensure the research is relevant to the long-term goal. The team will consist of people representing Alaska Department of Fish and Game, the National Oceanic and Atmospheric Administration, academia, and the local fishing community. There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year's work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermens United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydroacoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

Other important programs for coordinating with are the existing PWS herring survey program and existing ADF&G herring research. This program has been developed with input from both of these programs and the focus of this proposal is extending the interpretation of the data from those two programs. The Herring Survey program will still be operating in FY12 and FY13. There are field observations scheduled in FY12 and in FY13 funds are strictly for analysis and report writing. Included in the report writing is a synthesis of previous and current research. This report will be finished in FY13 and be the basis for the synthesis required under this request for proposals.

Lead Principal Investigator Dr. Thomas C. Kline, Jr. will be responsible for the execution of project's energy observations and energy modeling and oversight of the proposed project. Dr. Kline is a world-leader in applying natural stable isotope abundance to fish ecology problems. Dr. Kline has been a research scientist at the Prince William Sound Science Center (PWSSC) since 1995. During this time he has led numerous projects on the oceanography of Prince William Sound and adjacent Gulf of Alaska. He has published dozens of research papers based on the resulting data.

Dr. Kline is currently the principal investigator of the *Exxon Valdez* Oil Spill Trustee Council project 'Prince William Sound Herring Survey: Pacific Herring Energetic Recruitment Factors**'** that is investigating the role of food sources and energy status of herring for recruitment. He was the principal investigator of several previous *Exxon Valdez* Oil Spill Trustee Council projects that had a herring focus. These included Herring Forage Contingency (2007-9), Productivity Dependencies: Stable Isotopes (1998-9), and Sound Ecosystem Assessment: Conforming Food Webs of Fishes with Stable Isotope Tracers (1995-8). Results of these projects have been incorporated into approximately two-dozen scientific publications. The data from the existing project and past projects will synergize with this proposed project.

Co-Principal Investigator Dr. Ron Heintz will be responsible for the execution of the RNA/DNA aspects of the proposed project.
Ron- please add more stuff here

Both investigators are also investigators of ongoing and proposed herring condition monitoring projects that are part of the herring program. This dual role will facilitate near real-time integration of project results with the monitoring program. Both investigators will contribute to programmatic synthesis scheduled to take place in FY14. This synthesis may include suggested changes to the herring monitoring according to depending on outcome.

Table summarizing proposed project tasks (the responsible investigator indicated by initials):

1. (TK) Systematically assess energy levels of age-0 herring per the experimental design.

2. (TK) Model overwintering mortality using data from (1) to evaluate the monitoring experimental design in conjunction with data from (3) through collaborating with Heintz.

3. (RH) Systematically assess RNA/DNA of age-0 herring per the experimental design.

4. (RH) Collaborate with Kline per (2).

5. Both P.I.'s will contribute to the synthesis effort in 2013 and workshop in 2014.

As part of the integrated herring program, this project will be interacting with virtually all other aspects of the program. Personnel from multiple projects will be working in cooperation. This project will furnish one field technician for field sampling. This technician will be expected to cooperate with other projects during this sampling. For example, Dr. Kline's current technician has been simultaneously collecting, sorting, and preparing samples for multiple investigators such as Dr. Hershberger disease samples as part of research cruise duties. Field sampling is being conducted on shared research vessels, with funding for charter time outside the scope of this project. Vessel needs are summarized below.

Table summarizing project specific vessel needs

• Seven days, one each in September, October, December, January, April, May, and June to sample Simpson Bay

• Approximately three days each in November and March formed by expanding the on-going monitoring cruises

• Capability to sample age-0 herring and process samples on board.

III. SCHEDULE
A. Project Milestones

Objective 1. Expanded area Simpson Bay sampling in November 2011 and March 2012.
Sampling to be met by March 2012, analysis by March 2013, incorporation into project synthesis by October 2013, and incorporated into herring program by March 2014

Objective 2. Sample Simpson Bay monthly from September 2011 to June 2012
Sampling to be met by June 2012, analysis by June 2013, incorporation into synthesis by October 2013, and incorporated into herring program by March 2014

B. Measurable Project Tasks

FY12 1st Quarter (October 1, 11 to December 31, 11)
October Begin high temporal resolution sampling
November High spatial resolution sampling cruise

FY12 2nd Quarter
January Annual Marine Science Symposium
March High spatial resolution sampling cruise

FY12 3rd Quarter
May Annual PI meeting
June Submit FY13 work plan for review
June End high temporal resolution sampling

FY12 4th Quarter
August Submit annual report

FY13 1st Quarter (October 1, 12 to December 31, 12)

FY13 2nd Quarter
January Annual Marine Science Symposium

FY13 3rd Quarter
May Annual PI meeting
June Laboratory analysis of samples completed
June Submit FY14 work plan for review

FY13 4th Quarter
August Submit annual report

FY14 1st Quarter (October 1, 13 to December 31, 13)
October Data analysis completed
October Contribute to synthesis for EVOS science council

FY14 2nd Quarter
January Annual Marine Science Symposium
Winter Contribute to EVOS sponsored workshop with Herring and Long-term monitoring programs

FY14 3rd Quarter
May Annual PI meeting

FY14 4th Quarter
August Submit Final report

References Cited

Kline, T.C., Jr. and R.W. Campbell. 2010. Prince William Sound Herring Forage Contingency, *Exxon Valdez* Oil Spill Restoration Project Final Report (Project 070811). Prince William Sound Science Center, P.O. Box 705, Cordova, AK 99574.

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Budget Justification

Project:

A high temporal and spatial resolution study to validate the separate herring condition monitoring program

P.I.: T. Kline

Personnel

Dr. T. C. Kline, Lead Principal Investigator (P.I.). The Lead P.I.'s job and therefore responsibility is the administration of the project including report writing, supervision of personnel, and interpretation of the results. The purpose of these activities is dictated by the funding agency (e.g., report writing) and the needs of the research (e.g., data interpretation). Accordingly, the P.I. expects to dedicate 3 months of his time to this project in FY12; 3 months in FY13, and 1.2 months in FY14.

Technician (to be named). One technician will be needed to accomplish the laboratory tasks and to lead in field sampling. Accordingly, The technician will be expected to dedicate 6.5 months of time in FY12, and 1.5 months in FY13.

Fringe benefit. It is the PWSSC's usual accounting practice that contributions to employee benefits (social security, retirement, etc.) are treated as direct costs. Workman's compensation for anticipated sea-days varies per year according to the anticipated number of cruise days. Included are anticipated modest benefit cost increases of 3% and 5% each year, respectively for the P.I. and technician, based on recent experience.

Travel

Travel is budgeted each year to attend the Alaska Marine Symposium in Anchorage through an existing project for FY12 and a separate project for FY13 and FY14. Additionally, travel is budgeted to attend project workshops during the synthesis year, FY14 in a separate project. The P.I. will attend and participate in workshops, special symposia, and town meetings at a national conference. The P.I. tentatively plans on attending the 2012 Ocean Sciences Meeting in Salt Lake City and the 2013 Aquatic Sciences Meeting in New Orleans. Symposia sponsored by PICES and AFS may be attended instead of these or in other years according to the details of the symposia content. Symposia registration fees run $300 to $500 and are incorporated as part of the ticket cost in the EVOS budget form. Emphasis will be symposia where methods used by the P.I. or herring are the focus. Air travel is based on the current cost of round-trip, economy airfare. Travel will be by US-flag carriers, if available.

Supplies

Field supplies: Ice, coolers, cast nets, gill nets, floats, lead lines, rope, sampling bags, foul-weather gear, and other items as determined by project needs (such as replacement items). The large number of samples to be collected dictates that about $5000 will be spent in FY12.

Laboratory supplies: LSC vials, vacuum pump oil, chemicals, grinder components, forceps, lab safety equipment and apparel, notebooks, bags, boxes, bulbs, anything else as determined by project needs (such as replacement items). The large number of samples to be collected dictates that about $5000 will be spent in FY12 and $1600 will be needed in FY13.

Office supplies: Paper, folders, pens, pencils, and computer accessories as needed. Experience dictates that about $900 will be spent in FY12 and $500 in FY13. A laptop computer ($3K) to facilitate computer use and data transport to and from workshops. Experience dictates that after two years of daily use a laptop will cease to function or have significant problems and thus in need of replacement. Accordingly a laptop is budgeted for in year 1 of the project, FY12.

Equipment

None

Contractual

It is the practice to charge a per use fee for photocopies, printing, and shipping to a project. The annualized totals for FY12 and FY13 are estimated at $500. There is a base phone fee of $50 per person-month.

PWSSC Network charge (computer-months): The PWSSC presently must levy a $100 per person-month network charge to offset this cost.

Mass Spectrometry Elemental Analysis (EA): This is the actual mass spectrometric analysis of samples, which is outsourced to the UAF Stable Isotope Facility at $25 each.

Lyophilizer usage (LU): This is a PWSSC-mandated cost for the operation of this equipment at $3 each.

EA and LU are based upon analyzing 1400 samples in FY12 and 250 samples in FY13.

Software: word processing, spreadsheet, email, operating system (OS), presentation, scientific graphing, statistical updates as needed (virtually annually) due to OS updates and fixes. Experience dictates that about $500 will be needed per year.

Indirect Costs:

The Prince William Sound Science Center has a federally approved indirect rate of 30% on modified total direct costs (excluding equipment, subawards in excess of $25,000, and tuition). Please contact the financial officer, Penelope Oswalt, for further information.

Budget Justification:
Below is the NOAA budget for the project. Funds are requested for only one year, outlying years are not shown as they incur no cost to the Trustee Council.

FY12
Personnnel:
No funds requested

Travel:
Funds are requested for Heintz and Vollenweider to travel the annual herring meeting in Cordova

Conractual : Request contracts for:
Processing ($15/sample), nucleotide extraction, staining, digestion and fluorometry ($25/sample) collected during the intensive survey project in FY12.
450 samples x $50/sample = $18,000

Data management contract $5,000

Commodities:
Sample collection and preparation : vials, lables, bags
$3.00 per sample x 450 samples = $1350
Nucleic acid isolation : reagents, ethidium bromide, enzymes, multiplates
$6.75 per sample x 450 samples = $3038
Shipping: $600
Equipment:
No funds requested

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Scales as growth history records for Pacific herring.

Project Period: October 1 2011–May 2014

Primary Investigator(s): Steve Moffitt, ADF&G (steve.moffitt@alaska.gov)

Study Location: Prince William Sound

Abstract:
Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. Identification of conditions limiting herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Fish grow in response to the extrinsic influences of their environment constrained by the intrinsic influences of genetic predisposition for growth and of size already attained. Understanding how these intrinsic and extrinsic sources of variability influence growth is important for several reasons. Variation in growth has a strong affect on the selection of appropriate harvest policies that are based on demographic models that reflect the natural processes.

Analysis of growth increments between annular patterns on scales can provide a means to reconstruct past growth changes that can assist in determining the possible environmental and density-dependent causes of growth variation. Growth increment information incorporates a longitudinal history of growth that increases the effective degrees of freedom and can be used in modeling changes in growth in relationship to environmental and population indices Determining the underlying distribution of individual growth patterns can provide improved inputs into population dynamics models that are used to establish harvest guidelines.

Estimated Budget:
EVOSTC Funding Requested *(must include 9% GA)***:**

FY2012	**FY2013**
$86.15	**$43.24**

Non-EVOSTC Funds to be used:

FY2012	**FY2013**
$5.25	**$5.25**

Date: 5-25-2011

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC).   Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here are projects for a program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.**   While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to “Conduct research to find out why Pacific herring are not recovering” and “Monitor recovery”, listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes.   A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

II. PROJECT DESIGN

A. Objectives

Program Goals and Objectives

We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

Program Objective 2

Herring scale analysis: A very valuable source of information for many PWS herring studies includes approximately 200,000 herring scales (including ancillary data including collection location, date, length, weight, and sex) that are currently maintained in a collection at the Cordova ADF&G office. Unfortunately, only a small portion of these data are converted to an electronic format. We are proposing a project that will examine the growth history contained in scales from PWS. This information will be used to improve our understanding of any temporal and age-specific growth patterns that result in observed changes in size at age. Spatial patterns may also be examined given sufficient sample sizes. Project data can be used to model changes in growth in relation to environmental and population indices.

There is also potential for this information to help identify when fish first spawn as described in the project under Objective 1. There are many more scales than can be analyzed by either of these individual projects and we will ensure that the information collected in each effort can be combined to increase the statistical power of both sets of analyses. We believe that retrospective studies, such as this one, will be extremely useful in improving the quality of the required synthesis.

Project Objectives

1. FY2012:
    a. Standardize scale interpretive criteria, evaluate alternative measurement techniques, and develop semi-automated procedures for measuring scale increments of PWS herring.
    b. Measure scale growth increments on scales subsampled from archived collections.

2. FY2013:
    a. Finish measurements of scale growth increments on subsampled scales.

Fish grow in response to the extrinsic influences of their environment constrained by the intrinsic influences of genetic predisposition for growth and of size already attained (Weathedey and Gill 1987, Weisberg 1993). Understanding how these intrinsic and extrinsic sources of variability influence growth is important for several reasons. The effects of stock size and environmental conditions on growth have been studied by a number of investigators (Anthony and Fogarty 1985, Hagen and Quinn 1991, Kreuz et al. 1982, Martinson et al. 2009, Peterman and Bradford 1987, Rijnsdorp and van Leeuwen. 1992, Stocker et al. 1985), primarily because of the consequences that growth variation can have on reproductive potential through its influences on fecundity and spawn timing (Ware and Tanasichuk 1989), natural mortality, recruitment, and age at maturity (Haist and Stocker 1985, Schmitt and Skud 1978). Haist and Stocker 1985 stated that factors affecting growth rates can be of fundamental importance to the understanding of the dynamics of exploited populations and the responses of natural populations to abundance and environmental influences have remained a central issue in population biology (Tanasichuk 1997). Variation in growth has a strong affect on the selection of appropriate harvest policies that are based on demographic models that reflect the natural processes (Methot 1997, Tanasichuk 1997).

The underlying mechanisms for cyclic changes in annular growth for herring in the northern Gulf of Alaska are currently unknown. A period of the lowest observed average body sizes for PWS herring coincided with a period of historic high abundance followed by a catastrophic population decline associated with outbreaks of viral hemorrhagic septicemia virus (VHSV) and *Ichthyophonus hoferi* (Marty et al. 1998). Although the links between herring energetic condition (growth) and disease susceptibility are not yet well understood, it is postulated that the observed population decline was a result of density dependent growth effects leading to decreased body condition and resistance to disease. Analysis of growth increments between annular patterns on scales can provide a means to reconstruct past growth changes that can assist in determining the possible environmental and density-dependent causes of growth variation. The current picture of growth is based on cross sectional size at age data. In contrast, growth increment information incorporates a longitudinal history of growth that increases the effective degrees of freedom and can be used in modeling changes in growth in relationship to environmental and population indices (Chambers and Miller 1995, Kreuz et al. 1982, Tanaischuk 1997, Weisberg 1993). Determining the underlying distribution of individual growth patterns can provide improved inputs into population dynamics models that are used to establish harvest guidelines.

B. Procedural and Scientific Methods

Objective 1a.

Extensive scale collections are maintained in the Cordova ADF&G office. Many fish have associated records including location, age, size, weight, and maturation state. Some early collections of scales may not have been collected from the preferred area on the body and their condition and usefulness remains unknown. One task will be to identify the number of scales by year and age class available. To age herring scales consistently and accurately requires experience and training. To help develop consistent criteria for identifying and measuring annuli, sample personnel will meet with experienced age readers in the ADF&G Mark-Tag-Age Lab in Juneau. Side by side comparison and discussion of problems in reading scales and potential biases in measurements will be addressed. Image processing techniques will be used to collect the growth information from scales. Off-the-shelf imaging software will be used where possible, but additional customization of routines maybe necessary, particularly to streamline the data acquisition.

Scale collections were standardized in many locations in the mid 1980s by the identification of a preferred area on body of herring. However for earlier samples there is likely to be considerable variation on scale size and shape. Several approaches will be taken to determine methods for adjusting the growth increment data such that it accurate reflects body growth. The biological intercept model used for back calculation studies represents one possibility (Campana 1990). Other approaches may involve collecting multiple scales from several individuals and determine which transformations based on body size or scale size achieve the greatest reduction of within individual variation of the growth increments using variance component analysis (Sokal and Rohlf 1981). Concurrent studies on herring energetic may also provide samples by which scale growth can be measured in relationship to known somatic growth. If such specimens are available they will be examined. In addition, with the biological intercept approach for back calculation it is necessary to establish the body size at initial scale formation (Campana 1990). Collections of young of the year herring will be examined to determine those values. Once the methodology is established, production measurements will first be collected from the Prince William Sound archive collections.

Sample Collections: The PWS scale collections extend back to 1979, with some older scales from the early 1970's. The archives contain approximately 200,000 scales classified into different groups (harvest or collection types), and the most complete is the commercial harvest collection. The number of scales drawn from these collections will be determined by a power analysis. A preliminary sample size goal is 50 scales from 6 or 7 age classes per year for as many as 35 years (n=10k to 12k). The goal will be to measure a sufficient number of scales such that biologically significant differences in growth increments between cohorts can be detected. Since the scales themselves may not have examined since they were originally stored considerable effort may have to be expended in pulling out the selected scales to see if they are suitable for digitizing.

Objective 1b.

Scale Measurements:

Each scale selected for the study will be examined to confirm the original age estimate. Scales will be examined through a microfiche equipped with a scanner. The scanner feeds the image into a framegrabber board in a computer. Using software calibrated to the magnification of the image, a line or series of lines will be overlaid on the scale image from the focus to the scale edge by the reader and they will mark the annuli on the image. The number of annuli and the spacing between annuli will be collected in a database and collated with the existing information about the herring. The image and the overlaid measurements maybe saved for future reference. It is anticipated that this step can occur relatively quickly during the production phases.

C. Data Analysis and Statistical Methods

This proposal is to collate and collect data for future analysis. This could occur as part of the synthesis or as part of a graduate student program. The budget for this project does not provide money for analysis. This data will allow comparisons with historical data on scale growth increments, but comparisons with other regions would require a similar project to measure scale growth increments.

The number of scales drawn from these collections will be determined by a power analysis. A preliminary sample size goal is 50 scales from 6 or 7 age classes per year for as many as 35 years (n=10k to 12k). The goal will be to measure a sufficient number of scales such that biologically significant differences in growth increments between cohorts can be detected.

D. Description of Study Area

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question “What is the appropriate sampling distribution?” as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

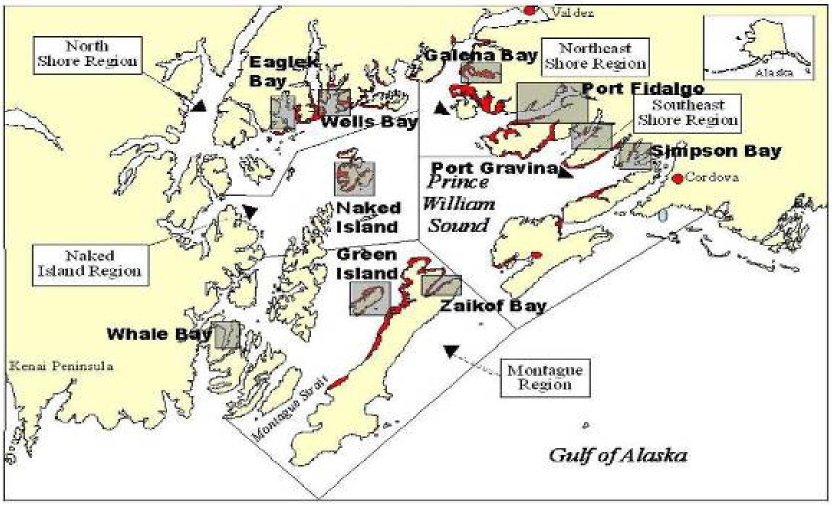

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is part of the integrated “PWS Herring Research and Monitoring” proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

III. SCHEDULE

A. Project Milestones

Objective 1. Standardize scale interpretive criteria, evaluate alternative measurement techniques, and develop semi-automated procedures for measuring scale increments of PWS herring.

To be met by March 2012

Objective 2. Measure scale growth increments on scales subsampled from archived collections.

To be met by August 2013.

B. Measurable Project Tasks

FFY 12, 1st quarter (October 1, 2011-December 31, 2011)

October *Project funding approved by Trustee Council*
November *Purchase scanning microfiche and software*

December   *Develop criteria for selection of scales to be processed*

FFY 12, 2rd quarter (January 1, 2012-March 31, 2012)
January   *Annual Marine Science Symposium*
February   *Meet with ADF&G Age Lab staff in Juneau*
March   *Conduct trial scale processing, finalize scale processing design*

FFY 12, 3th quarter (April 1, 2012-June 30, 2012)
May   *Conduct annual PI meeting*
June   *Begin production scale processing*

FFY 12, 4st quarter (July 1, 2012-September 30, 2012)
July–Sept.   *Production scale processing*
August   *Submit annual report*

FFY 13, 1st quarter (October 1, 2012- December 31, 2012)
Oct.–Dec.   *Production scale processing*

FFY 13, 2rd quarter (January 1, 2013-March 31, 2013)
January   *Annual Marine Science Symposium*
Oct.–Dec.   *Production scale processing*

FFY 13, 3th quarter (April 1, 2013-June 30, 2013)
May   *Conduct annual PI meeting*
June   *Begin production scale processing*

FFY 13, 4st quarter (July 1, 2013-September 30, 2013)
July–August.   *Finish scale processing*
August   *Submit annual report*

FFY 14, 2rd quarter (January 1, 2014-March 31, 2014)
January   *Annual Marine Science Symposium*

FFY 14, 3th quarter (April 1, 2014-June 30, 2014)
April 15   *Submit final report. This will consist of a draft manuscript for publication to the Trustee Council Office.*

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BUDGET JUSTIFICATION: Fiscal Year: 2012

Personnel:

Funds are requested ($58.8 K) to support ADF&G Fish and Wildlife Technician (FWT) II positions in Prince William Sound (12 months or 1.00 FTE). The technician will identify the number scales available by age class and collection year, standardize scale interpretive criteria, assist with equipment setup and calibration, and begin measuring scales growth increments (*Objectives 1a*).

ADF&G will provide an in-kind contribution of 0.5 months of staff time ($2.0 K) to supervise the technician in Cordova and 0.1 months (0.008 FTE) of staff time ($5.25 K) to supervise the technician in Cordova. (*Objective 1a*).

Travel:
Funds are requested for a technician to travel from Cordova to Juneau to meet with Alaska Department of Fish and Game Age Laboratory staff about scale aging criteria, scale measurement procedures, and software use ($0.57 K). Funds are requested for travel from Cordova to Anchorage for the Alaska Marine Science Symposium ($0.470 K) (*Objectives 1a).*

Contractual:
Funds are requested to retrofit scanner plate to accommodate the larger herring scales ($0.2 k) (*Objective 1a*).

Commodities:
Funds are requested to purchase Optimas Image Pro software for measuring scale growth increments ($3.5 K) and external hard drives to store data ($0.5 K) (*Objective1a).*

Equipment:
Funds are requested to purchase the Indus Model 4601-11 microfiche with screen scan model PC ($15.0 K) for capturing digital images of herring scales (*Objective1a).*

ADF&G will provide the following equipment as an in-kind contribution (*Objective 1a*): Dell desktop computers and software ($10.0 K).

Indirect:
The indirect for the Trustee Agency costs were calculated at 9% ($7.1K).

BUDGET JUSTIFICATION: Fiscal Year: 2013

Personnel:

Funds are requested ($39.2 K) to support ADF&G Fish and Wildlife Technician (FWT) II position in Prince William Sound (8.0 months or 0.67 FTE). The technicians will work on the production scanning and measuring the growth increments of selected herring scales. ADF&G will provide an in-kind contribution of 0.5 months of staff time ($5.25 K) to supervise the technician in Cordova (*Objective 1b*).

Travel:

Funds are also requested for travel to the annual PI meeting ($0.470 K).

Contractual:
No funds requested in FY 2013.

Commodities:
No funds requested in FY 2013.

Equipment:
ADF&G will provide the following equipment as an in-kind contribution (*Objectives 1b)*:
Dell desktop computers and software ($10.0 K).

Indirect:
The indirect for the Trustee Agency costs were calculated at 9% ($3.6K).

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: PWS Herring: Coordination and Logistics

Project Period: 1 October 2011 to 30 September 2016

Primary Investigator(s): W. Scott Pegau, Prince William Sound Science Center

Study Location: Prince William Sound

Abstract:

This project is for the coordination and logistics aspects of the proposed program titled, "PWS Herring Research and Monitoring". The objectives of the program are 1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model,* 2) *Inform the required synthesis effort, 3) Address assumptions in the current measurements, and 4) Develop new approaches to monitoring.* The Coordination and Logistics program objectives are to 1) ensure coordination between projects to achieve the program objectives, 2) Provide a synthesis from existing results, and 3) provide logistical support to the various projects.

Coordination includes scheduling of projects to ensure the maximum sharing of vessel time and so that projects dependent on results or samples from another project are in the correct order. Coordination will be primarily through email and teleconference, but each year all the investigators are required to meet in person. Coordination is also taking place with the existing Herring Survey program, the Long-Term monitoring program, and ADF&G herring sampling.

Logistics is primarily in providing vessel time although a remotely operated vehicle is requested in this budget to support non-lethal fish identification and being able to search under the ice.

The synthesis to be provided by this project is leveraging the required synthesis of the existing Herring Survey program. We intend to update that effort with new results and add a section on how environmental conditions affect herring growth.

Estimated Budget:
EVOSTC Funding Requested: $1,513,000
(breakdown by fiscal year and must include 9% GA)

FY 12	FY13	FY14	FY15	FY16
$327,200	$349,300	$364,200	$238,600	$233,700

Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date:
May 27, 2011

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the Exxon Valdez Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here is a single project that is a part of an integrative program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an improved modeling approach.

II. PROJECT DESIGN

A. Objectives

This project is designed as the oversight and logistics portion of the "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center. The objectives of that program are:

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

This projects objectives are:

1) Ensure coordination between projects to achieve the program objectives.
2) Provide a synthesis from existing results.
3) Provide logistical support to the various projects.

The subcontracts for Data Management and Non-Lethal Sampling projects are contained within the budget of this project since the Coordination project has an oversight role for all projects.

B. Procedural and Scientific Methods

The first objective is to ensure coordination between programs. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Pegau will act as the program team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program.

There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year’s work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermens United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

The wide array of projects that make up PWS Herring Research and Monitoring program required careful integration to ensure the maximum collaboration between projects. Not all observation projects are directly connected to each other, but are connected through the objectives of the program. The full benefits of the linkages will be seen at the points where synthesis efforts occur.

Coordination between programs is also taking place through scheduling of vessels by the Coordination project and the scheduling order of individual projects. All the investigators are required to work together to determine vessel type and number of days needed. Coordination was also achieved through the scheduling of projects to ensure results would be available for projects dependent on samples or data from another project. More information is available in section E. of this proposal.

The second objective is to provide a synthesis of results in year 3. A synthesis is also required for the currently funded herring program and due at approximately the same time. To reduce the cost of this proposal we will be relying on the existing synthesis effort to provide the required work. The aim of the current synthesis effort is not to summarize the existing information, but to use that information to address specific questions. We are looking to address the questions of

1) How many bays must we sample to provide a juvenile herring index?
2) Where don’t we find juvenile herring and why?
3) Energetically is it more important to be in good condition in the fall or have food available in the spring? This includes the quality of food available.
4) How do the sources of mortality (disease, energy, predation) interact with each other?

For the purpose of the synthesis required in this proposal we will add the question of how does environmental conditions affect growth and refine the answers to the other questions based on results obtained in this program.

The third objective is to supply logistical support. The primary logistical support is providing vessel time to the various projects. This is contained in the coordination budget to ensure maximum utilization of the vessels. This project will also obtain a remotely operated vehicle for use by the various projects. This is needed for non-lethal sampling, but has been identified as a need for the herring tagging project (mooring recovery), and for surveying under ice edges where large numbers of juvenile fish have been observed.

C. Data Analysis and Statistical Methods

This project is dependent on the investigators of the other projects to help identify questions for the synthesis and upon their expertise in the subject areas to define the appropriate data analysis and statistical methods.

D. Description of Study Area

The study area includes all of Prince William Sound (N, E, S, and W boundaries of respectively, ~ 61, -145.5. 60, and -149°). However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 2). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

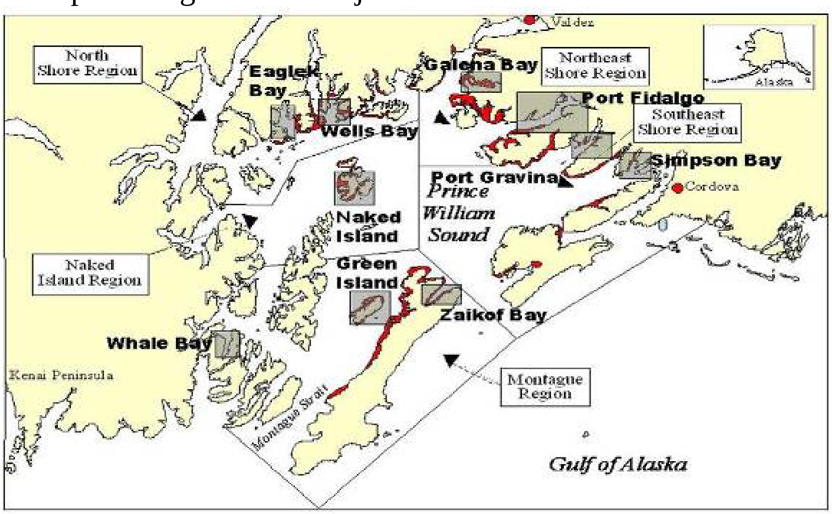

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is structured to be part of a collaborative programmatic effort being led by the Prince William Sound Science Center. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Pegau will act as the program team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program.

There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year's work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermens United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

The wide array of projects that make up this program required careful integration to ensure the maximum collaboration between projects. Not all observation projects are directly connected to each other, but are connected through the objectives of the program. The full benefits of the linkages will be seen at the points where synthesis efforts occur.

Direct overlap between observation projects occurs in the area of logistics. We intend to have the acoustic surveys, direct capture, and non-lethal collection components sharing a vessel. The direct capture and non-lethal collection are intended to provide validation to the acoustics. The direct capture component will be responsible for providing fish to the RNA condition, energetic condition, disease research, fatty acid indicators, and genetic stock indicator projects. Another direct project overlap occurs between the herring scale analysis and primiparous herring projects, which will share growth information as determined from the scales. The combined efforts will lead to a greater number of scales becoming digitized and improving the statistics for both projects. All projects will also interact with the data management efforts to ensure the data is properly archived and maintained.

Indirect project overlap occurs between projects through the scheduling. Projects like the genetic stock indicators are pushed back in the cycle to ensure that the methodologies used by the direct capture program are mature enough to ensure collection of the required samples. Non-lethal collection is also later in the program to ensure new direct capture techniques are fully tested. Fish collected from the RNA and energetics intensive studies will also be used by the fatty acid indicator project. The acoustic tagging project is early in the program to take advantage of the acoustic receiver array that is in place and has a limited life span. Some projects like the disease research component also start later in the program because of coordination with the existing herring monitoring program. We worked hard to ensure that there isn't duplication between the proposed program and the existing program. One apparent exception is the RNA and energetic condition intensives. By moving these projects early in the program we intend to fill what is seen as a major gap in the existing program and hopefully more quickly resolve the information value that each project provides.

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydroacoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

Other important programs for coordinating with are the existing PWS herring survey program and existing ADF&G herring research. This program has been developed with input from both of these programs and the focus of this proposal is extending the interpretation of the data from those two programs. The Herring Survey program will still be operating in FY12 and FY13. There are field observations scheduled in FY12 and in FY13 funds are strictly for analysis and report writing. Included in the report writing is a synthesis of previous and current research. This report will be finished in FY13 and be the basis for the synthesis required under this request for proposals.

III. SCHEDULE
A. Project Milestones

Objective 1. Ensure coordination between projects to achieve the program objectives.
This is an ongoing objective and will last through the proposal period

Objective 2. Provide a synthesis from existing results.
To be met by October 2013

Objective 3 Provide logistical support to the various projects.
This is an ongoing objective and will last through the proposal period

B. Measurable Project Tasks

FY12 1st Quarter (October 1, 11 to December 31, 11)
October Begin juvenile condition intensive, primiparous fish, and herring scale analysis

FY12 2nd Quarter
January Annual Marine Science Symposium

March	Complete ordering ROV
March	Obtain samples for fatty acid analysis

FY12 3rd Quarter

May	Conduct annual PI meeting
June	Submit FY13 work plan for review
June	Collect histology samples (timing depends on results of laboratory study)
June	Complete sampling for juvenile intensive

FY12 4th Quarter

August	Submit annual report

FY13 1st Quarter (October 1, 12 to December 31, 12)

October	Begin fatty acid analysis
November	Conduct juvenile index survey

FY13 2nd Quarter

January	Annual Marine Science Symposium
March	Conduct spring juvenile collection

FY13 3rd Quarter

April	Conduct extended adult biomass cruise, collect samples for genetics & histology
May	Conduct annual PI meeting
June	Submit FY14 work plan for review

FY13 4th Quarter

August	Submit annual report

FY14 1st Quarter (October 1, 13 to December 31, 13)

October	Submit synthesis to EVOS science council
October	Begin acoustic intensive study
November	Conduct juvenile index survey, test non-lethal sampling systems
December	Complete acoustic tagging project

FY14 2nd Quarter

January	Annual Marine Science Symposium
March	Complete acoustic intensive
March	Conduct spring juvenile collection
Winter	EVOS sponsored workshop with Herring and Long-term monitoring programs

FY14 3rd Quarter

April	Conduct extended adult biomass cruise, collect samples for genetics
May	Conduct annual PI meeting
June	Submit FY15 work plan for review

FY14 4th Quarter

August	Submit annual report

FY15 1st Quarter (October 1, 14 to December 31, 14)

November	Conduct juvenile index survey

FY15 2nd Quarter

January	Annual Marine Science Symposium
March	Conduct spring juvenile collection

FY15 3rd Quarter

April	Conduct extended adult biomass cruise
May	Conduct annual PI meeting
May	Submit five-year plan for FY17-22 and work plan for FY16

FY15 4th Quarter

August	Submit annual report

FY16 1st Quarter (October 1, 15 to December 31, 15)

November	Conduct juvenile index survey

FY16 2nd Quarter

January	Annual Marine Science Symposium
March	Conduct spring juvenile collection

FY16 3rd Quarter

April	Conduct extended adult biomass cruise
May	Conduct annual PI meeting
June	Submit work plan for FY17

FY16 4th Quarter

August	Submit annual report

PWS Herring Research and Monitoring: Coordination and Logistics
PRINCE WILLIAM SOUND SCIENCE CENTER

Personnel
One month salary is requested in each year for Dr. Pegau to act as the program coordinator. This effort is leveraged by his duties as the Research Program Manager with the Oil Spill Recovery Institute (OSRI). Up to an additional month of salary each year is available to the program from OSRI. Based on experience with the current herring program the one month a year is adequate for coordination efforts in most years. There is also a combination of salary between the two herring programs in years 1 and 2 when the synthesis effort is underway. Salary for an assistant to Pegau is requested each year (1, 2, 2, 1, 1 months in FY12-16) This person will be responsible for helping set up meeting, ensuring data sharing between PIs, and finding material needed for the synthesis effort.

Travel
In each year travel is requested to bring a program advisory group to Cordova to review the program. The intent is to have this review during the annual P.I. meeting. In year 1 travel is requested to allow Pegau to be trained in the operation of a remotely operated vehicle that is to be used for non-lethal identification and for surveying under ice edges. In years 2-5 travel to the Alaska Marine Science Symposium is requested. In year 3 funds are requested to travel to a EVOSTC review of the Herring and Long-Term Monitoring programs as outlined in the RFP. In FY12 and FY16 funds are requested to ensure that the PIs can meet jointly with the Long-Term Monitoring program. Since there is a required joint meeting in year 3, this allows the two teams to meet at a minimum every other year.

Contractual
Each year funds are requested for Information Technology, which includes $100/person month for network connections, and costs associated with software license renewals or purchases. Funds are requested each year for printing/mailing/copying. The request is based on historic and anticipated usage. Funds are also requested each year for communications, which includes $50/person month for phone, plus additional funds for long distance and fax costs. Vessel charter funds are requested each year ($62.5K, $83.2K, $104.0K, $91.8K, and $86.4K) based on the anticipated number of vessel days required for the projects running that year and the typical rate for the size of vessel needed. In years 2- 5 we are requesting funding for a subcontract with Cordova District Fishermen United to hire local fishermen to collect herring samples in the spring in lieu of scientific cruises. This provides additional local involvement and collects herring necessary for energetics studies. Subcontracts for Data Management (all years) and Non-lethal collection (FY14) are contained within this budget for administrative purposes. Detailed budgets and descriptions are provided separately.

Commodities
In each year funds are requested for office supplies (paper, pens, printers, etc.) that are typically consumed in association with the project. Additional funds are requested for miscellaneous cruise supplies (lines, nets, totes, etc.). We have found that in these multi-

PI projects that some shared items fall between the programs and the logistics office must be prepared to cover the cost of these supplies to ensure proper program performance.

Equipment

Funds are requested in year one to purchase a small remotely operated vehicle. The cost is based on a SeaBotix LBV300-5 for its versatility and camera capabilities.

INDIRECT COSTS

The PWSSC indirect rate is estimated at 30% of total modified direct cost (TMDC) based on our currently negotiated rate. TMDC is calculated as the sum of direct costs minus the cost of equipment and only the first $25K of subcontracts. Since vessel support is split between multiple vessels each year that contractual line is subject to full indirect cost being applied.

FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: PWS Herring Research and Monitoring **-**

Project Period: October 1, 2011 – September 30, 2016

Primary Investigator(s): Sharon Wildes
Co-operating Investigator: Jeff Guyon

Study Location: Prince William Sound

Abstract: This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al. The purpose of this proposal is to determine the genetic stock structure of Pacific herring in Prince William Sound using available microsatellite markers. Samples will be collected and their genetic characteristics compared between locations, spawning times and years. In addition, year classes within spawning stocks will also be analyzed for genetic differences. Herring will be collected from two geographical disparate locations within Prince William Sound, one from the east and one from the west. Each location will be extensively sampled such that at least 200 samples from each group (for a specific location, year, spawn time, and age class) will be available for analysis. As a control, a small group of 200 Pacific herring will also be collected from Lynn Canal. Lynn Canal herring are (1) easily accessible from Auke Bay Laboratories, (2) of high priority to the National Marine Fisheries Service and the Alaska Department of Fish and Game, and (3) have been part of our herring program for the last 2 years. DNA will be isolated from each collection of 200 herring and the samples genotyped using a group of microsatellite markers, many of which have already been standardized in our laboratory for Pacific herring (Wildes et al., accepted Fish Bull). To date, over 40 herring microsatellite markers have been described and each loci contains multiple alleles making them ideal genetic markers for analyzing migratory fish like herring with limited stock structure. Resulting genotypes will be compared to determine the genetic uniqueness of each collection using standard analyses (F_{ST} and G-test). Principle component analyses will be performed to illustrate stock separations. Chord distances will be calculated and a phlyogenetic tree constructed to illustrate genetic relationships. Finally, genetic results will be summarized to communicate their biological significance, as well as their significance to management and restoration.

Estimated Budget:
EVOSTC Funding Requested:
(breakdown by fiscal year and must include 9% GA)

Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date: May 18, 2011

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Identify the problem the project is designed to address. Describe the background and history of the problem. Include a scientific literature review that covers the most significant previous work history related to the project.

Robust Pacific herring populations, suitable for exploitation by commercial row fisheries are typically sustained by periodic recruitment of strong year classes into the adult spawning population; however, the Prince William Sound herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound (PWS) requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

What is described here are a series of projects that make up a program that enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we don't anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular it addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop, or test, biological and physical models of herring growth and recruitment rather than relying on empirical models.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated

Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS from the effects of EVOS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring lifecycle necessary to move us from an empirical modeling approach towards an analytical modeling approach.

II. PROJECT DESIGN

A. Objectives

List the objectives of the proposed research, the hypotheses being tested during the project, and briefly state why the intended research is important.

The Herring Monitoring Program goal is to improve predictive models of herring stocks through observations and research. To meet this goal we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass. The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies were put together based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

The goals of this study support program goal #4 - developing new approaches to monitoring, by identifying stocks and examining year class structure-both essential to a strong monitoring program.

B. Procedural and Scientific Methods

Herring will be collected from two geographical disparate locations within Prince William Sound, one from the east and one from the west. As a means to examine the fidelity of herring remaining in the Sound or returning to spawn in PWS, an additional sample from outside PWS will be used. We suggest Yakutat, as it is upstream from the Alaska current and more likely to be the nearest genetic contributor outside of PWS. Through collaboration with the Alaska Department of Fish and Game (ADF&G) in Cordova and Yakutat, each location will be extensively sampled such that at least 150 samples from each group (for a specific location, year, spawn time, and age class) will be available for analysis. Samples will be collected by coordinating with ADF&G and other EVOS funded projects from three locations, or nearby locations, as outlined in Table 1.

Table 1

Location	Area	Year	Collected from Late Spawn	Number* Analyzed
Montague Island	Western PWS	2011	500	300
		2012	500	300
St. Matthews Bay	Eastern PWS	2011	500	300
		2012	500	300
Yakutat (1 year class)	Central Alaska	2011	500	150
		2112	500	150
Total			**3000**	**1500**

*****number analyzed will include two year classes, obtained from the larger number collected.

Age class will be approximated from size information and DNA will be isolated from two age classes (150 each) from each collection of 500 at the time of collection. Scale reading later will determine the age classes. Samples will be genotyped using 15 microsatellite markers, all of which have already been standardized in our laboratory for Pacific herring (Wildes et al., accepted, Fish Bull).

C. Data Analysis and Statistical Methods

Resulting genotypes will be analyzed using standard genetic analyses in MICROCHECKER, GENEPOP, and FSTAT. Using PHYLIP, genetic distance among collections will be calculated and a neighbor-joining tree constructed to illustrate genetic relationships. The degree of genetic diversity will be examined with F_{ST} , G-test, and AMOVA among the following collections: (1) inside/outside PWS, (2) between collections within PWS, (3) among year classes within a spawning cohort and (4) among years of collections. Finally, genetic results will be summarized to communicate their biological significance, as well as their significance to management and restoration.

D. Description of Study Area

Where will the project be undertaken? Describe the study area, including if applicable decimally-coded latitude and longitude readings of sampling locations or the bounding coordinates of the sampling region (e.g., 60.8233, -147.1029, 60.4739, -147.7309 for the north, east, south and west bounding coordinates). The formula for converting from degree minute seconds to decimal degrees is: degrees + (minutes/60) + (seconds/3600) so 121°8'6" = 121. + (8/60) + (6/3600) = 121.135

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

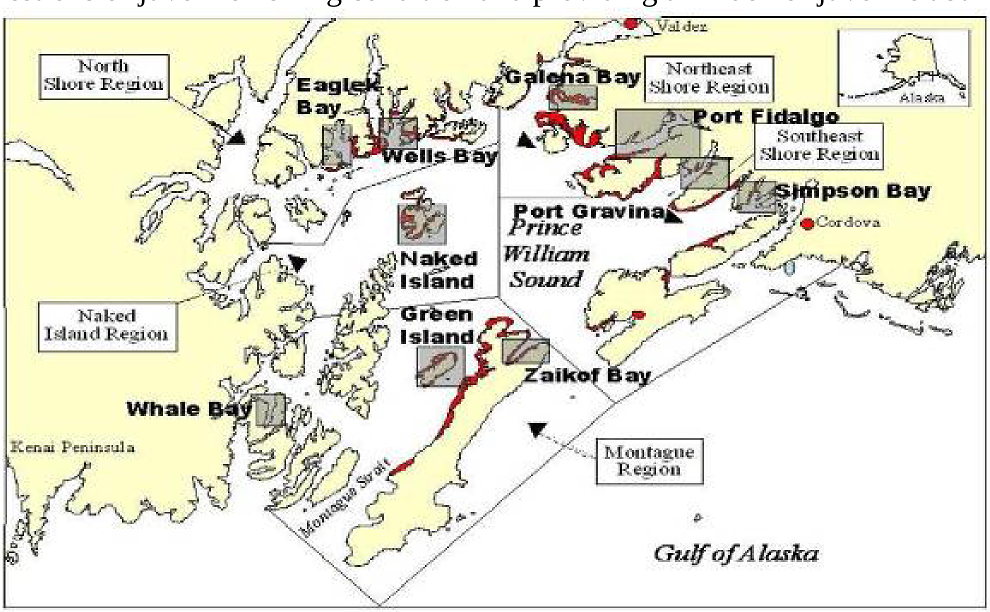

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

Indicate how your proposed project relates to, complements or includes collaborative efforts with other proposed or existing projects funded by the Trustee Council. Describe any coordination that has taken or will take place (with other Council funded projects, ongoing agency operations, activities funded by other marine research entities, etc.) and what form the coordination will take (shared field sites, research platforms, sample collection, data management, equipment purchases, etc.). If the proposed project requires or includes collaboration with other agencies, organizations or scientists to accomplish the work, such arrangements should be fully explained and the names of agency or organization representatives involved in the project should be provided. If your proposal is in conflict with another project, note this and explain why.

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

III. SCHEDULE

A. Project Milestones

March/April 2013 – First sample collection
Sep 30, 2013 – Complete genotyping first samples
March/April 2014 – Second sample collection
Sep 30, 2014 – Complete genotyping of second set of samples, begin data analysis
Oct 2015 – Issue Final report

B. Measurable Project Tasks

FY13
3rd Q- April- Collect herring samples

FY13
4th Q- Genotype 2013 collections and analyze data

FY14
3rd Q- April- Collect second set of herring samples

FY14
4th Q- Genotype 2014 collections and analyze data

FY15
4th Q- complete genetics project and report

IV. BUDGET - Genetic Stock Structure of Herring in Prince William Sound

	FY11	FY12	Total
100 Personnel	$17,662	$17,662	$35,325
200 Travel	$2,415	$3,785	$6,200
300 Supplies	$26,000	$27,500	$55,000
Total Direct Costs	$46,078	$48,948	$94,915
General Administration	$	$	$
Total All Costs	$	$	$

<u>Budget justification by Line Item:</u>

Line 100 Personnel. *Technician support totaling $35,325 to support a soft-funded Term appointment.* No support is requested for Full-Time Permanent personnel (Guyon, Wildes). 2.5 months in 2011, and 2.5 in 2012 is requested for technician support to conduct the bulk of the analyses and to supplement the needs for DNA isolation and genotyping. Wildes will lead the genotyping directly, but will need some aid. Costs are for one molecular biological technician at Auke Bay Laboratories for a total of 5 months at $7,065/month. This includes salary, COLA, and benefits.

Line 200 Travel. *Travel will includes trips for presenting results at the Alaska Marine Science Symposium, participating in annual herring meetings and field trips for sample collection.* - Results will be presented by Guyon and Wildes at the 2014 and 2015 Alaska Marine Science Symposia and published in the scientific literature. Results will also be presented by Wildes at the annual herring meetings in Cordova in 2014 and 2015. Finally Wildes and the technician will travel to Yakutat in 2015 to collect samples.

YR 1
Airfare to Anchorage $400 x 2 = $800
Per Diem in Anchorage $165 x 8 = $1320

Airfare to Cordova $400 x 1 = $400
Per Diem in Cordova $185 x 3 = $555

YR 2
Airfare to Anchorage $400 x 2 = $800
Per Diem in Anchorage $165 x 8 = $1320

Airfare to Cordova $400 x 1 = $400
Per Diem in Cordova $185 x 3 = $555

Airfare to Yakutat $480 x 2 = $960
Per Diem in Yakutat $185 x 8 = $1480

Line 300 Supplies. *Total supplies for sampling supplies ($1,000) and population analysis of PWS herring ($50,000) totaling $51,000.*

Sampling Supplies (Years 1-2) – Supplies are required for collecting genetic samples. Estimated at $500/year or $1,000 total.

Population Analysis (Years 1-2) – to determine population structure in PWS. 1,800 fish will be genotyped at 15 microsatellite markers at $29.17/fish (total of 1,800 x $29.17 = $52,500).

Cost Sharing

Salary support is being provided for both Jeff Guyon and Sharon Wildes in the completion of this project. These costs are estimated as follows:

Person	*Year 1*	*Year 2*	*Year 3*	*Total Costs*
Jeff Guyon, Fish Geneticist				
(2 months at $8,886/month)	$17,772	$17,772	$17,772	$53,316
Sharon Wildes, Fish Geneticist				
(4 months at $8,628/month)	$35,512	$35,512	$35,512	$106,536
Total	$53,284	$53,284	$53,284	$159,852

LITERATURE CITED

Wildes, S. L., J. Vollenweider, H. Nguyen, and J. R. Guyon. 2011. Microsatellite variation distinguishes outer-coastal and fjord populations of Pacific herring (*Clupea pallasii*) in the eastern Gulf of Alaska. Accepted Fish Bull. May 2011.

IV. BUDGET - Genetic Stock Structure of Herring in Prince William Sound

	FY11	FY12	Total
100 Personnel	$17,500	$17,500	$35,000
200 Travel	$3,400	$5,800	$9,200
300 Supplies	$26,000	$25,400	$50,800
Total Direct Costs	$46,300	$48,700	$95,000

<u>Budget justification by Line Item:</u>

Line 100 Personnel. *Technician support totaling $35,325 to support a soft-funded Term appointment.* No support is requested for Full-Time Permanent personnel (Guyon, Wildes). 2.5 months in 2011, and 2.5 in 2012 is requested for technician support to conduct the bulk of the analyses and to supplement the needs for DNA isolation and genotyping. Wildes will lead the genotyping directly, but will need some aid. Costs are for one molecular biological technician at Auke Bay Laboratories for a total of 5 months at $7,065/month. This includes salary, COLA, and benefits.

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Total	$53,284	$53,284	$53,284	$159,852