FY14 PROGRAM PROPOSAL FORM

Program Title: PWS Herring Research and Monitoring

Program Period: February 1, 2014 – January 31, 2015

Team Lead(s): W. Scott Pegau, Prince William Sound Science Center, Box 705 Cordova, AK 99574 ph: 907-424-5800 x222 email wspegau@pwssc.org

Abstract:

The goal of the Herring Research and Monitoring program is to improve the predictive models of herring stocks through observations and research. The program is designed around a twenty year time frame with changes in emphasis of the process studies every five years. During this period we have four objectives to help us move towards our goal. They are: *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model. Inform the required synthesis effort. Address assumptions in the current measurements. Develop new approaches to monitoring.*

A combination of monitoring and process studies will be used to address these objectives. The monitoring projects follow changing conditions and provide inputs to modeling efforts. The process studies are designed to be much shorter and to answer a very specific question.

The monitoring components include tracking the prevalence of disease, increased adult biomass surveys, and juvenile condition and biomass surveys. All of the monitoring components address the first objective.

There are seventeen studies that range in length of one to five years designed to address the different objectives. To address the first objective we are examining the age that fish join the spawning stock, the genetic structure, and examining the approaches available to model herring stocks. To address the second objective we are working on gathering relevant datasets and providing visualization, conducting an analysis using the herring scale library owned by ADF&G, and providing coordination between projects to examine the connectivity. To address the third objective there are intensive studies of juvenile condition and acoustic estimates of juvenile populations, trying to determine if immigration may impact our surveys, providing validation to the acoustic surveys, and conducting laboratory studies of disease. We are looking to herring tagging, disease forecasting, and non-lethal acoustic validation to address the last objective.

Estimated Budget:

EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
1,027,225	1,264,786	1,358,431	1,294,916	1,241,527	6,186,885

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date:

August 30, 2013

A. Summary of work performed to date

Some of the projects in this program are nearing their end, while others are just starting. We were able to work with the PWS Herring Survey program that proceeded the HRM program to ensure we maintained the scientific schedule even though there was a shift in the funding dates. During the development of the synthesis for the herring survey program there were several meetings where investigators from both programs were invited to ensure everyone was aware of what people had done and what was planned. We anticipate being able to build off the synthesis that was completed in 2013 in our synthesis due in 2014.

Sampling for the Juvenile Herring Intensive and Fatty Acid Analysis projects occurred in 2011 and 2012 and those fish have now been processed and the data being analyzed. The Juvenile Herring Abundance Index project sampled seven bays in November 2012 and fish were collected by the Validation project for the disease and herring condition projects. Fishermen from Cordova then sampled the same locations in March of 2013. The Expanded Adult Surveys were conducted as scheduled in April 2013. Fortunate circumstances allowed us to collect a rare sample of herring spawning at Kayak Island in April 2013. This sample was turned over to ADF&G for their age-sex-length analysis and will then be sent to NOAA for inclusion in the genetics study that is about to start.

Fish were collected for the Age At First Spawning project and the laboratory tests to determine if histology could detect fish that had not previously spawned were completed. Histology can identify fish that have not previously spawned and we are examining if growth indicated by the scales can be used as a marker of when a fish begins to spawn. The Scales As Growth History Records scanned a portion of the ADF&G herring scale library and begun making the measurements of growth over time. Early results indicate that growth in the first year of life has experienced pronounced changes over time and is not a good predictor of recruitment (Figure 1). The Age At First Spawning project will use the data from Scales As Growth History Records project to examine if the age at first spawn can be determined by changes in growth rate.

Adult herring were implanted with acoustic tags in April 2012 and 2013. A temporary array of receivers was installed near the spawning grounds in Port Gravina was installed two days after the fish were tagged.Of the sixty nine fish tagged in 2013 fifty six were detected by a receiving array near the spawning grounds. Detections peaked three times in April and some fish were still being detected into May when the spawning ground array was retrieved (Figure 2). Behavior of the detections in May were consistent with live fish and not tags that were lost or fish consumed by predators. We are still awaiting data from the receiving arrays that are installed in the entrances to determine if the fish left Prince William Sound.

The modeling program selected a student to work on the project and she has transitioned the age-structure-analysis model used by ADF&G to ADModel framework to allow for Bayesian predictions and testing the importance of different pieces of information being provided to the model.

The outreach project transitioned the herring research webpages to the new PWSSC website. The transition allowed us to better organize the available outreach products. The new website can be accessed at http://pwssc.org/research/fish/pacific-herring/. Project profiles, Field Notes radio program, and school programs have been developed and delivered. The herring program was highlighted at the

Ocean Fest public science events in Cordova and Valdez. Individual investigators presented on their research at forums, such as the Alaska Marine Science Symposium.

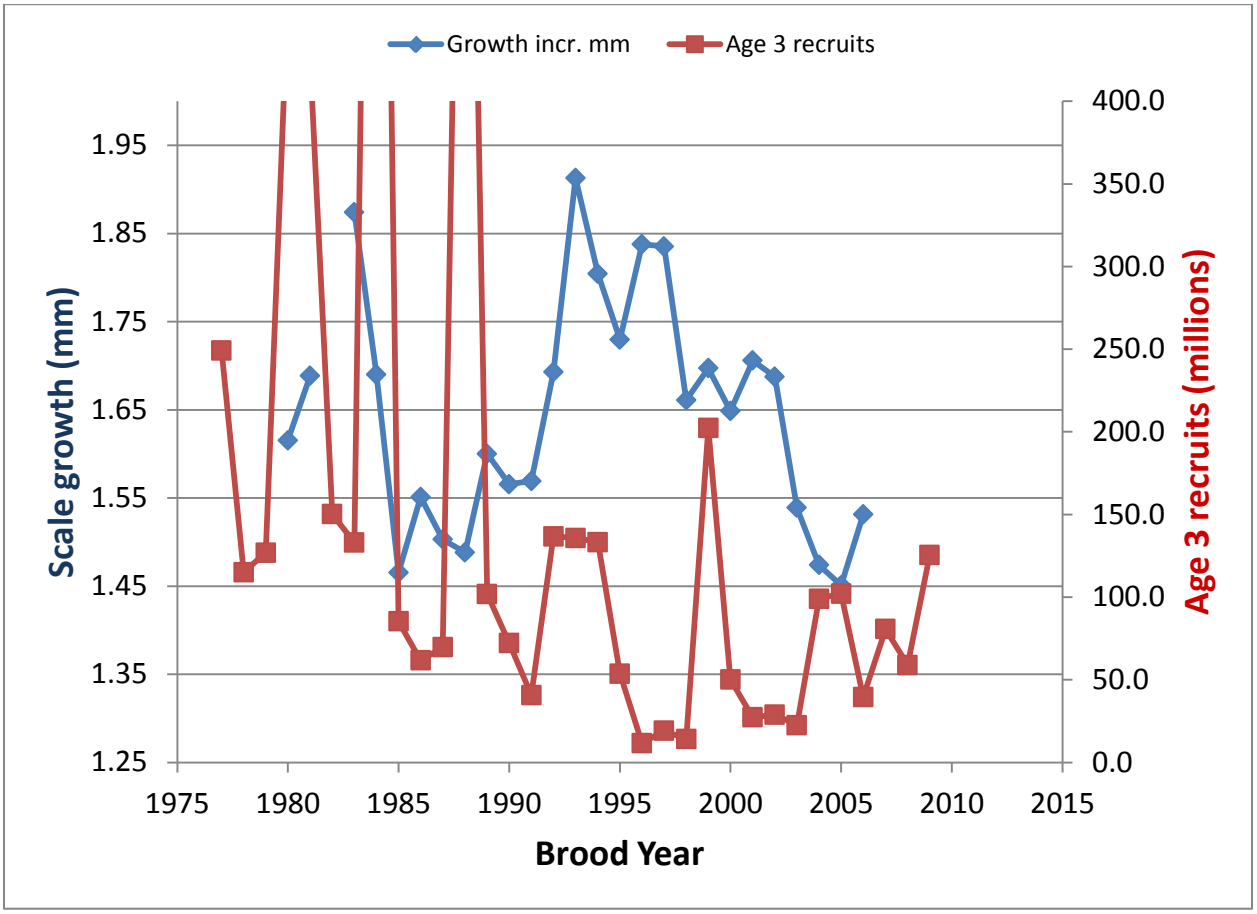

Figure 1. The blue line shows the mean growth increment of scales during the first year of life. The red line is the subsequent recruitment of age-3 fish from that brood year.

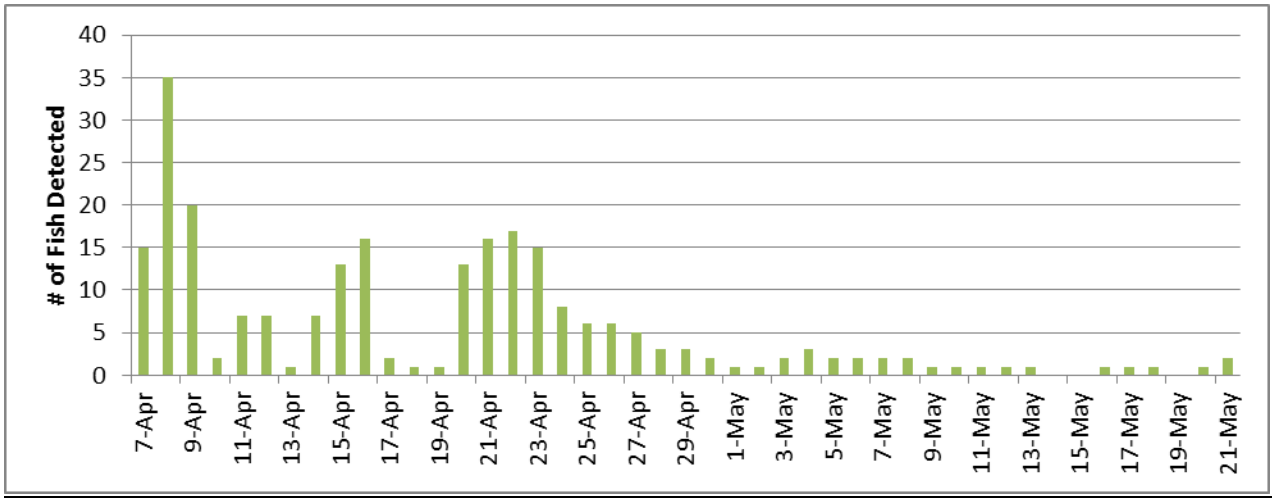

Figure 2. The number of tagged herring detected by an acoustic array near the spawning grounds at Red Head. The array was installed two days after the fish tagging was completed.

The program has experienced some setbacks. A new trawl system for collection of fish was purchased just prior to the November 2012 cruise. The valves on the trawl winch were undersized and the system could not be used so we used gill nets and cast nets as we had in the past for sampling during this cruise. Diagnosing the issues with the winch also cost us a day and we were only able to sample seven of the planned eight locations. The winch has been fixed and confirmed that it can properly deploy and retrieve the net.

The fatty acid project was designed to examine fish from several nearby locations to determine if a difference could be detected that would be useful for tracking movement of the fish. A test sampling in August was able to collect fish from four of the five desired locations, but during the planned November and March sampling fish were only found at two of the five locations. The project has adapted by using more fish from sampling the previous three years to provide the best possible spatial sampling.

We were unable to gather herring in November for the tagging project and found that sampling during the spawning season resulted in quicker collection of fish of an appropriate size. We shifted the focus of the project to the spring, which also allowed us to adapt to a delay in the installation of the Ocean Tracking Network receiver array that was installed in March 2013.

Very cold water temperatures in April 2013 delayed spawning in PWS for many of the fish. This may have made it very difficult for the expanded adult survey project to identify other spawning stocks. The only large spawn event outside the Port Gravina and Port Fildago regions was at Kayak Island. The spawning at Kayak occurred at the same time as the first spawn at Port Gravina. The lack of larger spawn events in other regions may create issues with sampling for genetics as well as identifying other spawning biomasses for the adult surveys to quantify.

Juvenile herring sampled by local fishermen in March were stored on ice and degrading some prior to being returned to Cordova. We purchased travel freezers to send out with the fishermen to ensure the fish are in the best possible condition for analysis.

B. Summary of work to be performed

The long-term goal of the program is to improve predictive models of herring stocks through observations and research. The objectives 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
4) Develop new approaches to monitoring.

To address objective 1 we will be completing the work on the age at first spawn project that is designed to determine the parameters used by the maturation function of the ASA model. We will conduct expanded adult herring biomass surveys to provide information on herring spawning biomasses in Prince William Sound. We will also continue to conduct acoustic surveys and condition measurements of age-0 herring to provide a prediction of the incoming year class strength for the ASA model. Disease prevalence sampling will be conducted to provide information used by the ASA model. We will conduct simulations to test which data sources are most important in assessing the population estimate

derived by the ASA. We will begin sampling different spawning populations to determine if there are genetic differences that may suggest multiple stocks within the region.

The required synthesis referred to in objective 2 will be prepared during this year. It will benefit from the completion of the scales as growth history records project that will provide an opportunity to examine how growth rates have changed through the last three decades and how that may tie to different oceanographic conditions. Improvements in the herring portal and other aspects of the data management system scheduled to be completed by the data management support project.

To address objective 3 we will be completing the fatty acid analysis project designed to look at the issue of immigration affecting the juvenile herring surveys. We will also be continuing the intensive surveys of juvenile herring that will begin in October 2013. These surveys are designed to determine the repeatability of our estimates through time. The intensive monitoring of juvenile herring condition will be wrapping up the analysis phase and provide the information necessary to determine if our sampling periods are appropriate for the questions being asked about the changes in overwinter condition. We will continue to collect samples to validate the interpretation of the acoustic survey measurements.

Addressing objective 4 we will be completing the analysis of the acoustic tracking of adult herring. This method may greatly expand our understanding of the movements of adult herring. We will continue to our testing of non-lethal approaches to validating the acoustic measurements using cameras and imaging sonar. That effort will be starting in the fall of 2013.

The coordination and logistic efforts will ensure coordination within the program, coordination with the Gulfwatch Alaska program, logistics for the various components, and be responsible for the synthesis. The outreach and education component will continue to provide materials and delivery of outreach to reach a broader audience than is normally reached by a scientific program.

The milestones listed in the original program proposal are provided below. More detailed deliverables can be found in the project proposals.

FY14 2nd Quarter

March	Complete histology study, complete acoustic intensive
March	Conduct spring juvenile collection
Winter	EVOS sponsored workshop with Herring and Long-term monitoring programs (This has been rescheduled for the following year)

FY14 3rd Quarter

April	Conduct extended adult biomass cruise, collect samples for genetics, submit fatty acid report
May	Conduct annual PI meeting, complete written outreach materials
June	Submit FY15 work plan for review (This now occurs at the end of August)

FY14 4th Quarter

August	Submit annual report
September	Complete acoustic tagging project, Complete non-lethal sample testing
September	Complete annual outreach efforts

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

October	Assess data submitted to data management
November	Conduct juvenile index survey, validation and sampling for energetics and disease
November	Submit synthesis report to EVOS (This was rescheduled from an earlier date.)

C. Budget changes from prior years

All budget changes in FY14 from the original proposal are a result of changes made in the FY13 proposal to allow funding to match the research deliverables. The reductions in budgets described below are because the funds were received in FY13

Pegau – Coordination and Logistics

FY14 Subtract $40,070 for Boswell subcontract
Subtract $15,600 for boat days
Subtract $12,180 for indirect

Buckhorn – Juvenile Herring Intensive Monitoring

FY14 Subtract $21,000 personnel
Subtract $6,300 indirect

D. Completed budget spreadsheet (attached).

The detailed budgets for all projects and summaries by organization can be found in the attached workbook. The overview showing the totals each year is provided below. This budget includes the Herring Population Dynamics modeling project that was approved as an addition to the original HRM proposal.

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$201,500	$377,300	$535,700	$524,200	$518,000	$2,156,700		$556,700	($21,000)
Travel	$26,800	$31,500	$47,000	$49,700	$46,600	$201,600		$47,000	$0
Contractual	$336,960	$544,799	$406,188	$367,616	$362,757	$2,018,320		$461,858	($55,670)
Commodities	$81,600	$33,700	$104,100	$100,300	$67,100	$386,800		$104,100	$0
Equipment	$187,200	$0	$0	$0	$0	$187,200		$0	$0
Indirect Costs (*will vary by proposer*)	$108,500	$173,030	$153,200	$146,100	$144,370	$725,200		$171,680	($18,480)
SUBTOTAL	$942,560	$1,160,329	$1,246,188	$1,187,916	$1,138,827	$5,675,820		$1,341,338	($95,150)
General Administration (9% of subtotal)	$84,665	$104,489	$112,291	$106,991	$102,656	$511,093		$114,700	($2,409)
PROJECT TOTAL	$1,027,225	$1,264,818	$1,358,479	$1,294,907	$1,241,483	$6,186,913		$1,456,038	($97,559)
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0		$0.0	$0

E. Proposals from each individual project contained within the program.

Attached are project proposal forms from the fourteen projects that are requesting funding in FY14.

Attachments:

Program Project Proposal Form
Budget Form

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS Herring Research and Monitoring Validation of Acoustic Surveys for Pacific Herring Using Direct Capture

Project Period: February 1, 2014 – January 31, 2015

Primary Investigator(s): Mary Anne Bishop, Ph.D., Prince William Sound Science Center, Cordova
mbishop@pwssc.org

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 of acoustic backscatter to confirm species and length frequency of insonified targets. Since November 2012, juvenile and adult herring acoustic surveys have been conducted in November and late March, respectively. 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 sweeper trawl capable of towing speeds (up to 3 knots) as a method to ground truth acoustic surveys for juvenile 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). Because of concerns of the Alaska Department of Fish and Game, for the March *Expanded Adult Herring Surveys* (years 2-5) we are being required to use gillnets and jigging for validation. 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:

FY12	FY13	FY14	FY15	FY16	TOTAL
68,000	90,600	148,000	141,100	145,300	593,000

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 30, 2013

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 one project of a multi-project 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 overall multi-project program is to improve predictive models of herring stocks through observations and research.

We recognize that a major deficit in the existing *PWS Herring Survey* program is the lack of an effective means of validating the acoustic signal. Fortunately, if we can establish through direct capture of insonified 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.

From November 2007 through March 2012, juvenile herring acoustic surveys were conducted at the beginning (November) and end (March) of each winter. A variety of methods were 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 *in situ* 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 sweeper trawl capable of towing speeds of 2-3 knots designed specifically to capture juvenile forge fish as a direct capture method for collecting the number of fish necessary to provide validation. These surveys will take place as part of two 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). A third study, *Expanded Adult Herring Surveys* (years 2-5) will use gillnets and cast nets to ground truth insonified fish, due to overfishing concerns of Alaska Department of Fish & Game.. 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).

B. Summary of Project to Date (if applicable)

All milestones are on track and scheduled to be completed by November 2015 (1 milestone), or in 2016 (4 milestones). The first direct capture study, *HRM: A High Temporal and Spatial Resolution Study to Validate the Separate Herring Condition Monitoring Program* (PI's Kline and Heintz) began in August

2011 (pre-award) and was completed in June 2012. Personnel from this study assisted with the monthly direct capture on several occasions, under the direction of HRM project leader Scott Pegau.
Our first multi-project direct capture effort was scheduled for November 2012 in conjunction with the *HRM study: Juvenile Herring Abundance Index*. Prior to that juvenile herring survey and to ensure that our validation methods would be appropriate for our study area and goals, Megan McKinzie, the project's fisheries biologist, participated in the EVOS Gulfwatch study: *Monitoring long-term changes in forage fish distribution, abundance, and body condition in Prince William Sound* (USGS Alaska Science Center, PI's Piatt and Armitsu). From July 20-26, 2012 McKinzie was onboard the *R/V* Alaskan Gyre with other scientists assisting with data collection. In addition to acquiring experience fishing the mid-water trawl, McKinzie acquired critical information to determine the appropriate net and mesh size required for our herring validation surveys.

When we wrote the original proposal for this project we planned to use a trawl that was part of the PWS Science Center's inventory. Unfortunately, this trawl was lost during field work on another project, forcing us to purchase a new trawl. Due to hydraulic compatibility issues between our reel/winches and the charter vessel during the initial November 2012 survey we were unable to obtain sufficient power to successfully deploy and haul our mid-water sweeper trawl, despite several attempts at system modifications and replumbing. Therefore, within each survey bay variable mesh adult and juvenile herring gillnets were deployed and allowed to soak overnight in areas of high acoustic signature as an alternative validation method. To provide samples to the juvenile herring and disease projects conducted concurrently with the acoustic surveys we supplemented our validation efforts with a small mesh gillnet and cast nets. All fish captured were identified to species, separated and measured for total length and weight.

The first expanded adult herring acoustic survey began late March through early April 2013 aboard the *R/V Auklet.* We collected fish for Herring and Research Monitoring acoustic validation and genetics studies primarily using jigs and gillnets, and to a lesser extent castnets. We did not utilize the mid-water trawl for the adult survey validation component because of ADFG concerns that too many adult herring would be captured.

To prepare for the upcoming fall 2013 juvenile herring survey, we made equipment adjustments to our trawl winches and our hydraulics. On 15 March 2013 we successfully tested the trawl to ensure it is fully functional and that we have the necessary power to deploy and retrieve the net. From October 2013-December 2013 we participate in the biweekly *Juvenile Herring Intensive Acoustic & Validation Surveys*. In addition, in November 2013 we will conduct the validation surveys for the annual *Juvenile herring abundance index* acoustic surveys.

II. PROJECT DESIGN

A. Objectives

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.

B. Procedural and Scientific Methods

Field Collections and Laboratory Methods

To provide accurate data on insonified fish, the trawl will be towed simultaneous with acoustic surveys for juvenile herring and from the same research vessel. Based on our sampling objectives, desired species and age classes it was determined that a mid-water sweeper trawl would be the most effective net design. The net has an approximately 154 m^2 mouth (14 m x 11m) and is 22 m long. Mesh size diminishes from 38 mm at the mouth to 12 mm at the cod end (Innovative Net Systems, Inc.). The net is held open by two 0.4 m^2, series 2000 steel mid-water trawl doors (Nor 'Eastern, Inc.); each weighing approximately 76 lbs. The net and doors are deployed via dual winches with enough 3/8" dynema line to fish to a maximum depth of about 70 m. Target depth for juvenile herring capture is 15-25 m. Until a trawl master can be obtained, trawl depth and water temperature will be recorded every second using a DST centi-TD temperature depth recorder (Star-Oddi). To analyzed trawl performance and net orientation the trawl will also be equipped with as DST-tilt sensor (Star-Oddi). Data will be downloaded and reviewed between trawls. Average trawling speeds will be 2-3 kts.

Validation of acoustic echograms relies on ground trothing acoustic backscatter to confirm species composition and length frequency distribution of insonified fish (McClatchie et al. 2000). In each survey bay, we will conduct three 1-km tows in areas and depths with the strongest acoustic signature, as designated by the lead acoustician. For each haul, all catch items will be collected, broken down by species, then weighed and measured. In the case of large hauls, a random sub-sample of the catch will be collected and measured. For all non-herring species, 60 individuals/species will be randomly selected along with 200 herring for the collection of morphometric data.

Species composition and length frequency will be characterized by identifying all fish to species and measuring individual total length, 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.

C. 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:

$$TS = m \log L + b + \mathcal{E}$$

where TS is the target strength, m and b are species specific coefficients, Ɛ 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.

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.

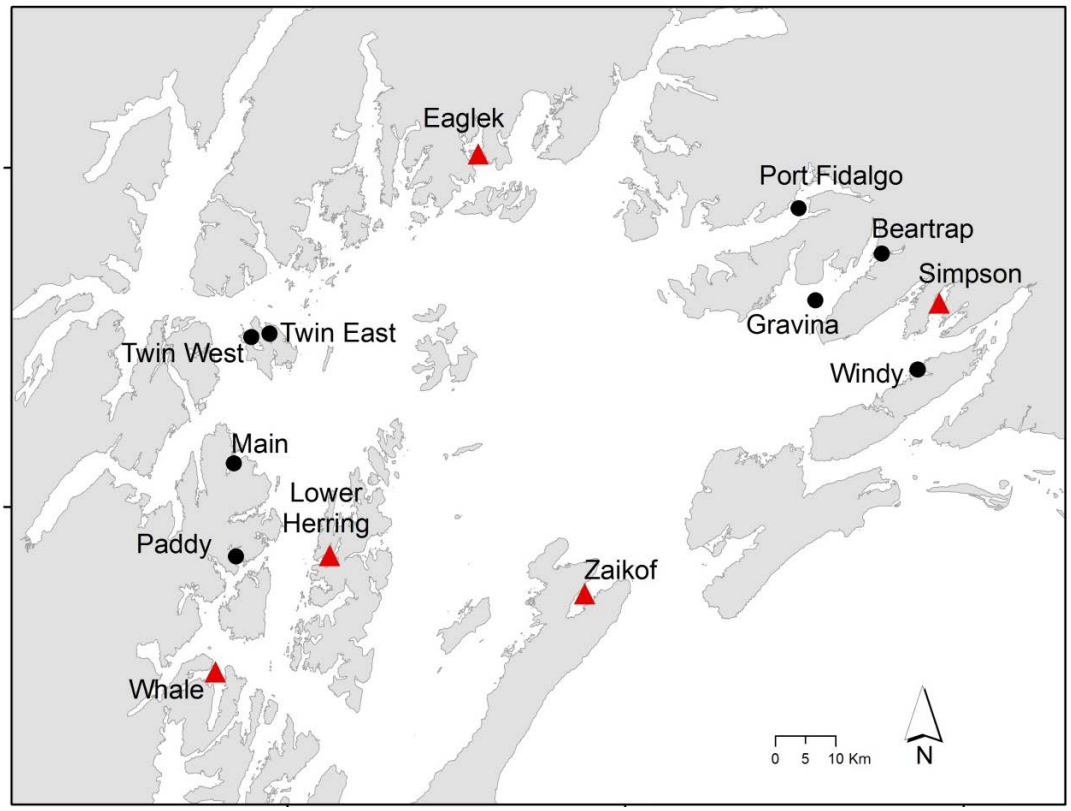

Figure 1. Map of Prince William Sound indicating bays surveyed for juvenile herring between November 2009 and March 2012. Primary bays indicated with red triangles.

E. Coordination and Collaboration with the Program

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 *Gulfwatch 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.

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 her research assistant. Megan McKinzie. 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. CV's/RESUMES

Curriculum Vitae

MARY ANNE BISHOP, Ph.D.
Research Ecologist,
Prince William Sound Science Center
300 Breakwater, PO Box 705
Cordova, Alaska 99574
907-424-5800 x 228; mbishop@pwssc.org

EDUCATION

Ph.D. Department of Wildlife and Range Sciences, University of Florida, Gainesville, 1988.
M.S. Wildlife and Fisheries Sciences, Department of Wildlife and Fisheries Sciences, Texas A & M University, College Station, 1984.
B.B.A. School of Business, University of Wisconsin, Madison, 1974.

RECENT PROFESSIONAL EXPERIENCE

Research Ecologist, Prince William Sound Science Center, Cordova, Alaska, Jun 1999-present
Research Wildlife Biologist, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska, 1990-1994 and 1997- May1999
Research Wildlife Biologist, Center for Streamside Studies and Dept. Fisheries, University of Washington, assigned to Copper River Delta Institute, Cordova, Alaska, 1994-1997
Acting Manager, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska, 1992-1993.

SELECTED SCIENTIFIC PUBLICATIONS (10 of 53)

*= publication resulting from herring research

***Bishop, M.A.,** J.T. Watson, K. Kuletz, T. Morgan. Pacific herring consumption by marine birds during winter in Prince William Sound, Alaska. *Fisheries Oceanography*. (accepted pending revisions).

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

***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.

*Dawson, N.M., **M.A. Bishop**, K.J. Kuletz, A.F. Zuur.. Using ships of opportunity to assess winter habitat associations of seabirds in subarctic coastal Alaska. *Arctic*. *(accepted pending revisions)*.

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. Pages 87-99 in C. A. Woody (ed) *Sockeye salmon evolution, ecology and management*. American Fisheries Society, Symposium 54, Bethesda, MD.

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.

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.

*Watson, J.T., **M.A. Bishop**, and S.P. Powers. Pacific cod predation on pacific herring during winter in Prince William Sound. *Fisheries Oceanography*. (in press).

*Zuur, A.F., N. Dawson, **M.A. Bishop**, K. Kuletz, A.A Saveliev and E.N. Ieno. 2012. Two-stage GAMM applied on zero inflated Common Murre density data. Pages 155-188 *in* A.F. Zuur, A.A.Saveliev, E.N. Ieno (eds). *Zero Inflated and Generalized Linear Mixed Models with R.* Highland Statistics Ltd, Newburgh, United Kingdom.

PROFESSIONAL COLLABORATIONS

M. Buckhorn (PWSSC), K. Carpenter (CRWP), N. Dawson (PWSSC), J. Eiler (NOAA), R. Federer (PWSSC), R. Heintz (NOAA), N. Hill (MIT), E.N. Ieno (Highland Statistics), K. Kuletz (USFWS), A. Lang (Memorial Univ.), F. Li (Intl. Crane Foundation), J. Moran (NOAA), T. Morgan (PWSSC), E. Nol (Trent Univ.), W.S. Pegau (OSRI), S. Powers (U. S. Alabama), B. Reynolds (PWSSC), G. Robertson (CA), D. Roby (OSU), J. Runstadler (MIT), A Saveliev (Highland Statistics), S. Senner (Audubon), Y. Suzuki (OSU), A. Taylor (UAA), R. Thorne (PWSSC), D. Tsamchu (Tibet Plateau Institute of Biology, PR China), J. Vollenweider (NOAA), J. Watson (PWSSC), M. Wille (Memorial Univ.), Z. Zuur (Highland Statistics)

IV. SCHEDULE

A. Project Milestones

Objective 1. Improve capture methods used for ground truthing acoustic surveys.
Field work completed April 2016. Synthesis evaluating techniques, August 2016.

Objective 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.

Objective 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.

Objective 4. Provide adult herring samples to Alaska Department of Fish and Game for the adult herring age-structure-analyses model.
Completed April 2016.

Objective 5. Provide juvenile herring samples to researchers investigating juvenile herring fitness and disease.
Completed November 2015.

B. Measurable Project Tasks

FY 14, 1st quarter (Feb 1 – Apr 30, 2014)

Feb-Mar Biweekly Field Cruises: *Juvenile Herring Intensive Acoustic & Validation Surveys*
late Mar Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

FY 14, 2nd quarter (May 1, 2014-Jul 31, 2014)

May-Jul Process fish & analyze data
Jul Prepare mid-year report & FY15 work plan

FY 14, 3rd quarter (Aug 1, 2014- Oct 31, 2014)

Aug Submit report & FY 15 work plan
Aug-Oct Analyze data

FY 14, 4th quarter (Nov 1, 2014 – January 31, 2015)

Nov Field cruise: *Juvenile herring abundance index* with hydroacoustic & validation surveys; disease & energetics collections
Dec Process fish samples
Jan Alaska Marine Symposium

V. BUDGET

Budget Form (Attached)

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS Herring Research and Monitoring Tracking Seasonal Movements of Adult Pacific Herring in Prince William Sound

Project Period: February 1 2014 – January 31, 2015

Primary Investigator(s):
Dr. Mary Anne Bishop, Prince William Sound Science Center, Cordova , mbishop@pwssc.org
Collaborators:
Dr. Sean Powers, University of South Alabama & Dauphin Island Sea Lab, spowers@disl.org
John Eiler, NMFS, Ted Stevens Marine Research Institute, john.eiler@noaa.gov

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 wild adult herring for the first time. Herring will be sampled from around Port Gravina, a spring spawning area. We will examine detections from acoustic arrays to determine seasonal movement patterns in 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 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:

FY12	FY13	FY14	FY15	FY16	TOTAL
70,700	17,500	17,400	0	0	105,600

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 31, 2013

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 one project of a multi-project 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 overall multi-project program is to improve predictive models of herring stocks through observations and research.

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).

Previous efforts to acoustic tag and monitor fish in Prince William Sound over more than a one year period have been proven successful. 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, as well as eight portable receivers at pinnacles near

the POST array. In September 2010 an array was installed at the mouth of Zaikof Bay near Hinchinbrook Entrance consisting of six portable receivers. Acoustic-tagged lingcod (*Ophiodon elongatus*) were then successfully monitored at Zaikof and Port Gravina through February and May 2012, respectively (Bishop et al. 2010; Fig. 1).

Following several years of planning and negotiations, in March 2013, PWS Science Center collaborated with Canada's Ocean Tracking Network (OTN) to install two, large-scale arrays including one across the mouth of Hinchinbrook Entrance and one across Montague Strait, and four small arrays at the southwest PWS passages of Erlington, LaTouche, Bainbridge, and Prince of Whales (Fig. 1). These arrays will allow for detections of acoustic-tagged herring moving into and out of Prince William Sound.

B. Summary of Project to Date (if applicable)

All milestones are on track and scheduled to be completed by July 2014 and September 2014.

Our first tagging effort took place from 18-22 November 2011 in conjunction with the Alaska Department of Fish and Game (ADFG) herring bait surveys. Field efforts by ADFG to purse seine were stymied by poor weather conditions (exceptionally cold, or high winds), whales in and around herring schools, and herring schools remaining deeper than the seine. We were provided samples from their final set for tagging. Fish ranged in age from 2.5 to 3+, and were smaller than our pre-determined size restriction for tagging and release, however, we were able to practice our surgical procedures on 20 herring before sacrificing these fish.

Our second tagging cruise coincided with herring spawn aggregations and took place from 8-11 April 2012 in Port Gravina. Compared with November, fish were much larger and were of sufficient size to hold an acoustic tag. We practiced tagging pre-spawning adults and based on our observations and experienced gained on pre-spawners, on our final day (11 April) we jigged 38 adult herring >19 cm TL. We surgically implanted 25 adult herring with coded acoustic transmitters (V9-2L/2H, 69kHz). While a few fish appeared to have spawned, most fish had not yet spawned. The 25 tagged fish and 13 controls (untagged fish) were released simultaneously near the capture site in 25 m of water at ~ 1600h on 11 April (Figs. 1, 2). A singleVR2W receiver (60.68885, -146.39118) was retrieved from 17 m of water on 19 May 2012 to upload the detection data.

This was the first time that wild herring have been tagged with acoustic transmitters. The VR2W receiver near our point of release detected 23 (92%) of the tagged individuals multiple times (≤ 227 detections) on one or more days (≤ 5 d) post release at (Fig. 3). Only 1 of the 25 herring was never detected. Final detections of tagged fish by 15 April coincided with a cessation of spawning in the immediate area suggesting that fish departed from Port Gravina and did not return.

Our third tagging cruise also coincided with spawn aggregations in Port Gravina. Between 6-7 April 2013 we surgically implanted coded acoustic transmitters (Model V9-2L/2H, 69kHz) into 69 adult herring from 3 separate schools (24, 20 and 25 tagged). All but one herring had not yet spawned. We used the same methodology as in April 2012, including releasing tagged fish and controls (untagged fish) simultaneously and near a herring school. Due to recent technological changes, the VR3 acoustic receiver array at Port Gravina cannot detect the new generation of transmitters. Therefore, we installed a temporary acoustic array from 7 April – 21 May 2013. Of the 69 tagged individuals, 56 (81 %) were detected multiple times (≥8 detections) on one or more days. Most detections occurred over three distinct periods: 7-9, 15-16 and 20-26 April, possibly indicating periods of increased spawning activity

Determining whether or not herring depart from Prince William Sound has been dependent on the installation of acoustic arrays across the major entrances and passages between the Sound and the Gulf of Alaska. When this project was planned, arrays across the entrances and passages were scheduled to be deployed in fall 2011. However due to a series of delays, the equipment did not arrive from Canada

until late December 2012, after the transmitters on herring tagged in April 2012 had expired. In March 2013, the Ocean Tracking Network (OTN) arrays were deployed and acoustic arrays are now installed across Hinchinbrook Entrance, Montague Strait, and four major passages in southwest Prince William Sound.

II. PROJECT DESIGN

A. Objectives

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).

B. Procedural and Scientific Methods

Here we propose to synergize with efforts of the Ocean Tracking Network by undertaking a pilot study to mark adult Pacific herring with acoustic tags. Our tagging efforts will coincide with Alaska Department of Fish & Game (ADFG) surveys for adult herring (known as bait surveys) in November 2011. Our spring 2012 and spring 2013 efforts will coincide with the beginning of spawn in the Port Gravina area. For November efforts, we will use a dipnet to collect herring captured by ADFG purse-seines. For spring 2012 and 2013, we will jig adult herring. Healthy individuals will be transferred 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 V9-2L/2H acoustic transmitter (Vemco, Halifax, Nova Scotia) programmed to transmit an individually-encoded signal at 40-60 s (high power) and 60-150 s (low power) 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 ~260 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. We will tag up to 100 herring around Port Gravina and Port Fidalgo. In spring 2012 and 2013, VR2W acoustic receivers will be temporarily installed to monitor for tagged fish in Port Gravina from April through mid-May. Data from Ocean Tracking

Network arrays at the entrances to Prince William Sound will be uploaded in late February/early March 2014.

C. 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 in Port Gravina will be examined to determine the amount of time spent in an area.

D. Description of Study Area

While herring can potentially move throughout the Sound, acoustic receivers will be located in Port Gravina, and across Hinchinbrook Entrance, Montague Strait, and in the four southwest passages of Bainbridge, Prince of Whales, Erlington, and LaTouche.

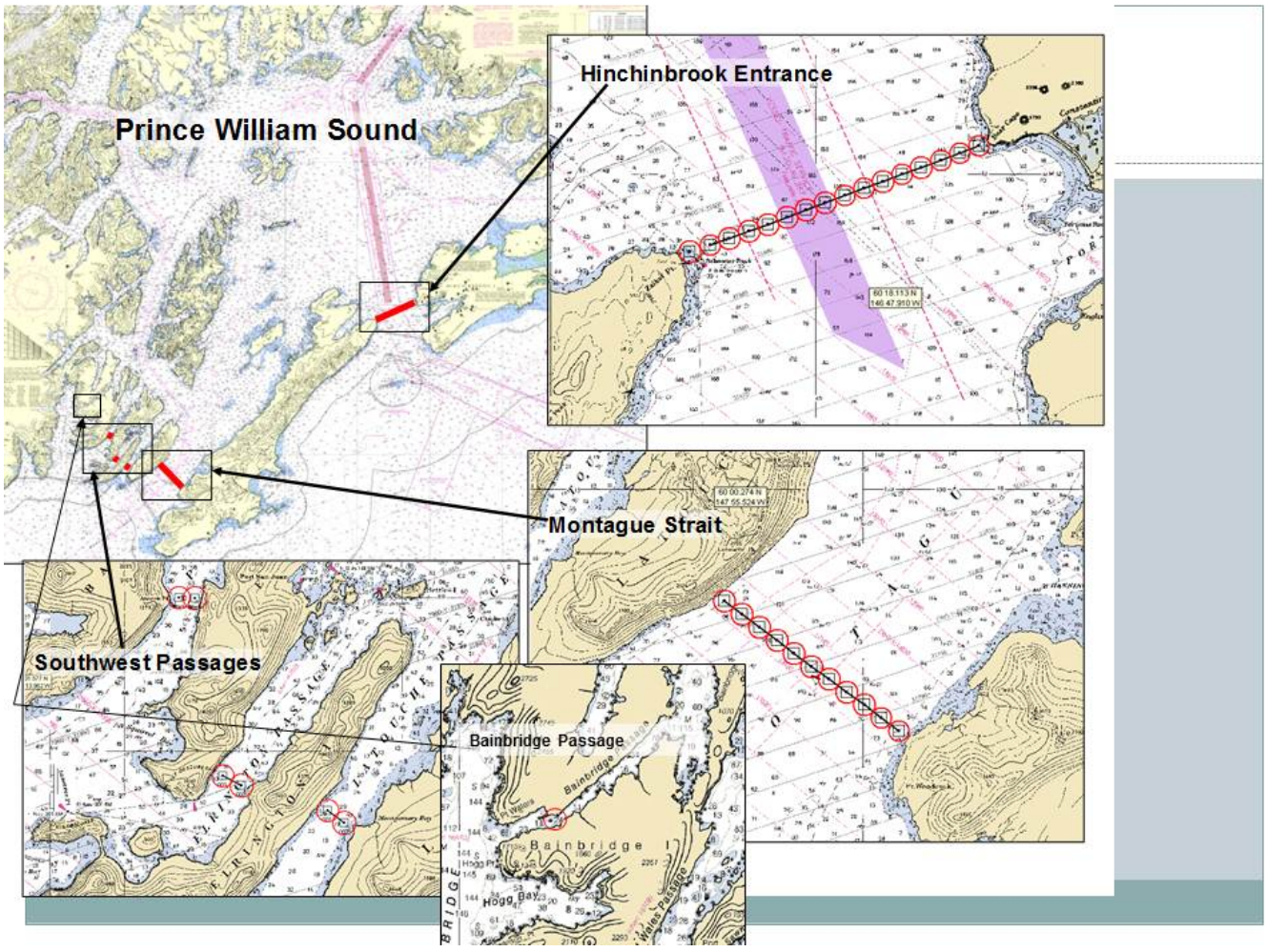

Fig. 1. Location of Ocean Tracking Network acoustic arrays, installed in Prince William Sound in March 2013.

E. Coordination and Collaboration with the Program

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 Gulfwatch Long-Term Monitoring program. 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, preparation of a manuscript and completion of final products for *PWS Herring Research & Monitoring* synthesis. Initially a PI on this project, Dr. Sean Powers (University of South Alabama) is now a collaborator on this project due to unforeseen circumstances relating to the obligations relating to investigating impacts of the Deep Water Horizon oil spill. John Eiler, of NOAA Ted Stevens Marine Research Institute is also a collaborator on this project. This project will rely on obtaining data from the Ocean Tracking Network arrays proposed that were installed at major entrances to Prince William Sound in March 2013. We collaborated with Alaska Department of Fish and Game for our November 2011 tagging efforts that coincided with their fall herring bait surveys.

III. CV's/RESUMES

MARY ANNE BISHOP, Ph.D.
Research Ecologist,
Prince William Sound Science Center
300 Breakwater, PO Box 705
Cordova, Alaska 99574
907-424-5800 x 228; mbishop@pwssc.org

EDUCATION

Ph.D. Department of Wildlife and Range Sciences, University of Florida, Gainesville, 1988.
M.S. Wildlife and Fisheries Sciences, Department of Wildlife and Fisheries Sciences, Texas A & M University, College Station, 1984.
B.B.A. School of Business, University of Wisconsin, Madison, 1974.

RECENT PROFESSIONAL EXPERIENCE

Research Ecologist, Prince William Sound Science Center, Cordova, Alaska, Jun 1999-present
Research Wildlife Biologist, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska, 1990-1994 and 1997- May1999
Research Wildlife Biologist, Center for Streamside Studies and Dept. Fisheries, University of Washington, assigned to Copper River Delta Institute, Cordova, Alaska, 1994-1997
Acting Manager, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska, 1992-1993.

SELECTED SCIENTIFIC PUBLICATIONS (10 of 53)

- = publication resulting from either acoustic or radio telemetry study (13 total)

***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

***Bishop, M.A.**, N. Warnock, and J. Takekawa. 2004. Differential spring migration of male and female Western Sandpipers at interior and coastal stopover sites. *Ardea* 92: 185-196.

***Bishop, M.A.**, N. Warnock, and J.Y. Takekawa. 2006. Spring Migration Patterns in Western Sandpipers *Calidris mauri.* Pages 545-550 in G.C. Boere, C.A. Galbraith, and D.A. Stroud (eds.) *Waterbirds around the world*. The Stationery Office, Edinburgh, U.K.

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.

***Bishop, M.A.** and N. Warnock. 1998. Migration of Western Sandpipers: links between their Alaskan stopover areas and breeding grounds. *Wilson Bulletin* 110: 457-462.

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. Pages 87-99 in C. A. Woody (ed) *Sockeye salmon evolution, ecology and management*. American Fisheries Society, Symposium 54, Bethesda, MD.

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Zuur, A.F., N. Dawson, **M.A. Bishop**, K. Kuletz, A.A Saveliev and E.N. Ieno. 2012. Two-stage GAMM applied on zero inflated Common Murre density data. Pages 155-188 *in* A.F. Zuur, A.A.Saveliev, E.N. Ieno (eds). *Zero Inflated and Generalized Linear Mixed Models with R.* Highland Statistics Ltd, Newburgh, United Kingdom.

PROFESSIONAL COLLABORATIONS

M. Buckhorn (PWSSC), K. Carpenter (CRWP), N. Dawson (PWSSC), J. Eiler (NOAA), R. Heintz (NOAA), N. Hill (MIT), E.N. Ieno (Highland Statistics), K. Kuletz (USFWS), A. Lang (Memorial Univ.), F. Li (Intl. Crane Foundation), J. Moran (NOAA), T. Morgan (PWSSC), E. Nol (Trent Univ.), W.S. Pegau (OSRI), S. Powers (U. S. Alabama), B. Reynolds (PWSSC), G. Robertson (CA), D. Roby (OSU), J. Runstadler (MIT), A Saveliev (Highland Statistics), S. Senner (Audubon), Y. Suzuki (OSU), A. Taylor (UAA), R. Thorne (PWSSC), D. Tsamchu (Tibet Plateau Institute of Biology, PR China), J. Vollenweider (NOAA), J. Watson (PWSSC), M. Wille (Memorial Univ.), A. Zuur (Highland Statistics)

IV. SCHEDULE

A. Project Milestones

1) Field test the application of recent advances in acoustic telemetry on wild adult herring. ***To be completed July 2014.***

(2) Utilize the PWS acoustic arrays to monitor herring migration into and out of PWS. ***To be completed July 2014.***

(3) Elucidate herring movement patterns between overwinter and spawning sites. ***To be completed September 2014.***

B. Measurable Project Tasks

FY 14, 1st quarter (February 1 – May 31, 2014)

February, 2014	*Project funding available*
late Feb/early Mar	*Upload data from Ocean Tracking Network array*
Mar-May	*Process and analyze data*

FY 14, 2nd quarter (June 1, 2014-August 30, 2014)

Jun-Aug	*Process and analyze data, prepare final report*

FY 14, 3rd quarter (September 1, 2014-November 30, 2014)

September 30	*Submit final report*

FY 14, 4th quarter (December 1, 2015 – January 31, 2015)

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: Data Management Support for the EVOSTC Long Term Monitoring Program

Project Period: Feb 1st 2014 to Jan 31st 2015

Primary Investigator(s): Rob Bochenek, Axiom Consulting & Design

Abstract: This project supplies the EVOS Long Term Monitoring (LTM) effort 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 long term monitoring program. In the first two years, 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. These efforts would continue into year three through five but efforts would also focus on developing management and outreach applications for the data and data products produced from the LTM program.

Estimated Budget:

EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
130,800	130,800	22,500	23,300	24,000	331,400

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: August 6th 2013

(THIS SUMMARY PAGE 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 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. Summary of Project to Date (if applicable)

During the first few months of the EVOS PWS Herring Program Data Management project investigators have been focused on establishing protocols for data transfer, metadata requirements and initiating the data salvage effort. Investigators have been meeting and planning with Matt Jones to coordinate future activities. PIs have participated in several PI meetings and are coordinating activities between the Herring and LTM programs. In addition, the AOOS ocean workspace has been rolled out to PIs and their user and group profiles have been created. Several training seminars have been held via webinars and PIs are beginning to use the system to organize and consolidate their project level data. Software

engineers at Axiom have also been working to support workspace, resolving bugs and implementing new functionality in response to user feedback. The PWS Herring Portal has been updated with available herring data from ADF&G and expanded with additional regional datasets of relevance to the PWS Herring Program.

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/.

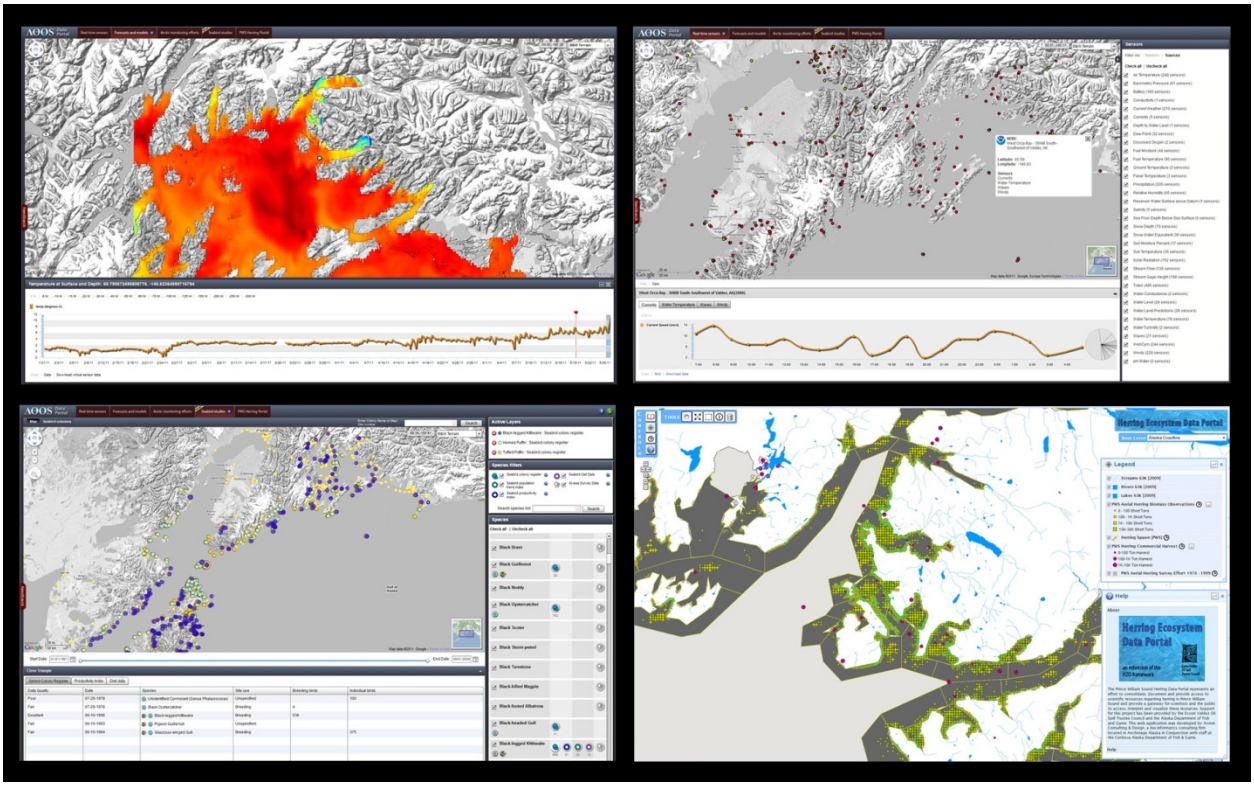

Figure 1. Screenshots of existing AOOS data management and visualization systems which are available at http://data.aoos.org. At the top left is a screenshot of the AOOS model explorer displaying a ROMS circulation model of Prince William Sound and an ocean temperature point source time series extraction 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.

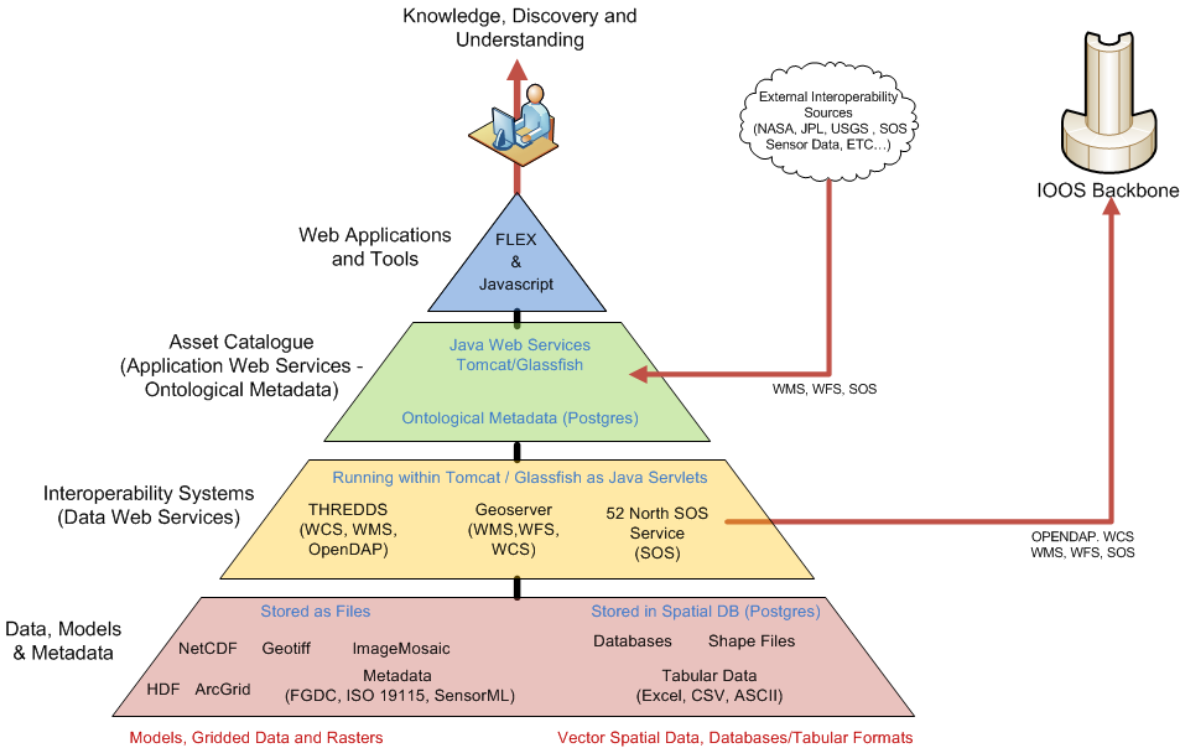

Figure 2. Data knowledge pyramid detailing the flow of data through logical technology tiers so that it can be consumed by users to enable discovery and understanding about the ocean environment.

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. CV's/RESUMES

CV — Robert Bochenek

Position and Address
Information Architect
Axiom Consulting and Design, 523 W. 8th Ave, Anchorage, AK 99501, USA

Professional Preparation
University of Michigan, Aerospace Engineering, B.S.E., 2001

Appointments

2010 – Present	Technical Lead, Alaska Ocean Observing System, Anchorage, AK
2006 – Present	Information Architect, Axiom Consulting and Design, Anchorage, AK
2003 – 2006	Data Systems Manager, Exxon Valdez Oil Spill Trustee Council (EVOSTC), Anchorage AK, 99504
2001 – 2002	Analyst Programmer, Alaska Department of Fish & Game, Anchorage, AK

Publications
None

Synergistic Activities

2012 – Present	Funded under the NOAA High Performance Computing program for exploratory research in applying HPC concepts to serving and visualizing gridded multidimensional models and observational data sets
2011 – Present	Member of the IOOS Sensor Observation Service standardization Committee
2010 – Present	Member of the Alaska Data integration Working Group (ADIWG) focused on developing frameworks for interchange of scientific information across Alaskan Agencies.
2009 - Present	Development of the Prince William Sound Data Portal, A tool for scientists, educators and the public to visualize four dimensional fisheries data

Collaborators and Co-Editors

Broderson, Dayne	Geographic Information Network of Alaska (GINA), Fairbanks, AK
Howard, Katherine	Alaska Department of Fish and Game, Anchorage, AK
Jones, Matt	National Center for Ecological Analysis and Synthesis, Santa Barbara, CA
Krueger, Charles	Great lakes Fishery Council, Ann Arbor, MI
Moffit, Steve	Alaska Department of Fish and Game, Anchorage, AK
Moss, Jamal	Alaska Fisheries Science Center, Juneau, AK
Mueter, Franz	University of Alaska, Juneau, AK
Mundy, Phillip	Alaska Fisheries Science Center, Juneau, AK
Pegau, Scott	Oil Spill Recovery Institute, Cordova, AK
Saupe, Susan	Cook Inlet Citizen's Advisory Council, Anchorage, AK
Smith, Stan	United states geological Survey, Anchorage, AK
Snowden, Derrick	Integrated Ocean Observing System, Silver Springs, MD
Svoboda, Michael	Environment Canada, Whitehorse, Canada
Wiese, Francis	North pacific Research Board, Anchorage, AK

CV — Shane R. StClair

Position and Address
Senior Software Engineer
Axiom Consulting and Design, 523 W. 8th Ave, Anchorage, AK 99501, USA

Professional Preparation
University of Alaska Anchorage, Biological Sciences, B.S., 2002

Appointments

2008 – Present	Senior Software Engineer, Axiom Consulting and Design, Anchorage, AK
2006 – 2008	Analyst Programmer, Exxon Valdez Oil Spill Trustee Council, Anchorage, AK
2002 – 2006	Research Analyst, Alaska Department of Fish & Game, Anchorage, AK

Publications

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.

Hamner, H. H., S. St Clair, and H. Moore. 2004. An inventory of age, sex and length data for Norton Sound, Kotzebue, and Kuskokwim chum salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-06, 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.

Hamner H., S. Karpovich, S. StClair. 2003. Development Of A Shared AYK Salmon Database. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-23, Anchorage.

Hamner, H. H., S. Karpovich, S. St. Clair. 2003. Norton Sound salmon information database file inventory and problem review. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-01, Anchorage.

Synergistic Activities

2011 - Present	Member of the IOOS Sensor Observation Service standardization committee
2011 - Present	Developer of IOOS customizations of 52North SOS software and significant contributor to main codebase
2011 - Present	Maintainer of GeoServer (open source geospatial data server) Excel WFS output plugin
2010 - Present	Maintainer of Redmine/ChiliProject (open source project management software) Recaptcha anti-spam plugin
2009 - Present	Contributor to several widely used open source projects including jTDS, OpenScales, Maven Shade, GeoTools
2009 - 2012	Developed spatially enabled online data management application for Alaska Dept. of Fish & Game aerial surveys and transferred software to client systems and programmers
2008 - Present	Developer for global seabird abundance, population health, and diet database in conjunction with USFWS, World Seabird Union, Pacific Seabird Group, and others

Collaborators

Aime, Andrea	GeoSolutions, Reggiolo, Italy
Bridger, Eric	Gulf of Maine Research Institute, Portland, ME
Chaouchi, Mohamed	Center for Operational Oceanographic Products and Services, Silver Spring, MD
Deoliveira, Justin	OpenGeo, New York, NY
Dickinson, Ian	Epimorphics, Bristol, UK
Garcia, Mike	National Data Buoy Center, John C. Stennis Space Center, MS
Hollmann, Carsten	52North Initiative for Geospatial Open Source Software, Muenster, Germany

Irons, David	U.S. Fish and WIldlife Service, Anchorage, AK
Jones, Kathleen	Alaska Department of Fish and Game, Juneau, AK
Kaler, Robb	U.S. Fish and WIldlife Service, Anchorage, AK
Kellon, Cathy	Ecotrust, Portland, OR
Kimball, Heath	Alaska Department of Fish and Game, Anchorage, AK
Mayorga, Emilio	Northwest Association of Networked Ocean Observing Systems, Seattle, WA
Moffit, Steve	Alaska Department of Fish and Game, Cordova, AK
Snowden, Derrick	Integrated Ocean Observing System, Silver Springs, MD
Walton, Kelly	Alaska Natural Heritage Program, Anchorage, AK
Welch, Tim	Ecotrust, Portland, OR
Wilcox, Kyle	Applied Science Associates, South Kingstown, RI

IV. 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 (January 2014).

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

Y3 1st Quarter (February 1, 14 to April 30, 14)

Winter	EVOS workshop with Herring and Long-term monitoring programs
February	Submit annual report
February	Submit annual financial report

Y3 2nd Quarter (May 1, 14 to July 31, 14)

May	Participate in annual PI meeting

Y3 3rd Quarter (August 1, 14 to October 31, 14)

August	Submit semi-annual report and year 4 work plan
September	Oversee transfer of field year 3 data
October	Assess year 3 datasets and metadata submitted through Ocean Workspace

Y3 4th Quarter (November 1, 14 to January 31, 15)

January	Annual Marine Science Symposium

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: Non lethal sampling: In situ estimation of juvenile herring sizes

Project Period: (Please use the fiscal year of February 1 – January 31)

Primary Investigator(s): Kevin M. Boswell; Florida International University, North Miami, FL, 33029

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:

FY12	FY13	FY14	FY15	FY16	TOTAL
0	43,676	51,263	0	0	94,939

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: 8/30/2013

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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. Summary of Project to Date (if applicable)
Agreements have recently been arranged between PWSSC and FIU to initiate the contract process.`

II. PROJECT DESIGN

A. Objectives

Objective 1-Apply non-invasive techniques to estimate the in situ distribution (size, abundance, behavior and 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 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 conceived 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.

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 the Program

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. CV's/RESUMES

Kevin M. Boswell

Florida International University
Marine Sciences Program
Department of Biological Sciences
3000 NE 151st St
North Miami, FL 33181, USA

Office: 305-919-4009
Fax: 305-919-4030
Email: kevin.boswell@fiu.edu
Web: http://www2.fiu.edu/~kmboswel/

(a). Professional Preparation

2006 PhD, Oceanography and Coastal Sciences, Louisiana State University, Baton Rouge, LA.
Minor- Experimental Statistics
1998 BS, Marine Fisheries, Texas A&M University, Galveston, TX

(b). Appointments

2011-Present Assistant Professor, Marine Science Program, Department of Biological Sciences, Florida International University
2012- Present Assistant Professor- Adjunct, Department of Oceanography and Coastal Sciences, Louisiana State University
2010- 2011 Assistant Professor- Research, Department of Oceanography and Coastal Sciences, Louisiana State University

(c). Products

Five most relevant products

Grabowski, TB, **KM Boswell**, BJ McAdam, RJD Wells, G Marteinsdottir. *2012*. Characterization of Atlantic cod spawning habitat and behavior in Icelandic coastal waters. *PLoS ONE, 7(12)*. doi:10.1371/journal.pone.0051321

Handegard, NO, **KM Boswell**, C.C. Ioannou, S.P. LeBlanc, D.B. Tjostheim and I.D. Couzin. *2012*. The dynamics of coordinated group hunting and collective information-transfer among schooling prey. *Current Biology*, 22:1213-1217.

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.

Boswell KM, MP Wilson and JH Cowan. 2008. A semi-automated approach to estimating fish size, abundance and behavior from Dual-frequency Identification Sonar (DIDSON) data. *North American Journal of Fisheries Management*, 28:799-807.

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, 395:181-190.*

Five other products

Campbell MD, KA Rose, **KM Boswell** and JH Cowan. 2011. Individual-Based Modeling of Fish Population Dynamics of an Artificial Reef Community: Effects of Habitat Quantity and Degree of Refuge. *Ecological Modeling*, 222 (2011) 3895– 3909.

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

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 and CA Wilson. 2008. Side-aspect target strength measurements of bay anchovy (*Anchoa mitchilli*) and Gulf menhaden (*Brevoortia patronus*). *ICES Journal of Marine Science*, 65:1012-1020.

(d). Synergistic Activities

Selected Professional Services, Committees and Outreach

i. Founding member: Southeast Acoustics Consortium (seac.fiu.edu)
ii. US Representative: ICES Working Group on Fisheries Acoustics Science and Technology
iii. Participant: ICES Study Group on Calibration of Acoustic Equipment
iv. Member of the Advisory Committee of the Atlantic Coastal Cooperative Statistics Program
v. Manuscript reviewer for American Fisheries Society Symposium Series, Conservation Biology; Estuarine, Coastal and Shelf Science; J of Experimental Marine Biology and Ecology; Gulf of Mexico Science; ICES J of Marine Science; J of Sea Research; Marine and Coastal Fisheries; Marine Ecology Progress Series; Marine Technology Society Journal; North American J of Fisheries Management; Transactions of the American Fisheries Society

(e). Collaborators and Other Affiliations

Collaborators in past 48 months

Dennis Allen (USC BBML); Hongsheng Bi (UMCES); Iain Couzin (Princeton); James Cowan (LSU), Kim de Mustert (GMU), Alex De Robertis (NOAA), Nils Olav Handegard (IMR), John Hedgepeth (Tenera); Ron Heintz (NOAA); Joe Hightower (NCSU); Mike Jech (NOAA); Matt Kimball (UNF); Chunyan Li (LSU); Brenda Norcross (UAF); Doug Nowacek (Duke); Guillaume Rieucau (IMR); Jay Rooker (TAMU); Jan Straley (UAS); Tracey Sutton (VIMS); Chris Taylor (NOAA); Joel Trexler (FIU); Joe Warren (SUNY); David Wells (TAMU)

Graduate advisors and postdoctoral sponsors

PhD- Dr. Charles A. Wilson; Gulf of Mexico Research Initiative
Post Doctoral- Dr. James H. Cowan; Louisiana State University

Thesis Advisor and Postgraduate-Scholar Sponsor

Postdoctoral scholar- Dr. Marta D'Elia, Postdoctoral advisee, 2013-present
Visiting Scientists- Dr. Guillaume Rieucau, 203
Thesis committee: Mark Barton (PhD, Florida International University); Michael Bush (PhD, Florida International University); Grace Harwell (MS, Louisiana State University); Ashley Melancon (PhD, Louisiana State University); Andrew Repp (PhD, Florida International University); Kirsten Simonsen (PhD, Louisiana State University); Adam Zenone (MS, Florida International University)

IV. 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

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS Herring Research and Monitoring: Expanded Adult Herring Surveys

Project Period: February 1, 2014 – January 31, 2015

Primary Investigator(s): Michele Buckhorn, PhD; Richard Thorne, PhD; Prince William Sound Science Center, Cordova, 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:

FY12	FY13	FY14	FY15	FY16	TOTAL
6,500	84,400	68,100	90,600	84,400	334,000

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: 30 August 2013

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.

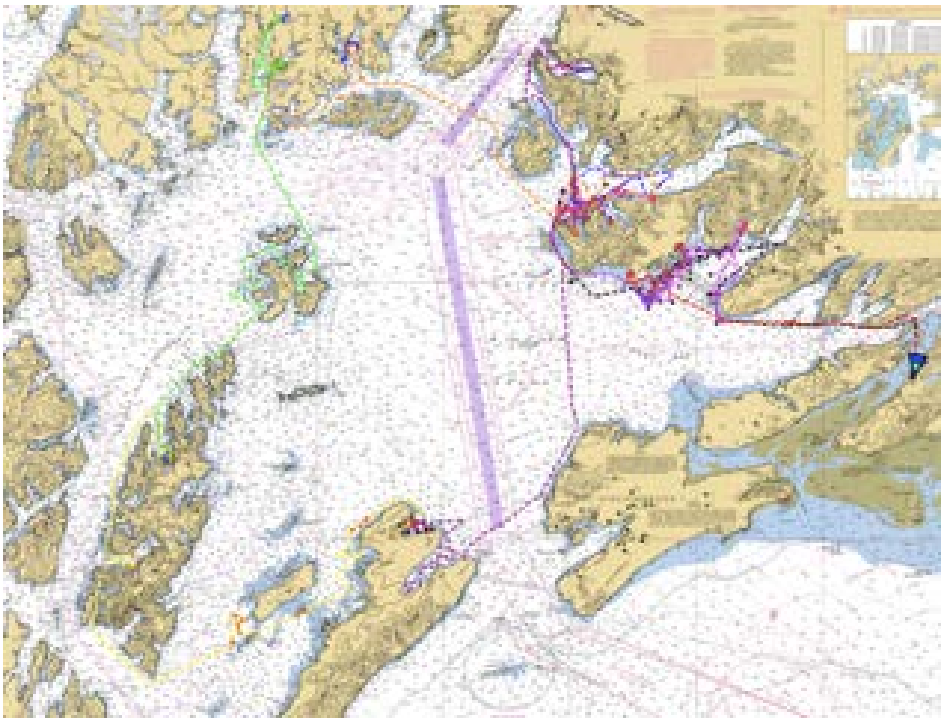
The current management of the Prince William Sound (PWS) herring stock by the Alaska Department of Fish and Game (ADF&G) depends heavily on hydroacoustic surveys. Biomass estimates from these surveys provide a direct measure of the stock abundance and are also a primary input into the age-structured 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. Summary of Project to Date (if applicable)

a) Hydroacoustic surveys of adult herring schools were conducted March 27- April 5, 2013 and covered 629 nautical miles within Prince William Sound. Surveys were started in Port Gravina and Fidalgo, which have historically been surveyed by the previous hydroacoustic projects, then moved south and northwest to cover areas not previously covered.



Map of Prince William Sound with survey tracks for adult herring surveys.

II. PROJECT DESIGN

A. Objectives

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. CV's/RESUMES

- **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:**
- Principal Investigator. Fish Ecologist, Prince William Sound Science Center. November 2011 – present
- Postdoctoral Researcher Fish Ecologist, Prince William Sound Science Center. June 2010 – November 2011
- Postdoctoral Researcher. U.C. Davis. Department of Wildlife, Fish and Conservation Biology. 2008-2009.

- **Publications**
- *Journal Articles:*
- Thorne, R and M. L. Buckhorn. "Assessment of Adult Herring Abundance in Prince William Sound, Alaska, 1993-2012." In prep.
- Buckhorn, M.L. and R. Thorne. "Use of acoustic surveys to examine juvenile herring habitat and abundance in Prince William Sound, Alaska." In prep

- **Selected Presentations**
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- 2011 Buckhorn, M.L., Richard Thorne, James Thorne. Evaluation of a Floating, Two-Vessel Towed Transducer System for Detection of Near-Surface Fishes. Poster. American Fisheries Society 141st Annual Meeting. Seattle, WA.

- **Recent Collaborators**
- Scott Pegau, PhD., Prince William Sound Science Center
- Richard Thorne, PhD., Prince William Sound Science Center
- A. Pete Klimley, PhD., UC Davis

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CURRICULUM VITAE

Richard E. Thorne, Ph.D.
rthorne@pwssc.org
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 (in press). The Exxon Valdez Oil Spill and the Collapse of the Prince William Sound Herring Stock: A Reexamination of Critical Biomass Estimates, In: Alfred, J.B. and Peterson, M (eds), Impacts of Oil Spill Disasters on Marine Fisheries in North America, CRC Press/Taylor & Francis, Boca Raton, FL

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

Collaborations:

Gary L. Thomas,
Rosenstiel School of Marine and Atmospheric Sciences
4600 Rickenbacker Causeway
Miami, Florida 33149
gthomas@rsmas.miami.edu

IV. SCHEDULE

A. Project Milestones

Objective 1. 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. *To be met by April 2014*

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.

FY14 1st Quarter	
January	Annual Marine Science Symposium
Winter	EVOS sponsored workshop with Herring and Long-term monitoring programs
FY14 2nd Quarter	
April	Conduct extended adult biomass cruise, collect samples for genetics
May	Attend annual PI meeting
FY14 3rd Quarter	
August	Submit FY15 work plan for review
FY14 4th Quarter	
October- December	Process and analyze data

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS Herring Research and Monitoring: Juvenile Herring Abundance Index

Project Period: February 1, 2014 – January 31, 2015

Primary Investigator(s): Michele Buckhorn, PhD (Lead PI)
Richard Thorne, PhD (co-PI); Prince William Sound Science Center, Cordova, 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:

FY12	FY13	FY14	FY15	FY16	TOTAL
90,100	80,100	66,100	84,900	83,000	404,200

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
		0			

Date: 30 August 2013

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. Summary of Project to Date (if applicable)

Hydroacoustic surveys were conducted November 6- 16, 2012. Bays surveyed were the SEA bays: Simpson, Eaglek, Whale, Zaikof plus Lower Herring, Port Fidalgo, and Port Gravina. We were unable to conduct surveys in Windy Bay due to weather and delays due to mechanical failures involving the midwater trawl. Fish capture was accomplished using gillnets and castnets. Acoustic data is currently being processed and analyzed.

II. PROJECT DESIGN

A. Objectives

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.

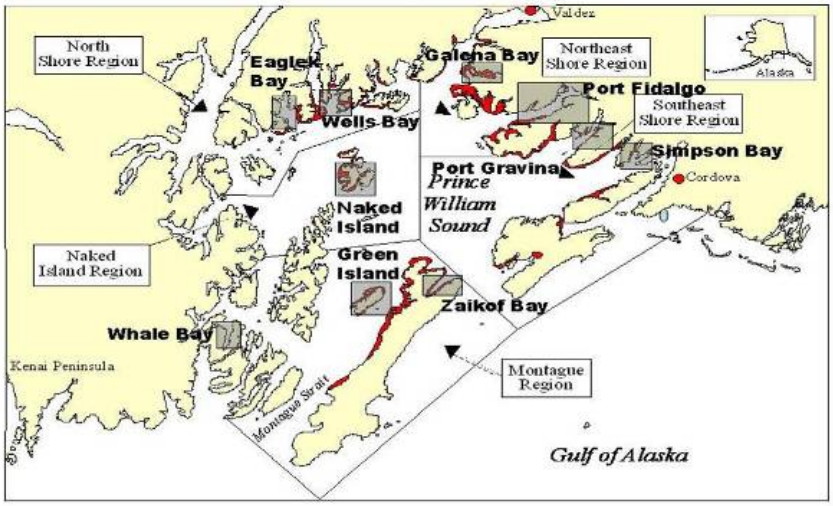

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with the Program

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. CV's/RESUMES

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Education:

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Recent Collaborators

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Richard 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

CURRICULUM VITAE

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

Employment History

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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
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Collaborations:

Gary L. Thomas,
Rosenstiel School of Marine and Atmospheric Sciences
4600 Rickenbacker Causeway
Miami, Florida 33149
gthomas@rsmas.miami.edu

IV. SCHEDULE

A. Project Milestones

Objective 1: Conduct annual surveys of juvenile herring to create an index of future recruitment. *To be met by November 2013*

Objective 2: Validate species and size composition of fish ensonified during acoustic transects (See Bishop proposal). *To be met by November 2013*

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.

FY14 1st Quarter

FY14 2nd Quarter

May	Attend annual PI meeting
June	Submit FY15 work plan for review

FY14 3rd Quarter

September	Provide juvenile data for synthesis efforts.

FY14 4th Quarter

November	Conduct juvenile index survey

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS Herring Research and Monitoring: Intensive surveys of juvenile herring

Project Period: February 1, 2014 – January 31, 2015

Primary Investigator(s): Michele Buckhorn, PhD (Lead PI)
Richard Thorne, PhD (co-PI); Prince William Sound Science Center, Cordova, 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:

FY12	FY13	FY14	FY15	FY16	TOTAL
50,100	29,757	46,543	6,800	0	133,200

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
		0			

Date: 30 August 2013

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. Summary of Project to Date (if applicable)

This project is not slated to begin until October 2013.

II. PROJECT DESIGN

A. 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

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. CV's/RESUMES

Curriculum Vitae: Michele Leigh Buckhorn

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Education:

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Journal Articles:

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A. Pete Klimley, PhD., UC Davis

CURRICULUM VITAE

Richard E. Thorne, Ph.D.
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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 (in press). The Exxon Valdez Oil Spill and the Collapse of the Prince William Sound Herring Stock: A Reexamination of Critical Biomass Estimates, In: Alfred, J.B. and Peterson, M (eds), Impacts of Oil Spill Disasters on Marine Fisheries in North America, CRC Press/Taylor & Francis, Boca Raton, FL

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.

Collaborations:

Gary L. Thomas,
Rosenstiel School of Marine and Atmospheric Sciences
4600 Rickenbacker Causeway
Miami, Florida 33149
gthomas@rsmas.miami.edu

IV. SCHEDULE

A. Project Milestones

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.

To be met by March 2014

Objective 2. estimate the level of immigration and emigration of age 0 herring between bays

To be met by September 2014

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.

FY13 4th Quarter (October 1, 13 to December 31, 13)

October	Begin acoustic intensive study

FY14 1st Quarter

January	Annual Marine Science Symposium
Febrary	Continue with intensive study

FY14 2nd Quarter

May	Attend annual PI meeting

FY14 3rd Quarter

Summer	Complete intensive study

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT PROPOSAL FORM

Project Title: PWS Herring Research and Monitoring: Outreach & Education

Project Period: February 1, 2014 – January 31, 2015

Primary Investigator(s): Lindsay Butters, Education Coordinator, PWS Science Center (PWSSC)
lbutters@pwssc.org

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:

FY12	FY13	FY14	FY15	FY16	TOTAL
16,500	30,500	$32,700	36,000	38,300	154,000

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
		0			

Date: August 30, 2013

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. Summary of Project to Date (if applicable)

All written and web-based outreach materials have been produced as proposed, including seven *Project Profiles*, six *Delta Sound Connections* articles/infographics, and three articles in the *Breakwater* newsletter. The herring research webpage is live and we will continue to add content (www. http://pwssc.org/research/fish-2/pacific-herring/). A video of a *Community Lecture* was posted on the *PWSSC YouTube Channel* (http://youtu.be/NlVTcpxLccw) and blog and *Facebook* posts have been made.

Education programs about Pacific herring research have been delivered to school groups in Cordova, and Chenega Bay, and to science campers participating in PWSSC's summer education programs. To date, PWSSC educators have delivered twelve *Discovery Room* programs, one *Outreach Discovery* program and herring-themed lessons in four *Summer Field Programs*. Six *Community Lectures* presented by project PIs have also been held. Three *Field Notes* radio programs were produced and aired on KCHU public radio.

I am behind on two milestones: marketing of herring lesson plans to programs outside of this region (September 2012) and the production of three *Field Notes* programs (May 2013). These delays are the result of my being pregnant and having a baby in January 2013, and setbacks caused by the revision of the Field Notes radio program format by PWSSC. I expect to have the three radio programs completed by December 2013 and the lesson plans prepared for public outreach by May 2014.

II. PROJECT DESIGN

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.

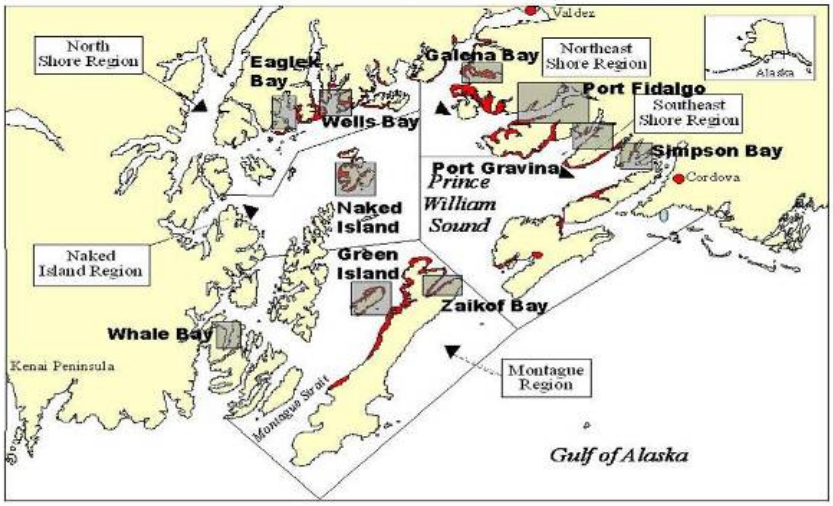

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

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. CV's/RESUMES

Lindsay Nan Butters
PO Box 2035
Cordova, AK 99574
Office (907) 424-5900 x 231 Email: lbutters@pwssc.org
Home (907) 424-7830 Fax (907) 424-5820

EDUCATION

Post Baccalaureate, University of Wisconsin, Stevens Point
Fundamentals of Environmental Education, 2006
Applied Environmental Education Program Evaluation, 2007
Strategic Planning and Implementation, 2007

Johnson State College, Johnson, VT, 2004
B.S. Environmental Science-Integrated Science
Graduated Cum Laude

PROFESSIONALEXPERIENCE

PrinceWilliam Sound Science Center, Cordova, AK
A non-profit research and education organization with a focus on ecosystem science in Coastal Alaska
Education Specialist **December 2012-present**
• Produce written, radio and web-based outreach materials to communicate ecosystem research information to the general public.
• Develop/oversee delivery of educational programs that engage students and community members in presentations, hands-on activities and field experiences to learn about ecosystem science research in the Prince William Sound region.

Education Program Coordinator **November 2004-2011**
Education Program Development and Coordination responsibilities:
• Coordinate logistics for summer Science Camps and field courses for youth aged 7-18 and adults. Oversee program advertising and recruitment, registration, scholarships, staff training, field camp, meals, healthcare, adventure activities, educational programming and evaluation.
• Plan and implement standards-based science education programs for students in K-6 grades with an emphasis on place-based, experiential learning. Curriculum compilations include salmon and herring biology, lake and ocean monitoring and oil spill response technology.
• Design and conduct environmental monitoring projects to involve 4-6 grade students in field research techniques and credible data collection. Recent projects focused on salmon habitat, water quality and weather.
• Collaborate with community partners to coordinate community festivals and one-day events to educate participants about the ecosystems of PrinceWilliam Sound and the Copper River Delta. Events include Copper River Delta Shorebird Festival, Copper River Wild! Salmon Festival, Tidepooling for Tots and Community Kayak Day.
• Coordinate Cordova's National Ocean Sciences Bowl program and coach high school students in preparation for the regional competition.

Program Administration responsibilities:
• Prepare grant proposals and project budgets, $1000-$135,000.

• Submit annual progress reports to funders and education updates to the PWSSC board.
• Supervise school-year and summer program education staff members.
• Conduct program evaluation and strategic planning activities.

PrinceWilliam Sound Community College, Cordova, AK September-December 2008
Biology Teacher Assistant
• Prepared laboratory for student activities, facilitated lab experiments and graded student work.

Harborside Pizza, Cordova, AK June 2006-present
Bookkeeper
Restaurant Management responsibilities
• Assist in implementation of the Harborside Pizza Development and Business Plans.
• Maintain accounting records and financial documents including balance sheets, profit & loss statements and annual sales projections.

Cambridge Elementary School, Cambridge, VT January-May 2004
Volunteer Program Coordinator
• Prepared nature education workshops for second and third graders for the Environmental Learning for the Future (ELF) program. Topics included animal and plant adaptations, nature's designs and earth's systems.

Learning Resource Center, Johnson State College, VT October-May 2003
English and Earth Science Tutor
• Tutored students in CollegeWriting and Earth Science courses.
• Assisted with test preparation and research skills, proofreading and paper revision techniques.

PROJECT COLLABORATION
Alaska River Expeditions: Geology of the Copper RiverWatershed field course.
Copper River Watershed Project: Discovery Room, Copper River Stewardship Program, community monitoring.
Cordova and Chugach School Districts: Discovery Room, Outreach Discovery, National Ocean Sciences Bowl, monitoring projects
Prince William Sound Science Center research staff: youth science camps, adult workshops, community lectures, student presentations, outreach materials.
Other project partners: Cordova Arts and Pageants, Cordova District Fishermen United, Native Village of Eyak, Prince William Soundkeeper Wrangell Institute of Science and Environment
U.S. Forest Service Cordova Ranger District: Discovery Room, science and wetlands ecology camps

WORKSHOPS ATTENDED
• 2006 Project WET activity and curriculum use training
• 2006 Alaska Natural Resource and Outdoor Education workshop series
• 2007, 2008 Communicating Ocean Science, AK Marine Science Symposium
• 2007 Project WILD, ProjectWILD Aquatic and AlaskaWildlife Curriculum training
• 2010 Citizen Science for K-12 Teachers, Kachemak Bay Research Reserve
• 2012 Adobe software skills workshop, Kristin Link via Copper River Watershed Project
• 2012 ServSafe Food Protection Manager Certification Program, Anchorage CHARR

IV. 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 public 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

FY 14, 1st quarter (February 1 – May 31, 2014)

May	Evaluate/update oceanography and herring *Discovery Room* program curriculum
	Participate in Principal Investigator update and outreach meeting
	Delivery of *Community Lectures* complete for FY14
	Production of written outreach materials complete for FY14 (*Delta Sound Connections, Breakwater* newsletter articles, *Project Profiles*)
	Herring lesson plans ready for public outreach/marketing

FY 14, 2nd quarter (June 1, 2014-August 30, 2014)

August	Delivery of *Field Notes* complete for FY14
August	Deliver *Summer Field Program*
August	Submit Project Annual Report

FY 14, 3rd quarter (September 1, 2014-November 30, 2014)

September	Delivery of *Outreach Discovery* program complete for FY14
October	Begin implementing oceanography and herring *Discovery Room*

FY 14, 4th quarter (December 1, 2015 – January 31, 2015)

December	Develop *Field Notes* radio program based on fall surveys
January	Alaska Marine Science Symposium

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS Herring Research and Monitoring: Herring Disease Program (HDP)

Project Period: February 1, 2014 – January 31, 2015

Primary Investigator(s):
Paul K. Hershberger
U.S. Geological Survey, Marrowstone Marine Field Station
616 Marrowstone Point Road
Nordland, WA 98358
Telephone: (360) 385-1007, Ext. 225
Email: phershberger@usgs.gov

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. During FY 2014 we will continue the health assessments of adult herring from Prince William Sound and Sitka Sound, we will continue to rear colonies of specific-pathogen-free Pacific herring for controlled studies in the laboratory, and we will develop a chromogenic in situ hybridization assay that will be capable of identifying *Ichthyophonus* in histological tissue sections.

Estimated Budget:
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
0	0	$281,900	291,900	298,000	871,800

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
		$42,100			

Includes in-kind salary and benefit contributions (20%) for P. Hershberger ($26,400) and J. Gregg ($15,700)

Date: August 9, 2013

(THIS SUMMARY PAGE NOT TO EXCEED ONE PAGE)

I. NEED FOR THE PROJECT

A. Statement of Problem

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

B. Summary of Project to Date (if applicable)

FY 2014 will be the first year of a new integrated herring project.

II. PROJECT DESIGN

A. Objectives

- Provision of disease prevalence data necessary for the ASA herring model
- 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.

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.

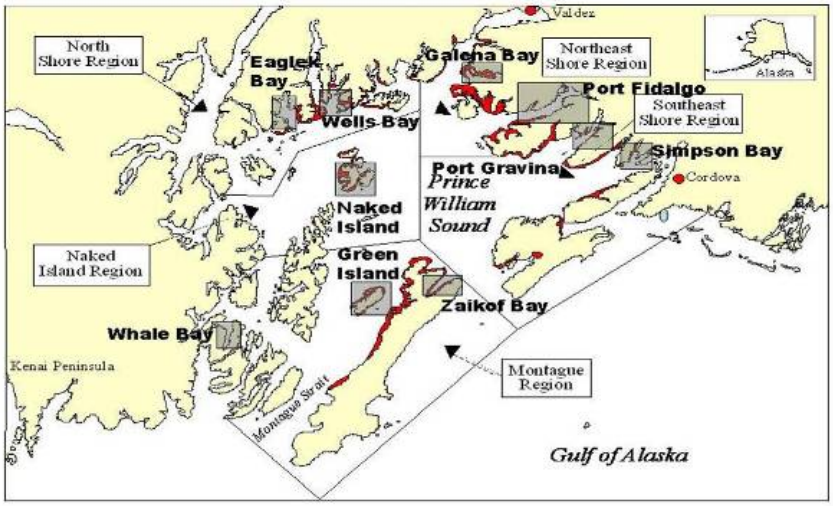

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

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.

E. Coordination and Collaboration with the Program

Results from the HDP will inform the larger Herring Research and Monitoring Project by providing disease information intended to help improve predictive models of herring stocks. This will be accomplished by informing the ASA model with infection and disease values and by applying novel techniques to assess diseases-related mortality in wild herring.

III. CV's/RESUMES

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): Current President
International Society of Aquatic Animal Epidemiology (ISAAE)
Pacific Northwest Society of Environmental Toxicology and Chemistry (PNW SETAC)

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- 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:

Lovy, J., P. Piesik, P.K. Hershberger, K. A. Garver. 2013. Experimental infection studies demonstrating Atlantic salmon as a host and reservoir of viral hemorrhagic septicemia virus type IVa with insights into pathology and host immunity. Veterinary Microbiology 166: 91-101.

Kocan, R, S. LaPatra, P. Hershberger. 2013. Evidence for an amoeba-like infectious stage of *Ichthyophonus* sp. and description of a circulating blood stage: a probable mechanism for dispersal within the fish host. Journal of Parasitology 99: 235-240.

Hershberger, P.K., M. K. Purcell, L.M. Hart, J.L. Gregg, R.L. Thompson, K.A. Garver, J.R. Winton. 2013. Influence of temperature on viral hemorrhagic septicemia (Genogroup IVa) in Pacific herring, *Clupea pallasii* Valenciennes. Journal of Experimental Marine Biology and Ecology 444: 81-86.

Lovy, J., N.L. Lewis, P.K. Hershberger, W. Bennett, K.A. Garver. 2012. Viral tropism and pathology associated with viral hemorrhagic septicemia in larval and juvenile Pacific herring. Veterinary Microbiology 161: 66-76.

Purcell, M.K., E.S. Bromage, J. Silva, J.D. Hansen, S.M. Badil, J.C. Woodson, P.K. Hershberger. 2012. Production and characterization of monoclonal antibodies to IgM of Pacific herring (*Clupea pallasii*). Fish and Shellfish Immunology 33: 552-558.

Five Additional Selected Publications

Burge, C. A., C. M. Eakin, C. S. Friedman, B. Froelich, P. K. Hershberger, E. E. Hofmann, L. E. Petes, K. C. Prager, E. Weil, B. L. Willis, S.E. Ford, C. D. Harvell. *In Press*. Climate change influences on marine infectious diseases: implications for management and society. Annual Review of Marine Science.

Hershberger, P.K., L. Rhodes, G. Kurath, J. Winton. *In Press*. Infectious diseases of fishes in the Salish Sea. Fisheries.

Hart, L.M., N. Lorenzen, S.E. LaPatra, C.A. Grady, S.E. Roon, J. O'Reilly, J.L. Gregg, P.K. Hershberger. 2012. Efficacy of a glycoprotein DNA vaccine against viral hemorrhagic septicemia (VHS) in Pacific herring *Clupea pallasii*. Journal of Fish Diseases 775-779.

Glenn, J.A., E.J. Emmenegger, C. M. Conway, J. R. Winton, C.A. Grady, J.L. Gregg, S.E. Roon, P.K. Hershberger. 2012. Kinetics of viral load and erythrocytic inclusion body formation in Pacific herring artificially infected with erythrocytic necrosis virus. Journal of Aquatic Animal Health 195-200

Gregg, J.L., C.A. Grady, C.S. Friedman, P.K. Hershberger. 2012. Inability to demonstrate fish-to-fish transmission of *Ichthyophonus* from laboratory-infected Pacific herring *Clupea pallasii* to naïve conspecifics. Diseases of Aquatic Organisms 99: 139-144

Recent Collaborators and Co-Authors (Past 4 years):

S.M. Badil (USGS – Western Fisheries Research Center), **J. Beaulaurier** (Central Michigan University), **W. Bennett** (DFO – Pacific Biological Station), **N. Bickford** (University of Great Falls), **E.S. Bromage** (U. Mass – Dartmouth), **C.A. Burge** (Cornell University), **H.E. Christiansen** (Columbia River Research Laboratories), **R. Collins** (U. Hawaii), **C.M. Conway** (USGS – Western Fisheries Research Center), **E.S. Copeland** (USGS – Columbia River Research Laboratories), **H. Dolan** (University of Washington), **C.M. Eakin** (NOAA – Coral Reef Watch), **D. Elliott** (USGS – Western Fisheries Research Center), **E.J. Emmenegger** (USGS – Western Fisheries Research Center), **C.S. Friedman** (University of Washington), **B. Froelich** (University of North Carolina – Chapel Hill), **A. Gannam** (USFWS – Abernathy Fish Technology Center), **K.A. Garver** (DFO – Pacific Biological Station), **J.A. Glenn** (USGS – Western Fisheries Research Center), **T. L. Goldberg** (University of Wisconsin), **C. Grady** (USGS – Marrowstone Marine Field Station), **J.L. Gregg** (USGS – Marrowstone Marine Field Station), **S. Gutenberger** (Lower Columbia River Fish Health Center), **J.D. Hansen** (USGS – Western Fisheries Research Center), **L. Hart** (USGS – Marrowstone Marine Field Station), **C.D. Harvell** (Cornell University), **R.A. Heintz** (NOAA – Auke Bay Labs), **E.E. Hofmann** (Old Dominion University), **R.F. Goetz** (NOAA- Manchester Research Station), **A. Kagley** (NOAA – Northwest Fisheries Science Center), **R.M. Kocan** (University of Washington), **G. Kurath** (USGS – Western Fisheries Research Center), **K.L. Toohey-Kurth** (University of Wisconsin), **S.E. LaPatra** (Clear Springs Foods, Inc.), **N.L. Lewis** (DFO – Pacific Biological Station), **N. Lorenzen** (National Veterinary Institute – Denmark), **J. Lovy** (New Jersey Department of Natural Resources), **K. Lujan** (USFWS – Lower Columbia River Fish Health Center), **S.V. Marquenski** (Wisconsin Department of Natural Resources), **M.G. Mesa**, (USGS – Columbia River Research Laboratories), **T.R. Meyers** (ADF&G), **C.H. Moon** (University of Ulsan, Korea), **B.L. Norcross** (U. Alaska – Fairbanks), **W. J. Olson** (University of Wisconsin), **J. O'Reilly** (USGS – Marrowstone Marine Field Station), **M. Parsley** (USGS – Columbia River Research Laboratories), **L. E. Petes** (NOAA – Climate Program Office), **P. Piesik** (DFO – Pacific Biological Station), **M.K. Purcell** (USGS – Western Fisheries Research Center), **K. C. Prager** (UCLA), **C. Rasmussen** (USGS – Western Fisheries Research Center), **L. Rhodes** (NOAA – Northwest Fisheries Science Center), **J. Richard** (DFO – Pacific Biological Station), **S.E. Roon** (Oregon State University), **A.C. Seitz** (U. Alaska – Fairbanks), **J. Silva** (U. Mass – Dartmouth), **L. Taylor** (USGS – Marrowstone Marine Field Station), **R.L. Thompson** (USGS – Western Fisheries Research Center), **G.S. Traxler** (DFO – Pacific Biological Station), **B.K. van der Leeuw** (USGS – Columbia River Research Laboratories), **J. J. Vollenweider** (NOAA – Auke Bay Labs), **E. Weil** (University of Puerto Rico), **B. L. Willis** (James Cook University – Australia), **A.E. Wilson** (University of Wisconsin), **J.R. Winton** (USGS – Western Fisheries Research Center), **J.C. Woodson** (USGS – Western Fisheries Research Center), **S. Zuray** (Rapids Research Center)

IV. 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 Aug 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 2010 - 2013)

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 CISH development

FY14, 4th quarter (July 1 – Sept 30, 2014)

- Complete CISH development

V. BUDGET

Budget Form (Attached)

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS Herring Program – Herring Condition Monitoring

Project Period: February 1, 2014 – January 31, 2015

Primary Investigator(s): W. Scott Pegau, Prince William Sound Science Center, Box 705, Cordova, AK 99574 wspegau@pwssc.org
Ron Heintz, NOAA Auke Bay Laboratory ron.heintz@noaa.gov

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:

FY12	FY13	FY14	FY15	FY16	TOTAL
0	230,000	238,700	251,500	253,900	974,100

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date:
8/30/13

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. Summary of Project to Date (if applicable)

Collection of samples in November and March were completed as scheduled. Processing of the fish to determine the energetic content remains underway. The November samples should be completed in October and the March samples by December.

For Heintz' component of the study, YOY herring samples from March 2013 field collections in PWS were received at ABL in August 2013 for analysis of proximate composition and RNA/DNA. Contracts have been awarded and commodities procured for laboratory processing of samples, to be completed in fall 2013.

A setback to the project occurred when one of the principal investigators (Dr. Thomas Kline) left the Prince William Sound Science Center in June 2013. The Science Center is currently seeking a replacement for Dr. Kline and Dr. Pegau has taken responsibility for the project until a suitable replacement can be found. The gap in personnel may impact the completion of the analysis of this project, however Dr. Pegau worked with Dr. Kline to ensure a smooth transition of materials and is in a position to rapidly bring a new person up to speed or complete the deliverables if needed. Deliverables in the short term are related to work conducted by the project technician who remains working on the project.

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.

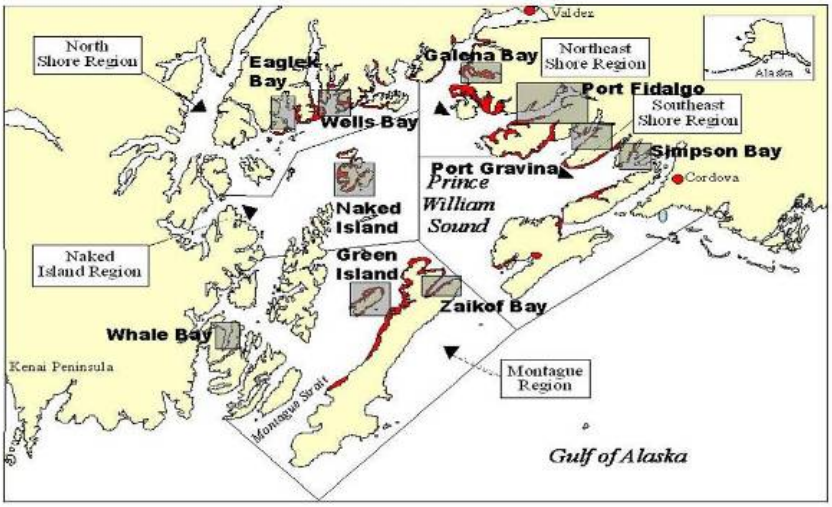

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

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).

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.

III. CV's/RESUMES

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-present 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.

Publications
Selected publications

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

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.

Streever, B., R. Suydam, J.F. Payne, R. Shuchman, R.P. Angliss, G. Balogh, J. Brown, J. Grunblatt, S. Guyer, D.L. Kane, J.J. Kelley, G. Kofinas, D.R. Lassuy, W. Loya, P. Martin, S.E. Moore, W.S. Pegau, C. Rea, D.J. Reed, T. Sformo, M. Sturm, J.J. Taylor, T. Viavant, D. Williams, and D. Yokel, Environmental Change and Potential Impacts: Applied Research Priorities for Alaska's North Slope, *Arctic*, **64**, 390-397, 2011.

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Musgrave, D.L., M.J. Halverson, and W.S. Pegau, Seasonal Surface Circulation, Temperature, and Salinity in Prince William Sound, Alaska, *Cont. Shelf Res.*, doi:10.1016/j.csr.2012.12.001, 2012

Collaborators

Mary Abercrombie (USF), Robyn Angliss (NOAA), Greg Balogh (USFWS), Mike Banner (UNSW), P. Bhandari (UM), Mary Anne Bishop (PWSSC), Rob Bochenek (Axiom consulting), Emmanuel Boss (U Maine), Kevin Boswell (FIU), Tim Boyd (SAM), Trevor Branch (UW), Evelyn Brown (Flying fish), John Brown, Michele Buckhorn (PWSSC), Lindsay Butters (PWSSC), Rob Cambell (PWSSC), L Carvalho (UCSB), Grace Chang (UCSB), Yi Chao (JPL), Paula Coble (USF), Robyn Conmy (EPA), Tim Cowles (OSU), Helen Czerski (U Southhampton), M. Darecki (PAS), Tommy Dickey (UCSB), C. Dong (IGGP), David Farmer (URI), Jim Farr (NOAA), Scott Freeman (NASA), J. Gemmrich (UVic), P. Gernez (U Nantes), Jess Grunblatt (UAF), Scott Guyer (BLM), Jeff Guyon (NOAA), B. Hagen (SAM), Nate Hall-Patch (IOS), Mark Halverson (PWSSC), Ron Heintz (NOAA), Paul Hershberger (USGS), Ben Holt (JPL), S. Jiang (UCSB), Mark Johnson (UAF), C. Jones (UCSB), Doug Kane (UAF), Lee Karp-Boss (U Maine), George Kattawar (TAMU), John Kelley (UAF), T. King (BIO), Tom Kline (PWSSC), Cory Koch (Wetlabs), Gary Kofinas (UAF), Kathy Kuletz (USFWS), J. Lacoste (Dalhousie), Denny Lassuy (DOI), D. LeBel (Lamont), Ken Lee (BIO), L. Lenain (SIO), Marlin Lewis (Satlantic), Y. Liu (MIT), L. Logan (UMiami), Wendy Loya (Wilderness org), Ted Maksym (WHOI), Darek Manov (UCSB) Phillip Martin (USFWS), W. Melville (SIO), Scott Miles (LSU), Steve Moffitt (ADF&G), Mark Moline (Cal Poly), Sue Moore (NOAA), Rue Morison (UNSW), Dave Musgrave, F. Nencioli (MIO), Carter Ohlmann (UCSB), John Payne (DOI), Sean Powers (USA), Caryn Rea (Conoco), Dan Reed (ADFG), B. Reineman (SIO), Ian Robbins (Cal Poly), B. Robinson (BIO), Chris Roman (WHOI), R. Rottgers (HZG), Scott Ryan (BIO), H. Schultz (UMass), Li Shen (Johns Hopkins), M. Shinki (CRI), Matt Slivkoff(ISMO), M. Sokolski (PAS), Frank Spada (Sea Engineering), Nate Statom (SIO), Darius Stramski (SIO), Bill Streever (BP), Todd Sformo (NSB), Robert Shuchman (Mich Tech), Petere Sutherland (SIO), Hanumat Singh (WHOI), Matt Sturm (ACE), Robert Suydam (NSB), J. Taylor, Richard Thorne (PWSSC), Mike Twardowski (Wetlabs), S. Vagle (IOS), Ronnie Van Dommelen (Satlantic), Tim Viavant (ADFG), Johanna Vollenweider (NOAA), Ken Voss (UMiami), Ian Walsh (Wetlabs), Libe Washburn (UCSB), J. Wei (Dal), Hemantha Wijesekera (NRL), Dee Williams (BOEM), Sharon Wilde (NOAA), Amanda Whitmire (OSU), Jeremy Wilkinson (BAS), Michelle Wood (UO), O. Wurl (Old Domin), D. Yankg (John Hopkins), Dave Yokel (BLM), Dick Yue (MIT), Len Zabilansky (CRREL), Ron Zaneveld (Wetlabs), Chris Zappa (Lamont), Brian Zelenke (Cal Poly)

Ron A. Heintz
Fishery Research Biologist
National Marine Fisheries Service
Auke Bay Laboratory
17109 Pt. Lena Loop Rd
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:

Program Manager, Recruitment Energetics and Coastal Assessment Program
National Marine Fisheries Service
Alaska Fisheries Science Center

Employed with NMFS for 27 years

RECENT PUBLICATIONS:

1. **Heintz,RA,** E.C. Siddon, E.V. Farley and J. Napp. In press. Correlation between recruitment and fall condition of age-0 pollock (*Theragra chalcogramma*) from the eastern Bering Sea under varying climate conditions. Deep Sea Research II. Accepted February 2013.
2. Siddon, EC, **Heintz RA**, Mueter FJ (In Press) Conceptual model of energy allocation in walleye pollock (*Theragra chalcogramma*) from larvae to age-1 in the southeastern Bering Sea. Deep Sea Research II. Accepted November, 2012.
3. Rinella, D. J., M. S. Wipfli, C. Stricker and **R. Heintz**. 2012. Salmon returns and consumer fitness: Marine-derived nutrients show saturating effects on growth and energy storage in stream-dwelling salmonids. Canadian Journal of Fisheries and Aquatic Sciences.69(1):73-84. DOI: 10.1139/f2011-133
4. Vollenweider, J.J., J.L. Gregg, **R.A. Heintz**, P.K. Hersberger. Energetic cost of *Ichthyophonus* infection in juvenile Pacific herring (*Clupea pallasi*). J. Parasit ology Research 2011:1-10. doi:10.1155/2011/926812
5. Gregg, KJ.L., J.J. Vollenweider, C.A. Grady**, R. A. Heintz** and P.K. Hershberger. Effects of environmental temperature on the dynamics of Ichthyophonus in juvenile Pacific herring (*Clupea pallasii*). J. Parasitology Research 2011:1-9. doi:10.1155/2011/563412

COLLABORATIONS IN LAST 48 MONTHS

AK. Dep. Fish and Game:	S. Moffit,
University of Alaska Fairbanks:	E. Siddon, A. Pinchuk, F. Mueter, B. Norcross
U.S. Geological Survey:	P. Hershberger
University of Alaska Southeast:	J. Straley
Florida International Univeristy:	K. Boswell
Prince William Sound Science Center:	T. Kline

Oil Spill Research Institute	S. Pegau
University of Washington:	G. Hunt
Bureau Ocean Energy Management:	C. Coon
Sitka Sound Science Center:	A. Sreenivasan
North Slope Borough	L. de Sousa
Louisiana State University	C. Li

IV. 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

FY 14, 1st quarter (February 1 – May 31, 2014)

February	Submit annual report
March	Conduct March juvenile collection
May	Annual PI meeting

FY 14, 2nd quarter (June 1, 2014-August 30, 2014)

August	Submit semi-annual report

FY 14, 3rd quarter (September 1, 2014-November 30, 2014)

September	Support synthesis effort
October	Complete processing of March Samples
November	Participate in the fall herring collection cruise

FY 14, 4th quarter (December 1, 2015 – January 31, 2015)

January	Annual Marine Science Symposium

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.

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
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Prince William Sound Science Center:	T. Kline
Oil Spill Research Institute	S. Pegau
University of Washington:	G. Hunt
Bureau Ocean Energy Management:	C. Coon
Sitka Sound Science Center:	A. Sreenivasan

Ron Heintz – BIBLIOGRAPHY

Currently submitted to journals and in review

1. Rinella, D., Wipfli, M., Walker, C., Stricker, C. and **Heintz, R**. (Submitted) Seasonal persistence of marine-derived nutrients in south-central Alaskan salmon streams. Ecosphere.
2. Siddon, E. C., Kristiansen, T., Mueter, F. J., Holsman, K., Heintz, R. and Farley, E.V. (Submitted). Spatial match-mismatch between juvenile fish and prey explains recruitment variability across contrasting climate conditions in the eastern Bering Sea. PLoS One.
3. **Heintz, RA**, and JJ Vollenweider. Submitted. Reproductive investment and fitness costs associated with spawning in healthy and depressed herring (*Clupea pallasi*) populations from the Gulf of Alaska. Fisheries Oceanography

4. **Heintz, R**A, J. Moran, JJ vollenweider, J Straley and K Boswell. Submitted. The impact of fish and predate on Pacific herring production in different states of abundance. Fisheries Oceanography.
5. **Heintz RA**, J Moran, JJ Vollenweider and J Straley. Submitted. Regional variation in the intensity of humpback whale predation on Pacific herring in the Gulf of Alaska. Fisheries Oceanography
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7. Vollenweider, JJ, **RA Heintz**, MA Bishop and JT Watson. Submitted. Age-dependent winter energetic of juvenile Pacific herring in the Gulf of Alaska. Fisheries Oceanography

Published

6. **Heintz,RA,** E.C. Siddon, E.V. Farley and J. Napp. In press. Correlation between recruitment and fall condition of age-0 pollock (*Theragra chalcogramma*) from the eastern Bering Sea under varying climate conditions. Deep Sea Research II. Accepted February 2013.
7. Siddon, EC, **Heintz RA**, Mueter FJ (In Press) Conceptual model of energy allocation in walleye pollock (*Theragra chalcogramma*) from larvae to age-1 in the southeastern Bering Sea. Deep Sea Research II. Accepted November, 2012.
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FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS – Juvenile Herring Intensive Monitoring

Project Period: February 1, 2014 – January 31, 2015

Primary Investigator(s): W. Scott Pegau, Prince William Sound Science Center, Box 705, Cordova, AK 99574 wspegau@pwssc.org
Ron Heintz, NOAA Auke Bay Laboratory ron.heintz@noaa.gov

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:

FY12	FY13	FY14	FY15	FY16	TOTAL
207,000	77,300	20,400	0	0	304,700

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date:
8/30/13

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. Summary of Project to Date

The milestones of sample collection and processing for this project were completed as scheduled. During late winter the numbers of samples were limited as the fish became more difficult to locate. The analysis phase is in progress.

For Heintz' component of the project, biological data (lengths, weights) has been collected on all YOY herring received at ABL from the PWS collections in September 2011 through June 2012. Due to prioritizing chemical analysis of samples associated with related herring projects (herring growth and condition, herring fatty acid study), processing has been delayed slightly from the original timeline. Samples are currently in queue for chemical analysis, which is expected to be completed in fall 2013.

A setback to the project occurred when one of the principal investigators (Dr. Thomas Kline) left the Prince William Sound Science Center in June 2013. The Science Center is currently seeking a replacement for Dr. Kline and Dr. Pegau has taken responsibility for the project until a suitable replacement can be found. The gap in personnel may impact the completion of the analysis of this project, however Dr. Pegau worked with Dr. Kline to ensure a smooth transition of materials and is in a position to rapidly bring a new person up to speed or complete the deliverables if needed.

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.

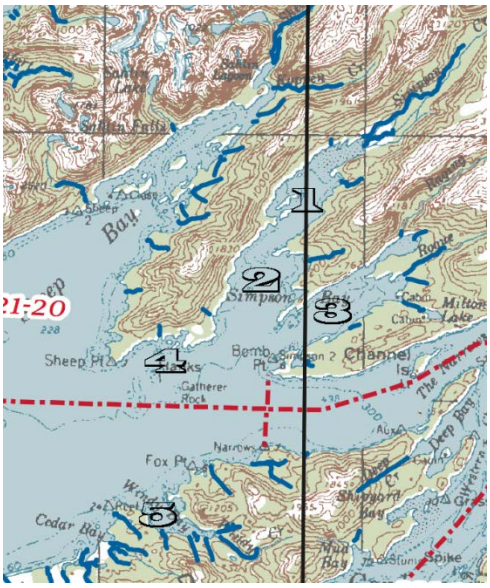

Figure 1. Map of Simpson Bay and surrounding waters showing five sampling areas.

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.

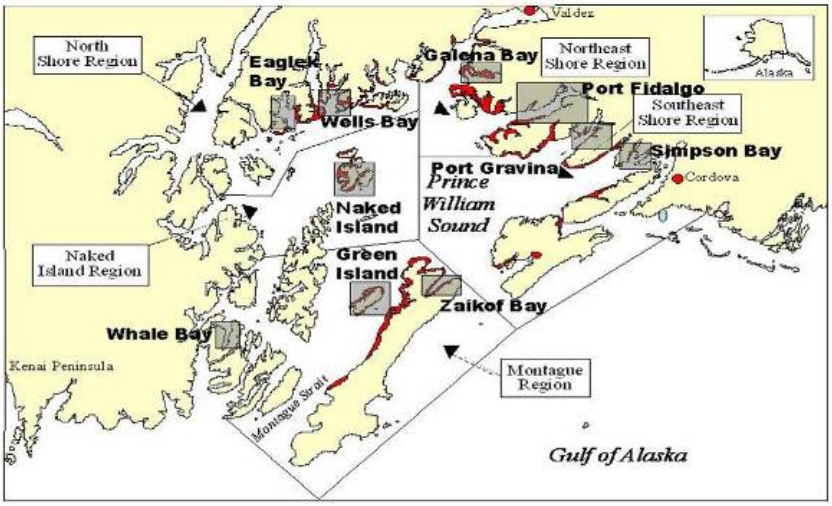

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

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.

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.

III. CV's/RESUMES

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-present 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.

Publications
Selected publications

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

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.

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Collaborators

Mary Abercrombie (USF), Robyn Angliss (NOAA), Greg Balogh (USFWS), Mike Banner (UNSW), P. Bhandari (UM), Mary Anne Bishop (PWSSC), Rob Bochenek (Axiom consulting), Emmanuel Boss (U Maine), Kevin Boswell (FIU), Tim Boyd (SAM), Trevor Branch (UW), Evelyn Brown (Flying fish), John Brown, Michele Buckhorn (PWSSC), Lindsay Butters (PWSSC), Rob Cambell (PWSSC), L Carvalho (UCSB), Grace Chang (UCSB), Yi Chao (JPL), Paula Coble (USF), Robyn Conmy (EPA), Tim Cowles (OSU), Helen Czerski (U Southhampton), M. Darecki (PAS), Tommy Dickey (UCSB), C. Dong (IGGP), David Farmer (URI), Jim Farr (NOAA), Scott Freeman (NASA), J. Gemmrich (UVic), P. Gernez (U Nantes), Jess Grunblatt (UAF), Scott Guyer (BLM), Jeff Guyon (NOAA), B. Hagen (SAM), Nate Hall-Patch (IOS), Mark Halverson (PWSSC), Ron Heintz (NOAA), Paul Hershberger (USGS), Ben Holt (JPL), S. Jiang (UCSB), Mark Johnson (UAF), C. Jones (UCSB), Doug Kane (UAF), Lee Karp-Boss (U Maine), George Kattawar (TAMU), John Kelley (UAF), T. King (BIO), Tom Kline (PWSSC), Cory Koch (Wetlabs), Gary Kofinas (UAF), Kathy Kuletz (USFWS), J. Lacoste (Dalhousie), Denny Lassuy (DOI), D. LeBel (Lamont), Ken Lee (BIO), L. Lenain (SIO), Marlin Lewis (Satlantic), Y. Liu (MIT), L. Logan (UMiami), Wendy Loya (Wilderness org), Ted Maksym (WHOI), Darek Manov (UCSB) Phillip Martin (USFWS), W. Melville (SIO), Scott Miles (LSU), Steve Moffitt (ADF&G), Mark Moline (Cal Poly), Sue Moore (NOAA), Rue Morison (UNSW), Dave Musgrave, F. Nencioli (MIO), Carter Ohlmann (UCSB), John Payne (DOI), Sean Powers (USA), Caryn Rea (Conoco), Dan Reed (ADFG), B. Reineman (SIO), Ian Robbins (Cal Poly), B. Robinson (BIO), Chris Roman (WHOI), R. Rottgers (HZG), Scott Ryan (BIO), H. Schultz (UMass), Li Shen (Johns Hopkins), M. Shinki (CRI), Matt Slivkoff(ISMO), M. Sokolski (PAS), Frank Spada (Sea Engineering), Nate Statom (SIO), Darius Stramski (SIO), Bill Streever (BP), Todd Sformo (NSB), Robert Shuchman (Mich Tech), Petere Sutherland (SIO), Hanumat Singh (WHOI), Matt Sturm (ACE), Robert Suydam (NSB), J. Taylor, Richard Thorne (PWSSC), Mike Twardowski (Wetlabs), S. Vagle (IOS), Ronnie Van Dommelen (Satlantic), Tim Viavant (ADFG), Johanna Vollenweider (NOAA), Ken Voss (UMiami), Ian Walsh (Wetlabs), Libe Washburn (UCSB), J. Wei (Dal), Hemantha Wijesekera (NRL), Dee Williams (BOEM), Sharon Wilde (NOAA), Amanda Whitmire (OSU), Jeremy Wilkinson (BAS), Michelle Wood (UO), O. Wurl (Old Domin), D. Yankg (John Hopkins), Dave Yokel (BLM), Dick Yue (MIT), Len Zabilansky (CRREL), Ron Zaneveld (Wetlabs), Chris Zappa (Lamont), Brian Zelenke (Cal Poly)

Ron A. Heintz
Fishery Research Biologist
National Marine Fisheries Service
Auke Bay Laboratory
17109 Pt. Lena Loop Rd
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:

Program Manager, Recruitment Energetics and Coastal Assessment Program
National Marine Fisheries Service
Alaska Fisheries Science Center

Employed with NMFS for 27 years

RECENT PUBLICATIONS:

1. **Heintz,RA,** E.C. Siddon, E.V. Farley and J. Napp. In press. Correlation between recruitment and fall condition of age-0 pollock (*Theragra chalcogramma*) from the eastern Bering Sea under varying climate conditions. Deep Sea Research II. Accepted February 2013.
2. Siddon, EC, **Heintz RA**, Mueter FJ (In Press) Conceptual model of energy allocation in walleye pollock (*Theragra chalcogramma*) from larvae to age-1 in the southeastern Bering Sea. Deep Sea Research II. Accepted November, 2012.
3. Rinella, D. J., M. S. Wipfli, C. Stricker and **R. Heintz**. 2012. Salmon returns and consumer fitness: Marine-derived nutrients show saturating effects on growth and energy storage in stream-dwelling salmonids. Canadian Journal of Fisheries and Aquatic Sciences.69(1):73-84. DOI: 10.1139/f2011-133
4. Vollenweider, J.J., J.L. Gregg, **R.A. Heintz**, P.K. Hersberger. Energetic cost of *Ichthyophonus* infection in juvenile Pacific herring (*Clupea pallasi*). J. Parasit ology Research 2011:1-10. doi:10.1155/2011/926812
5. Gregg, KJ.L., J.J. Vollenweider, C.A. Grady**, R. A. Heintz** and P.K. Hershberger. Effects of environmental temperature on the dynamics of Ichthyophonus in juvenile Pacific herring (*Clupea pallasii*). J. Parasitology Research 2011:1-9. doi:10.1155/2011/563412

COLLABORATIONS IN LAST 48 MONTHS

AK. Dep. Fish and Game:	S. Moffit,
University of Alaska Fairbanks:	E. Siddon, A. Pinchuk, F. Mueter, B. Norcross
U.S. Geological Survey:	P. Hershberger
University of Alaska Southeast:	J. Straley
Florida International Univeristy:	K. Boswell
Prince William Sound Science Center:	T. Kline

Oil Spill Research Institute	S. Pegau
University of Washington:	G. Hunt
Bureau Ocean Energy Management:	C. Coon
Sitka Sound Science Center:	A. Sreenivasan
North Slope Borough	L. de Sousa
Louisiana State University	C. Li

IV. 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

FY 14, 1st quarter (February 1 – May 31, 2014)
March *Complete analysis*

FY 14, 2nd quarter (June 1, 2014-August 30, 2014)
July *Complete final report*

V. BUDGET

Budget Form (Attached)
Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS Herring: Coordination and Logistics

Project Period: 1 February 2014 to 31 January 2015

Primary Investigator(s): W. Scott Pegau, Prince William Sound Science Center, Box 705 Cordova, AK 99574 ph: 907-424-5800 x222 email wspegau@pwssc.org

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:

FY12	FY13	FY14	FY15	FY16	TOTAL
364,125	510,261	388,136	339,007	338,583	1,940,113

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: 16 August 2013

(THIS SUMMARY PAGE 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 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. Summary of Project to Date (if applicable)

All milestones to date have been met. The cruises have occurred as scheduled and there have been several meetings of the investigators to help coordination both within the program and with the PWS Herring Survey program and Gulf Watch Alaska program. All subcontracts to PWSSC are in place.

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, Modeling, 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.

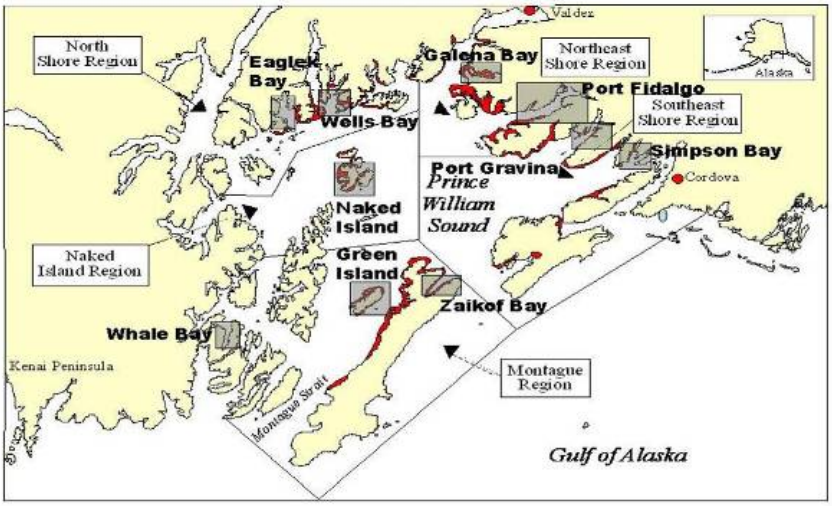

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

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. CV's/RESUMES

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-present 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.

Publications

Selected publications

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

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.

Streever, B., R. Suydam, J.F. Payne, R. Shuchman, R.P. Angliss, G. Balogh, J. Brown, J. Grunblatt, S. Guyer, D.L. Kane, J.J. Kelley, G. Kofinas, D.R. Lassuy, W. Loya, P. Martin, S.E. Moore, W.S. Pegau, C. Rea, D.J. Reed, T. Sformo, M. Sturm, J.J. Taylor, T. Viavant, D. Williams, and D. Yokel, Environmental Change and Potential Impacts: Applied Research Priorities for Alaska's North Slope, *Arctic*, **64**, 390-397, 2011.

Moline, M.A., I. Robbins, B. Zelenke, W.S. Pegau, and H. Wijesekera, Evaluation of bio-optical inversion of spectral irradiance measured from an autonomous underwater vehicle, *J. Geophys. Res.*, **117**, 12pp., doi:10.1029/2001JC007352, 2012.

Musgrave, D.L., M.J. Halverson, and W.S. Pegau, Seasonal Surface Circulation, Temperature, and Salinity in Prince William Sound, Alaska, *Cont. Shelf Res.*, doi:10.1016/j.csr.2012.12.001, 2012

Collaborators

Mary Abercrombie (USF), Robyn Angliss (NOAA), Greg Balogh (USFWS), Mike Banner (UNSW), P. Bhandari (UM), Mary Anne Bishop (PWSSC), Rob Bochenek (Axiom consulting), Emmanuel Boss (U Maine), Kevin Boswell (FIU), Tim Boyd (SAM), Trevor Branch (UW), Evelyn Brown (Flying fish), John Brown, Michele Buckhorn (PWSSC), Lindsay Butters (PWSSC), Rob Cambell (PWSSC), L Carvalho (UCSB), Grace Chang (UCSB), Yi Chao (JPL), Paula Coble (USF), Robyn Conmy (EPA), Tim Cowles (OSU), Helen Czerski (U Southhampton), M. Darecki (PAS), Tommy Dickey (UCSB), C. Dong (IGGP), David Farmer (URI), Jim Farr (NOAA), Scott Freeman (NASA), J. Gemmrich (UVic), P. Gernez (U Nantes), Jess Grunblatt (UAF), Scott Guyer (BLM), Jeff Guyon (NOAA), B. Hagen (SAM), Nate Hall-Patch (IOS), Mark Halverson (PWSSC), Ron Heintz (NOAA), Paul Hershberger (USGS), Ben Holt (JPL), S. Jiang (UCSB), Mark Johnson (UAF), C. Jones (UCSB), Doug Kane (UAF), Lee Karp-Boss (U Maine), George Kattawar (TAMU), John Kelley (UAF), T. King (BIO), Tom Kline (PWSSC), Cory Koch (Wetlabs), Gary Kofinas (UAF), Kathy Kuletz (USFWS), J. Lacoste (Dalhousie), Denny Lassuy (DOI), D. LeBel (Lamont), Ken Lee (BIO), L. Lenain (SIO), Marlin Lewis (Satlantic), Y. Liu (MIT), L. Logan (UMiami), Wendy Loya (Wilderness org), Ted Maksym (WHOI), Darek Manov (UCSB) Phillip Martin (USFWS), W. Melville (SIO), Scott Miles (LSU), Steve Moffitt (ADF&G), Mark Moline (Cal Poly), Sue Moore (NOAA), Rue Morison (UNSW), Dave Musgrave, F. Nencioli (MIO), Carter Ohlmann (UCSB), John Payne (DOI), Sean Powers (USA), Caryn Rea (Conoco), Dan Reed (ADFG), B. Reineman (SIO), Ian Robbins (Cal Poly), B. Robinson (BIO), Chris Roman (WHOI), R. Rottgers (HZG), Scott Ryan (BIO), H. Schultz (UMass), Li Shen (Johns Hopkins), M. Shinki (CRI), Matt Slivkoff(ISMO), M. Sokolski (PAS), Frank Spada (Sea Engineering), Nate Statom (SIO), Darius Stramski (SIO), Bill Streever (BP), Todd Sformo (NSB), Robert Shuchman (Mich Tech), Petere Sutherland (SIO), Hanumat Singh (WHOI), Matt Sturm (ACE), Robert Suydam (NSB), J. Taylor, Richard Thorne (PWSSC), Mike Twardowski (Wetlabs), S. Vagle (IOS), Ronnie Van Dommelen (Satlantic), Tim Viavant (ADFG), Johanna Vollenweider (NOAA), Ken Voss (UMiami), Ian Walsh (Wetlabs), Libe Washburn (UCSB), J. Wei (Dal), Hemantha Wijesekera (NRL), Dee Williams (BOEM), Sharon Wilde (NOAA), Amanda Whitmire (OSU), Jeremy Wilkinson (BAS), Michelle Wood (UO), O. Wurl (Old Domin), D. Yankg (John Hopkins), Dave Yokel (BLM), Dick Yue (MIT), Len Zabilansky (CRREL), Ron Zaneveld (Wetlabs), Chris Zappa (Lamont), Brian Zelenke (Cal Poly)

IV. 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 November 2014

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

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.

FY14 2nd Quarter	
January	Annual Marine Science Symposium
March	Complete acoustic intensive
March	Conduct spring juvenile collection
FY14 2nd Quarter	
April	Conduct extended adult biomass cruise, collect samples for genetics
May	Conduct annual PI meeting
FY14 3rd Quarter	
August	Submit semi-annual report and FY15 work plan for review
October	Complete herring program synthesis.
FY14 4th Quarter (November 1, 14 to January 31, 15)	
November	Conduct juvenile index survey

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT PROPOSAL FORM

Project Title: *Genetic stock structure - Herring*

Project Period: 2014

Primary Investigator(s): Dr. Jeffrey Guyon and Sharon Wildes (NOAA)

Abstract:
Understanding if there is one PWS herring stock or multiple stocks is important for proper management of fisheries. We propose to study the genetic uniqueness of 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. 2011). 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 2011), 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, and if sampling allows (4) spatial stability from collections from two different historical locations (east, west). Evaluation of temporal and spatial variation of herring population(s) in and around PWS using updated genetic protocols will provide important information about herring life history that will contribute to improving the application of the ASA model.

Estimated Budget:
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
0	0	$50,500	$53,100	0	103,600

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date:
August 10, 2013

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I. NEED FOR THE PROJECT

A. 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 last20 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. It would be important to understand the uniqueness of spawning areas. 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.

B. Summary of Project to Date (if applicable)

Some samples (n=600) have already been collected in 2012 from the Port Gravina, Port Fidalgo, eastern PWS.

II. PROJECT DESIGN

A. Objectives

The primary objective of this proposal is to identify genetic uniqueness of herring in Prince William Sound using a group of 15 informative microsatellite markers to:

a. Determine if unique populations exist by sampling within and around 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 -if ample sample size allows (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.

B. Procedural and Scientific Methods

Age class will be approximated from size information and DNA will be isolated from two age classes (150 each) from each collection of 500. 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., 2011).

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, as samples permit (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

It is anticipated that herring will be collected from within Prince William Sound, with the goal of collecting from both east and west. As a means to examine the fidelity of herring remaining in the Sound or returning to spawn in PWS, additional samples from outside PWS will be used. Through collaboration with the Alaska Department of Fish and Game (ADF&G) in Cordova and Yakatat, the goal will be to collect at least 150 samples from each group (for a specific location, year, spawn time,

and age class). Samples will be collected by coordinating with ADF&G and other EVOS funded projects from locations as outlined in Table 1.

Table 1

Location	Area	Year	Collected from Late Spawn	Number* Analyzed
Montague area	Western PWS	2014	500	300
St. Matthews Bay	Eastern PWS	2012	600	200
		2013	500	200
		2014	500	200
Kamishak	Cook Inlet	2012	200	200
Yakutat	Central Alaska	2008	200	200
Kukak	Kodiak	2013	150	150
Total			**2650**	**1450**

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

E. Coordination and Collaboration with the Program

This project is part of the Overall Project Objective 1: Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model. 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.

III. CV's/RESUMES

CURRICULUM VITAE

NAME: Jeffrey R. Guyon

WORK ADDRESS: Genetics Program, ABL/TSMRI/AFSC/NMFS
17109 Point Lena Loop Rd
Juneau, AK 99801
jeff.guyon@noaa.gov

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	Staff Officer, United States Coast Guard
Aug 1993 - Aug 1997	Graduate student, University of Notre Dame, South Bend, IN
Aug 1997 - Aug 2000	Graduate Student, Massachusetts General Hospital, Boston, MA.
Aug 2000 - Dec 2004	Post-doctoral fellowship, Children's Hospital Boston, Boston, MA.
Jan 2005 – Jun 2007	Instructor, Children's Hospital Boston, Boston, MA.
Jul 2007 – Jun 2008	Geneticist, Alaska Department of Fish and Game, Anchorage, AK.
Jul 2008 – Apr 2010	Supervisory Geneticist, Auke Bay Laboratories, Juneau, AK.
Apr 2010 – present	Program Manager, Auke Bay Laboratories, Juneau, AK.

SCIENCE BIBLIOGRAPHY (selected)

1. Farley, E.V., A. Starovoytov, S. Naydenko, R. Heintz, M. Trudel, C. Guthrie, L. Eisner, and J.R. Guyon. (2011) Implications of a warming eastern Bering Sea for Bristol Bay sockeye salmon. ICES Journal of Marine Science **68**:1138-46.
2. McCraney, W.T., Farley, E.V., Kondzela, C.M., Naydenko, S.V., Starovoytov, A.N., and J.R. Guyon. (2012) Genetic stock identification of overwintering chum salmon in the North Pacific Ocean. Environmental Biology of Fishes 94:663-668.
3. McCraney, W. T., Saski, C.A. and Guyon, J.R. 2012. Isolation and characterization of 12 microsatellites for the commercially important sablefish, *Anoplopoma fimbria*. Conservation Genetics Resources 4(2): 415-417.
4. Vulstek, S. C., Linderoth, T.P., Guyon, J.R., and D.A. Tallmon. 2013. Spatio-temporal population genetic structure and mating system of red king crab (*Paralithodes camtschaticus*) in Alaska. Journal of Crustacean Biology in press.
5. Garvin, M. R., Kondzela, C. M., Martin, P. C., Finney, B., Guyon, J., Templin, W. D., DeCovich, N., Gilk-Baumer, S. and Gharrett, A. J. (2013), Recent physical connections may explain weak genetic structure in western Alaskan chum salmon (*Oncorhynchus keta*) populations. Ecology and Evolution. doi: 10.1002/ece3.628

Collaborators/coauthors within last 4 years:

Alexander, M	Children's Hospital Boston, Boston, MA
Cheng, W	Alaska Department of Fish and Game, Anchorage, AK
DeCovich, N	Alaska Department of Fish and Game, Anchorage, AK
Eisner, L.	National Marine Fisheries Service, Juneau, AK
Farley, E.V	National Marine Fisheries Service, Juneau, AK
Finney, B	Departments of Biological Sciences and Geosciences, Idaho State University, Pocatello, Idaho

Galdzicki, M.	Children's Hospital Boston, Boston, MA
Garvin, M.R	School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Juneau, Alaska
Gharrett, A.J.	School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Juneau, Alaska
Gilk-Baumer, S	Alaska Department of Fish and Game, Anchorage, AK
Goswami, J	Children's Hospital Boston, Boston, MA
Grant, W.S	Alaska Department of Fish and Game, Anchorage, AK
Grauvogel, Z	Alaska Department of Fish and Game, Anchorage, AK
Gussoni, E.	Children's Hospital Boston, Boston, MA
Guthrie,C.M.III	National Marine Fisheries Service, Juneau, AK
Heintz, R.	National Marine Fisheries Service, Juneau, AK
Howell, M	Children's Hospital Boston, Boston, MA
Huang, P	Children's Hospital Boston, Boston, MA
Jun, S.J	Children's Hospital Boston, Boston, MA
Kalluri, R	Children's Hospital Boston, Boston, MA
Karpf, J	Children's Hospital Boston, Boston, MA
Kawahara, G	Children's Hospital Boston, Boston, MA
Kondzela, C.M	National Marine Fisheries Service, Juneau, AK
Kunkel, L.M	Children's Hospital Boston, Boston, MA
Linderoth, T.P	University of Alaska Southeast, Juneau, Alaska
Martin, P.C	Concerned Area M Fishermen, 2771 Deer Creek Drive, Bozeman, Montana
McCraney,W.T	National Marine Fisheries Service, Juneau, AK
Mitchell, M	Children's Hospital Boston, MA,
Mizuno, Y	Dept of Neurology, Gunma U. Grad School of Medicine Maebashi, Gunma 371-8511, Japan
Montanaro, F.	Children's Hospital Boston, Boston, MA
Murphy, J	National Marine Fisheries Service, Juneau, AK
Myers, J	Children's Hospital Boston, Boston, MA
Nakamura, Y	Children's Hospital Boston, Boston, MA
Naydenko, S.	Pacific Scientific Research Fisheries Center, Vladivostok 690950, Russia
Nguyen, H	National Marine Fisheries Service, Juneau, AK
Okamoto, K	Dept. of Neurology, Gunma U. Grad. School of Medicine, Maebashi, Gunma 371-8511, Japan
Pusack, T	Children's Hospital Boston, Boston, MA
Sasaoka, T.	Dept. of Neurology, Gunma U. Grad. School of Medicine, Maebashi, Gunma 371-8511, Japan
Saski, C.A	Clemson University, Clemson, SC
Sohn, R.L	Children's Hospital Boston, Boston, MA
Starovoytov, A.	Pacific Scientific Research Fisheries Center, Vladivostok 690950, Russia
Steffen, L.S	Children's Hospital Boston, Boston, MA
Tallmon, D.	University of Alaska Southeast, Juneau, Alaska
Templin, W.D	Alaska Department of Fish and Game, Anchorage, AK
Thorne, M	Children's Hospital Boston, Boston, MA
Trudel, M.	Division of Fisheries and Oceans, Canada
Vollenweider, J	National Marine Fisheries Service, Juneau, AK
Vulstek, S.C	National Marine Fisheries Service, Juneau, AK
Wildes, S.L	National Marine Fisheries Service, Juneau, AK
Zon, L.	Children's Hospital Boston, Boston, MA

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.Wildes@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:

mtDNA barcoding of pacific sand lance and analysis of sequence data for species identification.
Species identification of rougheye/blackspotted rockfish complex using SNP and microsatellite markers.
Microsatellite development of Arctic cod
Examination of microsatellite frequencies for Arctic cod and capelin
Microsatellite development of Pacific sleeper sharks
mtDNA sequence evaluation of Pacific sleeper sharks in the Bering Sea and Gulf of Alaska

Publications:

Wildes, S.L., J.W. Orr, Y. Kai, N. Raring, T. Nakabo, O. Katugin, and J. Guyon. Systematics of North Pacific sand lances of the genus *Ammodytes* based on molecular and morphological evidence, with the description of a new species from Japan. In Prep.

Liu, J.X., A. Tatarenkov, T.D. Beacham, V. Gorbachev, **S. Wildes**, and J. Avise. 2011. Effects of Pleistocene climatic fluctuations on the phylogeographic and demographic histories of Pacific herring (Clupea pallasii). Mol. Ecol. 20:3879-3893.

Wildes, S.L., J.J. Vollenweider, H.V. Nguyen and J.R. Guyon. 2011. Genetic variation between outer-coastal and fjord populations of Pacific herring *(Clupea pallasi)* in the eastern Gulf of Alaska. Fishery Bulletin 109:382-393.

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., 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.

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
Nakabo, T., Kyoto University, Japan
Nelson, Dr. R. John, Seastar Biotech, Victoria BC, Canada
Orr, Dr. Jay, Alaska Fisheries Science Center, Seattle, WA
Raring, Nate, 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

IV. SCHEDULE

A. Project Milestones

Objective 1. To identify population structure of herring in Prince William Sound.
To be met by September 2017

B. Measurable Project Tasks

FY 14, 1st quarter (February 1 – May 31, 2014)
February, 2014 *Project funding available*

FY 14, 2nd quarter (June 1, 2014-August 30, 2014)
Finalize samples to analyze, Isolate DNA

FY 14, 3rd quarter (September 1, 2014-November 30, 2014)
Begin collection of microsatellite data

FY 14, 4th quarter (December 1, 2015 – January 31, 2015)
Continue collection of microsatellite data

V. BUDGET

Budget Form (Attached)
Please complete the budget form for each proposed year of the project.

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: Modeling the population dynamics of Prince William Sound herring

Project Period: February 1, 2014 – January 31, 2015

Primary Investigator(s): Trevor A. Branch, University of Washington, tbranch@uw.edu, 206-221-0776

Abstract: Shortly after the Exxon Valdez oil spill, the Prince William Sound herring populations collapsed and have not yet recovered. We propose a modeling project to (1) revise and update the ASA model used to manage this population, (2) conduct simulations to test which data sources are most important in assessing the current status of this population, and (3) collect data on herring populations worldwide to find out how often these populations collapse under ordinary conditions.

Estimated Budget:
EVOSTC Funding Requested:

FY12	FY13	FY14	FY15	FY16	TOTAL
36,907	87,014	97,836	100,406	104,920	427,083

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
		0			

Date:

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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. Summary of Project to Date (if applicable)

All milestones have been met. A graduate student has been identified and hired, and completed most of the remaining coursework on schedule, and has translated the current Excel model of herring dynamics into AD Model Builder, ready for conversion to a Bayesian model of herring abundance. The immediate goal is a fast-running model that assesses population status of Prince William Sound herring including characterization of uncertainty in abundance.

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.

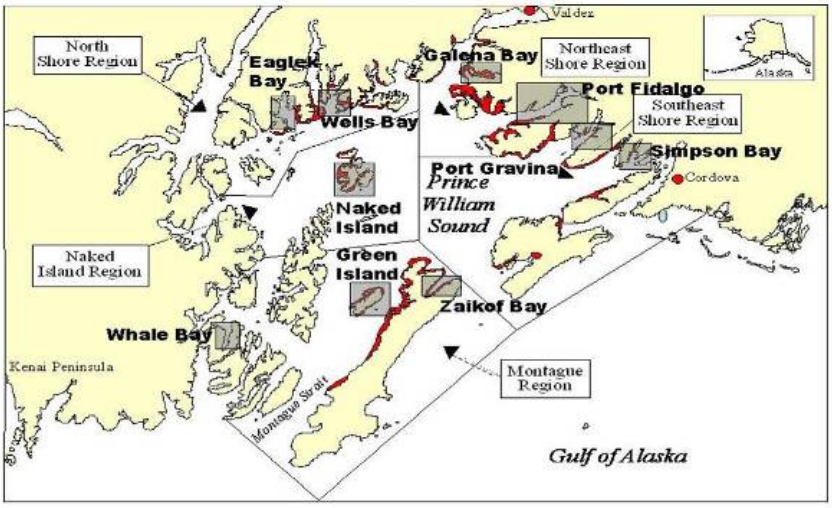

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with the Program

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. CV's/RESUMES

Biographical sketch

Trevor A. Branch, tbranch@uw.edu

Professional preparation

University of Cape Town	Zoology, 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

Appointments

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 Scientist, Marine Resource Assessment and Management Group, Department of Mathematics and Applied Mathematics, University of Cape Town
2000–2004	Research Assistant, School of Aquatic and Fishery Sciences, Univ. of Washington
1999–2000	Research Assistant, Marine Resource Assessment and Management Group, Department of Mathematics and Applied Mathematics, University of Cape Town
1998–2000	Consultant, Marine Resources Assessment Group, London (MRAG, Ltd)
1995–1998	Research Assistant, Marine Resource Assessment and Management Group, Department of Mathematics and Applied Mathematics, University of Cape Town

Products

Five scientific papers closely related the proposed project:

Branch TA, Watson R, Fulton EA, Jennings S, McGilliard CR, Pablico GT, Ricard D, Tracey SR (2010) The trophic fingerprint of marine fisheries. Nature 468:431-435

Sethi SA, Branch TA, Watson R (2010) Fishery development patterns are driven by profit but not trophic level. Proc Natl Acad Sci USA 107:12163-12167

Branch TA, Jensen OP, Ricard D, Ye Y, Hilborn R (2011) Contrasting global trends in marine fishery status obtained from catches and from stock assessments. Cons Biol 25:777-786

Worm B, Branch TA (2012) The future of fish. Trends Ecol Evol 27:594-599

Worm B, Hilborn R, Baum JK, Branch TA, Collie JS, Costello C, Fogarty MJ, Fulton EA, Hutchings JA, Jennings S, Jensen OP, Lotze HK, Mace PM, McClanahan TR, Minto C, Palumbi SR, Parma AM, Ricard D, Rosenberg AA, Watson R, Zeller D (2009) Rebuilding global fisheries. Science 325:578-585

Five other significant scientific papers (n = 53):

Branch TA, Lobo AS, Purcell SW (2013) Opportunistic exploitation: an overlooked pathway to extinction. Trends Ecol Evol 28:409-413

Branch TA, DeJoseph BM, Ray LJ, Wagner CA (2013) Impacts of ocean acidification on marine seafood. Trends Ecol Evol 28:178-186

Branch TA and 42 coauthors (2007) Past and present distribution, densities and movements of blue whales *Balaenoptera musculus* in the Southern Hemisphere and northern Indian Ocean. Mammal Rev 37:116-175

Branch TA, Hilborn R, Haynie AC, Fay G, Flynn L, Griffiths J, Marshall KN, Randall JK, Scheuerell JM, Ward EJ, Young M (2006) Fleet dynamics and fishermen behavior: lessons for fisheries managers. Can J Fish Aquat Sci 63:1647-1668

Hilborn R, Branch TA (2013) Does catch reflect abundance? No, it is misleading. Nature 494:303-306

Synergistic activities

1. Outstanding Researcher award for the College of the Environment, University of Washington, 2013. For "research or scholarship contributed within the past two years that has been or has the potential to be widely recognized by peers and whose achievements have had or may have a substantial impact of the profession, on research or the performance of others, or on society as a whole."
2. Ecological Society of America "2011 Sustainability Science Award" for the paper Worm et al. (2009) "Rebuilding Global Fisheries" published in Science. For "the peer reviewed paper published in the past

five years that makes the greatest contribution to the emerging science of ecosystem and regional sustainability through the integration of ecological and social sciences."

3. Aldo Leopold Fellow, 2013, training mid-career researchers in "translating their knowledge to action and for catalyzing change to address the world's most pressing environmental and sustainability challenges."
4. Editor, Animal Conservation, 2012-present.
5. Reviewer for 32 journals including Science, Nature, Proceedings of the National Academy of Sciences USA, Ecology Letters, Ecology, Proceedings of the Royal Society B, Biology Letters, Canadian Journal of Fisheries and Aquatic Sciences, Marine Ecology Progress Series, Fisheries Research, ICES Journal of Marine Science, and Fish and Fisheries.

Collaborators and co-editors in the last 48 months (*n* = 117)

Acevedo-Whitehouse, K (UK), Agnew, D (UK), Alagiyawadu, A (Sri Lanka), Altweg, R (South Africa), A'mar, ZT (NOAA), Anderson, RC (Maldives), Anderson, SC (Simon Fraser Univ), Ashe, E (UK), Austin, J (Univ Florida), Baker, CS (Oregon State Univ), Baker, MR (UW), Baldwin, R (Oman), Banobi, J (UW), Baum, JK (Univ Victoria, Canada), Bianci, PL (UC Santa Barbara), Bravington, M (Australia), Clarke, E (NOAA), Clark, S (Sea World), Collie, JS (Univ Rhode Island), Cope, JM (NOAA), Cornejo-Donoso, J (Chile), Costello, C (UC Santa Barbara), DaVolls, L (UK), Defeo, O (Uruguay), deJoseph, B (UW), Dziak, RP (NOAA), Essington, TE (UW), Evans, DM (UK), Findlay, KP (South Africa), Fogarty, MJ (NOAA), Froese, R (Germany), Fulton, EA (Australia), Garner, TWJ (UK), Gedamke, J (NOAA), Gompper, ME (Univ Missouri), Gordon, IJ (UK), Guinet, C (France), Guttierrez, NL (UK), Haynie, AC (NOAA), Hammond, P (UK), Hancock-Hanser, B (NOAA), Hedley, S (UK), Heppell, SS (Oregon State Univ), Hilborn, R (UW), Hively, DJ (UW), Hoggarth, DD (UK), Hollowed, A (NOAA), Holtgrieve, GW (UW), Hoyt, E (UK), Hutchings, JA (Dalhousie Univ), Jackson, JA (Oregon State Univ), Jennings, S (UK), Jensen, OP (Rutgers Univ), Johnson, JA (Univ N Texas), Karachle, PK (Greece), Kato, H (Japan), Katzner, TE (W Virginia Univ), Kendall, NW (UW), Krkosek, M (New Zealand), Larsen, A (UC Santa Barbara), LeDuc, RL (NOAA), Link, JS (NOAA), Lobo, AS (India), Lotze, HK (Dalhousie Univ), Mace, PM (New Zealand), Marsac, F (South Africa), Martell, SJD (Int Pac Halibut Comm), McClanahan, TR (Kenya), McGilliard, CR (UW), Melnychuk, MC (UW), Mikhalev, Y (Ukraine), Minto, C (Ireland), Ninnes, C (UK), Noren, DP (NOAA), Pablico, GT (Philippines), Palomares, MLD (Univ British Columbia), Palumbi, SR (Stanford Univ), Parma, AM (Argentina), Pettorelli, N (UK), Pope, JG (UK), Purcell, SW (Australia), Proelß, A (Germany), Quaas, M (Germany), Quinn, TP (UW), Ranjan, R (India), Rantanen, E (UK), Ray, L (UW), Ricard, D (Dalhousie Univ), Rosen, D (Univ British Columbia), Rosenberg, AA (Univ New Hampshire), Royer, J-Y (France), Sainsbury, K (Australia), Samaran, F (France), Schindler, DE (UW), Selden, RL (UC Santa Barbara), Sethi, SA (UW), Sistla, S (UC Santa Barbara), Smith, ADM (Australia), Sremba, A (Oregon State Univ), Stafford, KM (UW), Stern-Pirlot, A (UK), Stewart, IJ (NOAA), Teck, SJ (UC Santa Barbara), Thorson, JT (UW), Tracey, SR (Australia), Valencia, SR (UC Santa Barbara), Visser, IN (New Zealand), Wagner, C (UW), Watson, R (Australia), Williams, NE (Australia), Williams, RS (Canada), Winship, A (Dalhousie Univ), Worm, B (Dalhousie Univ), Ye, Y (Italy), Zeller, D (Univ British Columbia), Zerbini, AN (Cascadia Research), Zimmermann, C (Germany)

Graduate advisors and postdoctoral sponsors: Douglas S. Butterworth, University of Cape Town (M.Sc.); John G. Field, University of Cape Town (M.Sc.); Ray Hilborn, University of Washington (Ph.D.)

Thesis advisor and postgraduate-scholar sponsor (last five years): Cole Monnahan (MS, UW), Melissa Muradian (MS, UW), Peter Kuriyama (MS, UW). Total graduate students: 3. Postdoctoral: 0.

IV. 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

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

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.

V. BUDGET

Budget Form (Attached)

FY14 PROGRAM PROJECT
PROPOSAL FORM

Project Title: PWS Herring: Aerial Survey Support

Project Period: 1 February 2014 to 31 January 2016

Primary Investigator(s): W. Scott Pegau, Prince William Sound Science Center

Abstract:

This project is for providing aerial survey support to the EVOSTC sponsored Herring Research and Monitoring (HRM) and Gulf Watch Alaska (GWA) programs. For the HRM program the aerial support will be used to help collect herring samples for the genetics project and to provide an aerial index of age-1 herring abundance. For the GWA program the aerial support will be used by the forage fish project. The desire is to provide an aerial index of forage fish abundance and guide the capture efforts of the vessel. In turn the vessel will be providing ground truth of fish types and size of schools for better interpretation of the aerial based forage fish information. This proposal request is strictly for aerial support, all analysis and vessel funding will come from the existing projects. Funding for this project will be managed as a supplement to the HRM Coordination and Logistics project (12120111-O) led by Dr. Pegau.

Estimated Budget:
EVOSTC Funding Requested: $130,000
(breakdown by fiscal year and must include 9% GA)

FY 12	FY13	FY14	FY15	FY16
$ 0	$ 0	$65,000	$65,000	$ 0

Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date:
August 30, 2013

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.

There are several needs for aerial support for the EVOSTC funded Herring Research and Monitoring (HRM) and Gulf Watch Alaska (GWA) programs. We need a capability to rapidly respond to remote locations in PWS for the collection of required samples that have been difficult to obtain using ships. The age-structure-analysis (ASA) model results can be improved by better knowledge of the expected incoming recruit class. Prediction of the recruiting class strength requires information that currently is not available. The aerial surveys provide one mechanism to address that need. The forage fish project in the GWA program also requires a better idea of the distribution of forage fish schools to help ensure their sampling program provides the best estimate of forage fish population. Additional aerial surveys will complement and improve the ongoing GWA forage fish research.

II. PROJECT DESIGN

A. Objectives

This project's objectives are:

1) Provide aerial support for collection of samples for the genetics project.
2) Provide an index of abundance of age-1 herring.
3) Provide aerial support to the forage fish project of the GWA program:
    a. Test the efficiency of adaptive vs. conventional sampling methods to optimize survey design for estimating stock size with an accurate estimate of the associated variance
    b. Validate aerial observations for species, age class, average biomass and school density.

B. Procedural and Scientific Methods

The herring genetics project is dependent on collecting samples from multiple spawning locations. In recent years there have been limited spawn events in areas outside of the Port Gravina and Port Fildago areas. This makes it difficult to ensure we can get a vessel to the spawning locations in time to collect fish. In 2013 we were able to use a plane to collect a herring sample from Kayak Island. The ability to rapidly access the spawning event allowed us

an opportunity to get a rare sample of fish from that location. The fish were turned over to ADF&G for their analysis and then to be shared with the genetics project of the HRM program. We intend to use a plane to access regions with active spawn for capture using cast nets, jigs, or gill nets. Four days of survey effort is requested for this purpose each of the next two years.

Aerial surveys led by Dr. Evelyn Brown during the Sound Ecosystem Assessment, Apex Predator Experiment, and PWS Herring Survey program provided an indication of the potential for using aerial surveys to provide an index of age-1 herring. This index has the potential for greatly improving the estimate of the number of age-3 herring to recruit to the spawning stock. The estimation of recruitment is critical to the ability for the age-structure-analysis model to be used to forecast herring biomass.

In the past, the aerial surveys were used to provide a measure of the density of age-1 herring in either June or July. In the last year of the aerial surveys for the PWS Herring Survey program Dr. Brown set up a survey approach that could be transitioned to a single spotter pilot. The approach divides PWS into several regions (Figure 1) and the pilot then surveys the region recording the number and size of schools and the assumed species/age. Size is split into three categories (small, medium, and large) based on the number of grid cells covered using the sighting tube used in previous surveys. Species and age is based on appearance of the school, with herring divided into age-0, age-1, and age-2+. Additional verification of aerial observations using vessel-based methods (i.e., hook and line, net collection methods, and hydroacoustics) will improve the reliability of the aerial schools index. Based on the previous surveys it was determined that June was the ideal month for surveying age-1 herring. This is due to no age-0 herring being present and eulachon and capelin tending to be in separate areas due to spawning. The simplified method proposed here is not used to estimate total density, but is used to provide a total number of schools per region. This simplified approach was used successfully in 2013.

Each survey region represents about one day of effort. By splitting the Sound into regions we can prioritize the regions in case the entire Sound cannot be surveyed due to weather. This will be done to maximize consistency between years. We expect to refine the survey regions this fall based on analysis of the previous data. Enough location information was collected in 2013 to allow us to reanalyze existing data if the boundaries of sampling regions are changed. The most likely changes will be in discontinuing surveys on the Gulf of Alaska side of Montague and Hinchinbrook islands and region 13. These are areas that traditionally do not have age-1 herring and are riskier to fly. Regions 2 and 3 will likely be combined.

Data from the previous years of surveys is currently being converted into the number of schools per region to determine how well the approach provides a prediction of incoming recruitment levels. We only have one measure of recruitment from the last four years of surveys. The age data from the 2013 spawning population needed to assess the recruitment will become available in the fall of 2013. There has been over an order of magnitude difference in the numbers of schools of age-1 herring observed in June in the recent years. From 2010 through 2013 the numbers of schools observed were 595, 150, 131, and 1,980 respectively. We still need to assess the number of schools observed during the Sound Ecosystem Assessment program, but the years of the observations were generally associated with small recruitment classes.

Dr. Pegau will be responsible for ensuring that proper data collection and analysis is conducted for the aerial data collected in support of the HRM program. His funding is included in the HRM coordination and logistics project. Eight days of survey effort are requested each year for this purpose.

The forage fish component of the GWA program identified the desire for aerial observations to provide another index of forage fish distribution and to help guide vessel-based sampling efforts. As originally proposed, the objectives of this work are to: 1) identify robust indices for monitoring forage fish populations over time and devise a sampling strategy for long term monitoring of those indices, 2) assess the current distribution, abundance, species composition, and body condition of forage fishes (other than herring) in selected areas of Prince William Sound at selected times of the year, and 3) relate abundance and distribution of forage species to abiotic characteristics of the marine environment. We originally designed a stratified systematic survey design for sampling forage fish. After testing this design in 2012-2013, and exploring the potential for using aerial surveys to locate schools in 2013, we believe a more efficient approach will incorporate larger scale aerial surveys to identify high density areas in the Sound, coupled with finer scale vessel-based hydroacoustic surveys to quantify forage schools.

In 2013 we worked with an experienced spotter pilot to find schools of herring, sand lance and capelin. The pilot was skilled at directing the boat to schools, and we were successful in quantifying the species and size composition of the schools. We also quantified small and medium herring schools with split beam dual frequency hydroacoustics, and we are working on those data to estimate biomass and density during fall 2013. Hydroacoustic validation of aerial observations will improve the schools/region index by increasing certainty in allocation of schools to species and age class, and may facilitate the quantification of biomass and fish density over time.

This project is designed as a supplement to the Herring Research and Monitoring (HRM) and Gulf Watch Alaska (GWA) programs. Oversight and reporting regarding this funding will be incorporated into the HRM coordination and logistics project.

Because both programs need similar survey information we are trying to determine if a single set of surveys can serve both programs. This would allow us to stretch the funding to cover the remaining three years of the programs instead of the two we expect the funding to cover. What we are balancing is the logistical constraints of the forage fish surveys that may not have access to the vessel in June and the quality of observations of age-1 herring in June. Both groups are looking for opportunities to ensure the highest quality data is provided and collaborate in the most effective manner.

C. Data Analysis and Statistical Methods

For the HRM program the initial analysis will be by the number of schools per region (Figure 1). The assumption is that the relative proportion of small, medium, and large schools remains constant through time. We will be testing that assumption using an ANOVA analysis using the data collected to determine if significant differences exist. The number of years of data to include remains small (seven), which limits the ability to discern differences. If there are

significant differences in school composition then we will shift from number of schools in our analysis to the area covered by the schools. Each school size is associated with an approximate area that will allow us to make the conversion.

As the recruitment information becomes available we will regress the number of schools observed against the estimated number of age-3 fish recruiting to the spawning stock. We will examine if a subset of the regions can be used to provide an accurate predictor of the total number of schools. This will be used to determine if reduced survey effort can be used in the future and to help prioritize survey efforts.

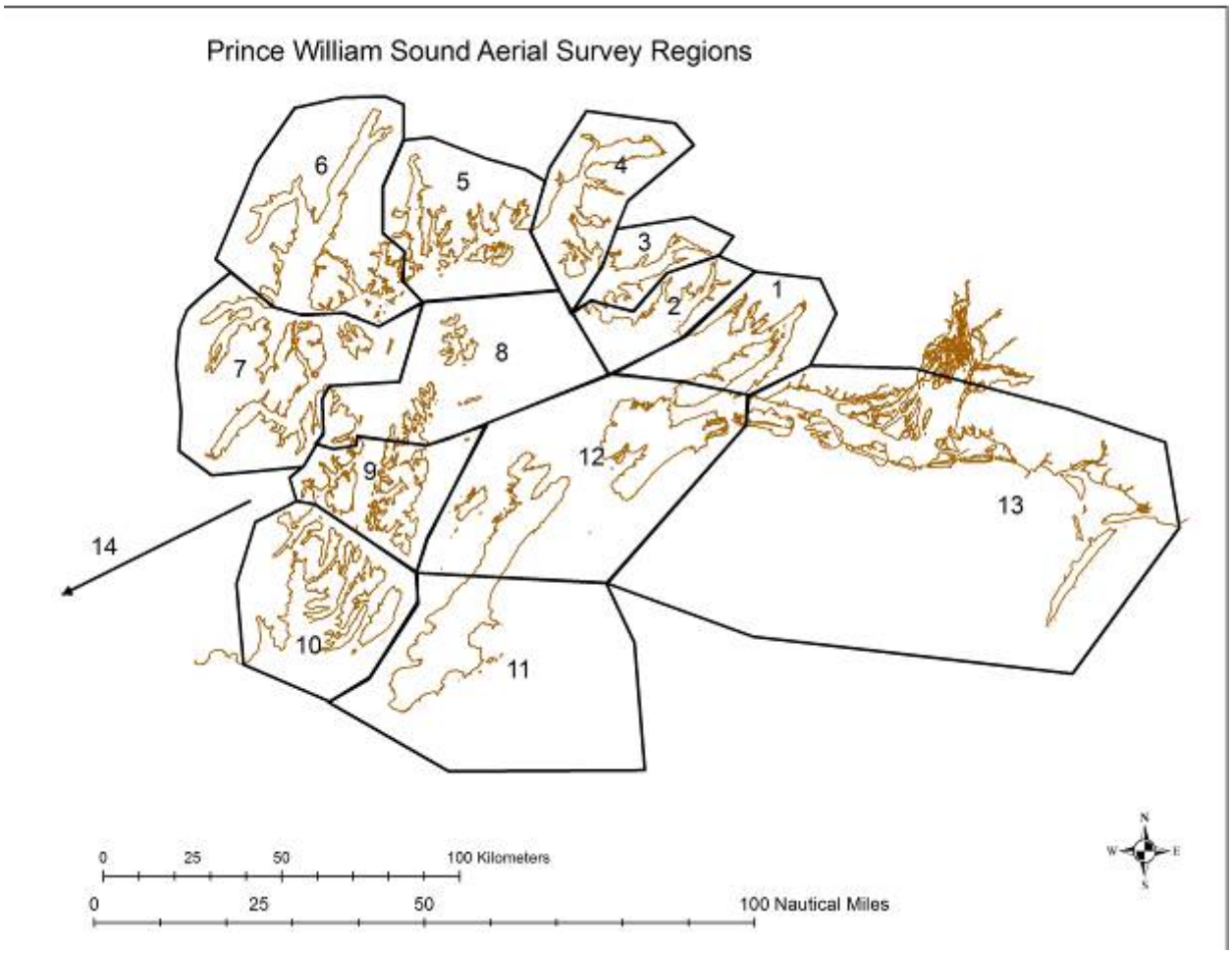

Figure 1. Survey regions as identified for the 2013 season. We expect to make refinements to regions 12 and 11 to remove the Gulf side of the islands and will probably drop region 13. These are not areas where age-1 herring tend to be found.

Work for the GWA forage fish program will require greater spatial resolution than proposed for the HRM program. In July 2013 the pilot made track lines using a handheld GPS, and recorded observations using a digital recorder. At the end of each flight day, the pilot handed off the data recorder and tracks so we could plot the locations of schools and rapidly assess high density areas for vessel-based work. This worked reasonably well (see Figure 2), and we would continue this level of effort at a minimum. Ideally we will have a near-real time large scale map of school

locations to aid in the allocation of hydroacoustic survey effort in the Sound. The validation of aerial observations will include 1) capture of fish in schools with jig, cast net, purse seine, midwater trawl, dip net, and underwater camera, and 2) hydroacoustic estimate of fish density and biomass for schools of different size and species classifications.

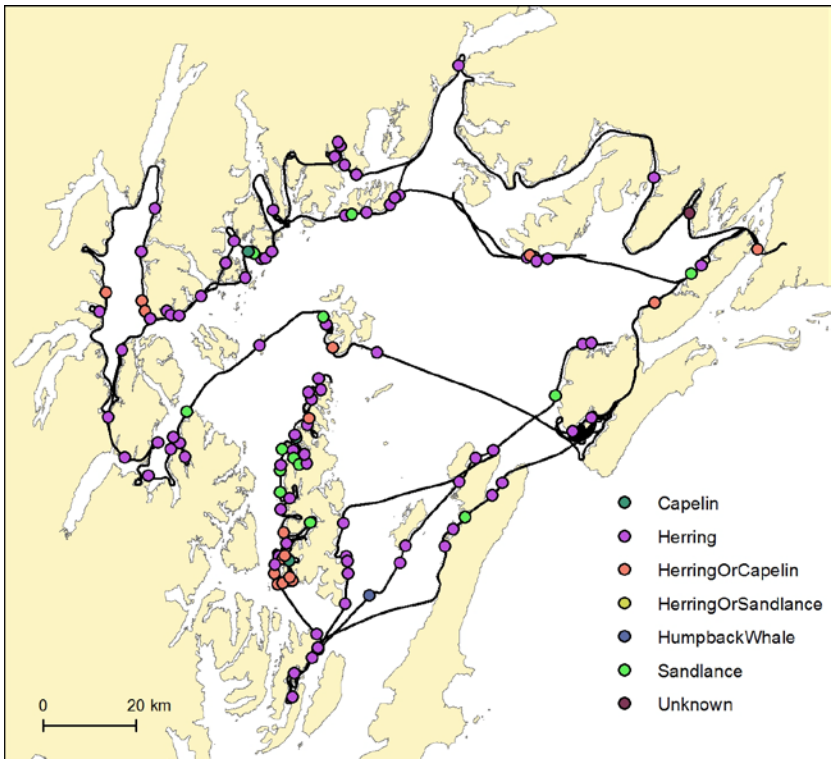

Figure 2. Aerial observations, including flight track (black line) and school locations (colored circles) during flights in July 2013.

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 of bays sampled 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.

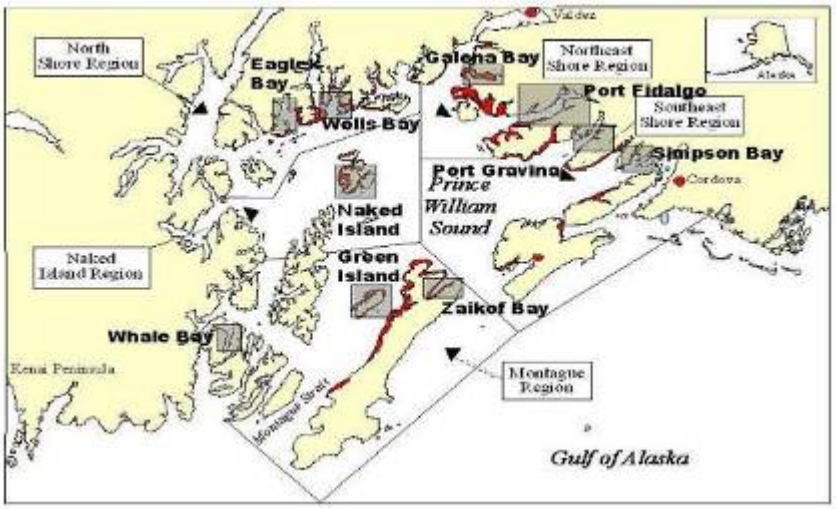

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal will support projects in both the HRM and GWA programs. W. Scott Pegau will be responsible for ensuring the contracting of flights to support the two programs. He will also be responsible for ensuring the data related to the herring program is analyzed. He will coordinate with Mayumi Arimitsu to provide support for the forage fish project in the GWA program.

III. CV's/RESUMES

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-present 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.

Publications
Selected publications

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

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.

Streever, B., R. Suydam, J.F. Payne, R. Shuchman, R.P. Angliss, G. Balogh, J. Brown, J. Grunblatt, S. Guyer, D.L. Kane, J.J. Kelley, G. Kofinas, D.R. Lassuy, W. Loya, P. Martin, S.E. Moore, W.S. Pegau, C. Rea, D.J. Reed, T. Sformo, M. Sturm, J.J. Taylor, T. Viavant, D. Williams, and D. Yokel, Environmental Change and Potential Impacts: Applied Research Priorities for Alaska's North Slope, *Arctic*, **64**, 390-397, 2011.

Moline, M.A., I. Robbins, B. Zelenke, W.S. Pegau, and H. Wijesekera, Evaluation of bio-optical inversion of spectral irradiance measured from an autonomous underwater vehicle, *J. Geophys. Res.*, **117**, 12pp., doi:10.1029/2001JC007352, 2012.

Musgrave, D.L., M.J. Halverson, and W.S. Pegau, Seasonal Surface Circulation, Temperature, and Salinity in Prince William Sound, Alaska, *Cont. Shelf Res.*, doi:10.1016/j.csr.2012.12.001, 2012

Collaborators

Mary Abercrombie (USF), Robyn Angliss (NOAA), Greg Balogh (USFWS), Mike Banner (UNSW), P. Bhandari (UM), Mary Anne Bishop (PWSSC), Rob Bochenek (Axiom consulting), Emmanuel Boss (U Maine), Kevin Boswell (FIU), Tim Boyd (SAM), Trevor Branch (UW), Evelyn Brown (Flying fish), John Brown, Michele Buckhorn (PWSSC), Lindsay Butters (PWSSC), Rob Cambell (PWSSC), L Carvalho (UCSB), Grace Chang (UCSB), Yi Chao (JPL), Paula Coble (USF), Robyn Conmy (EPA), Tim Cowles (OSU), Helen Czerski (U Southhampton), M. Darecki (PAS), Tommy Dickey (UCSB), C. Dong (IGGP), David Farmer (URI), Jim Farr (NOAA), Scott Freeman (NASA), J. Gemmrich (UVic), P. Gernez (U Nantes), Jess Grunblatt (UAF), Scott Guyer (BLM), Jeff Guyon (NOAA), B. Hagen (SAM), Nate Hall-Patch (IOS), Mark Halverson (PWSSC), Ron Heintz (NOAA), Paul Hershberger (USGS), Ben Holt (JPL), S. Jiang (UCSB), Mark Johnson (UAF), C. Jones (UCSB), Doug Kane (UAF), Lee Karp-Boss (U Maine), George Kattawar (TAMU), John Kelley (UAF), T. King (BIO), Tom Kline (PWSSC), Cory Koch (Wetlabs), Gary Kofinas (UAF), Kathy Kuletz (USFWS), J. Lacoste (Dalhousie), Denny Lassuy (DOI), D. LeBel (Lamont), Ken Lee (BIO), L. Lenain (SIO), Marlin Lewis (Satlantic), Y. Liu (MIT), L. Logan (UMiami), Wendy Loya (Wilderness org), Ted Maksym (WHOI), Darek Manov (UCSB) Phillip Martin (USFWS), W. Melville (SIO), Scott Miles (LSU), Steve Moffitt (ADF&G), Mark Moline (Cal Poly), Sue Moore (NOAA), Rue

Morison (UNSW), Dave Musgrave, F. Nencioli (MIO), Carter Ohlmann (UCSB), John Payne (DOI), Sean Powers (USA), Caryn Rea (Conoco), Dan Reed (ADFG), B. Reineman (SIO), Ian Robbins (Cal Poly), B. Robinson (BIO), Chris Roman (WHOI), R. Rottgers (HZG), Scott Ryan (BIO), H. Schultz (UMass), Li Shen (Johns Hopkins), M. Shinki (CRI), Matt Slivkoff(ISMO), M. Sokolski (PAS), Frank Spada (Sea Engineering), Nate Statom (SIO), Darius Stramski (SIO), Bill Streever (BP), Todd Sformo (NSB), Robert Shuchman (Mich Tech), Petere Sutherland (SIO), Hanumat Singh (WHOI), Matt Sturm (ACE), Robert Suydam (NSB), J. Taylor, Richard Thorne (PWSSC), Mike Twardowski (Wetlabs), S. Vagle (IOS), Ronnie Van Dommelen (Satlantic), Tim Viavant (ADFG), Johanna Vollenweider (NOAA), Ken Voss (UMiami), Ian Walsh (Wetlabs), Libe Washburn (UCSB), J. Wei (Dal), Hemantha Wijesekera (NRL), Dee Williams (BOEM), Sharon Wilde (NOAA), Amanda Whitmire (OSU), Jeremy Wilkinson (BAS), Michelle Wood (UO), O. Wurl (Old Domin), D. Yankg (John Hopkins), Dave Yokel (BLM), Dick Yue (MIT), Len Zabilansky (CRREL), Ron Zaneveld (Wetlabs), Chris Zappa (Lamont), Brian Zelenke (Cal Poly)

IV. SCHEDULE

A. Project Milestones

Objective 1. Provide aerial support for collection of samples for the genetics project.
This is an annual objective and will last through the two-year period.

Objective 2. Provide an index of abundance of age-1 herring.
This is an annual objective.

Objective 3 Provide aerial support to the forage fish project of the GWA program.
This is an annual objective and will last through the two-year period.

B. Measurable Project Tasks

FY14 1st Quarter (February 1, 2014 to May 30, 2014)

February	Establish finding
March	Contract pilot for survey efforts
May	Complete collection of fish for genetics research

FY14 2nd Quarter

June	Conduct aerial surveys for age-1 herring
July	Conduct aerial surveys for forage fish project

FY14 3rd Quarter

August	Complete annual processing of age-1 herring data.

FY14 4th Quarter

FY15 1st Quarter (February 1, 2014 to May 30, 2014)

February	Establish finding
March	Contract pilot for survey efforts
May	Complete collection of fish for genetics research

FY15 2nd Quarter

June	Conduct aerial surveys for age-1 herring
July	Conduct aerial surveys for forage fish project

FY15 3rd Quarter

August	Complete annual processing of age-1 herring data.

FY15 4th Quarter

V. BUDGET

Budget Form (Attached)

Budget Explanation

This budget includes a request for funding of aerial surveys. Twenty survey days are requested each year at a cost of $2,500 per day. Because the contracts are for a professional service and are actually three separate contracts the amount is subject to the PWSSC overhead rate of 30%.

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$201,500	$377,300	$535,700	$524,200	$518,000	$2,156,700		$556,700	($21,000)
Travel	$26,800	$31,500	$47,000	$49,700	$46,600	$201,600		$47,000	$0
Contractual	$336,960	$544,799	$406,188	$367,616	$362,757	$2,018,320		$461,858	($55,670)
Commodities	$81,600	$33,700	$104,100	$100,300	$67,100	$386,800		$104,100	$0
Equipment	$187,200	$0	$0	$0	$0	$187,200		$0	$0
Indirect Costs (*will vary by proposer*)	$108,500	$173,030	$153,200	$146,100	$144,370	$725,200		$171,680	($18,480)
SUBTOTAL	$942,560	$1,160,329	$1,246,188	$1,187,916	$1,138,827	$5,675,820		$1,341,338	($95,150)
General Administration (9% of subtotal)	$84,665	$104,489	$112,291	$106,991	$102,656	$511,093		$114,700	($2,409)
PROJECT TOTAL	$1,027,225	$1,264,818	$1,358,479	$1,294,907	$1,241,483	$6,186,913		$1,456,038	($97,559)
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0		$0.0	$0

COMMENTS: All amounts are give in dollars.

FY12-16

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

PROGRAM SUMMARY

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$142,700	$338,100	$347,800	$320,100	$327,200	$1,475,900		$368,800	($21,000)
Travel	$19,700	$21,500	$22,700	$19,800	$24,200	$107,900		$22,700	$0
Contractual	$260,760	$419,399	$319,188	$280,616	$275,757	$1,555,720		$374,858	($55,670)
Commodities	$67,200	$22,400	$14,500	$17,700	$9,900	$131,700		$14,500	$0
Equipment	$172,200	$0	$0	$0	$0	$172,200		$0	$0
Indirect Costs (*will vary by proposer*)	$108,500	$173,030	$153,200	$146,100	$144,370	$725,200		$171,680	($18,480)
SUBTOTAL	$771,060	$974,429	$857,388	$784,316	$781,427	$4,168,620		$952,538	($95,150)
General Administration (9% of subtotal)	$69,265	$87,689	$77,191	$70,691	$70,456	$375,293		$79,600	($2,409)
PROJECT TOTAL	$840,325	$1,062,118	$934,579	$855,007	$851,883	$4,543,913		$1,032,138	($97,559)
Other Resources (Cost Share	$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

PWSSC SUMMARY

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$0	$0	$17,500	$17,500	$0	$35,000		$17,500	$0
Travel	$6,000	$9,500	$7,300	$12,900	$4,000	$39,700		$7,300	$0
Contractual	$76,000	$125,400	$75,000	$75,000	$75,000	$426,400		$75,000	$0
Commodities	$10,400	$11,300	$30,400	$30,400	$5,000	$87,500		$30,400	$0
Equipment	$0	$0	$0	$0	$0	$0		$0	$0
Indirect Costs (*will vary by proposer*)	$0	$0	$0	$0	$0	$0		$0	$0
SUBTOTAL	$92,400	$146,200	$130,200	$135,800	$84,000	$588,600		$130,200	$0
General Administration (9% of subtotal)	$8,300	$13,200	$11,800	$12,200	$7,600	$53,100		$11,800	$0
PROJECT TOTAL	$100,700	$159,400	$142,000	$148,000	$91,600	$641,700		$142,000	$0
Other Resources (Cost Share Funds)	$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

NOAA SUMMARY

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$58,800	$39,200	$0	$0	$0	$98,000		$0	$0
Travel	$1,100	$500	$0	$0	$0	$1,600		$0	$0
Contractual	$200	$0	$0	$0	$0	$200		$0	$0
Commodities	$4,000	$0	$13,200	$13,200	$13,200	$43,600		$13,200	$0
Equipment	$15,000	$0	$0	$0	$0	$15,000		$0	$0
Indirect Costs (*will vary by proposer*)	$0	$0	$0	$0	$0	$0		$0	$0
SUBTOTAL	$79,100	$39,700	$13,200	$13,200	$13,200	$158,400		$13,200	$0
General Administration (9% of subtotal)	$7,100	$3,600	$1,200	$1,200	$1,200	$14,300		$1,200	$0
PROJECT TOTAL	$86,200	$43,300	$14,400	$14,400	$14,400	$172,700		$14,400	$0
Other Resources (Cost Share Funds)	$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

ADFG SUMMARY

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$0	$0	$170,400	$186,600	$190,800	$547,800		$170,400	$0
Travel	$0	$0	$17,000	$17,000	$18,400	$52,400		$17,000	$0
Contractual	$0	$0	$12,000	$12,000	$12,000	$36,000		$12,000	$0
Commodities	$0	$0	$46,000	$39,000	$39,000	$124,000		$46,000	$0
Equipment	$0	$0	$0	$0	$0	$0		$0	$0
Indirect Costs (*will vary by proposer*)	$0	$0	$0	$0	$0	$0		$0	$0
SUBTOTAL	$0	$0	$245,400	$254,600	$260,200	$760,200		$245,400	$0
General Administration (9% of subtotal)	$0	$0	$22,100	$22,900	$23,400	$68,400		$22,100	$0
PROJECT TOTAL	$0	$0	$267,500	$277,500	$283,600	$828,600		$267,500	$0
Other Resources (Cost Share Funds)	$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

USGS SUMMARY

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$19,100	$27,900	$28,700	$20,900	$21,700	$118,300		$28,700	$0
Travel	$9,500	$4,100	$5,000	$4,000	$8,700	$31,300		$5,000	$0
Contractual	$216,960	$375,999	$282,288	$244,916	$243,657	$1,363,820		$337,958	($55,670)
Commodities	$2,300	$4,000	$2,300	$4,400	$1,000	$14,000		$2,300	$0
Equipment	$50,500	$0	$0	$0	$0	$50,500		$0	$0
Indirect Costs (*30% TDC*)	$35,700	$56,130	$37,800	$36,800	$35,570	$202,000		$49,980	($12,180)
SUBTOTAL	$334,060	$468,129	$356,088	$311,016	$310,627	$1,779,920		$423,938	($67,850)
General Administration (9% of subtotal)	$30,065	$42,132	$32,048	$27,991	$27,956	$160,193		$38,154	($6,107)
PROJECT TOTAL	$364,125	$510,261	$388,136	$339,007	$338,583	$1,940,113		$462,092	($73,957)
Other Resources (Cost Share Funds)	$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	11.5		11,500.0
TBD	Assistant	2.0	8.6		17,200.0
					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	$28,700.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Advisory group travel	800.0	3	2	200.0	2,800.0
Marine Science Symposium	400.0	1	4	200.0	1,200.0
P.I. to EVOSTC meeting	400.0	1	3	200.0	1,000.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5,000.0

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	300.0
printing/mailing/copying	1,000.0
Communication (phone, fax)	300.0
CDFU fishing effort	35,000.0
Vessel charters 40 days at $2600/day	88,400.0
Data Management	20,500.0
Non-Lethal collection (Boswell)	47,030.0
modeling	89,758.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$282,288.0

Commodities Costs: Description	Commodities Sum
misc office supplies	1,300.0
misc cruise supplies	1,000.0
Commodities Total	$2,300.0

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
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$2,800	$16,300	$16,800	$18,900	$22,900	$77,700		$16,800	$0
Travel	$1,400	$1,800	$3,600	$2,500	$2,000	$11,300		$3,600	$0
Contractual	$400	$2,000	$800	$2,100	$1,000	$6,300		$800	$0
Commodities	$7,000	$1,400	$1,900	$1,900	$1,100	$13,300		$1,900	$0
Equipment	$0	$0	$0	$0	$0	$0		$0	$0
Indirect Costs (30%)	$3,500	$6,500	$6,900	$7,600	$8,100	$32,600		$6,900	$0
SUBTOTAL	$15,100	$28,000	$30,000	$33,000	$35,100	$141,200		$30,000	$0
General Administration (9% of subtotal)	$1,400	$2,500	$2,700	$3,000	$3,200	$12,800		$2,700	$0
PROJECT TOTAL	$16,500	$30,500	$32,700	$36,000	$38,300	$154,000		$32,700	$0
Other Resources (Cost Share Funds)	$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: Outreach
Team Leader: Butters

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	2.0	5900.0		11,800.0
Education Specialist	Education Specialist	1.0	5000.0		5,000.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	10900.0	0.0	
				Personnel Total	$16,800.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Meeting Travel (Anchorage)	500.0	2	6	200.0	2,200.0
Education Travel (program delivery outside of Cordova)	300.0	2	4	200.0	1,400.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3,600.0

FY14

Program Title: Outreach
Team Leader: Butters

FORM 3B
PERSONNEL & TRAVEL DETAIL

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

Contractual Costs:	Contract
Description	Sum
Networking ($100/person-month)	300.0
Communications ($100/person-month)	300.0
Printing/shipping	200.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$800.0

Commodities Costs:	Commodities
Description	Sum
Teaching and Outreach Supplies	1,900.0
Commodities Total	$1,900.0

FY14

Program Title: Outreach
Team Leader: Butters

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: Outreach
Team Leader: Butters

FORM 3B
EQUIPMENT DETAIL

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$0	$64,700	$67,300	$70,000	$72,800	$274,800		$67,300
Travel	$0	$3,000	$5,900	$5,900	$6,100	$20,900		$5,900
Contractual	$0	$24,800	$25,600	$26,300	$28,900	$105,600		$25,600
Commodities	$0	$7,500	$5,000	$8,300	$6,700	$27,500		$5,000
Equipment	$0	$0	$0	$0	$0	$0		$0
Indirect @ 30% MTDC	$0	$30,000	$31,200	$33,200	$34,400	$128,800		$31,200
SUBTOTAL	$0	$130,000	$135,000	$143,700	$148,900	$557,600		$135,000
General Administration (9% of subtotal)	$0	$11,700	$12,200	$12,900	$13,400	$50,200		$12,200
PROJECT TOTAL	$0	$141,700	$147,200	$156,600	$162,300	$607,800		$147,200
Other Resources (Cost Share Funds)	$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		3.0	11451.3		34,354.0
Tech to be named	Herring Condition Monitoring		6.0	5491.0		32,946.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	16942.3	0.0	
					Personnel Total	$67,300.0

Travel Costs:		Ticket	Round	Total	Daily	Travel
Description		Price	Trips	Days	Per Diem	Sum
January Symposium		500.0	1	4	200.0	1,300.0
Workshop		1100.0	1	4	200.0	1,900.0
Scientific Meeting		1500.0	1	6	200.0	2,700.0
registration added to ticket cost						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$5,900.0

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	900.0
Mass spectrometry 800 @ $26	20,800.0
Freeze drying 800 @ $3	2,400.0
Printing, copying, shipping	500.0
Communications (fax and phone)	500.0
Software	500.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$25,600.0

Commodities Costs: Description	Commodities Sum
Office supplies	500.0
Sampling supplies	2,300.0
Laboratory supplies	2,200.0
Commodities Total	$5,000.0

FY14

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: Description	Number of Units	Inventory Agency

FY14

Project Title: Herring Condition Monitoring
Project PI: Kline

FORM 3B
EQUIPMENT DETAIL

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

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0
$0

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$64,800	$41,200	$13,700	$0	$0	$119,700		$13,700
Travel	$2,700	$2,700	$0	$0	$0	$5,400		$0
Contractual	$41,600	$8,500	$700	$0	$0	$50,800		$700
Commodities	$13,900	$2,200	$0	$0	$0	$16,100		$0
Equipment	$0	$0	$0	$0	$0	$0		$0
Indirect @ 30% MTDC	$36,900	$16,300	$4,300	$0	$0	$57,500		$4,300
SUBTOTAL	$159,900	$70,900	$18,700	$0	$0	$249,500		$18,700
General Administration (9% of subtotal)	$14,400	$6,400	$1,700	$0	$0	$22,500		$1,700
PROJECT TOTAL	$174,300	$77,300	$20,400	$0	$0	$272,000		$20,400
Other Resources (Cost Share Funds)	$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		1.2	11416.7		13,700.0
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
						0.0
			Subtotal	11416.7	0.0	
					Personnel Total	$13,700.0

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
				Travel Total	$0.0

FY14

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 1.2 @ $100	100.0
Printing, copying, shipping	0.0
Communications (fax and phone) 1.2 @50	100.0
Software	500.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$700.0

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 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: Description	Number of Units	Inventory Agency

FY14

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

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0
$0

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$32,500	$58,300	$98,100	$95,000	$98,000	$381,900		$98,100
Travel	$1,000	$1,000	$2,000	$1,200	$1,200	$6,400		$2,000
Contractual	$900	$1,800	$2,600	$2,200	$2,200	$9,700		$2,600
Commodities	$5,400	$2,800	$1,800	$1,100	$1,100	$12,200		$1,800
Equipment	$10,700	$0	$0	$0	$0	$10,700		$0
Indirect Costs (*30% MTDC*)	$11,900	$19,200	$31,300	$29,900	$30,800	$123,100		$31,300
SUBTOTAL	$62,400	$83,100	$135,800	$129,400	$133,300	$544,000		$135,800
General Administration (9% of subtotal)	$5,600	$7,500	$12,200	$11,700	$12,000	$49,000		$12,200
PROJECT TOTAL	$68,000	$90,600	$148,000	$141,100	$145,300	$593,000		$148,000
Other Resources (Cost Share Funds)	$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	6.0	6783.3		40700.0
M.A. Bishop	Principal Investigator	5.0	11480.0		57400.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	18263.3	0.0	
				Personnel Total	$98,100.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Alaska Marine Symposium	300.0	1	4	175.0	1,000.0
Principal Investigators Meeting - Anchorage	300.0	1	4	175.0	1,000.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2,000.0

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	1700.0
communications (phone and fax) $50/staff mo	600.0
printing & copying $25/staff mo	300.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2,600.0

Commodities Costs: Description	Commodities Sum
Field, Lab, & Office supplies	1800.0
Commodities Total	$1,800.0

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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	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

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0
$0

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$7,300	$8,900	$11,300	$0	$0	$27,500		$11,300	$0
Travel	$5,100	$2,700	$0	$0	$0	$7,800		$0	$0
Contractual	$400	$300	$1,000	$0	$0	$1,700		$1,000	$0
Commodities	$37,100	$500	$0	$0	$0	$37,600		$0	$0
Equipment	$0	$0	$0	$0	$0	$0		$0	$0
Indirect Costs (*will vary by proposer*)	$15,000	$3,700	$3,700			$22,400		$3,700	$0
SUBTOTAL	$64,900	$16,100	$16,000	$0	$0	$97,000		$16,000	$0
General Administration (9% of subtotal)	$5,800	$1,400	$1,400	$0	$0	$8,600		$1,400	$0
PROJECT TOTAL	$70,700	$17,500	$17,400	$0	$0	$105,600		$17,400	$0
Other Resources (Cost Share Funds)	$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
M. Bishop	Principal Investigator	1.0	11,300.0		11,300.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	11300.0	0.0	
				Personnel Total	$11,300.0

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

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	100.0
printing & copying $25/staff mo	0.0
communications (phone and fax) $50/staff mo	100.0
page charges scientific journal	800.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1,000.0

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
		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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$16,200	$49,900	$40,900	$55,300	$55,900	$218,200		$40,900
Travel	$0	$2,600	$2,600	$2,600	$2,600	$10,400		$2,600
Contractual	$500	$4,000	$1,600	$2,000	$0	$8,100		$1,600
Commodities	$1,500	$0	$1,500	$0	$0	$3,000		$1,500
Equipment	$59,000	$0	$0	$0	$0	$59,000		$0
Indirect Costs (*will vary by proposer*)	$5,500	$17,000	$14,000	$18,000	$17,600	$72,100		$14,000
SUBTOTAL	$82,700	$73,500	$60,600	$77,900	$76,100	$370,800		$60,600
General Administration (9% of subtotal)	$7,400	$6,600	$5,500	$7,000	$6,900	$33,400		$5,500
PROJECT TOTAL	$90,100	$80,100	$66,100	$84,900	$83,000	$404,200		$66,100
Other Resources (Cost Share Funds)	$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	2.5	9000.0		22,500.0
Richard Thorne, PhD	co-PI	0.3	11333.3		3,400.0
James Thorne	acoustics tech	2.0	7500.0		15,000.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	27833.3	0.0	
				Personnel Total	$40,900.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Seattle to Cordova - Richard Thorne	700.0	2			1,400.0
Cordova to Anchorage AMSS - Richard Thorne	600.0	1	3	200.0	1,200.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2,600.0

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)	800.0
Printing	800.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1,600.0

Commodities Costs: Description	Commodities Sum
Sampling supplies	1,500.0
Commodities Total	$1,500.0

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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	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

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0
$0

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$0	$21,000	$30,100	$4,700	$0	$55,800		$51,100
Travel	$0	$0	$0	$0	$0	$0		$0
Contractual	$0	$0	$1,000	$100	$0	$1,100		$1,000
Commodities	$0	$0	$2,000	$0	$0	$2,000		$2,000
Equipment	$46,000	$0	$0	$0	$0	$46,000		$0
Indirect Costs (30% PWSSC)	$0	$6,300	$9,600	$1,400	$0	$17,300		$15,900
SUBTOTAL	$46,000	$27,300	$42,700	$6,200	$0	$122,200		$70,000
General Administration (9% of subtotal)	$4,100	$2,457	$3,843	$600	$0	$11,000		$6,300
PROJECT TOTAL	$50,100	$29,757	$46,543	$6,800	$0	$133,200		$76,300
Other Resources (Cost Share Funds)	$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
Michele Buckhorn, PhD	PI	1.5	9000.0		13,500.0
Richard Thorne, PhD	co-PI	0.8	11375.0		9,100.0
James Thorne	acoustics tech	1.0	7500.0		7,500.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	27875.0	0.0	
				Personnel Total	$30,100.0

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
				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)	900.0
Printing	100.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1,000.0

Commodities Costs: Description	Commodities Sum
Sampling supplies	2,000.0
Commodities Total	$2,000.0

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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	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

Difference FY 14
($21,000)
$0
$0
$0
$0
($6,300)
($27,300)
($2,457)
($29,757)
$0

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$0	$49,900	$40,900	$55,300	$55,900	$202,000		$40,900
Travel	$0	$3,600	$3,600	$3,600	$3,600	$14,400		$3,600
Contractual	$0	$2,000	$3,600	$3,000	$0	$8,600		$3,600
Commodities	$0	$4,000	$0	$2,000	$0	$6,000		$0
Equipment	$6,000	$0	$0	$0	$0	$6,000		$0
Indirect Costs (*will vary by proposer*)	$0	$17,900	$14,400	$19,200	$17,900	$69,400		$14,400
SUBTOTAL	$6,000	$77,400	$62,500	$83,100	$77,400	$306,400		$62,500
General Administration (9% of subtotal)	$500	$7,000	$5,600	$7,500	$7,000	$27,600		$5,600
PROJECT TOTAL	$6,500	$84,400	$68,100	$90,600	$84,400	$334,000		$68,100
Other Resources (Cost Share Funds)	$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
Michele Buckhorn, PhD	PI	2.5	9000.0		22,500.0
Richard Thorne, PhD	co-PI	0.3	11333.3		3,400.0
James Thorne	acoustics tech	2.0	7500.0		15,000.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	27833.3	0.0	
				Personnel Total	$40,900.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Cordova to Anchorage AMSS - Michele Buckhorn	600.0	1	4	200.0	1,400.0
Conference travel - Michele Buckhorn	1200.0	1	5	200.0	2,200.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3,600.0

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)	800.0
printing	800.0
equipment calibration	2,000.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$3,600.0

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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	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

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0
$0

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$0	$0	$0	$0	$0	$0		$0
Travel	$2,000	$0	$0	$0	$0	$2,000		$0
Contractual	$23,000	$0	$0	$0	$0	$23,000		$0
Commodities	$5,000	$0	$0	$0	$0	$5,000		$0
Equipment	$0	$0	$0	$0	$0	$0		$0
SUBTOTAL	$30,000	$0	$0	$0	$0	$30,000		$0
General Administration (9% of subtotal)	$2,700	$0	$0	$0	$0	$2,700		$0
PROJECT TOTAL	$32,700	$0	$0	$0	$0	$32,700		$0
Other Resources (Cost Share Funds)	$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

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
					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: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

FY14

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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY14

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

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$0	$0	$17,500	$17,500	$0	$35,000		$17,500	$0
Travel	$0	$0	$3,400	$5,800	$0	$9,200		$3,400	$0
Contractual	$0	$0	$0	$0	$0	$0		$0	$0
Commodities	$0	$0	$25,400	$25,400	$0	$50,800		$25,400	$0
Equipment	$0	$0	$0	$0	$0	$0		$0	$0
SUBTOTAL	$0	$0	$46,300	$48,700	$0	$95,000		$46,300	$0
General Administration (9% of subtotal)	$0	$0	$4,200	$4,400	$0	$8,600		$4,200	$0
PROJECT TOTAL	$0	$0	$50,500	$53,100	$0	$103,600		$50,500	$0
Other Resources (Cost Share Funds)	$0	$0	$0	$0	$0	$0			
									$0

FY12-16

Program Title:Genetic Stock Indicators
Team Leader: Guyon and Wildes
Agency: NOAA

FORM 4A
TRUSTEE AGENCY
SUMMARY

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Technician	Genetic Stock Inidcators	2.5	7000.0		17,500.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	7000.0	0.0	
				Personnel Total	$17,500.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Trips to AMSS (Guyon and Wildes)	400.0	2	8	200.0	2,400.0
Trip to Cordova (Wildes)	400.0	1	3	200.0	1,000.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3,400.0

FY14

Program Title:Genetic Stock Indicators
Team Leader: Guyon and Wildes
Agency: NOAA

FORM 4B
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
Supplies	25,400.0
Commodities Total	$25,400.0

FY14

Program Title:Genetic Stock Indicators
Team Leader: Guyon and Wildes
Agency: NOAA

FORM 4B
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

Program Title:Genetic Stock Indicators
Team Leader: Guyon and Wildes
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$0	$0	$0	$0	$0	$0		$0
Travel	$0	$6,400	$0	$0	$0	$6,400		$0
Contractual	$15,000	$36,000	$0	$0	$0	$51,000		$0
Commodities	$1,900	$2,800	$0	$0	$0	$4,700		$0
Equipment	$0	$0	$0	$0	$0	$0		$0
SUBTOTAL	$16,900	$45,200	$0	$0	$0	$62,100		$0
General Administration (9% of subtotal)	$1,500	$4,100	$0	$0	$0	$5,600		$0
PROJECT TOTAL	$18,400	$49,300	$0	$0	$0	$67,700		$0
Other Resources (Cost Share Funds)	$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

FORM 4A
TRUSTEE AGENCY
SUMMARY

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:Fatty Acids and Winter Migration Team
Leader:Heintz and Vollenweider
Agency: NOAA

FORM 4B
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

FY14

Program Title:Fatty Acids and Winter Migration Team
Leader:Heintz and Vollenweider
Agency: NOAA

FORM 4B
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: Description	Number of Units	Inventory Agency

FY14

Program Title:Fatty Acids and Winter Migration Team
Leader:Heintz and Vollenweider
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$0	$0	$0	$0	$0	$0		$0
Travel	$4,000	$3,100	$0	$0	$0	$7,100		$0
Contractual	$38,000	$14,400	$0	$0	$0	$52,400		$0
Commodities	$3,500	$2,500	$0	$0	$0	$6,000		$0
Equipment	$0	$0	$0	$0	$0	$0		$0
SUBTOTAL	$45,500	$20,000	$0	$0	$0	$65,500		$0
General Administration (9% of subtotal)	$4,100	$1,800	$0	$0	$0	$5,900		$0
PROJECT TOTAL	$49,600	$21,800	$0	$0	$0	$71,400		$0
Other Resources (Cost Share Funds)	$0	$0	$0	$0	$0	$0		

FY12-16

Program Title:Age at first spawning **Team Leader: Vollenweider**
Agency: NOAA

FORM 4A
TRUSTEE AGENCY SUMMARY

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:Age at first spawning **Team**
Leader: Vollenweider
Agency: NOAA

FORM 4B
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

FY14

Program Title:Age at first spawning **Team**
Leader: Vollenweider
Agency: NOAA

FORM 4B
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: Description	Number of Units	Inventory Agency

FY14

Program Title:Age at first spawning **Team**
Leader: Vollenweider
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$0	$0	$0	$0	$0	$0		$0
Travel	$0	$0	$3,900	$7,100	$4,000	$15,000		$3,900
Contractual	$0	$75,000	$75,000	$75,000	$75,000	$300,000		$75,000
Commodities	$0	$6,000	$5,000	$5,000	$5,000	$21,000		$5,000
Equipment	$0	$0	$0	$0	$0	$0		$0
SUBTOTAL	$0	$81,000	$83,900	$87,100	$84,000	$336,000		$83,900
General Administration (9% of subtotal)	$0	$7,300	$7,600	$7,800	$7,600	$30,300		$7,600
PROJECT TOTAL	$0	$88,300	$91,500	$94,900	$91,600	$366,300		$91,500
Other Resources (Cost Share Funds)	$0	$0	$0	$0	$0	$0		

FY12-16

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

FORM 4A
TRUSTEE AGENCY SUMMARY

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: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Travel to annual herring meeting in Cordova	470.0	2	4	165.0	1,600.0
Travel to AMSS in Anchorage	490.0	2	8	165.0	2,300.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3,900.0

FY14

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description		Contract Sum
Contract for RNA/DNA analysis		35000
Contract for lipid analysis		35000
Contract for data consolidation		5000
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$75,000.0

Commodities Costs: Description	Commodities Sum
standards, sample vials, pipette tips, reagents, dye	5,000.0
Commodities Total	$5,000.0

FY14

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

FORM 4B
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: Description	Number of Units	Inventory Agency

FY14

Program Title:Long-term growth monitoring Team Leader:Heintz
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$58,800	$39,200	$0	$0	$0	$98,000		$0
Travel	$1,100	$500	$0	$0	$0	$1,600		$0
Contractual	$200	$0	$0	$0	$0	$200		$0
Commodities	$4,000	$0	$0	$0	$0	$4,000		$0
Equipment	$15,000	$0	$0	$0	$0	$15,000		$0
SUBTOTAL	$79,100	$39,700	$0	$0	$0	$118,800		$0
General Administration (9% of subtotal)	$7,100	$3,600	$0	$0	$0	$10,700		$0
PROJECT TOTAL	$86,200	$43,300	$0	$0	$0	$129,500		$0
Other Resources (Cost Share Funds)	$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. **Supervision of the project (1.0 months of FB III general funds = $10.5 k), office space for equipment and personnel.**

FY12-16

Program Title: Scales as growth history records for Pacific herring.
Team Leader: Steve Moffitt
Agency: Alaska Dept. of Fish and Game

FORM 4A
TRUSTEE AGENCY SUMMARY

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
					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: Scales as growth history records for Pacific herring.
Team Leader: Steve Moffitt
Agency: Alaska Dept. of Fish and Game

FORM 4B
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

FY14

Program Title: Scales as growth history records for Pacific herring.
Team Leader: Steve Moffitt
Agency: Alaska Dept. of Fish and Game

FORM 4B
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: Description	Number of Units	Inventory Agency

FY14

Program Title: Scales as growth history records for Pacific herring.
Team Leader: Steve Moffitt
Agency: Alaska Dept. of Fish and Game

FORM 4B
EQUIPMENT DETAIL

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$0.0	$0.0	$170,400.0	$186,600.0	$190,800.0	$547,800.0		$170,400	$0
Travel	$0.0	$0.0	$17,000.0	$17,000.0	$18,400.0	$52,400.0		$17,000	$0
Contractual	$0.0	$0.0	$12,000.0	$12,000.0	$12,000.0	$36,000.0		$12,000	$0
Commodities	$0.0	$0.0	$46,000.0	$39,000.0	$39,000.0	$124,000.0		$46,000	$0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0		$0	$0
SUBTOTAL	$0.0	$0.0	$245,400.0	$254,600.0	$260,200.0	$760,200.0		$245,400	$0
General Administration (9% of subtotal)	$0.0	$0.0	$22,100.0	$22,900.0	$23,400.0	$68,400.0		$22,100	$0
PROJECT TOTAL	$0.0	$0.0	$267,500.0	$277,500.0	$283,600.0	$828,600.0		$267,500	$0
Other Resources (Cost Share Funds)	$0.0	$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: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

FORM 4A
TRUSTEE AGENCY
SUMMARY

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
New Hire	GS-7, Step-3 Lab Technician	12.0	5000.0		60,000.0
New Hire	GS-7, Step-3 Lab Technician for in situ hybridiz	12.0	5000.0		60,000.0
New Hire	Student Intern (student services contract)	12.0	3000.0		36,000.0
New Hire	Summer Intern (student services contract)	6.0	2400.0		14,400.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	15400.0	0.0	
				Personnel Total	$170,400.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Nordland, WA - Anchorage (presentation @ AK marine Science Symp.	1200.0	2	5	200.0	3,400.0
Nordland, WA - Cordova (adult and juvenile herring sampling)	1400.0	4	10	200.0	7,600.0
Nordland, WA - Sitka (adult herring sampling)	1200.0	2	4	200.0	3,200.0
Nordland, WA - Cordova (participate in PI integration meeting)	1400.0	1	7	200.0	2,800.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$17,000.0

FY14

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Subcontract: assistance with laboratory studies	12,000.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$12,000.0

Commodities Costs: Description	Commodities Sum
Fish food, enrichments, and live feed production for SPF herring	15,000.0
Laboratory supplies (cell culture, histology, molecular biology, parasitology, virology, etc.)	20,000.0
Histology Supplies	3,000.0
Fluorescent in situ hybridization supplies	8,000.0
Commodities Total	$46,000.0

FY14

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

FORM 4B
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: Description	Number of Units	Inventory Agency

FY14

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: USGS

FORM 4B
EQUIPMENT DETAIL

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0		$0
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0		$0
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0		$0
Commodities	$0.0	$0.0	$13,200.0	$13,200.0	$13,200.0	$39,600.0		$13,200
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0		$0
SUBTOTAL	$0.0	$0.0	$13,200.0	$13,200.0	$13,200.0	$39,600.0		$13,200
General Administration (9% of subtotal)	$0.0	$0.0	$1,200.0	$1,200.0	$1,200.0	$3,600.0		$1,200
PROJECT TOTAL	$0.0	$0.0	$14,400.0	$14,400.0	$14,400.0	$43,200.0		$14,400
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: Herring Disease
Team Leader: Paul Hershberger
Agency: ADF&G

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
					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: Herring Disease
Team Leader: Paul Hershberger
Agency: ADF&G

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)	13,200.0
Includes VHSV, VEN, and Ichthyophonus diagnostics	
samples: 180 PWS adults, 180 PWS juveniles, 60 Sitka adults	
Commodities Total	$13,200.0

FY14

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: ADF&G

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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY14

Program Title: Herring Disease
Team Leader: Paul Hershberger
Agency: ADF&G

FORM 4B
EQUIPMENT DETAIL

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

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14
Personnel	$94,400	$93,700	$16,700	$17,300	$17,900	$240,000		$16,700
Travel	$0	$0	$0	$0	$0	$0		$0
Contractual	$0	$0	$0	$0	$0	$0		$0
Commodities	$0	$0	$0	$0	$0	$0		$0
Equipment	$3,900	$4,800	$0	$0	$0	$8,700		$0
Indirect Costs (*23%*)	$21,700	$21,500	$3,800	$4,000	$4,100	$55,100		$3,800
SUBTOTAL	$120,000	$120,000	$20,500	$21,300	$22,000	$303,800		$20,500
General Administration (9% of subtotal)	$10,800	$10,800	$2,000	$2,000	$2,000	$27,600		$2,000
PROJECT TOTAL	$130,800	$130,800	$22,500	$23,300	$24,000	$331,400		$22,500
Other Resources (Cost Share Funds)	$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: Rob Bochenek

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
Shane StClair		0.5	8800.0		4,400.0
Luc Mehl		1.5	8200.0		12,300.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17000.0	0.0	
				Personnel Total	$16,700.0

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
				Travel Total	$0.0

FY14

Program Title: PWS herring: Data Management
Team Leader: Rob Bochenek

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: Rob Bochenek

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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY14

Program Title: PWS herring: Data Management
Team Leader: Rob Bochenek

FORM 3B
EQUIPMENT DETAIL

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

Difference FY 14
$0
$0
$0
$0
$0
$0
$0
$0
$0
$0

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$0	$16,500	$21,700	$0	$0	$38,200		$38,200	($16,500)
Travel	$0	$8,600	$8,600	$0	$0	$17,200		$17,200	($8,600)
Contractual	$0	$0	$7,000	$0	$0	$7,000		$7,000	$0
Commodities	$0	$6,700	$0	$0	$0	$6,700		$6,700	($6,700)
Equipment	$0	$0	$0	$0	$0	$0		$0	$0
Indirect Costs (*will vary by proposer*)		$8,270	$9,730			$18,000		$18,000	($8,270)
SUBTOTAL	$0	$40,070	$47,030	$0	$0	$87,100		$87,100	($40,070)
General Administration (9% of subtotal)	$0	$3,606	$4,233	$0	$0	$7,839		$7,839	($3,606)
PROJECT TOTAL	$0	$43,676	$51,263	$0	$0	$94,939		$94,939	($43,676)
Other Resources (Cost Share Funds)	$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
Kevin Boswell (plus 31.885 fringe)	PI	1.5	11000.0		16,500.0
Undergraduate Student (plus 0.0033% fringe)	Student	6.0	866.7		5,200.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	11866.7	0.0	
				Personnel Total	$21,700.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
Marine Science Symposium	1000.0	1	4	275.0	2,100.0
Annual PI Meeting	1050.0	1	5	230.0	2,200.0
Fieldwork (PI and Student)	2000.0	1	10	230.0	4,300.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8,600.0

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		7,000.0
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$7,000.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

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

Budget Category:	FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED		Original FY 14	Difference FY 14
Personnel	$20,734	$34,446	$35,824	$37,256	$38,747	$167,007		$35,824	$0
Travel	$982	$3,636	$8,194	$7,812	$8,508	$29,132		$8,194	$0
Contractual	$0	$0	$0	$0	$0	$0		$0	$0
Commodities	$200	$16,884	$20,552	$21,287	$22,050	$80,973		$20,552	$0
Equipment	$0	$4,000	$0	$0	$0	$4,000		$0	$0
Indirect Costs (*will vary by proposer*)	$11,944	$20,863	$25,188	$25,761	$26,952	$110,708		$25,188	$0
SUBTOTAL	$33,860	$79,829	$89,758	$92,116	$96,257	$391,820		$89,758	$0
General Administration (9% of subtotal)	$3,047	$7,185	$8,078	$8,290	$8,663	$35,264		$8,078	$0
PROJECT TOTAL	$36,907	$87,014	$97,836	$100,406	$104,920	$427,084		$97,836	$0
Other Resources (Cost Share Funds)	$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: 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	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: Modeling the population dynamics of Prince William Sound herring
Team Leader: Trevor A. Branch

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: Modeling the population dynamics of Prince William Sound herring
Team Leader: Trevor A. Branch

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: Modeling the population dynamics of Prince William Sound herring
Team Leader: Trevor A. Branch

FORM 3B
EQUIPMENT DETAIL