FY12 INVITATION

PROPOSAL SUMMARY PAGE

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

Project Period: October 1, 2011 – September 30, 2014

Primary Investigator(s):
Dr. Mary Anne Bishop, Prince William Sound Science Center, Cordova , mbishop@pwssc.org
Dr. Sean Powers, University of South Alabama & Dauphin Island Sea Lab, spowers@disl.org
Collaborators: S. Moffitt, Alaska Dept. Fish Game; J. Eiler, Auke Bay Lab, NOAA; Dr. Andy Seitz, Univ. Alaska Fairbanks

Study Location: Prince William Sound

Abstract:
Knowledge of fish movements and migrations are critical to understanding fish population dynamics. In Prince William Sound (PWS) adult herring disperse after spawning, however their movement patterns are poorly understood. Currently the only information on adult herring movements are a small number of observations from fishers that suggest PWS herring are regularly migrating out of PWS and onto the shelf. This proposal focuses on verifying adult Pacific herring movements using detections of tagged fish. The Herring Marking Workshop sponsored by EVOS in December 2008, reviewed all potential marking methods for herring and conditionally endorsed acoustic tagging as a method for determining herring movements. This pilot project will acoustic tag adult herring during November around Port Gravina, a spring spawning area. During the second season a small sample of adult herring will be tagged during spring at other spawning areas. We will then examine detections from two, established Pacific Ocean Shelf Tracking (POST) Project's acoustic arrays as well as new arrays to be deployed at the major entrances and passages to Prince William Sound. These acoustic arrays will enable us to determine seasonal movement patterns within and out of Prince William Sound. The proposed project builds on our previous and current research on acoustic-tagged fishes. This project will synergize with efforts of POST and the Ocean Tracking Network (OTN). The ability to track herring is critical to answer many questions including those about stock structure, migration habits, and the occurrence of skip-spawning. Determining the capabilities of this technology will help guide our choice of future research emphasis.

Estimated Budget:
EVOSTC Funding Requested: *(breakdown by fiscal year and must include 9% GA)*

FY12	FY13	FY14
$79,700	19,700	17,400

Non-EVOSTC Funds to be used:

Date: May 25, 2011

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

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

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

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

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

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

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

II. PROJECT DESIGN

A. Background for the Adult Seasonal Movement Study:

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

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

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

In October 2008 the Pacific Ocean Shelf Tracking Project (POST), PWS Science Center (M.A. Bishop, Co-PI), University of South Alabama (S. Powers, Co-PI) and the PWS Oil Spill Recovery Institute installed across the mouth of Port Gravina the first long-term, large-scale hydroacoustic array in Prince William Sound. At that same time, Bishop and Powers installed

eight portable receivers at pinnacles near the POST array. In September 2010 we installed a new array at the mouth of Zaikof Bay near Hinchinbrook Entrance consisting of six portable receivers. At both Port Gravina and Zaikof Bay, acoustic-tagged lingcod (*Ophiodon elongatus*) are currently being monitored (Bishop et al. 2010; Fig. 1).

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

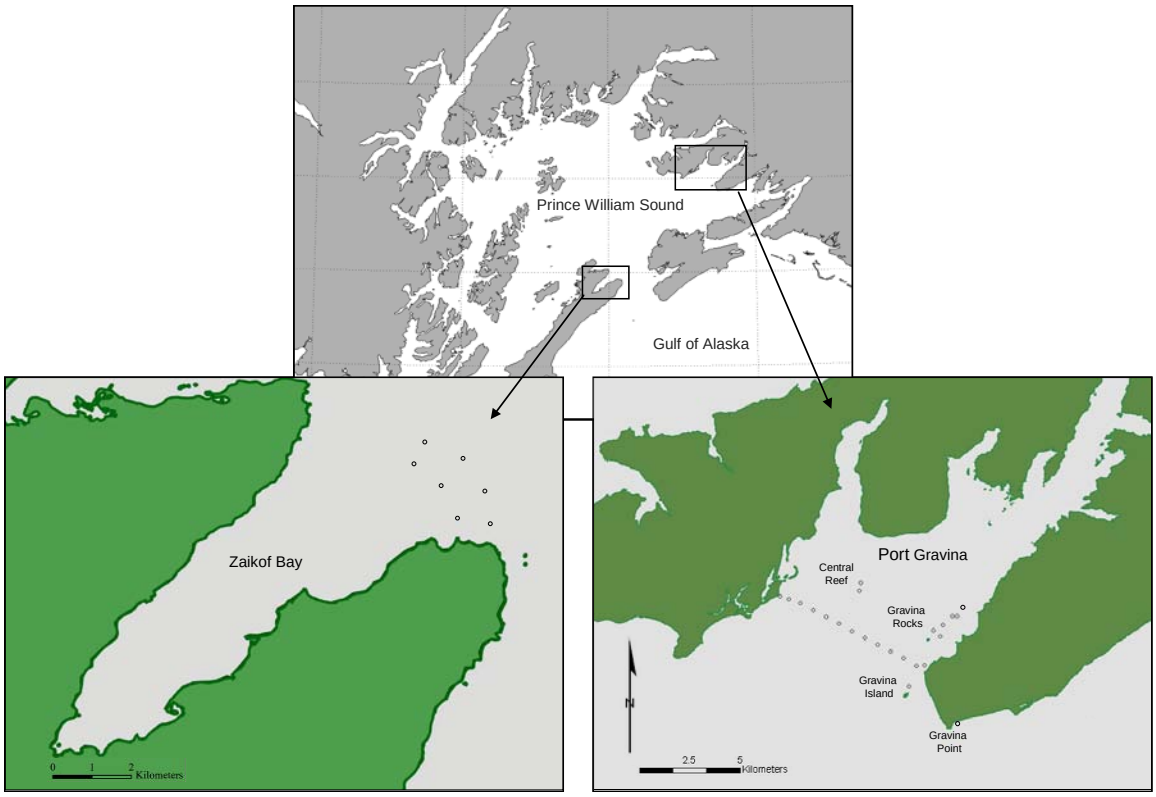

Figure 1. Map of Prince William Sound, Alaska, and acoustic array locations at Zaikof Bay and Port Gravina. Circles indicate the positions of hydro-acoustic receivers. Overwintering adult herring in this area will be captured and tagged during ADFG seine surveys in November 2011 (Port Gravina vicinity)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

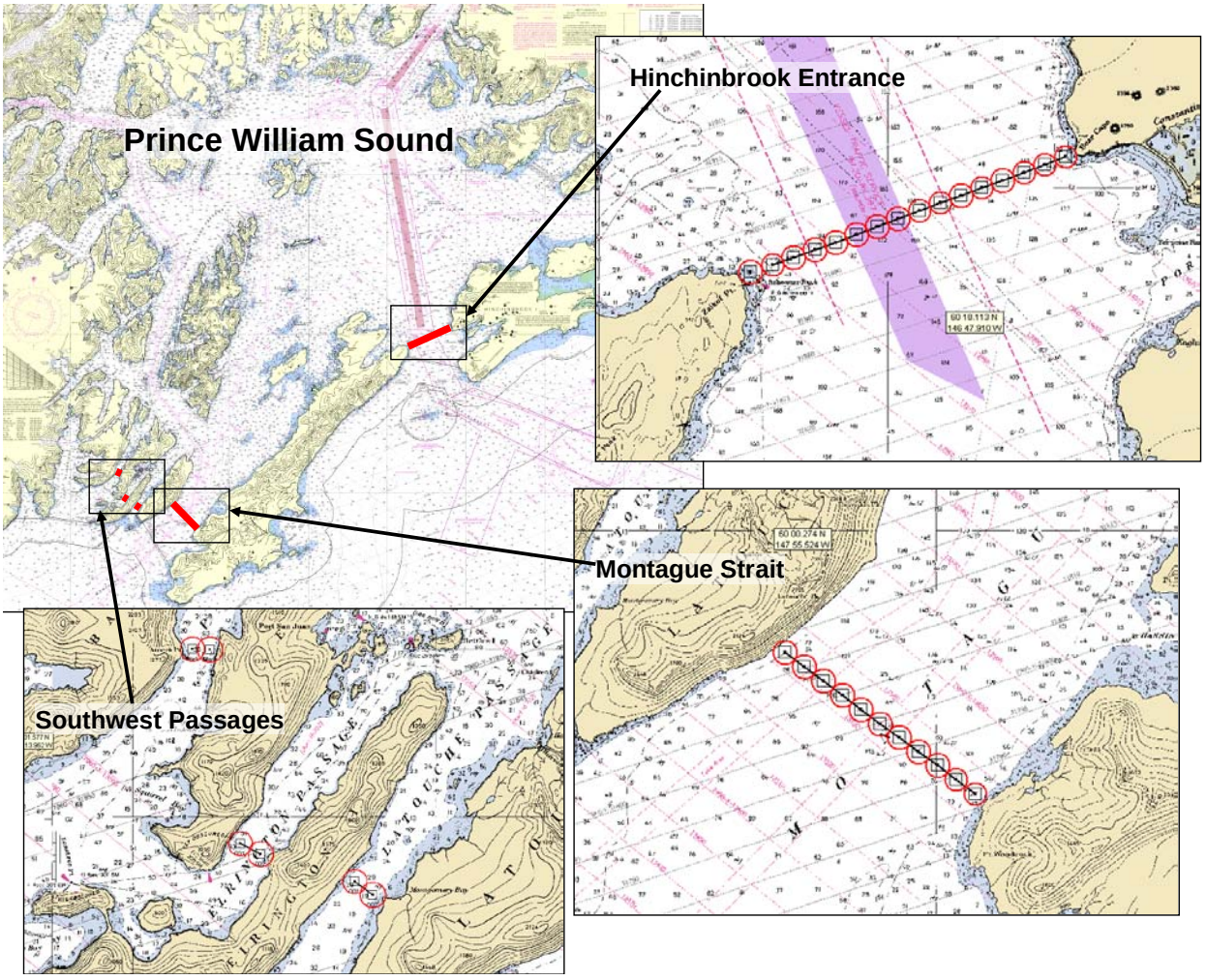

Figure 2. Proposed POST/OTN array locations, scheduled to be installed by PWS Science Center in fall 2011

B. Goal and Objectives

Goal: <u>Improve predictive models of herring stocks through observations and research</u>.

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

recommend modifications during a five-year period if needed. The remainder of the discussion in this proposal is focused on the proposed efforts between FY12 and FY16.

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

Objectives

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

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

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

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

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

This study, *Tracking Seasonal Movements of Adult Pacific Herring in Prince William Sound*, is a process study that addresses **objective 4** of the *PWS Herring Research and Monitoring**: develop new approaches to monitoring***. Our study will provide the ability to rapidly improve our understanding of herring populations in PWS. This effort will allow the design of the most accurate and efficient monitoring program.

Objectives specific to the *Seasonal Movements of Adult Herring* study include:

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

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

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

This project will use the preferred marking method for herring. The Herring Marking Workshop sponsored by EVOS in December 2008, reviewed all potential marking methods for herring and stated with regards to acoustic tagging:

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

C. Procedural and Scientific Methods

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

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

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

D. Data Analysis and Statistical Methods

Prior to analyses, we will assume a fish was detected only when there are at least two detections of a transmitter at an array during a 24h period. In order to test whether herring are detected more frequently based on size, month of capture, or location, we will calculate the detectability of each herring following a methodology similar to that outlined by Andrews et al. (2010). With this method, we will divide the number of days a herring was detected by the life span of the tag. We will then use detectability as the dependent variable in a linear mixed model.

We will consider a herring as having departed from the Sound if it is detected at one of the arrays at the PWS entrances or passages. Similarly, if that fish is later detected at one of these arrays, it will be considered having returned to PWS. Detections occurring at Zaikof Bay and detections either from the mobile receiver or at the arrays in Port Gravina will be examined to determine the amount of time spent in an area.

E. Description of Study Area

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

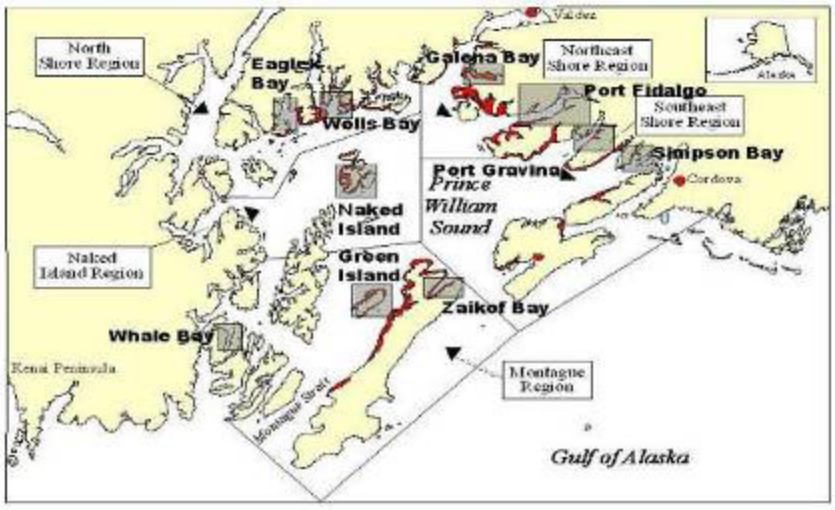

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

F. Coordination and Collaboration

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System.

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

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

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

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

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered

potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydroacoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

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

Dr. Mary Anne Bishop (PWSSC) will oversee the seasonal movements study and will coordinate with other studies that are part of the *PWS Herring Research & Monitoring* program as well as our collaborators. She will have primary responsibility for field work (fish tagging) data integration, and completion of final products for *PWS Herring Research & Monitoring* synthesis. Along with Co-Principal Investigator Dr. Sean Powers she will be responsible for project design, statistical analyses and data interpretation and preparation of a manuscript and contributing to the *PWS Herring Research & Monitoring* synthesis.

This project will rely on obtaining data from the existing POST Port Gravina acoustic array as well as arrays maintained by PWSSC near Gravina Rocks and at Zaikof Bay. In addition, data will be obtained from the POST/OTN arrays proposed to be installed at major entrances to Prince William Sound in fall 2011.

We will also be collaborating with Alaska Department of Fish and Game for our tagging efforts, that are scheduled to coincide with their fall herring bait surveys. Mr. John Eiler from NOAA Auke Bay Lab will also provide technical advice for our initial tagging efforts. And, Dr. Andy Seitz has indicated that he is interested in deploying an Automated Underwater Vehicle during our spring monitoring efforts.

III. SCHEDULE

A. Milestones

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

(3) Utilize the PWS acoustic arrays to monitor herring migration into and out of PWS. ***Completed July 2014.***

(2) Elucidate herring movement patterns between overwinter and spawning sites. ***Completed September 2014.***

B. Measurable Project Tasks

FY 12, 1st quarter (October 1, 2011-December 31, 2011)

- Oct Secure Trustee Council funding approval;
- Oct Purchase acoustic tags
- Nov Tag and monitor adult herring at Port Gravina/Port Fidalgo herring in conjunction with ADFG bait surveys

FY 12, 2nd quarter (January 1, 2012-March 31, 2012)

- Jan Alaska Marine Symposium
- Feb Upload data and change batteries on VR2W receivers in Port Gravina arrays
- Mar Monitor for tagged fish around spawning aggregations at Port Gravina & Port Fidalgo

FY 12, 3rd quarter (April 1, 2012-June 30, 2012)

- Apr Monitor for tagged fish around spawning aggregations at Port Gravina & Port Fidalgo
- May PI Meeting
- Jun Upload data from Port Gravina arrays
- Jun Submit FY 13 work plan for review

FY 12, 4th quarter (July 1, 2012-September 30, 2012)

- Jul–Sep Analyze data uploaded from POST arrays and PWSSC receivers
- Aug Submit Annual Report
- Sep Purchase acoustic tags

FY 13, 1st quarter (October 1, 2012-December 31, 2012)

- Nov Tag adult herring in cooperation with ADFG bait surveys in Prince William Sound

FY 13, 2nd quarter (January 1, 2013-March 31, 2013)

- Jan Alaska Marine Symposium
- Mar Monitor for tagged fish around spawning aggregations at Port Gravina & Port Fidalgo

FY 13, 3rd quarter (April 1, 2013-June 30, 2013)

- Apr Monitor for tagged fish around spawning aggregations at Port Gravina & Port Fidalgo; upload data and change batteries on VR2W receivers in arrays
- May PI Meeting
- Jun Prepare and submit work plan for FY14

FY 13, 4th quarter (July 1, 2013-September 30, 2013)

- Jul - Sep 30 Analyze data uploaded from POST arrays and PWSSC receivers
- Aug Submit Annual Report

FY 14, 1st quarter (October 1, 2013-December 31, 2013)

Oct-Dec analyze data

FY 14, 2nd quarter (January 1, 2014-March 31, 2014)

Jan Alaska Marine Symposium & PI meeting

Sep Submit final report

Winter EVOS sponsored workshop with Herring and Long-term monitoring programs

FY 14, 3rd quarter (April 1, 2014-June 30, 2014)

Apr-Jun Process & analyze data

May Annual PI meeting

FY 14, 4th quarter (July 1, 2014-September 30, 2014)

September Submit Final Report

IV. Literature Cited

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Seitz AC, BL Norcoss, JC Payne, AN Kagley, B Meloy, JL Gregg, and PK Hershberger. 2010. Feasibility of surgically implanting acoustic tags into Pacific herring. Trans Am Fish Soc 139: 1288–1291.

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

PRINCE WILLIAM SOUND SCIENCE CENTER &
UNIVERSITY OF SOUTH ALABAMA DAUPHIN ISLAND SEA LAB

PWSSC Personnel Salaries & Fringe Benefits
Yr 1 = $7.3, Yr 2 = $8.9, Yr 3 = $11.3
Co-Principal (Lead) Investigator Bishop Yr 1 = 0.2 mo @ $11.0/mo; Yr 2 = 0.2 mo @ 11.3/mo; Yr 3 = 1.0 mo @ $11.3/mo (includes vessel time yrs 1 & 2)
For this project Bishop will oversee the project and coordinate with other studies that are part of the *PWS Herring Research & Monitoring* program. She will have primary responsibility for field work (fish tagging) data integration, and completion of final products for *PWS Herring Research & Monitoring* synthesis. She will supervise the research assistant. Along with Powers she will be responsible for project design, statistical analyses and data interpretation and preparation of a manuscript and contributing to the *PWS Herring Research & Monitoring* synthesis.
Research Assistant Reynolds: Yr 1 = 0.8 mo @ $6.4/mo; Yr 2 = 1.0mo @ 6.6/mo (includes vessel time Yrs 1 & 2). Reynolds will conduct fish tagging operations, fish monitoring in spring, and data retrieval from acoustic receivers, and will process acoustic tag data.

PWSSC Travel
Yr 1 = $5.1, Yr 2 = $4.2, Yr 3 = $0
Yr 1: J. Eiler, NOAA Juneau, Juneau-Cordova, 1 rt. Ticket price $0.4 ea; per diem $0.18/d for 3d. To assist with Nov 2011 tagging effort.
Yrs 1 & 2: Univ. South Alabama personnel, Mobile –Cordova, 2 rt/year (fall, spring) to assist with field work (Nov & Mar). (airfare $1.1 ea; subsistence while on boat 7d =$0.3 Yr 1; 10 d subsistence =$0.4 Yr 2; per diem while in Cordova $0.18/d for 8d/yr. .

PWSSC Contractual
Yr 1 = $0.4, Yr 2 = $0.3, Yr 3 = $1.0
Yrs 1-3 Computer network & software subscriptions, direct cost based on $0.15/mo x staff mo
Yrs 1-3 Communications (Phone & Fax) direct cost based on $0.05/mo x staff mo
Yrs 1-3 Printing & copying direct cost based on $0.025/mo x staff mo
Yr 1 Mail/freight Charges; ship tags & batteries direct cost based on use only estimated at $0.1
Yr 3 Page charges for manuscript publication in scientific journal, estimated at $0.8.

PWSSC Commodities
Yr 1 = $37.1, Yr 2 = $0.5, Yr 3 = $0
Yr 1: Vemco Acoustic Tags (100@ $0.35/ea); Tagging Supplies $0.9; Acoustic Receiver Lithium Batteries (30 @ $0.03/ea); Boat groceries, spring monitoring $0.3.
Yr 2 Tagging Supplies $0.2, Boat groceries, spring monitoring $0.3.

PWSSC Equipment No equipment purchases are anticipated

PWSSC will be utilizing PWSSC acoustic array at Port Gravina (consisting of VR2 and VR2W receivers) & the Port Gravina Pacific Ocean Shelf Tracking Project's array (consisting of VR2 and VR3 receivers). PWSSC will also be using its Vemco portable tracking system and Vemco acoustic modem. .

PWSSC INDIRECT COSTS

Yrs 1-3 MTID is estimated at 30%, pending negotiations & and approval by NOAA.

Note: all vessel charter costs for years 1-2 are included under proposal by W.S. Pegau, *PWS Herring Research & Monitoring*