FY12 INVITATION

PROPOSAL SUMMARY PAGE

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

Project Period: October 1, 2011 – September 30, 2016

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

Study Location: Prince William Sound

Abstract: Acoustic surveys provide a relatively low-cost, remote sensing tool to estimate species-specific fish biomass and abundance. Interpreting acoustic data requires accurate ground truthing. In Prince William Sound, juvenile herring acoustic surveys have been conducted at the beginning (November) and end (March) of every winter since March 2007. Until now, a variety of methods have been used with limited success to ground truth these surveys.

Pelagic trawls are the recommended method for validating species composition and for obtaining relatively unbiased information on length frequency distribution, age, and other biological information. Here we propose to use a low-resistance, light-weight midwater trawl capable of increased towing speeds (up to 4 knots) as a method to ground truth acoustic surveys for juvenile and adult herring. Our pelagic trawl surveys will take place in conjunction with and onboard the same vessel as three studies in the *PWS Herring Research and Monitoring* program: a) *Juvenile Herring Abundance Index* (years 2-5); b) *Acoustic Consistency: Intensive Surveys of Juvenile Herring* (year 3); and, c) *Expanded Adult Herring Surveys* (years 2-5). In year 1 we will also use the trawl to collect juvenile herring during the 9-month intensive *Study to Validate the Separate Herring Condition Monitoring Programs*. Our project will provide data on species composition and length frequency to aid in the interpretation of current and historical acoustic surveys. In addition it will provide adult herring samples to Alaska Department of Fish and Game for the adult herring age-structure-analyses model and will provide juvenile herring samples to researchers investigating juvenile herring fitness and disease. Our trawls will also provide fishery-independent surveys for non-herring species, thus increasing our knowledge of pelagic fishes in Prince William Sound.

Estimated Budget:

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

FY 12	FY 13	FY 14	FY 15	FY 16
$68,000	$90,600	$148,000	$141,000	$145,300

Non-EVOSTC Funds to be used:

Date: May 25, 2011

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

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

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

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

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

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

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

II. PROJECT DESIGN

A. Background:

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

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

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

decreased energy content is further exacerbated by endemic diseases, which add additional bioenergetic demands. For example, *Ichthyophonus*-infected herring demonstrate a 30% reduction in total energy content compared to uninfected cohorts (Vollenweider et al. In press).

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

B. Goal and Objectives

Goal: <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, *Validation of Acoustic Surveys for Pacific Herring Using Direct Capture*, is a process study that addresses **objective 3** of the *PWS Herring Research and Monitoring**: to address assumptions in the current measurements***. Our study will provide the ability to rapidly improve our understanding of the herring population in PWS. This effort will allow the design of the most accurate and efficient monitoring program.

Objectives specific to the *Direct Capture* study include:

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

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

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

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

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

In addition, to providing better information on acoustic targets. this study will bolster the current understanding of pelagic species composition and abundance in PWS.

C. Procedural and Scientific Methods

We recognize that a major deficit in the existing *PWS Herring Survey* program is the lack of an effective means of validating the hydroacoustic signal. Fortunately, if we can establish through direct capture of ensonified fish that certain patterns in echograms can be interpreted as different year classes of herring, then we may be able to reanalyze historical acoustic measurements to better understand changes in juvenile herring populations.

In Prince William Sound, juvenile herring acoustic surveys have been conducted at the beginning (November) and end (March) of every winter since March 2007. A variety of methods have

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

Pelagic trawls are the recommended method for validating species composition and for obtaining relatively unbiased information on length frequency distribution, age, and other biological information (Simmonds et al. 1992, McClatchie et al. 2000, Adams et al. 2006, NOAA 2009). In the proposed program we plan to use a low-resistance, light-weight mid-water trawl capable of increased towing speeds (3-4 knots) as a direct capture method for collecting the number of fish necessary to provide validation. These surveys will take place as part of three studies in the *PWS Herring Research and Monitoring*: These include: a) *Juvenile Herring Abundance Index* (years 2-5); b) *Acoustic Consistency: Intensive Surveys of Juvenile Herring* (year 3); and, c) *Expanded Adult Herring Surveys* (years 2-5). Principal Investigators for these three studies are Buckhorn and Thorne. In addition to ground truthing acoustic surveys, in year 1 we will use the trawl along with cast nets to collect juvenile herring during the 9-month intensive A *High-Temporal & Spatial Resolution Study to Validate the Separate Herring Condition Monitoring Programs* (Principal Investigators Kline and Heintz).

Table 1. Schedule of PWS herring cruises that require collections by this study. Except for year 1 herring condition collections, all cruises will share the same vessel platform as hydroacoustic component.

Year	High Res Herring Condition	Juvenile Herring Abundance Index	Expanded Adult Herring Surveys	Intensive Juvenile Herring Sureys
1 FY 2012	No acoustics; Oct-Jun collections			
2 FY 2013		Nov	Mar/Apr	
3 FY 2014		Nov	Mar/Apr	Oct-Dec; Feb-Apr
4 FY 2015		Nov	Mar/Apr	
5 FY 2016		Nov	Mar/Apr	

Field Collections and Laboratory Methods

In order to provide accurate data on ensonified fish, the trawl will be towed simultaneous with acoustic surveys for herring and from the same research vessel. Our trawl measures 12.8 m in total length and is 7.6 m wide by 9.1 m high under tow. The net is designed to be low-resistance and is constructed of high-tensile, lightweight materials (Innovative Net Systems, Milton LA), Mesh sizes (stretched) taper from 57 mm at the forward end to 38 mm at the cod end. The cod end liner is 12 mm mesh. The net will be fished with Jupiter Aluminum doors weighing 28 kg each. The trawl will be equipped with a Simrad PI50 Catch Monitoring System. This system

utilizes wireless, trawl-mounted sensors to transmit real-time data on both trawl depth and net fullness. Average trawling speeds will be 3 to 4 kts.

Validation of acoustic echograms relies on ground truthing species composition and length frequency distribution of ensonified fish (McClatchie et al. 2000). We will tow a subsample of each stratified survey area, as designated by the lead acoustician. For each haul, all catch items will be collected. In the case of large hauls, a random sub-sample of the catch will be collected and measured.

Species composition and length frequency will be characterized by identifying all fish to species and measuring individual fork length, standard length, and weight. Juvenile herring of age 0+ and 1+ can be reliably aged based on length (Norcross et al. 2000, Kline unpubl. data), however, herring >150 mm will be aged using scale conventions developed by Alaska Department of Fish and Game (ADF&G). Adult herring captured during expanded spring surveys will be measured, sexed, aged, and assessed for spawning condition. Adult herring samples will be processed in collaboration with the Cordova office of ADF&G so that data can be incorporated into the ADFG herring age-structure-analysis model. All herring scales will be archived with ADF&G.

D. Data Analysis and Statistical Methods

Acoustic-based estimates of fish abundance rely on unique target strengths obtained for each fish species according to fishes' behaviors, physiologies, anatomies and morphologies, in addition to physical characteristics of the surveyed environment (Hazen and Horne, 2003). In most cases, the target strength obtained from hydroacoustic surveys is best described by the equation:

$$TS = m \log L + b + \varepsilon$$

where TS is the target strength, m and b are species specific coefficients, ε is an error term and L is the mean fish length for the school (McClatchie et al., 1996, Stokesbury et al. 2000). Thus in order to validate acoustic signals, the aforementioned trawls will provide requisite species and length data necessary to obtain values of m, b and L. Trawl data will be compiled for such validation analysis by Dr. Buckhorn. See Buckhorn and Thorne proposal for details on echo integration and acoustic surveys.

In addition to facilitating the validation of acoustic survey data, the proposed trawls will provide valuable fishery independent data on non-herring species and size composition (length and weight) for multiple bays throughout Prince William Sound. For a subset of non-herring species, otoliths will be collected, providing additional age data. These data will improve upon a scarce body of knowledge of pelagic fishes and populations, providing novel baseline data.

E. Description of Study Area

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be

reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

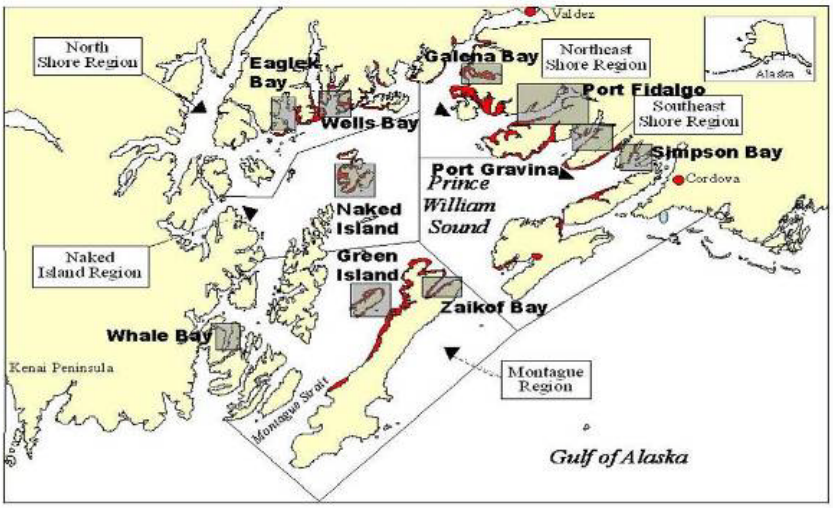

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

F. Coordination and Collaboration

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

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

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

Dr. Pegau currently is the coordinator of the existing EVOSTC funding PWS Herring Survey program. This program consists of ten individual projects that provide a coordinated examination of juvenile herring in Prince William Sound. This proposal is heavily influenced by the early findings from that effort. Dr. Pegau also serves as the Research Program Manager for

the Oil Spill Recovery Institute (OSRI). In that capacity he is responsible for developing annual work plans, ensuring proper reporting, making reports available, developing partnerships to leverage funding, and to ensure outreach of OSRI activities. All activities that provide experience delivering the team leader duties outline in the request for proposals.

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

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

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

Dr. Mary Anne Bishop (PWSSC) will lead the direct capture efforts needed for validation of hydroacoustic measurements and disease and condition studies. Bishop will oversee the project and coordinate with other studies that are part of the *PWS Herring Research & Monitoring* program. Specifically, the *Validation of Acoustic Surveys for Pacific Herring Using Direct*

Capture project will be providing samples for projects by Drs. Kline and Heintz (herring condition) Dr. Hershberger (herring disease), Moffitt (herring scales), and Drs. Buckhorn and Thorne (juvenile herring index and intensive surveys; expanded adult herring surveys). In addition, Bishop will have primary responsibility for field work (fish capture), data integration, and completion of final products for *PWS Herring Research & Monitoring* synthesis. She will supervise the research assistant. She will be responsible for project design, statistical analyses and data interpretation and preparation of a manuscript and contributing to the *PWS Herring Research & Monitoring* synthesis.

III. SCHEDULE

A. Milestones

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

2) Increase the sample size for identification, quantification, and measurement of juvenile (0+, 1+, 2+) and adult (3+ and older) herring schools as well as other fish schools in survey areas. *Completed April 2016.*

3) Provide data on species composition and length frequency to aid in the interpretation of current and historical acoustic surveys. *Sampling completed April 2016. Data synthesis completed August 2016.*

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

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

B. Measurable Project Tasks

FY 12, 1st quarter (October 1, 2011-December 31, 2011)
- Oct Secure Trustee Council funding approval & purchase trawl sensors
- Oct-Dec Monthly cruise: juvenile herring collections for *High-Resolution Condition Study*.

FY 12, 2nd quarter (January 1, 2012-March 31, 2012)
- Jan Alaska Marine Symposium
- Jan-Mar Monthly cruise: juvenile herring collections for *High-Resolution Condition Study*

FY 12, 3rd quarter (April 1, 2012-June 30, 2012)
- Apr-Jun Monthly cruise: juvenile herring collections for *High-Resolution Condition Study*
- May Annual PI meeting
- June Submit FY13 work plan for review

FY 12, 4th quarter (July 1, 2012-September 30, 2012)
- Jul - Sep 30 Analyze data
- Aug Submit Annual Report

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

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

FY 13, 2nd quarter (January 1, 2013-March 31, 2013)
Jan Alaska Marine Symposium
Jan-Mar Process fish samples
Mar Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

FY:13, 3rd quarter (April 1, 2013-June 30, 2013)
Apr Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys
Apr-Jun Process fish and analyze data
May Annual PI meeting
Jun Submit FY14 work plan for review

FY 13, 4th quarter (July 1, 2013-September 30, 2013)
Jul - Sep 30 Analyze data
Aug Submit Annual Report

FY 14, 1st quarter (October 1, 2013-December 31, 2013)
Oct-Dec Biweekly *Juvenile Herring Intensive Acoustic & Validation Surveys*
Nov Field cruise: *Juvenile herring abundance index* with hydroacoustic & validation surveys; disease & energetics collections
Dec Process fish samples

FY 14, 2nd quarter (January 1, 2014-March 31, 2014)
Jan Alaska Marine Symposium
Jan-Mar Process fish samples
Feb-Mar Biweekly *Juvenile Herring Intensive Acoustic & Validation Surveys*
Mar Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys
Winter EVOS sponsored workshop with Herring and Long-term monitoring programs

FY 14, 3rd quarter (April 1, 2014-June 30, 2014)
Apr Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys
Apr-Jun Process fish & analyze data
May Annual PI meeting
Jun Submit FY15 work plan for review

FY 14, 4th quarter (July 1, 2014-September 30, 2014)
Jul - Sep 30 Analyze data
Aug Submit Annual Report

FY 15, 1st quarter (October 1, 2014-December 31, 2014)
Nov Field cruise: *Juvenile herring abundance index* with hydroacoustic & validation surveys; disease & energetics collections
Dec Process fish samples

FY 15, 2nd quarter (January 1, 2015-March 31, 2015)
Jan Alaska Marine Symposium
Jan-Mar Process fish samples

Mar Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

FY 15, 3rd quarter (April 1, 2015-June 30, 2015)

Apr Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

Apr-Jun Process fish & analyze data

May Annual PI meeting

Jun Submit FY15 work plan for review

FY 15, 4th quarter (July 1, 2015-September 30, 2015)

Jul - Sep 30 Analyze data

Aug Submit Annual Report

FY 16, 1st quarter (October 1, 2015-December 31, 2015)

Nov *Juvenile herring abundance index* Juvenile herring field cruise: hydroacoustic & validation surveys; disease & energetics collections

Dec Process fish samples

FY 16, 2nd quarter (January 1, 2016-March 31, 2016)

Jan Alaska Marine Symposium

Jan-Mar Process fish samples

Mar Field cruise: *Expanded Adult Herring Survey* Adult herring survey with hydroacoustic & validation surveys

FY 16, 3rd quarter (April 1, 2016-June 30, 2016)

Apr Field cruise: *Expanded Adult Herring Survey* Adult herring survey with hydroacoustic & validation surveys

Apr-Jun Process fish & analyze data

May Annual PI meeting

June Submit work plan for FY17

FY 16, 4th quarter (July 1, 2016-September 30, 2016)

Jul - Sep 30 Analyze data

Sep 1 Submit Final Report on first 5 years of validation surveys

IV. REFERENCES

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PWS Herring Research and Monitoring:

Validation of Acoustic Surveys for Pacific Herring Using Direct Capture

PRINCE WILLIAM SOUND SCIENCE CENTER

PWSSC Personnel Salaries & Fringe Benefits

Yr 1 = $32.5, Yr 2 = $58.3, Yr 3 = $98.1, Yr 4 = $95.0, Yr 5 = $98.0

Research Assistant Watson Yr 1=1.5 mo @ $6.4, Yrs 2 = 6.0 mo @ $6.6, Yr 3 = 6.0 mo @ $6.8; Yr 4 = 5.0 mo @ $7.0, Yr 5 = 5.0 mo @$7.2. Watson will conduct fish capture operations for energetic intensive surveys (yr 1), expanded adult surveys (yrs 2-5), juvenile acoustic intensive surveys (yr 3). He will assist with data collection for other projects while on cruises (e.g. disease sampling). He will also process captured fish. maintain the database, conduct preliminary analyses, and assist with preparation of annual reports and work plans.

Research Assistant Hsu, Yr 1 = 1.0 mo @ $6.4. Hsu will assist with fish capture operations for the energetic intensive surveys.

Principal Investigator Bishop Yr 1 = 1.5 mo @ $11.0, Yr 2 = 1.7 mo @ $11.3, Yr 3 = 4.9 mo @ $11.7, Yr 4 = 5.0 mo @ $12.0, Yr 5 = 5.0 mo @ $12.4.

For this project Bishop will oversee the project and coordinate with other studies that are part of the *PWS Herring Research & Monitoring* program. She will have primary responsibility for field work (fish capture), data integration, and completion of final products for *PWS Herring Research & Monitoring* synthesis. She will supervise the research assistant. She will be responsible for project design, statistical analyses and data interpretation and preparation of a manuscript and contributing to the *PWS Herring Research & Monitoring* synthesis.

PWSSC Travel

Yrs 1 & 2 = $1.0/yr, Yr 3 = $2.0, Yrs 4 &.5 = $1.2/yr

Principal Investigator Bishop, Cordova-Anchorage: Ticket price $0.3 (Yrs 1-3) and $0.35 (Yrs 4-5). One 4d trip/yr @ $0.18/d per diem to attend Alaska Marine Symposium all 5 years; and Yr 3 one trip to Anchorage for a Principal Investigators Meeting.

PWSSC Contractual

Yr 1 = $0.9, Yr 2 = $1.8, Yr 3 = $2.6, Yrs 4 & 5 = $2.2/yr

Yrs 1-5 Computer network & software subscriptions, direct cost based on $0.15/mo x staff mo

Yrs 1-5 Communications (Phone & Fax) direct cost based on $0.05/mo x staff mo

Yrs 1-5 Printing & copying direct cost based on $0.025/mo x staff mo

PWSSC Commodities

Yr 1 = $5.4, Yr 2 = $2.8, Yr 3 = $1.8, Yr 4 -=$1.1, Yr 5 = $1.1

Supplies (Field, office, & lab) Includes fishing trawl gear set up including lines, fasteners, buoys, and replacement parts for the trawl and Simraud catch monitoring system, display monitor for catch monitoring system, gps, cast nets, jigs, scales, fish boards, fish sampling table, log books, knives, plastic bags, plastic buckets, personnel rain gear, rubber boots, gloves, field notebooks, office supplies, computer hardware, coolers, ice, whirl paks, formalin, gas for truck).

PWSSC Equipment

Yr 1 = $10.7, Yrs 2-5 = 0
In Year 1, this project will purchase a Simraud P150 Catch Monitoring system. The $10.7 covers a portion of the total cost, with the remainder covered by the Expanded Adult Survey Project (M. Buckhorn, Principal Investigator).

PWSSC INDIRECT COSTS
Yrs 1-5 MTID is estimated at 30%, pending negotiations & and approval by NOAA.

Note: all vessel charter costs for years 1-5 are included under proposal by W.S. Pegau, *PWS Herring Research & Monitoring*