FY12 INVITATION
PROPOSAL SUMMARY PAGE

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

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

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

Study Location: Prince William Sound, AK

Abstract: Management of the Pacific herring stock in Prince William Sound (PWS), Alaska, is based primarily on an age-structured-assessment (ASA) model. The current model, developed in 2005, incorporates both hydroacoustic estimates of the adult herring biomass and an index of the male spawning, called the "mile-days of spawn". Unfortunately, the forecast is based on measurements from the previous year and does not have a direct measure of future age 3 recruitment. Current knowledge suggests that most mortality occurs during the first winter of life, so the relative recruitment may be fixed by the end of the first year. Consequently, estimates of relative abundance of age 1 and age 2 fish should provide an index of future recruitment. An index of age 0 fish would also provide a forecast of recruitment if additional information were available on the magnitude of the first year mortality. We will conduct annual fall surveys (FY2013-2016) of 8 bays; four of which will be the Sound Ecosystem Assessment (SEA) bays (Cooney et al. 2001). This will maintain a continual database from these locations. The other 4 bays will be selected based upon the survey results of the current EVOSTC FY10 Herring Survey Project (# 10100132). Surveys will be conducted using 120 kHz split-beam hydroacoustic unit in a stratified systematic survey design (Adams et al. 2006). For this study, direct capture will be directed to size and species composition. A midwater trawl will be used to sample randomized transects within each strata.

Estimated Budget:
EVOSTC Funding Requested: 404.1
(breakdown by fiscal year and must include 9% GA)

FY 12	FY 13	FY 14	FY 15	FY 16
$90,100	$80,100	$66,100	$84,900	82,900

Non-EVOSTC Funds to be used: 0
(breakdown by fiscal year)

Date:

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PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

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

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

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

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

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

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

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

II. PROJECT DESIGN

A. Objectives

Program objectives:

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

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

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

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

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

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

This project will contribute to Program Objective #1: *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.*

Project Objectives:

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

B. Procedural and Scientific Methods

Objective 1: Conduct annual surveys of juvenile herring to create an index of future recruitment

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

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

Objective 2: Validate species and size composition of fish ensonified during acoustic transects (See Bishop proposal).

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

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

C. Data Analysis and Statistical Methods

There are well-developed protocols for hydroacoustic data analysis. Basic analysis is done using echo integration techniques (Thorne 1983a,b; McLennon and Simmonds 1992). We will be using to ECHOVIEW post processing software for the echo integration and analysis. Specific analysis of schools or layers requires a bounding process to limit analysis to a specific school or layer (Fig 8). Target strength characteristics of herring as well as several other common fishes are well documented (Thorne 1983b; Traynor 1998; Thomas et al. 2002). The acoustic analysis determines the biomass density of the fish. The biomass estimates use scaling factors that are size and species specific, but are relatively insensitive to these variables (Thorne 1983b). These densities are extrapolated to the appropriate area based on the GPS information that is automatically written to the acoustic data files. Conversion of biomass to numerical values is more sensitive to species/size

information. For adults and age 0 herring this information is typically available. Some assumptions are required for other species and these assumptions are dependent on the direct capture information.

D. Description of Study Area

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

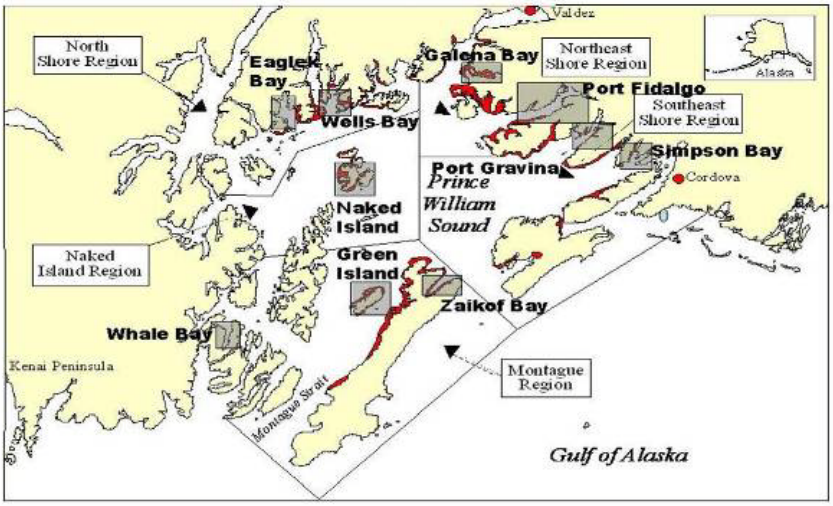

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

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

III. SCHEDULE

A. Project Milestones

Objective 1: Conduct annual surveys of juvenile herring to create an index of future recruitment. *Will be conducted every November FY2013-2016.*

Objective 2: Validate species and size composition of fish ensonified during acoustic transects (See Bishop proposal). *Will be conducted every November FY2013-2016.*

B. Measurable Project Tasks

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

FY12 2nd Quarter
January Annual Marine Science Symposium
March Complete ordering equipment

FY12 3rd Quarter
May Conduct annual PI meeting
June Submit FY13 work plan for review

FY12 4th Quarter
August Submit annual report

FY13 1st Quarter (October 1, 12 to December 31, 12)
November Conduct juvenile index survey

FY13 2nd Quarter
January Annual Marine Science Symposium

FY13 3rd Quarter
May Conduct annual PI meeting

FY13 4th Quarter
August Submit annual report

FY14 1st Quarter (October 1, 13 to December 31, 13)
November Conduct juvenile index survey, test non-lethal sampling systems

FY14 2nd Quarter
January Annual Marine Science Symposium
Winter EVOS sponsored workshop with Herring and Long-term monitoring programs

FY14 3rd Quarter
May Conduct annual PI meeting
June Submit FY15 work plan for review

FY14 4th Quarter
August Submit annual report

FY15 1st Quarter (October 1, 14 to December 31, 14)
November Conduct juvenile index survey

FY15 2nd Quarter
January Annual Marine Science Symposium

FY15 3rd Quarter

May	Conduct annual PI meeting
May	Submit five-year plan for FY17-22 and work plan for FY16

FY15 4th Quarter

August	Submit annual report

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

November	Conduct juvenile index survey

FY16 2nd Quarter

January	Annual Marine Science Symposium

FY16 3rd Quarter

May	Conduct annual PI meeting
June	Submit work plan for FY17

FY16 4th Quarter

August	Submit annual report

Literature Cited.

Adams, J. V., R. L. Argyle, G. W. Fleischer, G. L. Curtis, and R. G. Stickel. 2006. Improving the design of acoustic and midwater trawl surveys through stratification, with an application to lake Michigan prey fishes. North American Journal of Fisheries Management **26**:612-621.

Cooney, R. T., J. R. Allen, M. A. Bishop, D. L. Eslinger, T. Kline, B. L. Norcross, C. P. McRoy, J. Milton, J. Olsen, V. Patrick, A. J. Paul, D. Salmon, D. Scheel, G. L. Thomas, S. L. Vaughan, and T. M. Willette. 2001. Ecosystem control of pink salmon (Oncorhynchus gorbuscha) and Pacific herring (Clupea pallasi) populations in Prince William Sound, Alaska. Fisheries Oceanography **10**:1-13.

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

Simmonds, E. J., N. J. Williamson, F. Gerlotto, and A. Aglen. 1992. Acoustic Survey design and analysis procedure: a comprehensive review of current practice., ICES, Copenhagen, Denmark.

Thorne, R. E., R. J. Trumble, N. A. Lemberg, and D. Blankenbeckler. 1983. Hydroacoustic assessment and management of herring fisheries in Washington and southeastern Alaska. FAO, Rome Italy.

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Personnel
Two months' salary is requested in year one and three months in subsequent years for Dr. Buckhorn to act as lead Principle Investigator. Dr. Buckhorn will oversee the project and coordinate with the other projects in this program. She will have primary responsibility for project design, field work, data collection, analysis and completion of final products. She will supervise the acoustics technician.
Beginning in FY13, three months' salary is requested in year two, 2 months in year three, three months in year four and five for James Thorne, the acoustics technician. He will assist with data collection and is responsible for maintenance of acoustic equipment. One-third month salary is requested in each year for Dr. Thorne. He will provide technical consulting and support.

Travel
Beginning in FY13 travel is requested each year for Dr. Thorne to travel from Seattle to Cordova and for the attendance at AMSS.

Contractual
Each year funds are requested for Information Technology, which includes $100/person month for network connections and costs associated with software license renewals or purchases. Funds are requested each year for printing/mailing/copying. The request is based on historic and anticipated usage. Funds are also requested each year for communications, which includes $50/person month for phone, plus additional funds for long distance and fax costs.

Commodities
In each year funds are requested for office supplies (paper, pens, printers, etc.) that are typically consumed in association with the project. Additional funds are requested for miscellaneous cruise supplies (lines, nets, totes, etc.).

Equipment
Funds are requested in year one to purchase a 120 kHz split-beam hydroacoustic unit. The Science Center currently has 70 khz single beam transducers. This is an opportunity to upgrade this equipment to a higher frequency split-beam which more accurately measures target strength, especially for smaller size fish species.

INDIRECT COSTS
The PWSSC indirect rate is estimated at 30% based on our currently negotiated rate.