FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: PWS Herring Research and Monitoring -

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

Primary Investigator(s): Sharon Wildes
Co-operating Investigator: Jeff Guyon

Study Location: Prince William Sound

Abstract: This project is a component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services submitted by McCammon et. al. The purpose of this proposal is to determine the genetic stock structure of Pacific herring in Prince William Sound using available microsatellite markers. Samples will be collected and their genetic characteristics compared between locations, spawning times and years. In addition, year classes within spawning stocks will also be analyzed for genetic differences. Herring will be collected from two geographical disparate locations within Prince William Sound, one from the east and one from the west. Each location will be extensively sampled such that at least 200 samples from each group (for a specific location, year, spawn time, and age class) will be available for analysis. As a control, a small group of 200 Pacific herring will also be collected from Lynn Canal. Lynn Canal herring are (1) easily accessible from Auke Bay Laboratories, (2) of high priority to the National Marine Fisheries Service and the Alaska Department of Fish and Game, and (3) have been part of our herring program for the last 2 years. DNA will be isolated from each collection of 200 herring and the samples genotyped using a group of microsatellite markers, many of which have already been standardized in our laboratory for Pacific herring (Wildes et al., accepted Fish Bull). To date, over 40 herring microsatellite markers have been described and each loci contains multiple alleles making them ideal genetic markers for analyzing migratory fish like herring with limited stock structure. Resulting genotypes will be compared to determine the genetic uniqueness of each collection using standard analyses (F_{ST} and G-test). Principle component analyses will be performed to illustrate stock separations. Chord distances will be calculated and a phlyogenetic tree constructed to illustrate genetic relationships. Finally, genetic results will be summarized to communicate their biological significance, as well as their significance to management and restoration.

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

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

Date: May 18, 2011

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Identify the problem the project is designed to address. Describe the background and history of the problem. Include a scientific literature review that covers the most significant previous work history related to the project.

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

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

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

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

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated

Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS from the effects of EVOS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

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

II. PROJECT DESIGN

A. Objectives

List the objectives of the proposed research, the hypotheses being tested during the project, and briefly state why the intended research is important.

The Herring Monitoring Program goal is to improve predictive models of herring stocks through observations and research. To meet this goal we have arrived at the following objectives for the first five-year period.

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

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

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

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

The goals of this study support program goal #4 - developing new approaches to monitoring, by identifying stocks and examining year class structure-both essential to a strong monitoring program.

B. Procedural and Scientific Methods

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

Table 1

Location	Area	Year	Collected from Late Spawn	Number* Analyzed
Montague Island	Western PWS	2011	500	300
		2012	500	300
St. Matthews Bay	Eastern PWS	2011	500	300
		2012	500	300
Yakutat (1 year class)	Central Alaska	2011	500	150
		2112	500	150
Total			**3000**	**1500**

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

Age class will be approximated from size information and DNA will be isolated from two age classes (150 each) from each collection of 500 at the time of collection. Scale reading later will determine the age classes. Samples will be genotyped using 15 microsatellite markers, all of which have already been standardized in our laboratory for Pacific herring (Wildes et al., accepted, Fish Bull).

C. Data Analysis and Statistical Methods

Resulting genotypes will be analyzed using standard genetic analyses in MICROCHECKER, GENEPOP, and FSTAT. Using PHYLIP, genetic distance among collections will be calculated and a neighbor-joining tree constructed to illustrate genetic relationships. The degree of genetic diversity will be examined with F_{ST} , G-test, and AMOVA among the following collections: (1) inside/outside PWS, (2) between collections within PWS, (3) among year classes within a spawning cohort and (4) among years of collections. Finally, genetic results will be summarized to communicate their biological significance, as well as their significance to management and restoration.

D. Description of Study Area

Where will the project be undertaken? Describe the study area, including if applicable decimally-coded latitude and longitude readings of sampling locations or the bounding coordinates of the sampling region (e.g., 60.8233, -147.1029, 60.4739, -147.7309 for the north, east, south and west bounding coordinates). The formula for converting from degree minute seconds to decimal degrees is: degrees + (minutes/60) + (seconds/3600) so 121°8'6" = 121. + (8/60) + (6/3600) = 121.135

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

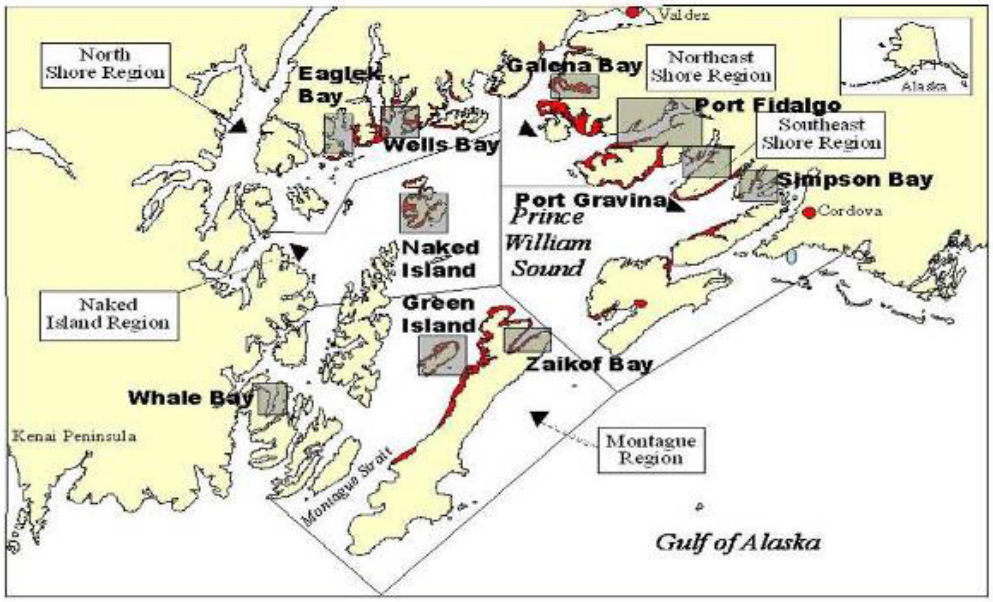

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

Indicate how your proposed project relates to, complements or includes collaborative efforts with other proposed or existing projects funded by the Trustee Council. Describe any coordination that has taken or will take place (with other Council funded projects, ongoing agency operations, activities funded by other marine research entities, etc.) and what form the coordination will take (shared field sites, research platforms, sample collection, data management, equipment purchases, etc.). If the proposed project requires or includes collaboration with other agencies, organizations or scientists to accomplish the work, such arrangements should be fully explained and the names of agency or organization representatives involved in the project should be provided. If your proposal is in conflict with another project, note this and explain why.

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

III. SCHEDULE

A. Project Milestones

March/April 2013 – First sample collection
Sep 30, 2013 – Complete genotyping first samples
March/April 2014 – Second sample collection
Sep 30, 2014 – Complete genotyping of second set of samples, begin data analysis
Oct 2015 – Issue Final report

B. Measurable Project Tasks

FY13
3rd Q- April- Collect herring samples

FY13
4th Q- Genotype 2013 collections and analyze data

FY14
3rd Q- April- Collect second set of herring samples

FY14
4th Q- Genotype 2014 collections and analyze data

FY15
4th Q- complete genetics project and report

IV. BUDGET - Genetic Stock Structure of Herring in Prince William Sound

	FY11	FY12	Total
100 Personnel	$17,662	$17,662	$35,325
200 Travel	$2,415	$3,785	$6,200
300 Supplies	$26,000	$27,500	$55,000
Total Direct Costs	$46,078	$48,948	$94,915
General Administration	$	$	$
Total All Costs	$	$	$

Budget justification by Line Item:

Line 100 Personnel. *Technician support totaling $35,325 to support a soft-funded Term appointment.* No support is requested for Full-Time Permanent personnel (Guyon, Wildes). 2.5 months in 2011, and 2.5 in 2012 is requested for technician support to conduct the bulk of the analyses and to supplement the needs for DNA isolation and genotyping. Wildes will lead the genotyping directly, but will need some aid. Costs are for one molecular biological technician at Auke Bay Laboratories for a total of 5 months at $7,065/month. This includes salary, COLA, and benefits.

Line 200 Travel. *Travel will includes trips for presenting results at the Alaska Marine Science Symposium, participating in annual herring meetings and field trips for sample collection.* - Results will be presented by Guyon and Wildes at the 2014 and 2015 Alaska Marine Science Symposia and published in the scientific literature. Results will also be presented by Wildes at the annual herring meetings in Cordova in 2014 and 2015. Finally Wildes and the technician will travel to Yakutat in 2015 to collect samples.

YR 1
Airfare to Anchorage $400 x 2 = $800
Per Diem in Anchorage $165 x 8 = $1320

Airfare to Cordova $400 x 1 = $400
Per Diem in Cordova $185 x 3 = $555

YR 2
Airfare to Anchorage $400 x 2 = $800
Per Diem in Anchorage $165 x 8 = $1320

Airfare to Cordova $400 x 1 = $400
Per Diem in Cordova $185 x 3 = $555

Airfare to Yakutat $480 x 2 = $960
Per Diem in Yakutat $185 x 8 = $1480

Line 300 Supplies. *Total supplies for sampling supplies ($1,000) and population analysis of PWS herring ($50,000) totaling $51,000.*

Sampling Supplies (Years 1-2) – Supplies are required for collecting genetic samples. Estimated at $500/year or $1,000 total.

Population Analysis (Years 1-2) – to determine population structure in PWS. 1,800 fish will be genotyped at 15 microsatellite markers at $29.17/fish (total of 1,800 x $29.17 = $52,500).

Cost Sharing

Salary support is being provided for both Jeff Guyon and Sharon Wildes in the completion of this project. These costs are estimated as follows:

Person	*Year 1*	*Year 2*	*Year 3*	*Total Costs*
Jeff Guyon, Fish Geneticist				
(2 months at $8,886/month)	$17,772	$17,772	$17,772	$53,316
Sharon Wildes, Fish Geneticist				
(4 months at $8,628/month)	$35,512	$35,512	$35,512	$106,536
Total	$53,284	$53,284	$53,284	$159,852

LITERATURE CITED

Wildes, S. L., J. Vollenweider, H. Nguyen, and J. R. Guyon. 2011. Microsatellite variation distinguishes outer-coastal and fjord populations of Pacific herring (*Clupea pallasii*) in the eastern Gulf of Alaska. Accepted Fish Bull. May 2011.

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