FY12 INVITATION
PROPOSAL SUMMARY PAGE

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

Project Period: October 2014-September 2015

Primary Investigator(s): Kevin M. Boswell; Louisiana State University, Baton Rouge, LA, 70803

Study Location: Prince William Sound

Abstract: A common source of bias in acoustic surveys is proper partitioning of size classes and their respective contribution to biomass estimates (see Simmonds and MacLennan 2005). This is particularly evident when considering the probability of encountering multiple size classes (or age classes) within a given survey region, or even within a large school. Several approaches have been successful in estimating *in situ* size distributions, though many require appropriate light fields to determine target sizes (Foote and Traynor 1988; Gauthier and Rose 2001; Kloser and Horne 2003). Recent application of imaging sonars have proven useful for acquiring high-resolution measurements of target-length distribution, without the need for ambient or external light sources, thereby reducing the potential of behaviorally mediated bias in length estimation. Further, automated analysis software has been refined to rapidly provide length estimates and target tracking parameters, even for tightly schooling fishes.

Estimated Budget:
EVOSTC Funding Requested:
(breakdown by fiscal year and must include 9% GA)
$94,900
Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date:
5/23/2011

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PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

A common source of bias in acoustic surveys is proper partitioning of size classes and their respective contribution to biomass estimates (see Simmonds and MacLennan 2005). This is particularly evident when considering the probability of encountering multiple size classes (or age classes) within a given survey region, or even within a large school. Several approaches have been successful in estimating *in situ* size distributions, though many require appropriate light fields to determine target sizes (Foote and Traynor 1988; Gauthier and Rose 2001; Kloser and Horne 2003). Recent application of imaging sonars have proven useful for acquiring high-resolution measurements of target-length distribution, without the need for ambient or external light sources, thereby reducing the potential of behaviorally mediated bias in length estimation. Further, automated analysis software has been refined to rapidly provide length estimates and target tracking parameters, even for tightly schooling fishes.

Recent work by Boswell and others in Southeast Alaska (Lynn Canal) has resulted in the development and successful integration of an imaging sonar and fishery echosounder system to directly compare estimates of biomass derived from traditional echo integration techniques. These traditional measures have been adopted and continue to be used as the baseline for estimating fish biomass, though have no real capacity for determining fish length distributions and their contribution to estimated biomass of PWS herring, as is the need for this research effort. A compelling result from the work conducted in Lynn Canal (Boswell et al., unpub.) was the large variability in estimated biomass from the traditional echo integration techniques as compared to the more direct approach with the imaging sonar. Interestingly, M. Jech (NOAA NEFSC) independently observed the same result with respect to variability in biomass estimates from echo integration and imaging sonar observations from Atlantic herring. Thus in addition to achieving in situ size estimates from the imaging sonar, the simultaneous integration of both sonar systems may enhance resolution of herring biomass estimates as well.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

By applying non-lethal approaches with under water remote sensing technologies, we are adhering to the principles set forth in the 1994 Restoration Plan. This project will evaluate the potential to apply advanced technologies to estimate the abundance and length distributions of herring in concert with direct collection methods.

II. PROJECT DESIGN

A. Objectives

Objective 1- Apply non-invasive techniques to estimate the *in situ* distribution (size, abundance, behavior, orientation) of herring.

Objective 2- Directly compare the abundance, size, and density estimates of herring derived from direct capture methods, fisheries echosounder data and *in situ* measurements.

Objective 3- Use data from in situ methods to evaluate biases with direct collection methods and estimates of abundance derived from traditional fisheries echosounder data.

Given that the condition of the herring population is of great concern the ability to estimate the in situ abundance, density and length distributions of herring is paramount. Moreover, by developing a method to acquire these metrics in a non-invasive manner, we will be better able to interpret the fisheries acoustic data collected and move beyond relying on intensive direct capture techniques.

B. Procedural and Scientific Methods

A multibeam imaging sonar and an ROV will be used to derive in situ estimates of herring size, abundance, behavior, and orientation to compare with direct capture methods and traditional fisheries echosounder data. We propose to augment surveys using traditional fisheries echosounder equipment (e.g., Simrad Ek60 Split-beam 38 and 120 kHz), with a vane or ROV deployment approach (see Figure 1) to opportunistically acquire both in situ length and density estimates, while simultaneously validating species composition (ROV). The imaging sonar (DIDSON or ARIS; www.soundmetrics.com) has a down-range resolution of <1cm, depending on range, offering the ability to discriminate among size classes in real time and will serve to quantify differences in length-frequencies among seasons and bay systems. This high-resolution sonar can be mounted onto a vane and deployed at depth or integrated into a towable-ROV designed by Boswell and Seamor Marine with 1200ft fiber optic tether, capable of towing at depth up to 5kts (Figure 1). Depending on vessel capabilities, size and power options, either the vane deployment method or ROV can be utilized. As illustrated in Figure 1, a transducer can be attached to the vane to allow for in situ measures of target strength to compliment echo integration techniques and density estimation; this is not unlike the work previously conducted by Thomas and Thorne in concept. However, in contrast to their work, we would integrate the more contemporary technology by making use of the position and compensation methods offered with split-beam transducers. Ultimately, this would provide an in situ estimate of fish length (via imaging sonar) and target strength (via echosounder) to derive two independent indices of herring size and abundance, while also acquiring information about in situ behavior which can greatly influence acoustic estimates of fish biomass from traditional echo integration techniques.

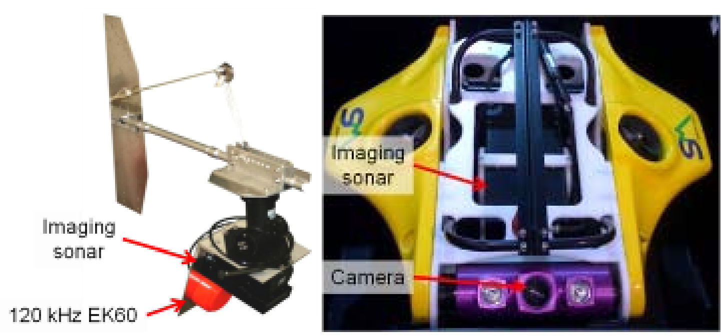

Figure 1. Deployment options for acquiring in situ estimates of fish length distribution. Left- Remotely controlled vane, comprising of two sonar systems, an imaging sonar (black) and traditional fisheries echosounder (orange) to be deployed at depth into herring schools for *in situ*

size and density estimation. Right- ROV with fully articulating camera and imaging sonar, configured to share the same view, both can look forward and completely pan to -90 degrees, simultaneously viewing the same mass of water. The ROV was developed by Boswell and Seamor Marine specifically to integrate the imaging sonar into a towable body to track herring schools at depth in Lynn Canal.

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C. Data Analysis and Statistical Methods

Acoustic data will be processed in both Echoview and Matlab (Boswell et al. 2008; Handegard and Williams 2008), for which algorithms have previously been developed for target identification, tracking, enumeration, and biomass estimation. Length frequency distributions derived from the sonar systems will be compared from direct collection methods (e.g., seines, gill nets, trawls) and offer insight into potential biases among different gear types used to target herring. Additionally, estimates of density and abundance derived form in situ methods will be compared with those derived by both direct capture and fisheries echosounder techniques. Specifically, the metrics derived from the imaging sonar (length, abundance, density) will be compared with the echointegrated estimate of density and abundance indices derived from the fisheries echosounder and direct capture methods, respectively. In addition, length-frequency estimates will be derived from all techniques and the distributions will be compared to identify potential sampling biases among gear types. Finally, these distributions will be available for use as a complimentary tool to enhance current modeling and assessment methods implemented by the ADFG for estimating spawning biomass, juvenile survivorship, and potentially even emigration from coastal bays.

The primary product will be to ground-truth juvenile herring length distributions in the core bays sampled in the monitoring program using a high-resolution imaging sonar. Thus, *in situ* target-length (imaging sonar) and target strength (echo-sounder) distributions will be derived. We will estimate proportional biomass contributions of herring size classes based on *in situ* length and abundance distributions. Additionally, we will evaluate size-based bias in collection methods (e.g., gill nets, trawls, seines, etc.) and extending those biases within the context of population level biomass estimates. An important, yet indirect product will be the estimation of herring sizes targeted by humpback whales during cruises with J. Moran (similar to previous work in Lynn Canal).

Following each survey, data will be assimilated and processed to derive aforementioned metrics and facilitate comparisons among gear types. Results and analyses will be provided to PWSSC researchers for integration into analysis and modeling components and to meet reporting requirements.

D. Description of Study Area

As this is a complimentary component to other proposed projects (listed below), the time frame for this proposed work will be dependent upon the finalized sampling program schedule developed throughout the first few fiscal years.

Juvenile Herring Abundance Index

Expanded Adult Herring Surveys

Acoustic Consistency: Intensive Surveys of Juvenile Herring
Use of concurrent trawls to validate acoustic surveys for Pacific Herring

E. Coordination and Collaboration with Other Efforts

This component will collaboratively and opportunistically compliment work of other investigators (e.g., MA Bishop, R Thorne, M. Buckhorn, J. Moran) involved by providing estimates of juvenile herring size distributions for which several other projects are dependent, and by making more efficient use of ship time and adding new observations at various spatial and temporal resolutions (e.g. seasonal estimates of herring size, behavior in response to predation, variability among different bays). Further, we will be able to address other relevant process-related questions using this approach (e.g., predation or mortality rates imposed by humpback whales).

III. SCHEDULE

A. Project Milestones

Objective 1. Apply non-invasive techniques to estimate the *in situ* distribution (size, abundance, behavior, orientation) of herring.
Data collection and analysis will be completed by January 2015

Objective 2- Directly compare the abundance, size, and density estimates of herring derived from direct capture methods, fisheries echosounder data and *in situ* measurements.
Statistical analyses completed by March 2015

Objective 3- Use data from *in situ* methods to evaluate biases with direct collection methods and estimates of abundance derived from traditional fisheries echosounder data.
To be completed by June 2015

B. Measurable Project Tasks

FFY 14, 1st quarter (October 1, 2014-December 31, 2014)
November 15: *Final collection and begin analysis for Objective 1*

FFY 14, 2nd quarter (January 1, 2015-March 31, 2015)
January 18: *Annual Marine Science Symposium*
March 31: *Completion of analyses of Objective 2*

FFY 14, 3rd quarter (April 1, 2015-June 30, 2015)
June 30: *Complete analyses for Objective 3*

FFY 14, 4rd quarter (July 1, 2015-September 30, 2015)
August 1 *Submit final report. This will consist of a draft manuscript for publication to the Trustee Council Office.*

Budget Justification- FY14

Salaries and Wages: Approximately 3 months of salary (at $8333 per month) are requested for PI Boswell who will oversee all components of the Non-lethal Herring evaluation study to include actively participating in field surveys, PI meetings, the Alaska Marine Science Symposium (AMSS) and all analyses, reporting and manuscript preparation. In addition, funds are requested for an undergraduate student worker (approximately 6 months, at $866.67 per month) whose responsibilities will be to participate in field work, data processing and report/manuscript preparation. Fringe Benefits: Fringe rates are included in the budget sheet and are applied to salaries at 31.88% for PI Boswell and 0.0033% for the participating undergraduate student.

Domestic Travel: Funds are requested to travel to participate in the PI meeting during FY14, the AMSS and three field surveys. Funds are requested for travel for both PI Boswell (all activities) and an undergraduate student (field work only). Travel expenses are estimated and include airfare, lodging and per diem during travel periods.

Contractual Costs: Funds are requested for ship time charter support during field surveys in Prince William Sound and will serve to extend the cruises for which the Non-lethal Herring Evaluation study will participate ($7,000).

Commodities Costs: Funds for three categories of commodities costs are requested to support both field collection and data processing needs and include: 1) expendable supplies for field deployments; cable material for data transfer between sonar, motor and computer; and material costs for designing and fabricating device to mounting and deploying DIDSON and motor assembly at depth; 2) office supplies, printing costs and data archiving devices; 3) shipping costs for equipment transport and insurance for 3 trips during FY 14.