FY14 PROGRAM PROJECT
PROPOSAL FORM

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

Project Period: (Please use the fiscal year of February 1 – January 31)

Primary Investigator(s): Kevin M. Boswell; Florida International University, North Miami, FL, 33029

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:

FY12	FY13	FY14	FY15	FY16	TOTAL
0	43,676	51,263	0	0	94,939

(Funding requested must include 9% GA)

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

Date: 8/30/2013

(THIS SUMMARY PAGE NOT TO EXCEED ONE PAGE)

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. Summary of Project to Date (if applicable)

Agreements have recently been arranged between PWSSC and FIU to initiate the contract process.`

II. PROJECT DESIGN

A. Objectives

Objective 1-Apply non-invasive techniques to estimate the in situ distribution (size, abundance, behavior and 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 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 conceived 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.

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 the Program

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. CV's/RESUMES

Kevin M. Boswell

Florida International University
Marine Sciences Program
Department of Biological Sciences
3000 NE 151st St
North Miami, FL 33181, USA

Office: 305-919-4009
Fax: 305-919-4030
Email: kevin.boswell@fiu.edu
Web: http://www2.fiu.edu/~kmboswel/

(a). Professional Preparation

2006 PhD, Oceanography and Coastal Sciences, Louisiana State University, Baton Rouge, LA. Minor- Experimental Statistics

1998 BS, Marine Fisheries, Texas A&M University, Galveston, TX

(b). Appointments

2011-Present	Assistant Professor, Marine Science Program, Department of Biological Sciences, Florida International University
2012- Present	Assistant Professor- Adjunct, Department of Oceanography and Coastal Sciences, Louisiana State University
2010- 2011	Assistant Professor- Research, Department of Oceanography and Coastal Sciences, Louisiana State University

(c). Products

Five most relevant products

Grabowski, TB, **KM Boswell**, BJ McAdam, RJD Wells, G Marteinsdottir. *2012*. Characterization of Atlantic cod spawning habitat and behavior in Icelandic coastal waters. *PLoS ONE, 7(12)*. doi:10.1371/journal.pone.0051321

Handegard, NO, **KM Boswell**, C.C. Ioannou, S.P. LeBlanc, D.B. Tjostheim and I.D. Couzin. *2012.* The dynamics of coordinated group hunting and collective information-transfer among schooling prey. *Current Biology*, 22:1213-1217.

Boswell KM, BM Roth and JH Cowan. 2009. Simulating the effects of fish orientation on acoustic biomass calculations*. ICES Journal of Marine Science*, 66: 1398-1403.

Boswell KM, MP Wilson and JH Cowan. 2008. A semi-automated approach to estimating fish size, abundance and behavior from Dual-frequency Identification Sonar (DIDSON) data. *North American Journal of Fisheries Management*, 28:799-807.

Kimball ME, **KM Boswell**, LP Rozas and JH Cowan. 2010. Evaluating the effect of slot size and environmental variables on the passage of estuarine nekton through a water control structure. *Journal of Experimental Marine Biology and Ecology, 395:181-190.*

Five other products

Campbell MD, KA Rose, **KM Boswell** and JH Cowan. 2011. Individual-Based Modeling of Fish Population Dynamics of an Artificial Reef Community: Effects of Habitat Quantity and Degree of Refuge. *Ecological Modeling,* 222 (2011) 3895– 3909.

Boswell KM, RJD Wells, JH Cowan and CA Wilson. 2010. Biomass, density, and size distributions of fishes associated with a large-scale artificial reef complex in the Gulf of Mexico. *Bulletin of Marine Science*. doi:10.5343/bms.2010.1026

Mueller AM, DL Burwen, **KM Boswell** and T Mulligan. 2010. Tail Beat Patterns in DIDSON Echograms and their Potential Use for Species Identification and Bioenergetics Studies. *Transactions of the American Fisheries Society*, 139:900-910.

Boswell KM, MP Wilson, PSD MacRae, CA Wilson and JH Cowan. 2010. Seasonal estimates of fish biomass and length distributions using acoustics and traditional nets to identify estuarine habitat preferences in Barataria Bay, Louisiana. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*, 2:83-97.

Boswell KM and CA Wilson. 2008. Side-aspect target strength measurements of bay anchovy (*Anchoa mitchilli*) and Gulf menhaden (*Brevoortia patronus*). *ICES Journal of Marine Science*, 65:1012-1020.

(d). Synergistic Activities

Selected Professional Services, Committees and Outreach

i. Founding member: Southeast Acoustics Consortium (seac.fiu.edu)
ii. US Representative: ICES Working Group on Fisheries Acoustics Science and Technology
iii. Participant: ICES Study Group on Calibration of Acoustic Equipment
iv. Member of the Advisory Committee of the Atlantic Coastal Cooperative Statistics Program
v. Manuscript reviewer for American Fisheries Society Symposium Series, Conservation Biology; Estuarine, Coastal and Shelf Science; J of Experimental Marine Biology and Ecology; Gulf of Mexico Science; ICES J of Marine Science; J of Sea Research; Marine and Coastal Fisheries; Marine Ecology Progress Series; Marine Technology Society Journal; North American J of Fisheries Management; Transactions of the American Fisheries Society

(e). Collaborators and Other Affiliations

Collaborators in past 48 months

Dennis Allen (USC BBML); Hongsheng Bi (UMCES); Iain Couzin (Princeton); James Cowan (LSU), Kim de Mustert (GMU), Alex De Robertis (NOAA), Nils Olav Handegard (IMR), John Hedgepeth (Tenera); Ron Heintz (NOAA); Joe Hightower (NCSU); Mike Jech (NOAA); Matt Kimball (UNF); Chunyan Li (LSU); Brenda Norcross (UAF); Doug Nowacek (Duke); Guillaume Rieucau (IMR); Jay Rooker (TAMU); Jan Straley (UAS); Tracey Sutton (VIMS); Chris Taylor (NOAA); Joel Trexler (FIU); Joe Warren (SUNY); David Wells (TAMU)

Graduate advisors and postdoctoral sponsors

PhD- Dr. Charles A. Wilson; Gulf of Mexico Research Initiative
Post Doctoral- Dr. James H. Cowan; Louisiana State University

Thesis Advisor and Postgraduate-Scholar Sponsor

Postdoctoral scholar- Dr. Marta D'Elia, Postdoctoral advisee, 2013-present
Visiting Scientists- Dr. Guillaume Rieucau, 203
Thesis committee: Mark Barton (PhD, Florida International University); Michael Bush (PhD, Florida International University); Grace Harwell (MS, Louisiana State University); Ashley Melancon (PhD, Louisiana State University); Andrew Repp (PhD, Florida International University); Kirsten Simonsen (PhD, Louisiana State University); Adam Zenone (MS, Florida International University)

IV. 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

V. BUDGET

Budget Form (Attached)

Please complete the budget form for each proposed year of the project.