ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

*Please refer to the Reporting Policy for all reporting due dates and requirements.

1. Program Number: *See*, Reporting Policy at III (C) (1).

15120111-F

2. Project Title: *See*, Reporting Policy at III (C) (2).

PWS Herring Program – Juvenile Herring Abundance Index

3. Principal Investigator(s) Names: *See*, Reporting Policy at III (C) (3).

Pete Rand

4. Time Period Covered by the Report: *See*, Reporting Policy at III (C) (4).

1 February 2015 to 31 January 2016

5. Date of Report: *See*, Reporting Policy at III (C) (5).

February 2016

6. Project Website (if applicable): *See*, Reporting Policy at III (C) (6).

http://pwssc.org/research/fish/pacific-herring/

7. Summary of Work Performed: *See*, Reporting Policy at III (C) (7).

Project Summary – Overview

This project is intended to establish a monitoring effort on juvenile herring to help better understand recruitment dynamics. If successful, this information could be incorporated into the ASA model of ADF&G to help track herring recruitment as an alternative, more empirical, method compared to relying on theoretical, stock-recruitment models.

The current project has now included three years of surveys (FY2013-2015) of 8 bays; four of which are the Sound Ecosystem Assessment bays. The additional 4 bays were selected based upon the survey results of the current EVOSTC FY10 Herring Survey Project (# 10100132). This project, and the related expanded adult herring survey project, is now being led by a new PI at the PWSSC, Pete Rand. Dr. Rand joined the PWSSC staff in June 2015. Acoustic data for the fall juvenile surveys from all three years of this project (2013-2015) have now been uploaded to the AOOS workspace. Results reported here is the first effort to derive estimates of densities and biomass from these surveys. We focus here on some initial analyses from data collected during the November 2015 cruise. Trawl catch analysis to derive herring size and weight information from midwater trawls in 3 of the bays is, as of the time of this report, incomplete. Subsequently, we only report here results for the initial five completed surveys. It is our intention to establish an analytical protocol to which we can apply to all years of this survey effort, to be described in the final project report.

In addition to the standard survey, in November 2015 we augmented our sampling to include nearshore waters (to approximately the 5 m depth contour) using a SIMRAD 120 kHz split-beam echosounder mounted on an autonomous surface vehicle (or ASV, see Figure 1). This work was conducted as part of a contract with Florida International University (Kevin Boswell, PI). The objective of this effort was to better understand the distribution and abundance of herring in waters too shallow to be included as part of the surveys on the R/V Montague. Aggregations of herring were noted frequently in areas too shallow for deep water trawling, or Montague transects. It is apparent that large numbers of herring may be unrepresented in current survey methodology and shallow survey methodology should be applied in future survey design.

Figure 1. The autonomous surface vehicle (ASV) was deployed during our November 2015 cruise in all 8 bays to acoustically survey near shore waters to compare with observations in the main bay transects.

Below we describe some details on our analytical methodology and some preliminary results of our research cruise in November 2015.

Acoustic Analysis Methods

Juvenile herring were surveyed acoustically, as in previous years of this project, along cross-bay transects (hereafter referred to as the main bay survey) (Figure 2). Samples were obtained with a Biosonics 120 kHz split-beam hydroacoustic transducer (Biosonics DT-X system) fixed to a towfin towed alongside the R/V Montague. Midwater trawl and gill net surveys were conducted synoptically to provide information on species and size structure of acoustic targets. Results of this work are reported under a separate project (see Bishop). CTD casts were also conducted at the head and mouth of each bay in our survey to characterize the environmental conditions in the water column. Nearshore acoustic data were collected on the ASV using a calibrated SIMRAD EK60 multi-frequency echosounder system operating a 120 kHz split-beam transducer interfaced to an onboard computer running the EK80 software (SIMRAD, v1.0). Vessel position was recorded using a WASS-enabled USB Garmin GPS unit that was corrected for positional offsets from the face of the transducer. We refer to this survey as the near shore survey (Figure 2).

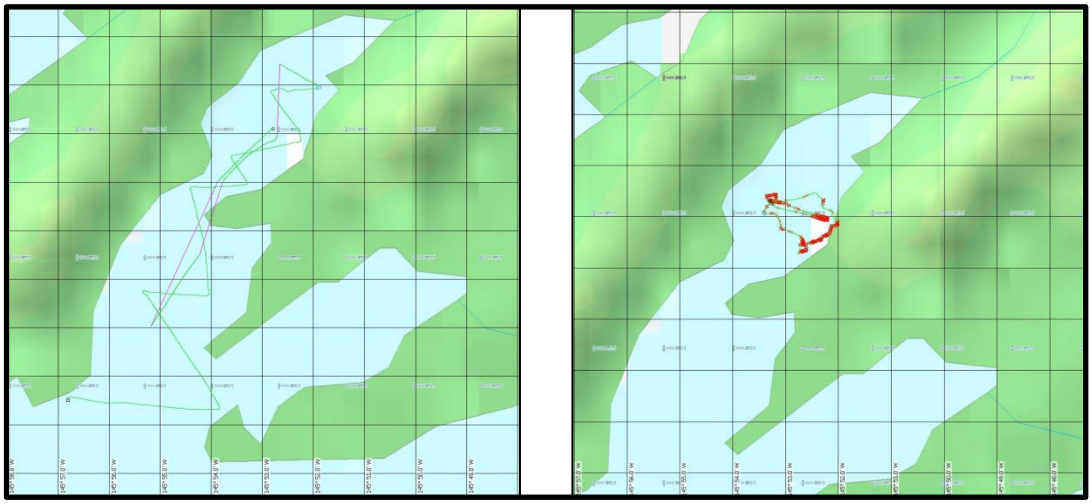

Figure 2. GPS data for main bay surveys (left) and nearshore acoustic surveys (right)

Acoustic data for both surveys were manually inspected and post-processed in Echoview 7.1 (Sonar Data Pty., Ltd.). An analysis threshold of -60.00 dB was applied to the volume backscattering (S_V) data in addition to a bottom detection algorithm to remove reverberation and unwanted acoustic backscatter (eg. benthic habitat, air bubbles, etc.). Additional manual inspections removed any remaining undesired data and the echograms were binned into 10m horizontal by 5m depth analysis cells. For deep surveys, we apportioned the Area Backscattering Coefficient (ABC), which is approximately proportional to biomass, to species based on the composition observed in each bay in the mid-water trawl catches (see Bishop for additional details on trawl results).

Acoustic fish density estimates for nearshore schools were calculated by using the backscattering cross-section ($\sigma_{bs;}$ MacLennan et al., 2002) and Target Strength (TS) as calculated using standard linear regression equations for TS derived by Thomas and Ona (Thomas et al, 2002 ; Ona, 2003). To fit the equation, the average length of herring caught by trawling in each bay was used. Multiple TS equations were used to obtain an estimate of the variability in acoustic biomass estimations. The area backscattering coefficient, s_a [$s_a = \int_{z1}^{z2} Sv * dz$], was then used to calculate fish densities (fish m^{-2}) in a transect as described in MacLennan et al., 2002 (Eq.2).

$\sigma_{bs} = 10^{\wedge(TS/10)}$ (Eq. 1)

Fish $m^{-2} = s_a / \sigma_{bs}$ (Eq. 2)

For density comparisons between deep surveys and nearshore surveys, we assumed all targets and backscatter were herring.

Preliminary results

We successfully completed a cruise onboard the R/V Montague during 6-14 November 2015. We successfully sampled all 8 bays. Based on CTD casts conducted in each of the bays (see examples in Figure 3), where we observed relatively mixed water column conditions, with an average water temperature of 9.8 C and salinities of 30.2 ppt.

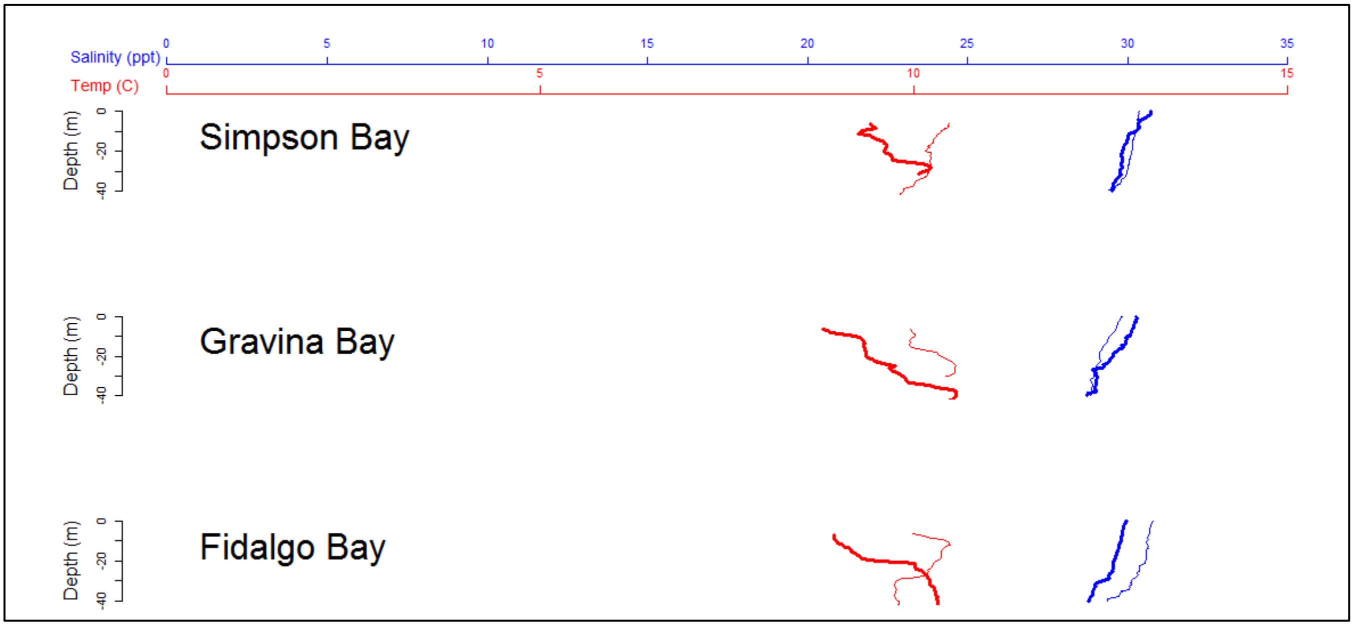

Figure 3. Example of data from CTD casts (temperature and salinity) in the eastern bays surveyed in November 2015 in Prince William Sound. Upper and lower bay cast locations are indicated by thin and bold lines, respectively.

As in previous years' surveys, most of the targets encountered, based on the size frequency of fish captured in mid-water trawls, were likely age 0 and age 1 herring (Figure 4).

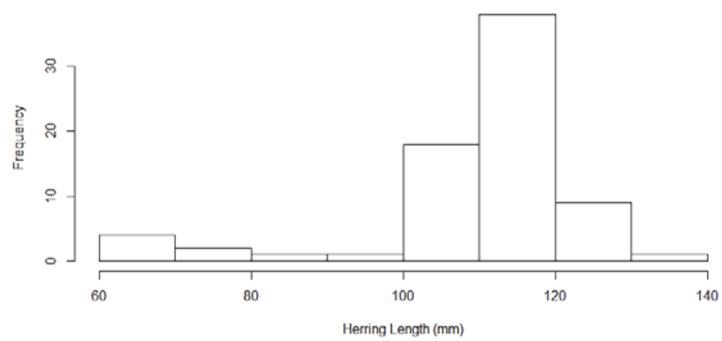

Figure 4. Length frequency of Pacific herring (standard lengths, in mm) collected in Simpson Bay on 6 November 2015 using a mid-water trawl.

Total acoustic fish biomass was apportioned into each of 5 taxonomic groups observed in the trawl catches (herring, Walleye Pollock, capelin, sculpin, and sandlance). Herring was the dominant species in all bays examined for this report (Table 1). Among the bays analyzed, the vast majority of the herring were observed in mid-bay in Simpson Bay at approximately 50 m depth extending across a ~4 km length of transect (Figure 5). This pattern of high biomass in Simpson Bay was corroborated by CPUE estimates from the synoptic trawl survey (see report by Bishop).

	Area Backscattering Coefficient by Bay				
	Eaglek	Fidalgo	Gravina	Simpson	Zaikof
Herring	3.3883e-7	5.4476e-7	1.0046e-7	4.9054e-6	3.8469e-7
Walleye Pollock	1.5717e-7	1.3244e-8	1.2429e-8	1.8643e-7	0
Capelin	0	0	2.0714e-9	5.6238e-8	1.3129e-9
Sandlance	0	0	5.9036e-8	2.4385e-7	0
Sculpin	0	0	0	6.8052e-8	0

Table 1. Biomass apportionment of acoustic backscatter based on species composition of trawl catches in each of five bays in Prince William Sound. Note, estimates describe only the water column ensonified during the survey; values were not extrapolated to entire bay volume. Individual figures for each bay may be found in the attached Appendix.

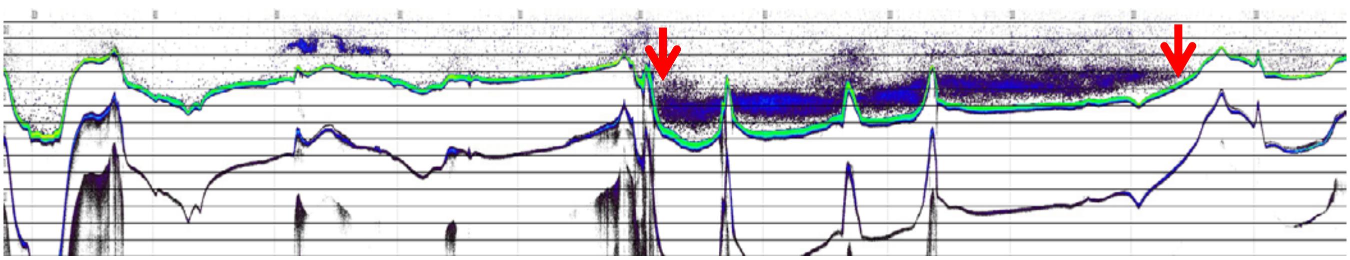

Figure 5. Echogram from the main bay transect in Simpson Bay on 6 November 2015. The majority of backscatter (bracketed by the red arrows) was observed in the deeper waters (~50 m) in the middle portion of the bay. The gridded horizontal lines represent 10 m depth intervals, and the vertical lines represent 1 km distance along the transect.

The depths occupied by fish in the bays appeared to be highly variable. In some bays (e.g. Gravina) most of the backscatter was observed at shallow depths, while in others (e.g. Simpson Bay) most of the backscatter was in deeper water (Figure 6).

We compared fish densities measured in the main bay transects with more shallow habitat in the near shore survey. Densities in the near shore survey were markedly higher, in some cases an order of magnitude higher, compared to densities observed in the main bays (Figure 7). It should be kept in mind that deep survey densities operated on the unlikely assumption that all backscatter was derived from herring. During this sampling we made multiple observations of birds (primarily kittiwakes, mew gulls and common murrs; A. Shaeffer, PWSSC, pers. comm.) feeding intensively on small fishes (presumably juvenile herring) near surface during early morning hours. These feeding events appeared to be ephemeral, lasting only 10-15 minutes.

To consider uncertainty in densities estimated acoustically, multiple Target Strength/Length equations were employed in estimating herring density. Results from Thomas et al. (2002) and Ona (2003) were used to examine variance in acoustic estimates, with values calculated using Ona (2003) more closely matching trawl weight values.

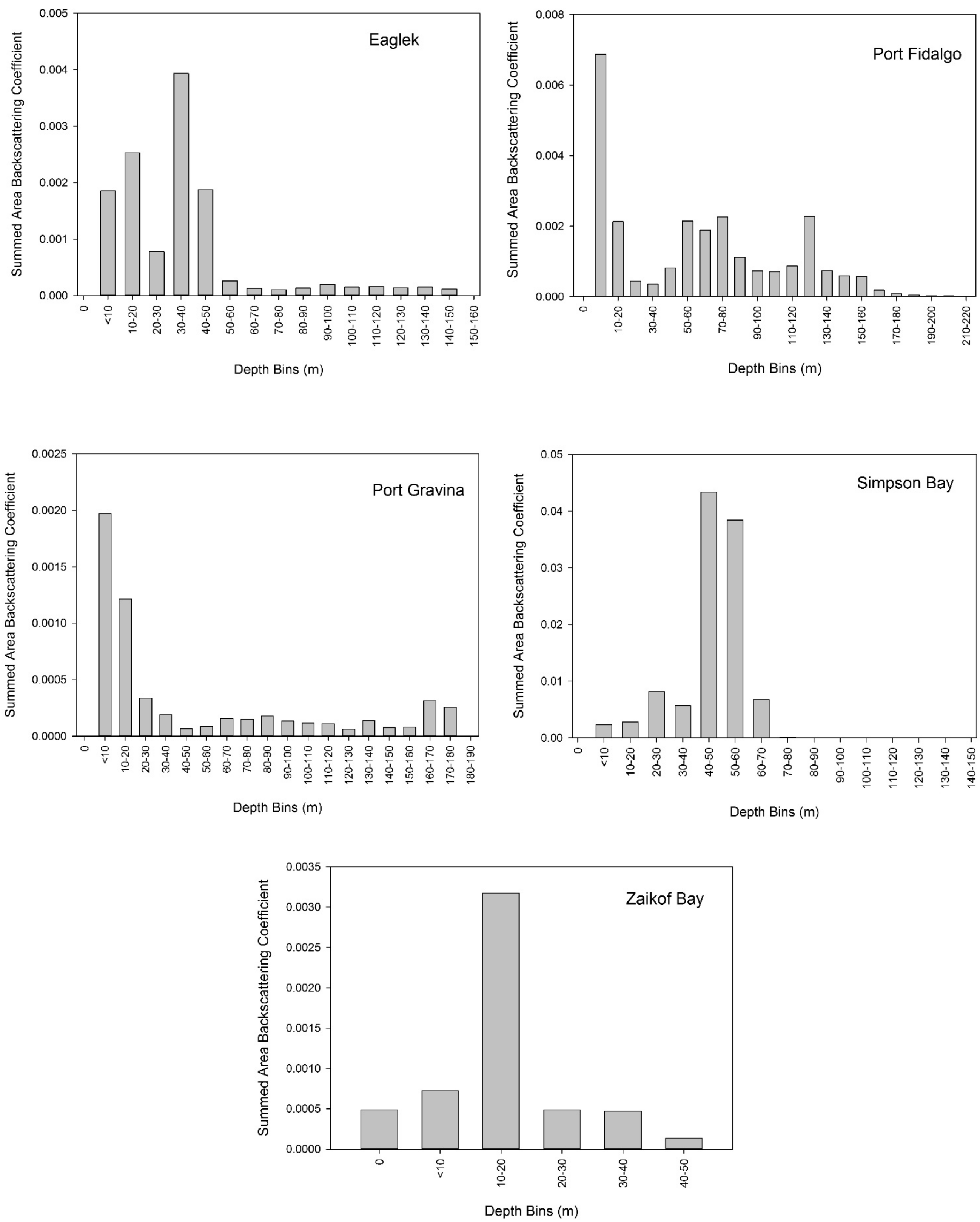

Figure 6. Distribution of acoustic backscatter across depth in five bays in Prince William Sound.

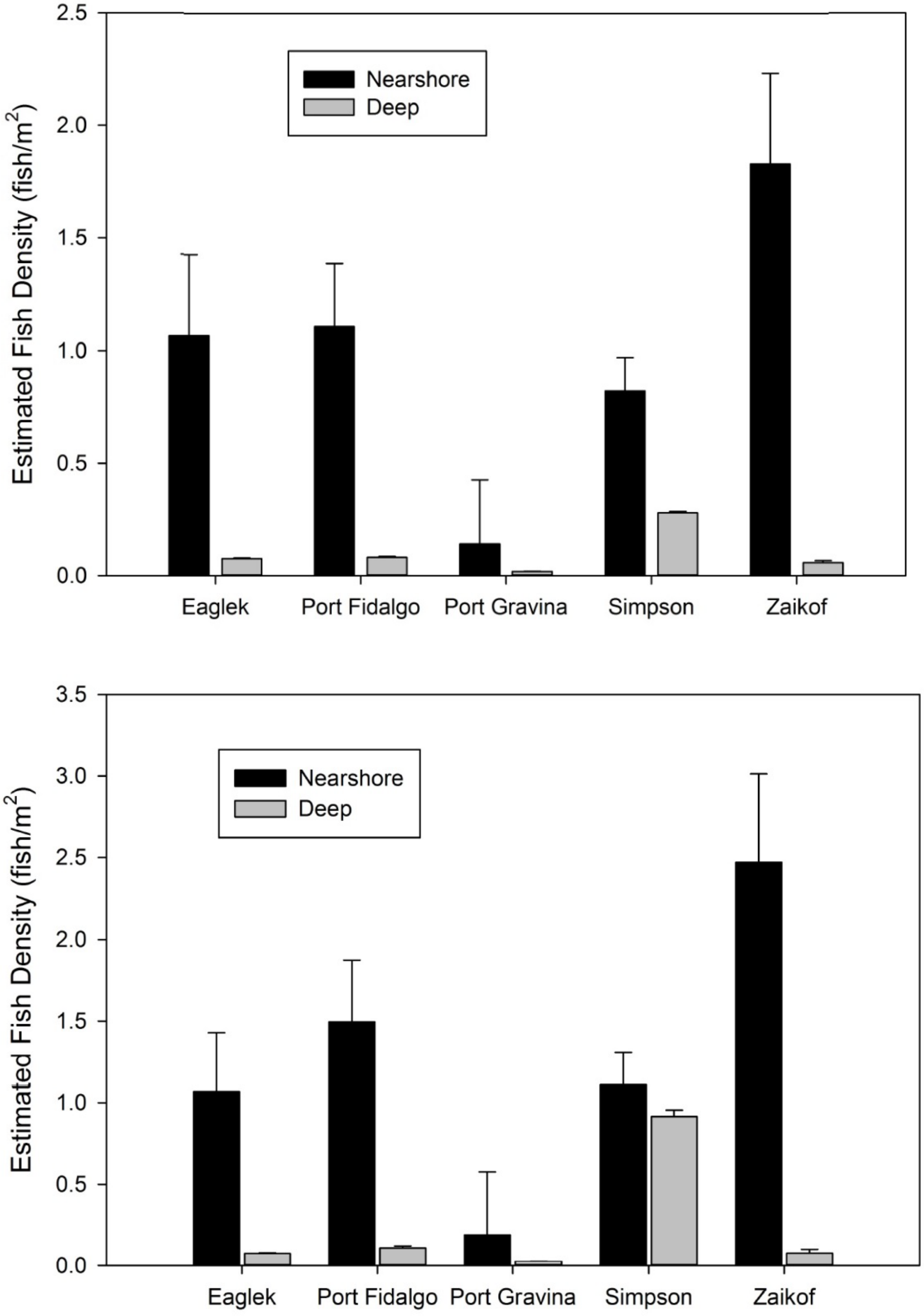

Figure 7. Acoustic density estimates for five bays during the November 2015 cruise. Top panel are density values using the TS relationship of Thomas et al. (2002); bottom panel are density values using the TS relationship of Ona (2003). Dark bars are estimates derived from ASV sampling, and gray bars depict densities in the main bay transects.

Appendix

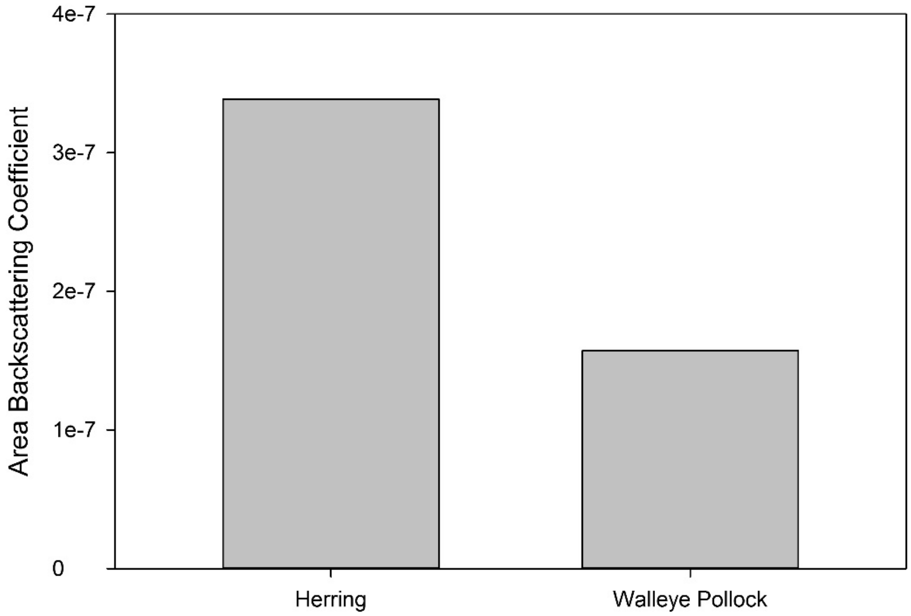

Figure A1. Acoustically estimated backscatter apportioned by trawl caught species in Eaglek Bay.

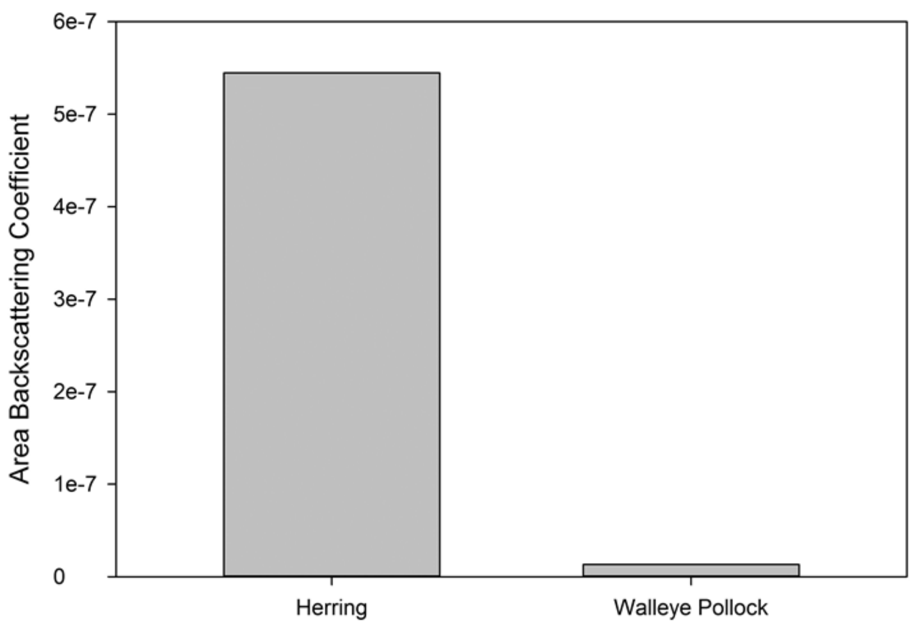

Figure A2. Acoustically estimated backscatter apportioned by trawl caught species in Port Fidalgo.

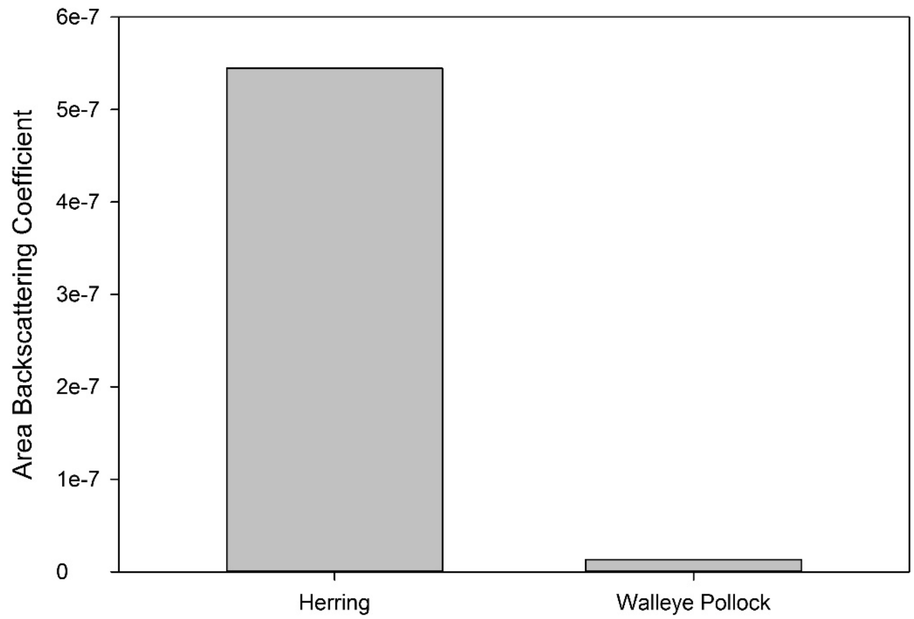

Figure A3. Acoustically estimated backscatter apportioned by trawl caught species in Port Gravina.

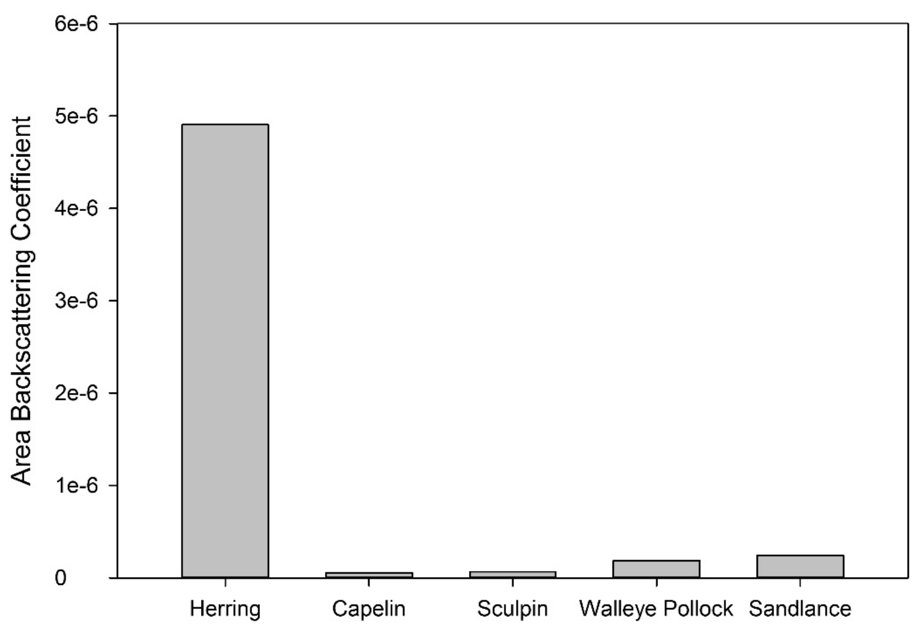

Figure A4. Acoustically estimated backscatter apportioned by trawl caught species in Simpson Bay.

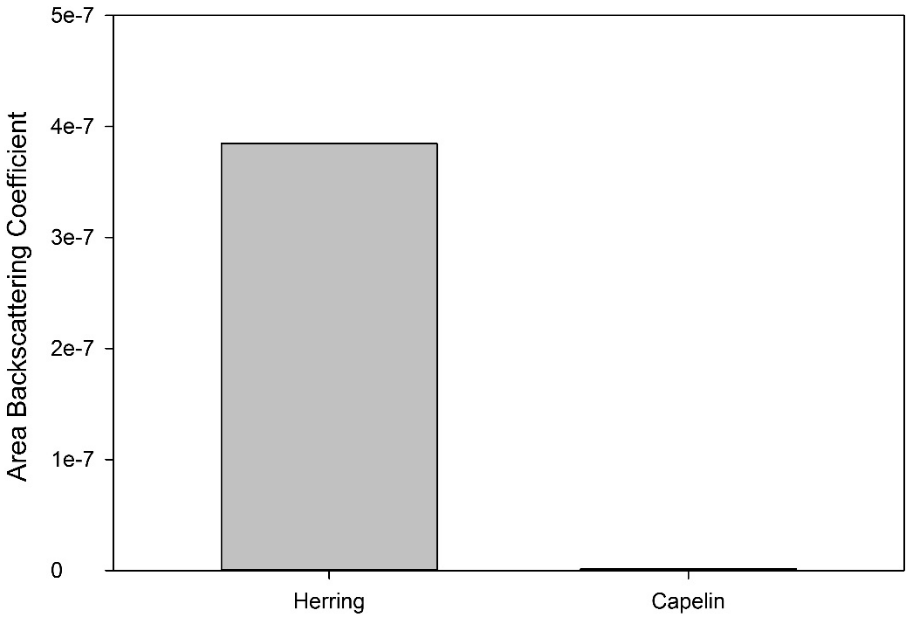

Figure A5. Acoustically estimated backscatter apportioned by trawl caught species in Zaikof Bay.

8. Coordination/Collaboration: *See*, Reporting Policy at III (C) (8).

We collaborated with FIU (Kevin Boswell and Aubree Zenone) for this project. We coordinated our cruise with several other EVOS HRM PIs, including Mary Anne Bishop and Kristen Gorman. Bishop led the midwater trawl and gillnet surveys for acoustic validation, and subsamples of herring were measured, preserved on the vessel, and transferred to Gorman for energetic and isotope analyses. During this cruise we also deployed a hydrophone at each anchorage to monitor for the presence of acoustically tagged herring (the HRM tagging program of Bishop).

9. Information and Data Transfer: *See*, Reporting Policy at III (C) (9).

All acoustic data collected as part of this project has been uploaded to the AOOS website.

10. Response to EVOSTC Review, Recommendations and Comments: *See*, Reporting Policy at III (C) (10).

The Science Panel commented on the need to establish a method of surveying juvenile herring as an alternative to estimating recruitment using a stock-recruitment model. The panel reacted to a lack of clarity and context in previous reports. This report is the first effort to use acoustic data and synoptic trawl catches to derive species-specific biomass estimates in each of the bays. We endeavor to complete analyses on all three years of data (and perhaps earlier surveys) and determine if these biomass estimates correlate with recruitment of age-3 herring into the spawning population.

In addition, results of our ASV survey indicated high densities of fish in near shore waters, suggesting the standard main bay surveys may not be capable of providing a robust estimate of juvenile herring biomass. Sampling in the near shore was limited in space and time during our November 2015 cruise, so it is not yet possible to determine how much shallow water habitat contributes to overall biomass in each of the bays. We propose to expand these ASV surveys, perhaps in a limited set of bays, to evaluate the relative importance of this habitat in supporting juvenile herring during the fall period.

Finally, we intend to bootstrap the acoustic data to determine error bounds on biomass estimates – this will provide a measure of uncertainty in our estimates of juvenile herring biomass.

We see value in continuing fall juvenile surveys as an important effort to better understand recruitment dynamics of herring in Prince William Sound.

11. Budget: *See*, Reporting Policy at III (C) (11).

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$16,200.0	$49,900.0	$40,900.0	$55,300.0	$55,900.0	$218,200.0	$ 92,947
Travel	$0.0	$2,600.0	$2,600.0	$2,600.0	$2,600.0	$10,400.0	$ 8,055
Contractual	$500.0	$4,000.0	$1,600.0	$2,000.0	$0.0	$8,100.0	$ 16,215
Commodities	$1,500.0	$0.0	$1,500.0	$0.0	$0.0	$3,000.0	$ 2,393
Equipment	$59,000.0	$0.0	$0.0	$0.0	$0.0	$59,000.0	$ 57,261
Indirect Costs (*will vary by proposer*)	$5,500	$17,000	$14,000	$18,000	$17,600	$72,100.0	$ 35,872
SUBTOTAL	$82,700.0	$73,500.0	$60,600.0	$77,900.0	$76,100.0	$370,800.0	$212,743.0
General Administration (9% of	$7,443.0	$6,615.0	$5,454.0	$7,011.0	$6,849.0	$33,372.0	
PROJECT TOTAL	$90,143.0	$80,115.0	$66,054.0	$84,911.0	$82,949.0	$404,172.0	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	

Spending on personnel is behind because of a change in P.I. in 2015. Funding is being shifted from personnel to contractual to allow for contracting with Kevin Boswell at Florida International University to assist in data collection and processing.

We appreciate your prompt submission
and thank you for your participation.