ATTACHMENT C **EVOSTC Annual Project Report Form**

Form Rev. 8.30.18

1. Program Number:

18120111-G

2. Project Title:

Herring Program – Adult Pacific Herring Acoustic Surveys in PWS

3. Principal Investigator(s) Names:

Peter S. Rand

4. Time Period Covered by the Report:

February 1, 2018-January 31, 2019

5. Date of Report:

April 2019

6. Project Website (if applicable):

http://pwssc.org/herring-research-and-monitoring/

7. Summary of Work Performed:

ABSTRACT

We successfully completed acoustic surveys in April 2018 to continue a long-term data set of biomass estimates of the spawning population of Pacific herring in Prince William Sound (PWS). We completed five separate surveys during 5-13 April at what is currently recognized as the largest spawning aggregation sites in PWS (Port Gravina and in Rocky and Zaikof Bays in the northeast region of Montague Island). All surveys were conducted off a chartered vessel (*M/V Auklet*). The greatest biomass in Port Gravina was measured during the night of 6-7 April (3,336 mt over a survey area of 15.1 km^2). Our single estimate generated for Rocky Bay was 193 mt over a survey area of 3.3 km^2, and we estimate 117 mt of herring was in adjoining Zaikof Bay (10.8 km^2 survey area). We summed these estimates to arrive at a total biomass of 3,646 mt, a lower estimate than that produced in 2017 (9,896 mt), and just slightly higher than the lowest recorded biomass on record for this survey (3,453 mt in 2016). We provided these estimates to Herring Research and Monitoring principal investigators for input in the age-structured assessment and Bayesian age-structured assessment model to meet the objective of supporting on-going stock assessment work.

SURVEY METHODS

Hydroacoustic survey methods are well documented and well established in fisheries (Thorne 1983a,b; Simmonds and MacLennon 2005). They have been applied to Pacific herring for nearly forty years (Thorne 1977a,b; Trumble et al. 1983). The specific methods used in Prince William Sound (PWS) are well documented and have been demonstrated to be precise (Thomas et al. 1997, Thomas et al. 2002, Thomas and Thorne 2003, Thorne and Thomas 2008). Below we provide a summary of the general methods applied for analysis of acoustic data collected during spring 2018.

A three-stage sampling design (Cochran 1977) is used for the acoustic surveys in PWS. Adult herring during the extended winter period in PWS are typically located in a few select bays and inlets and are distributed primarily in large, midwater schools or dense layers at night. Since 1995, survey efforts have focused on the late winter/early spring pre-spawning distribution when the herring are most concentrated. The initial survey stage focuses on locating adult herring aggregations within PWS. As in years past, we primarily relied on aerial survey identifications of foraging marine mammals, especially Steller sea lions and humpback whales, to determine general location of spawning aggregations.

After the herring are located, the second stage consists of echo integration surveys over the areas occupied by the herring schools (Thorne 1971, 1983a,b; MacLennan and Simmonds 1992; Simmonds and MacLennan 2005). The transects were situated in a spatial sampling frame that encompassed the herring schools recognized by aerial surveys and daytime sampling with ship-board sonar. Transects were arranged as roughly parallel zigs and parallel zags and were equally spaced. The key advantage with this survey design is to maximize the amount of transect sampling time relative to transit time. This allowed us to survey the entire sampling frame overnight. To collect acoustic data, a BioSonics 70 kHz digital single-beam transducer was mounted down-looking on a 1.2 m long aluminum towfin and deployed off the *M/V Auklet*. The echosounder was configured to transmit 1 pings s-1 with a pulse duration of 0.4 ms. Transects were conducted after sunset, and the deck lights were extinguished to avoid responses of herring to light. Tow speeds were maintained at approximately 2-3 knots and the transducer was positioned approximately 1-2 m below the surface. Position of the vessel along the transect was recorded with a Garmin 17x NMEA 0183 high-sensitivity GPS (accuracy rating under typical conditions < 10 m) connected via a power/data cable to the BioSonics DT-X top box so GPS coordinates were integrated as a cruise track into the *.DT4 data files. Calibration involving a standard sphere was carried out according to methods described in Foote et al. (1987). Our spring 2018 survey included some daytime transects to provide some contrast with our observations at night. The surveys were repeated several times to develop multiple estimates of the biomass of specific fish aggregations. After the echo integration surveys, the final sampling stage consists of subsampling herring schools (performed by the Alaska Department of Fish and Game, ADF&G) to provide data on mean sizes of individuals. During the spring 2018 survey, the ADF&G crew of the *R/V Solstice* captured adult herring with a purse seine.

The size composition of the herring in the net catches were used to estimate target strengths for converting backscatter to biomass. The general target strength equation used in PWS is:

$$TS_w = -5.98\text{Log}(L) - 24.23$$

Where TS_w is the target strength (decibels) per unit weight, w is weight in kg and L is standard length in cm. Based on the seine net collections described above, we used 17.6 cm mean standard lengths to represent mean target strengths for herring in all surveys.

This equation applies to the typical nighttime depths of herring during the late winter/early spring period (specifically 40 m, Thorne 1981). No alterations were made for different depths in the 2018 data set as most fish observed were occupying this depth stratum. Dates and times of the individual surveys are provided in Table 1.

The acoustic survey in 2018 consisted of two separate cruises on the *M/V Auklet.* We completed two night surveys (5-6 and 6-7 April 2018) in Port Gravina. Following a port call in Cordova, three additional night surveys were conducted, one in Port Gravina (9-10 April 2018) followed by two in a single night at Montague Island (Rocky and Zaikof Bays, 12-13 April 2018). We observed conditions in Port Fidalgo (a region that has been surveyed acoustically in the past), but no acoustic surveys were conducted there because of a lack of evidence of aggregations of herring. To display variability in target densities along the survey transects, we produced maps of NASC (nautical area scattering coefficient, NASC, in $m^2\,nm^{-2}$, as in MacLennan et al. 2002). We also produced echograms to visualize depth distribution of schools in the survey area. We estimated herring density by dividing the area backscatter coefficient (s_a, in $m^2\,m^{-2}$, as in MacLennan et al. 2002) estimated using Echoview 5.0 by the average target strength described above. We assumed all acoustic targets down to 60 m depth were herring. We estimated a mean herring density per ping along the entire transect. This mean value was then multiplied by average fish weight (in g) and the spatial area surveyed to arrive at a biomass estimate of herring (converted from g to mt) contained within the survey area. These calculations were performed in R (version 3.12.0, 2015-04-16).

RESULTS

As in recent years, we observed an aggregation of herring within the 30-40 m depth contour along the coastline near Hell's Hole in Port Gravina. We completed 3 separate, acoustic surveys in this region during April (Figs. 1-3). All were conducted at night. Biomass estimates varied from 189 to 3,336 mt (Table 1). Similar transects were run on all three nighttime surveys in Port Gravina. We encountered the most herring in our second survey (6-7 April 2018); however, very few schools were encountered (Fig. 3), and our biomass estimate was relatively low compared to previous years (3,336 mt, Table 1). The survey area ranged from 15.1 -19.7 km^2 (Table 1). The survey conducted on 6-7 April 2018 provided the largest estimate of pre-spawning biomass in Port Gravina during the 2018 survey season (3,336 mt, Table 1).

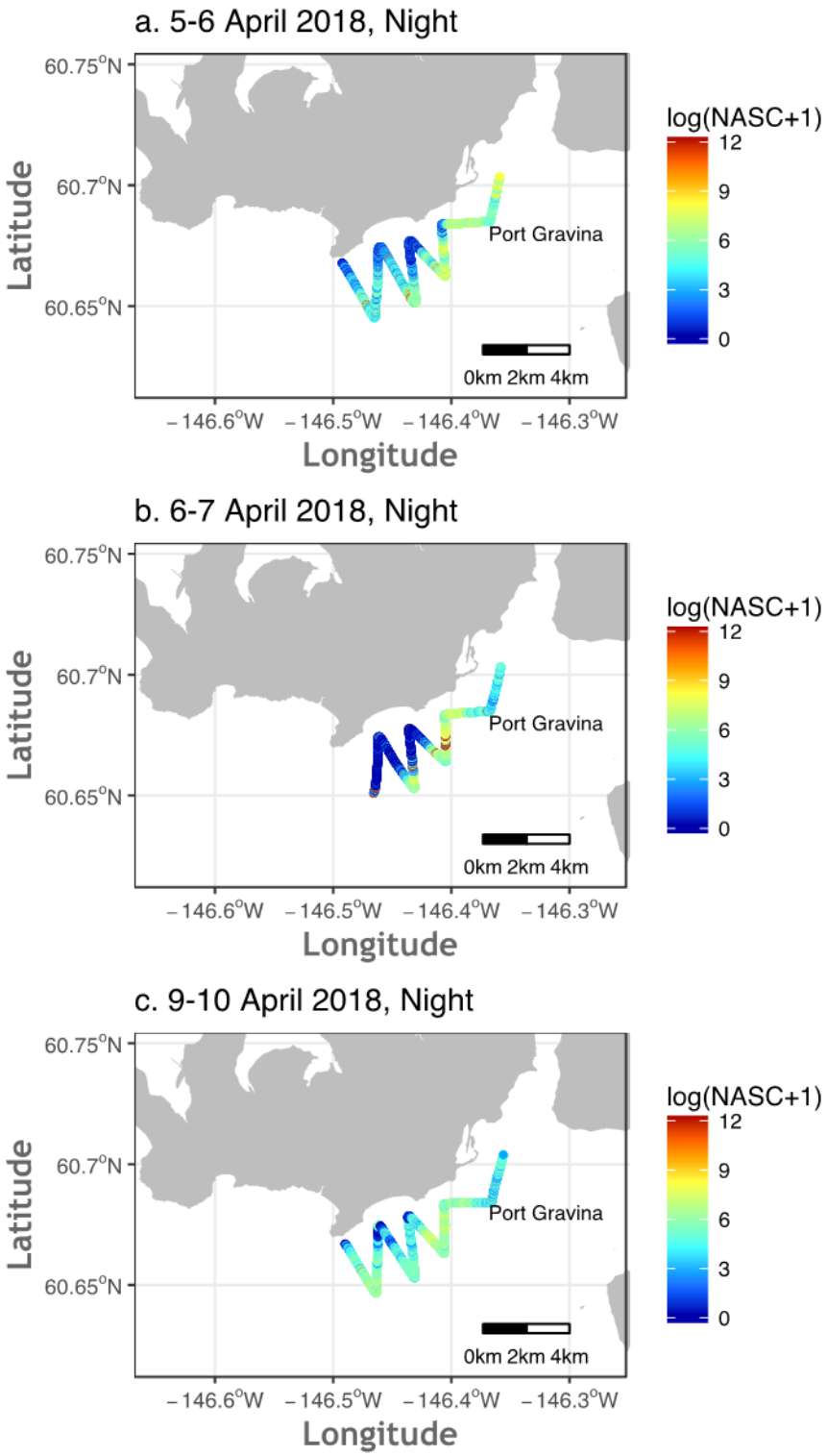

Figure 1. Cruise tracks during a spring 2018 adult herring biomass survey in Port Gravina, Prince William Sound (a., b., and c.). False color spectrum represents hydroacoustic backscatter measured along the transect (in NASC, $m^2\ nm^{-2}$).

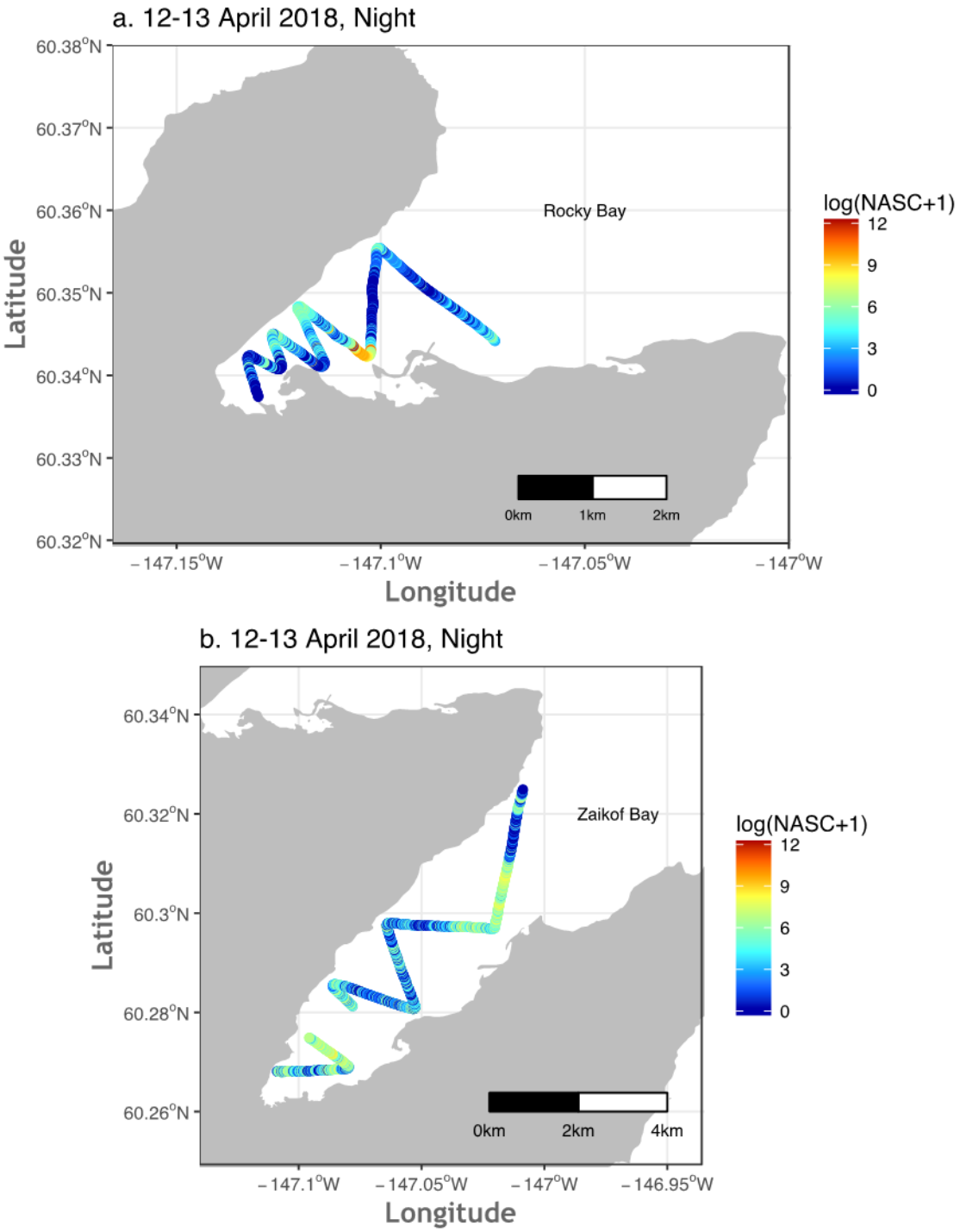

Figure 2. Cruise tracks during a spring 2018 adult herring biomass survey in Rocky Bay (a.) and Zaikof Bay (b.), Prince William Sound. False color spectrum represents hydroacoustic backscatter measured along the transect (in NASC, $m^2\ nm^{-2}$).

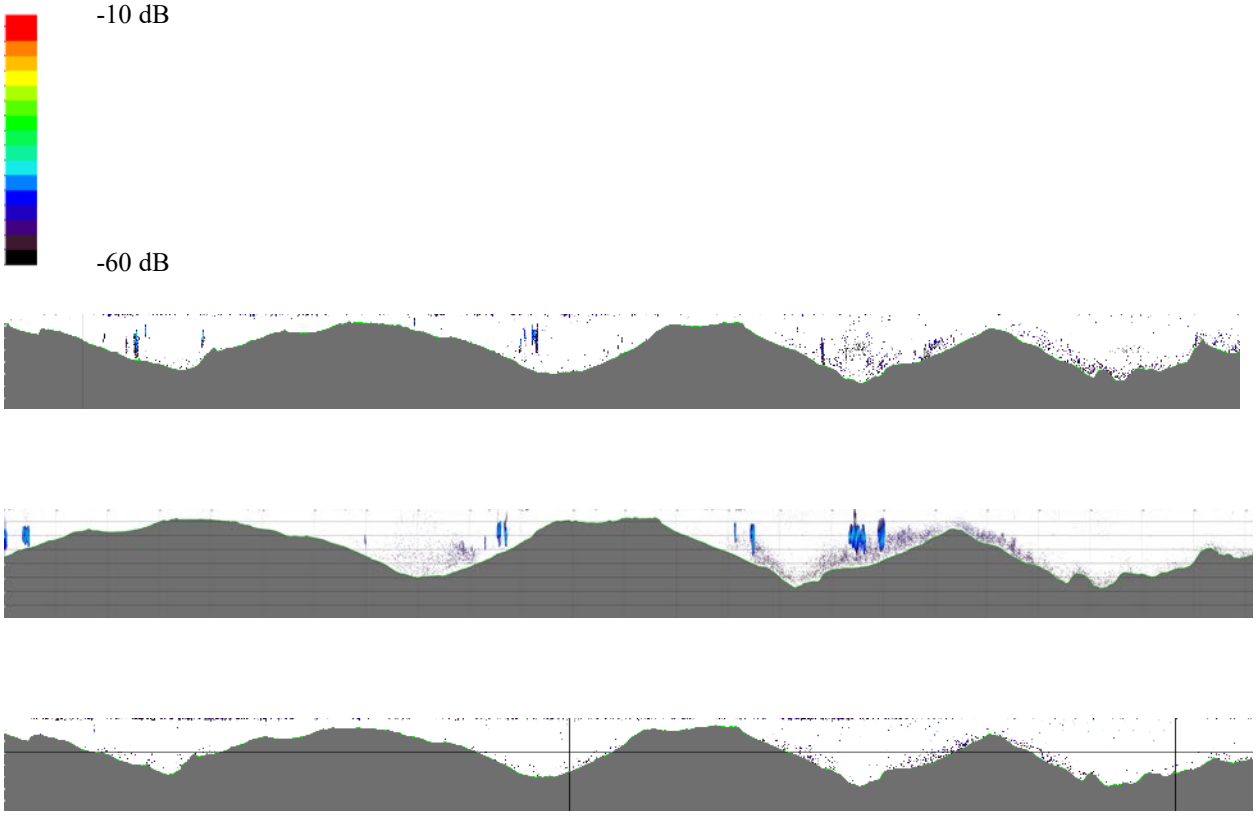

Figure 3. Echograms from transects conducted off of Hell's Hole in Gravina Bay, Prince William Sound during 5-6 April (upper panel), 6-7 April (middle panel), and 9-10 April (bottom panel) 2018. Horizontal bars represent 10 m depth strata. Acoustic data shown are filtered by applying a minimum threshold of -60 dB.

We only observed evidence of a single herring school in Rocky Bay near Montague Island (Fig. 4, upper panel). The survey conducted in Rocky Bay on 12-13 April 2018 produced a very small biomass estimate (193 mt, Table 1). In previous years we observed herring to be concentrated at the extreme head of the bay in relatively shallow (<20 m) water. That did not appear to be the case in 2018. The only school observed was along the southern shore approximately 2 km from the head of the bay (Fig. 2a.). A nighttime survey in Zaikof Bay revealed only trace amounts of targets that did not appear to be contained in schools. Our estimate of herring biomass in Zaikof Bay was extremely low (117 mt, Table 1).

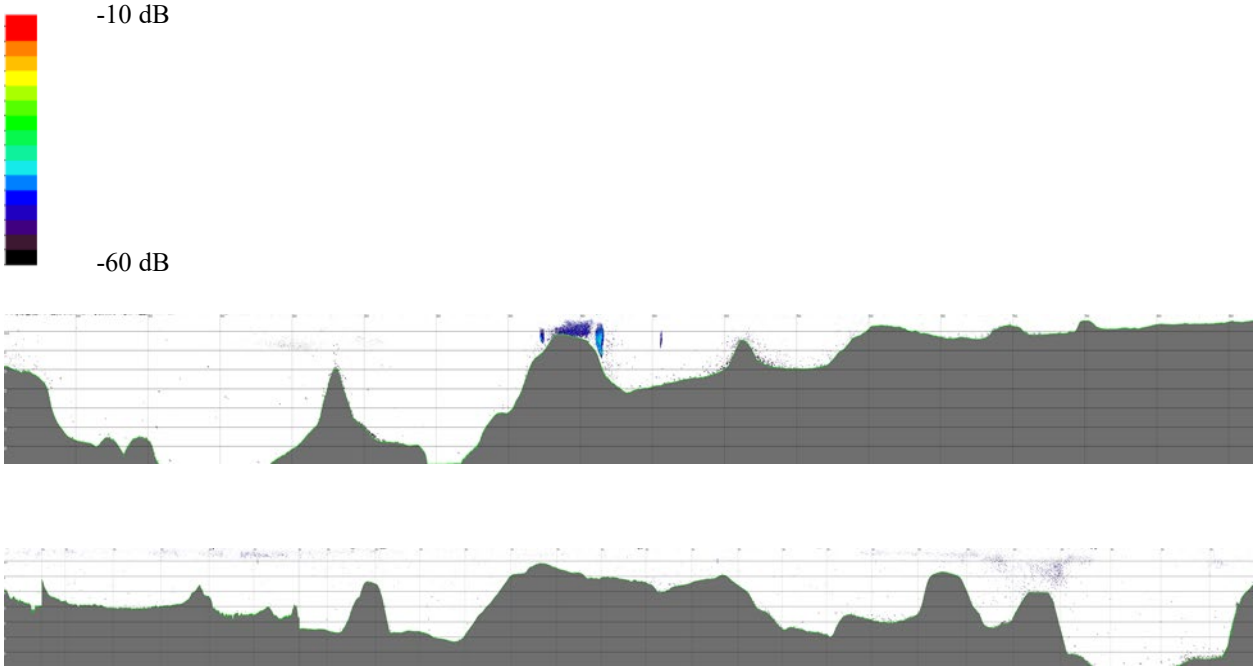

Figure 4. Echograms from transects conducted in northeast Montague Island, Prince William Sound during 12-13 April (Rocky Bay, upper panel) and 12-13 April (Zaikof Bay, lower panel) 2018. Horizontal bars represent 10 m depth strata. Acoustic data shown are filtered by applying a minimum threshold of -60 dB.

Table 1. Biomass estimates of adult Pacific herring during spring cruises, 2018. Shaded rows are the survey results used to estimate total herring biomass that appears in the bottom row (described more fully in the text).

Location	**Date**	**Time of Survey**	**Survey Area (km^2)**	**Biomass Estimate (mt)**
Gravina	5-6 April	Night	19.7	812
Gravina	6-7 April	Night	15.1	3,336
Gravina	9-10 April	Night	18.4	189
Rocky Bay	12-13 April	Night	3.3	193
Zaikof Bay	12-13 April	Night	10.8	117
Total:				3,646

After combining the biomass estimates for both surveyed regions, our effort yielded a biomass estimate of 3,646 mt, which is lower than what was observed in 2017 (9,896 mt) and only slightly higher than the lowest biomass observed during the period of record (3,453 mt in 2016, Fig. 5). We note that our time series lacks an estimate in 2014. Herring during this year were observed in very shallow water, and we were unable to effectively survey the population by using hydroacoustics.

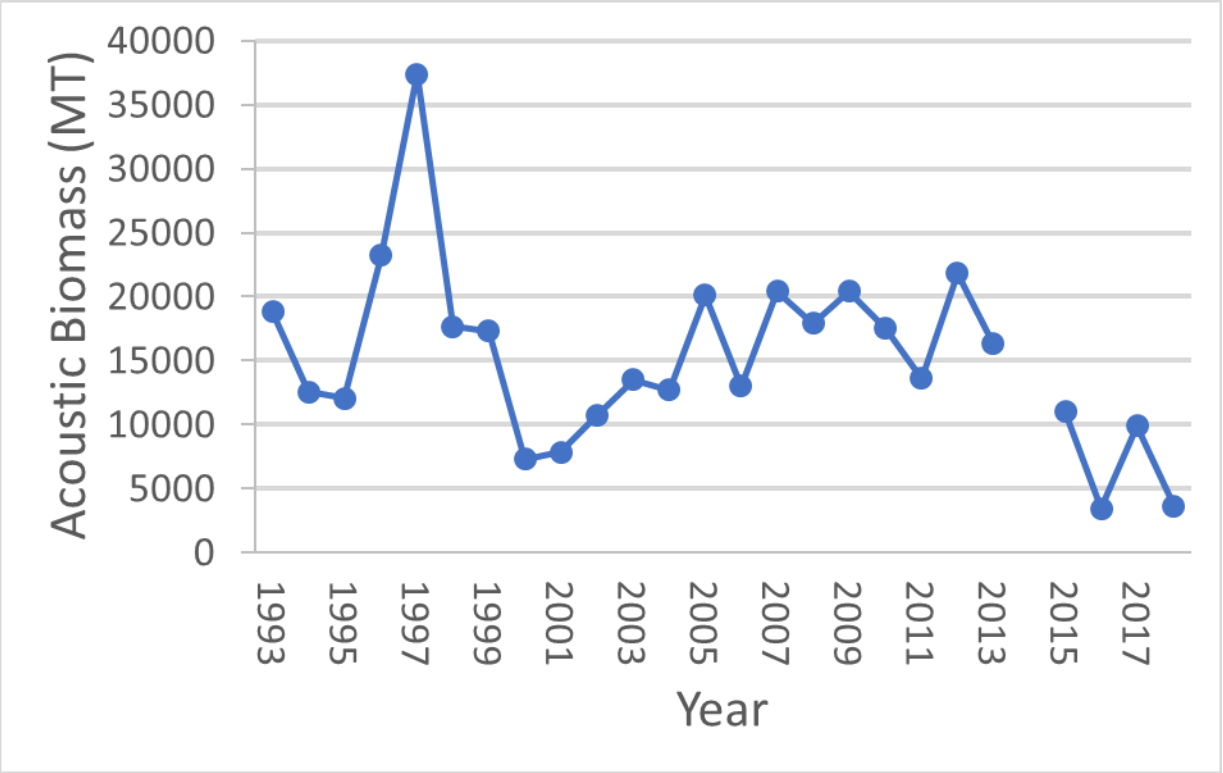

Figure 5. Time series of acoustic biomass estimates in metric tonnes (mt) of Pacific herring in Prince William Sound. The survey conducted during 2014 did not yield a biomass estimate due to adult herring occupying water too shallow to survey effectively with hydroacoustics.

LITERATURE CITED

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8. Coordination/Collaboration:

A. Projects Within a Trustee Council-funded program

1. Within the Program

We primarily coordinated and collaborated with Herring Research and Monitoring Project Number: 18160111-F (Herring Program – Surveys and age, sex and size collection and processing). We relied on this project to provide mean size of Pacific herring captured by purse seine for use in generating biomass estimates from our acoustic data.

2. Across Programs

a. Gulf Watch Alaska

NA

b. Data Management

Data uploaded to the Gulf of Alaska Data Portal to make it publicly available.

c. Lingering Oil

NA

B. Projects not Within a Trustee Council-funded program

NA

C. With Trustee or Management Agencies

Project 1816111-F is an ADF&G managed project.

9. Information and Data Transfer:

A. Publications Produced During the Reporting Period

Rand, P.S. 2018. Pacific herring response to surface predators in Prince William Sound, Alaska, USA. Marine Ecology Progress Series 600:239-244.

B. Dates and Locations of any Conference or Workshop Presentations where EVOSTC-funded Work was Presented

NA

C. Data and/or Information Products Developed During the Reporting Period, if Applicable

Raw acoustic data from the spring 2018 survey were uploaded to the Gulf of Alaska Data Portal following the research cruise (on 27 June 2018, by Pete Rand). Intermediary acoustic summary files were uploaded on 7 February 2019 (by Pete Rand), and the final biomass estimate was added to the time series and made public on 8 November 2018 (by Scott Pegau). Biomass estimates were shared with Herring Research and Monitoring Program principal investigators during November 2018.

D. Data Sets and Associated Metadata that have been Uploaded to the Program's Data Portal

See C. above.

10. Response to EVOSTC Review, Recommendations and Comments:

Science Panel Comments:

The Panel agrees that the acoustic surveys provide valuable information toward achieving the goals of the herring program. As noted in last year's work plan, the Panel appreciates the progress made to date but would like to see included results from the previous years, history of assessments and maps of survey tracks.

PI Response:

These reports now include results from previous years, and I include plots of survey tracks. Results from previous surveys are now available on the Gulf of Alaska Data Portal.

11. Budget:

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$39.5	$40.7	$41.9	$43.2	$44.5	$209.9	$ 58.1
Travel	$0.6	$0.6	$0.6	$0.6	$0.6	$2.8	$ 1.1
Contractual	$10.8	$10.8	$10.8	$10.8	$10.8	$54.0	$ 14.4
Commodities	$1.5	$0.0	$0.0	$0.0	$0.0	$1.5	$ -
Equipment	$0.0	$0.0	$0.0	$0.0	$1.1	$1.1	$ -
Indirect Costs (*will vary by proposer*)	$15.7	$15.6	$16.0	$16.4	$17.1	$80.8	$ 22.1
SUBTOTAL	$68.1	$67.7	$69.3	$70.9	$74.0	$349.9	$95.7
General Administration (9% of subtotal)	$6.1	$6.1	$6.2	$6.4	$6.7	$31.5	N/A
PROJECT TOTAL	$74.2	$73.8	$75.5	$77.3	$80.7	$381.4	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	