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

Form Rev. 9.14.17

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

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

17120111-G

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

Adult Pacific Herring Acoustic Surveys in PWS

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

Peter S. Rand

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

FY17

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

February 2018

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

http://pwssc.org/adult-biomass-surveys/

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

**ABSTRACT**

We successfully completed acoustic surveys in April 2017 to continue a long-term data set on biomass estimates of the spawning population of Pacific herring in Prince William Sound (PWS). We completed four separate surveys during 7-11 April at what is currently recognized as the largest spawning aggregation in PWS (Port Gravina) and in Rocky Bay in the northeast region of Montague Island. We did not observe any signs of a spawning aggregation in neighboring Stockdale Harbor (a small aggregation was observed there in 2016), and did not see any signs of aggregations over an extensive cruise track along the west shoreline of Knight Island and along Naked Island. We conducted a spatially-restricted survey (~ 1 $km^2$) on 7 April off the *R/V Solstice*, and the remaining surveys were conducted off a chartered vessel (*M/V Auklet*). The greatest biomass in Port Gravina was measured during the early morning hours of 8 April (9,650 MT over a survey area of 19.6 $km^2$). Our single estimate generated for Rocky Bay was 246 MT over a survey area of 4.8 $km^2$. We summed these estimated to arrive at a total biomass of 9,986 MT, a higher estimate than that produced in 2016 (3,453 MT) which was the lowest recorded biomass on record for this survey. We provided these estimates to HRM PIs for input in the age structure assessment (ASA) and Bayesian stock assessment models to meet the objective of supporting on-going stock assessment work conducted by the Alaska Department of Fish & Game (ADF&G).

**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 PWS are well documented and have been demonstrated to be both accurate and 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 2017.

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 surveys 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 MacLennon 2005). During 2017 we collected acoustic data off two platforms. A single, limited survey was conducted during the early morning of 7 April off the *R/V Solstice* using a 120 kHz split-beam transducer mounted downlooking on a 60 cm long towfin. More extensive surveys were then conducted off the *M/V Auklet* using a BioSonics 70 kHz digital single-beam transducer mounted down-looking on a 1.2 m long aluminum towfin. These echosounders were 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 transducers were 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. We relied on purse seine sampling on the *R/V Solstice* to characterize the mean size of acoustic targets.

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 our seine net collections conducted by ADF&G during April 2017, we used 18.8 and 18.7 cm mean lengths to represent mean target strengths for herring in Port Gravina and Rocky Bay, respectively (S. Haught, ADF&G, pers. comm.). This equation applies to the typical night-time depths of herring during the late winter/early spring period (specifically 40 m). No alterations were made for different depths in the 2017 data set as most fish observed were occupying this depth stratum (Thomas et al. 2002). Dates and times of the individual surveys are provided in Table 1.

**SURVEY RESULTS**

We observed an aggregation of herring within the 30-50m depth contours along the shoreline near Hell's Hole in Port Gravina and a small aggregation at the head of Rocky Bay, Montague Island. We completed 3 separate, acoustic surveys in Gravina and 1 survey in Rocky Bay (Table 1). The first survey was limited in scope and therefore was not representative of the entire aggregation (Table 1). The herring in this survey occupied the mid-water column at about 30 m. The survey conducted during the early hours of 8 April in Gravina produced the largest biomass estimate (9,650 MT, Table 1, Figure 1). The herring during this survey appeared to be closely associated with the seafloor (Figure 1b). The other survey in Gravina during 10-11 April yielded a lower biomass estimate (4,094 MT, Table 1, Figure 2). The herring during this survey appeared to occupy the mid-water column at about the 30-40 m depth contour (Figure 2b).

As in 2016, we surveyed a small aggregation at the head of Rocky Bay, Montague Island. This survey was conducted during 8-9 April, and yielded an estimate of 246 MT (Table 1, Figure 3). Fish were in relatively shallow water (~ 10 m) and closely associated with the seafloor (Figure 3b).

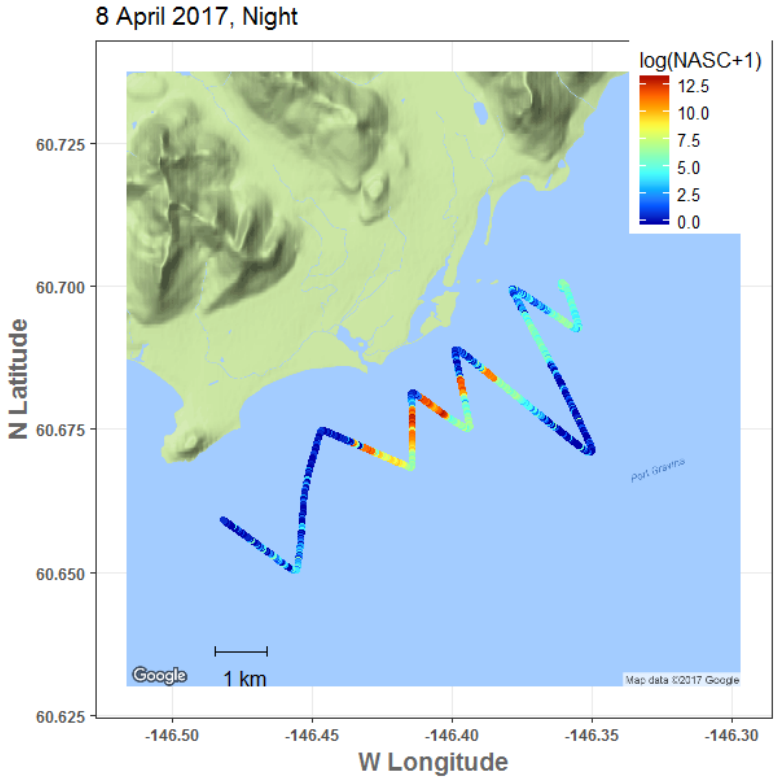
By combining the estimate in Gravina during the survey of 8 April and the Rocky Bay survey conducted during 8-9 April, we estimate a combined biomass during the spring survey of 9,986 MT.

**Table 1.** Biomass estimates of adult Pacific herring during spring cruises, 2017. Survey numbers 2 and 4 were used to estimate spawning biomass.

| Survey # | Location | Date | Time of Survey | Survey Vessel | Survey Area ($km^2$) | Biomass Estimate (mt) |
|---|---|---|---|---|---|---|
| 1 | Gravina | 7 April | 0350-0547 | *R/V Solstice* | 1.0 | 642 |
| 2 | Gravina | 8 April | 0146-0442 | *M/V Auklet* | 19.6 | 9,650 |
| 3 | Rocky Bay | 8-9 April | 1100-0100 | *M/V Auklet* | 4.8 | 246 |
| 4 | Gravina | 10-11 April | 1050-0214 | *M/V Auklet* | 17.2 | 4,094 |

**Figure 1.** The survey cruise track (#2 in Table 1) with color spectrum indicating strength of backscatter (a, NASC, $nm^2$ $m^{-2}$) and an echogram of the transect (b) conducted during the early hours of 8 April 2017 in Port Gravina, Prince William Sound.

**a)**




**b)**

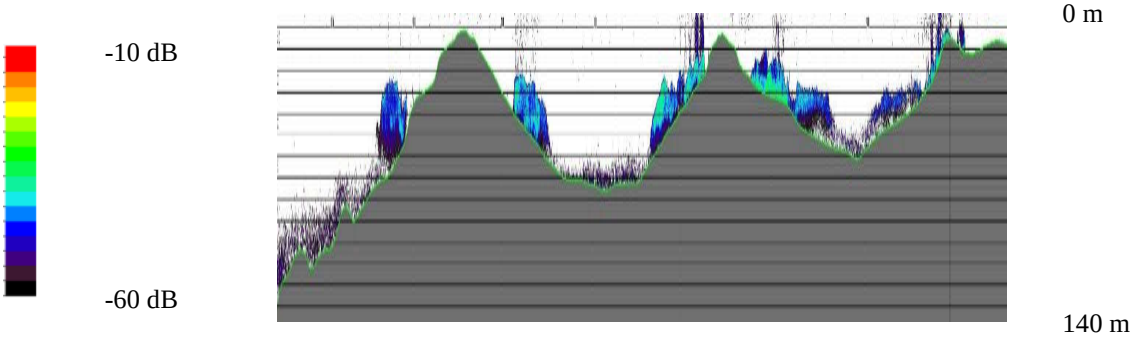
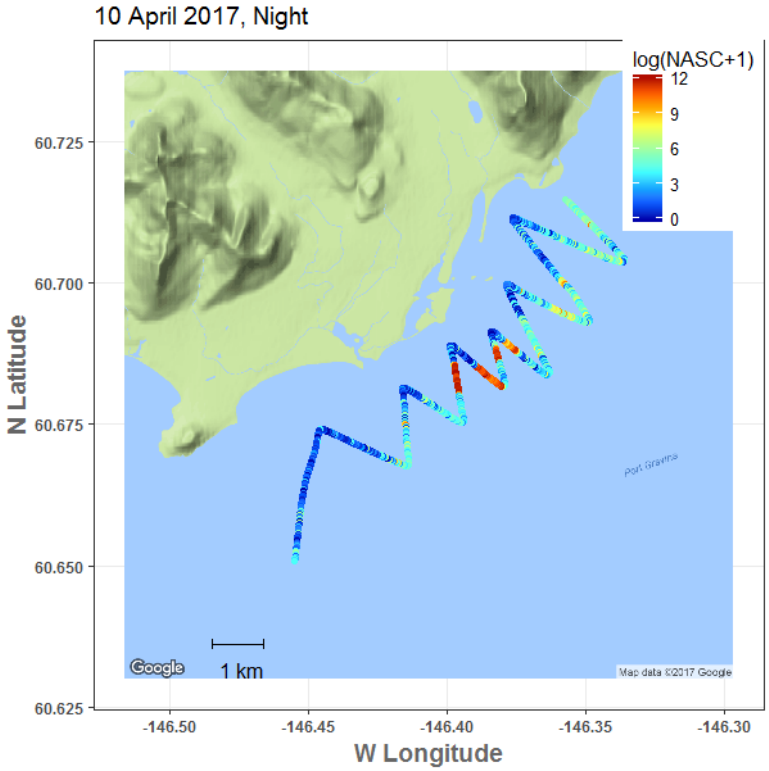


**Figure 2.** The survey cruise track (#4 in Table 1) with color spectrum indicating strength of backscatter (a, NASC, $nm^2$ $m^{-2}$) and an echogram of the transect (b) conducted during the early hours of 10 April 2017 in Port Gravina, Prince William Sound.

a)




b)

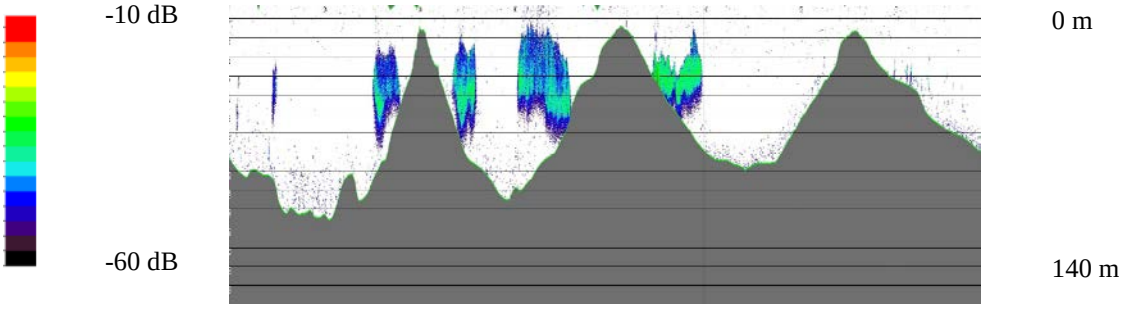
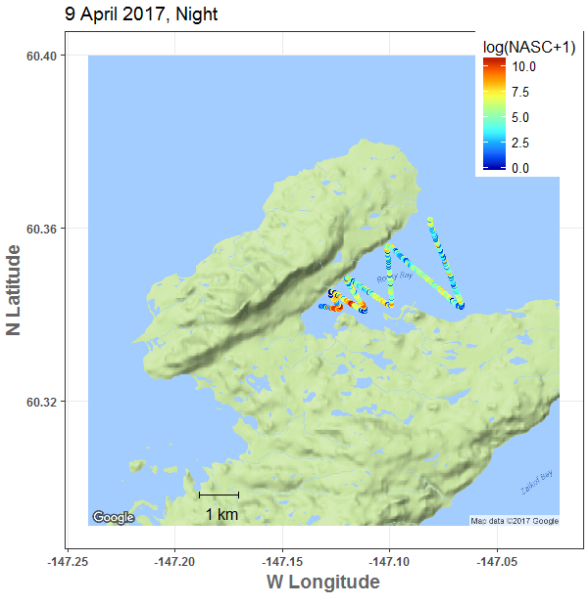
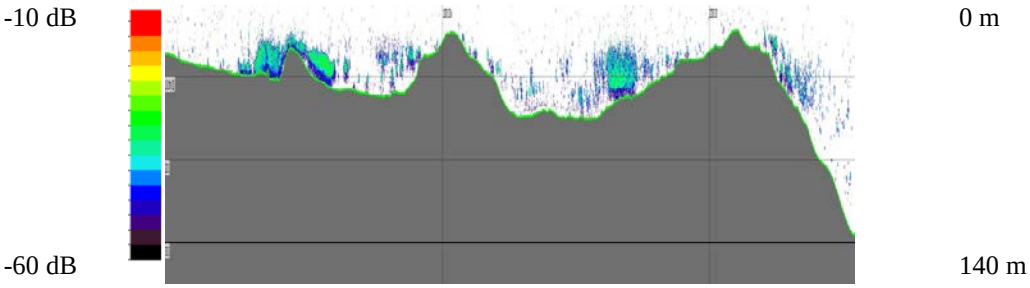


**Figure 3.** The survey cruise track with color spectrum indicating strength of backscatter (a, NASC, $nm^2$ $m^{-2}$) and an echogram of the transect (b) conducted during the early hours of 10 April 2017 in Rocky Bay, Montague Island, Prince William Sound.

a)




b)



**LITERATURE CITED**

Cochran, W.G. 1977. *Sampling Techniques*. John Wiley & Sons, New York, 428p.

MacLennan, D. N., and E.J. Simmonds 1992. *Fisheries Acoustics*. Chapman and Hall, London, 325p.

Simmonds, J. and D. MacLennon. 2005. Fisheries Acoustics: theory and practice, 2nd Ed. Blackwell Science, 429 p

Thomas, G.L., E.V. Patrick, Jay Kirsch and J.R. Allen. 1997. Development have and ecosystem model for managing the fisheries resources of Prince William Sound, Alaska. Proceedings of the 2nd World Fisheries Congress. Ed (D.A. Hancock, D.C. Smith, A. Grant, and J.P Beumer. CSIRO. Collingwood. Pages 606-614.

Thomas, G.L, J. Kirsch and R.E. Thorne. 2002. Ex situ target strength measurements of Pacific herring and Pacific sand lance. North American Journal of Fisheries Management 22:1136-1145.

Thomas, G. L. and Thorne, R.E. 2003. Acoustical-optical assessment of Pacific herring and their predator assemblage in Prince William Sound, Alaska. Aquatic Living Resources 16:247-253.

Thorne, R.E. 1971 Investigations into the relationship between integrated echo voltage and fish density. Journal of the Fisheries Research Board of Canada 28:1265-1274.

Thorne, R.E. 1977a. Acoustic assessment of hake and herring stocks in Puget Sound, Washington and southeastern Alaska. Pp. 265-278 in A.R. Margets (ed). Hydroacoustics in Fisheries Research. ICES Rapp. Et P.-v., Vol 170.

Thorne, R.E. 1977b. A new digital hydroacoustic data processor and some observations on herring in Alaska. Journal of Fisheries Research Board Canada 34:2288-2294.

Thorne, R. E. 1983a. Hydroacoustics. *In* Fisheries Techniques, pp. 239-259. Ed. by L. Nielson and D. Johnson. American Fisheries Society, Bethesda, MD.

Thorne, R.E. 1983b. Assessment of population abundance by echo integration. Proc. Symp. On Assessment of Micronekton. Biol. Ocean. J. 2:253-262.

Thorne, R.E. and G.L. Thomas. 2008. Herring and the "Exxon Valdez" oil spill: an investigation into historical data conflicts. ICES Journal of Marine Science 65:44-50.

Trumble, R., R.E. Thorne and Lemberg. 1983. The Strait of Georgia herring fishery: A case history of timely management aided by hydroacoustic surveys. Fisheries Bulletin 80:381-388.

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

(1) *Within the Program:* We primarily coordinated and collaborated with HRM Project Number: 17160111-F (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. While our plan was to rely on the *R/V Solstice* as a research platform to conduct acoustic surveys during the early part of the field season, this was made difficult due to a compressed period during which herring were aggregated. Further, there was limited numbers of berths on the vessel to accommodate field technicians focusing on different HRM objectives. Based on recent observed trends, the period during which acoustic surveys can be conducted has become compressed. There are clear advantages to having a vessel devoted solely to conducting acoustic surveys to provide adequate time for HRM PIs to accomplish a number of objectives over a relatively brief period of time.

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

A manuscript (Pacific herring response to surface predators in Prince William Sound, Alaska) was submitted and accepted with revisions to Marine Ecology Progress Series during FY17. The manuscript includes observations made during the spring 2016 herring survey in Port Gravina. I am currently working on revisions and intend to resubmit a revised manuscript in March 2018.

Raw acoustic data from the spring 2017 survey was uploaded to the data portal immediately following the research cruise (on 13 April 2017). Biomass estimates were presented to and shared with HRM PIs during November 2017 and the biomass estimates were uploaded to the data portal and made public in February 2018.

I was interviewed by Hayley Hoover for a radio program (Field Notes) in FY17. The focus of the interview was describing the importance of this project in understanding the factors preventing recovery of herring in PWS. The interview is including in a media link on our PWSSC project page: http://pwssc.org/adult-biomass-surveys/

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

**Science Panel Comments and Responses on Revised FY17-21 Proposal, September 2016**

The Panel particularly appreciated the assembly of the historical acoustic database. This database is one of two key databases used for annual biomass assessments. Such an accessible database, supported by an accessible report is an essential component for continued biological assessments.

Therefore we salute the progress made to date but urge the complete of the documentation of past acoustic surveys.

*PI Response: The EVOSTC Science Panel comments (dated September 2016) focused on documenting the historical data from past acoustic surveys. I now have data from recent years organized in the research workspace (raw, intermediary and final data summaries) included detailed metadata, and have made the file with the annual biomass estimates (now spanning the years 1993-2017) available in a public folder. I intend to complete an analysis on this historic data and revise an existing manuscript that was originally drafted by Dick Thorne.*

**Science Panel Comments and Responses on Revised FY18 Proposal, September 2017**

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 (10/13/2017)*
*We thought the results from previous years were already available on the AOOS Gulf of Alaska data catalog. We are working with the Data Management program to make it available as soon as possible. The history of assessments and maps of survey tracks are available in the cruise reports and EVOS annual reports from 2000-2016. Raw data from 1993-1999 was not collected digitally and is no longer available, only the final processed biomass estimates remain. We will work with the data management program to make these available through the AOOS data catalog.*

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

***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 | $ 17.2 |
| Travel | $0.6 | $0.6 | $0.6 | $0.6 | $0.6 | $2.8 | $ 0.6 |
| Contractual | $10.8 | $10.8 | $0.8 | $0.8 | $0.8 | $24.0 | $ 0.3 |
| Commodities | $1.5 | $0.0 | $0.0 | $0.0 | $0.0 | $1.5 | $ - |
| Equipment | $0.0 | $0.0 | $0.0 | $0.0 | $0.6 | $0.6 | $ - |
| Indirect Costs (*will vary by proposer*) | $15.7 | $15.6 | $13.0 | $13.4 | $13.9 | $71.6 | $ 5.4 |
| **SUBTOTAL** | $68.1 | $67.7 | $56.3 | $57.9 | $60.4 | $310.3 | $23.5 |
| General Administration (9% of subtotal) | $6.1 | $6.1 | $5.1 | $5.2 | $5.4 | $27.9 | N/A |
| **PROJECT TOTAL** | $74.2 | $73.8 | $61.3 | $63.1 | $65.8 | $338.2 | |
| Other Resources (Cost Share Funds) | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | |

COMMENTS:
**This summary page provides an five-year overview of proposed project funding and actual cumulative spending.** The column titled 'Actual Cumulative' must be updated each fiscal year as part of the annual reporting requirements. Provide information on the total amount actually spent for all completed years of the project. On the Project Annual Report Form, if any line item exceeds a 10% deviation from the originally-proposed amount; provide detail regarding the reason for the deviation.

Funding in some lines is underspent because funding did not become available until May 2017 and previous funding was used to cover the major field season in April.

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