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).

17170111-D

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

Studies of Reproductive Maturity among Age Cohorts of Pacific Herring (*Clupea pallasii*) in Prince William Sound, Alaska

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

Kristen B. Gorman, Prince William Sound Science Center (PWSSC), P.O. Box 705, Cordova, AK 99574

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

February 1, 2017 – January 31, 2018

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

February 2, 2018

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

http://pwssc.org/reproductive-maturity-of-pacific-herring/

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

PROJECT SUMMARY (FY17)

This project, "Studies of Reproductive Maturity among Age Cohorts of Pacific Herring (*Clupea pallasii*) in Prince William Sound, Alaska" was proposed as a new study to the *Exxon Valdez* Oil Spill Trustee Council's (EVOSTC) Herring Research and Monitoring (HRM) Program FY17-21 funding cycle. This annual report is the first for this project and will provide a summary of the research accomplished over the last year (FY17), in addition to a review of the extensive revision to the FY18 renewal proposal for this project.

Initially, this project was designed as an extension of a pilot project supported by EVOSTC between 2012-13 as reported by Vollenweider and Heintz (2017), which focused on the use of scale growth to understand reproductive maturity schedules among female Pacific herring (hereafter herring) in Alaska. Thus, the original proposal for this project to the FY17-21 EVOSTC funding cycle aimed to primarily expand the sample sizes needed to more rigorously compare scale growth patterns with ovary histology at the individual level for female herring within the same age cohort between 3-5 years of age. The focus on ages 3-5 reflected the fact that the Prince William Sound (PWS) Pacific herring Age-Structured-Assessment (ASA) model (see Hulson et al. 2008, Muradian et al. 2017), which estimates the entire biomass of herring in PWS for management purposes, provides output regarding the proportion of mature and immature herring in these age cohorts as part of the analysis. However, the ASA model's output regarding the reproductive maturity schedule of herring has never been compared with empirical data from the field. Thus, the FY17-21 project was proposed as an important test of the ASA model's reproductive maturity schedule, which Vollenweider and Heintz (2017) never addressed. Because the originally proposed study (FY17-21) involved both histological assessment of ovaries and the

measurement of scale growth, the work inherently captured both direct measures of ovary maturation and indirect methods of female maturation schedules based on scale growth patterns, allowing for two different approaches to test the ASA model output. However, the proposal was written with a focus on the scale technique given the previous work by Vollenweider and Heintz (2017) in addition to the important fact that the scale growth technique allows for assessment of maturity schedules across the entire population of recruited herring, which is much harder to accomplish using direct measures of gonad maturation. Since the original FY17 proposal was funded in fall 2016, the collection of 2017 samples followed the methods outlined in the original proposal. However, when the original project was proposed for renewal in FY18, which included the exact same work as in the funded FY17 proposal, the study received considerable criticism by the EVOSTC Science Panel (see Section 10 below) and underwent significant revision in terms of refocusing the project to rely on direct methods of gonad maturation as the primary test of the ASA model maturity schedule, as opposed to relying on the scale growth technique. Further, the Science Panel recommended that the project focus on males, as well as females, for FY18. Because of the changes requested by the Science Panel during the FY18 proposal review process, slightly different data were collected between spring 2017 and fall 2017 as is represented in the results and figures presented below. Further, because of the extensive re-write and re-focus of the proposal during fall 2017, several aspects of the FY17 work are still forthcoming, which are detailed below.

PROJECT SPECIFIC GOALS (FY17-21)

The overall goal of the proposed Herring Research and Monitoring Program (2017-2021) is *to improve predictive models of PWS herring stocks through observations and research*. To this end, the goal of the project is ***to improve the Bayesian PWS herring Age-Structured Assessment model's ability to more accurately predict the total population's biomass by empirically assessing reproductive maturity among age cohorts***. Specifically, the FY17-21 proposed project had the following objectives: 1) assess the seasonal timing (spring, summer, and fall) that allows for accurate determination of both previously spawned and maturing female herring based on ovary histology to determine maturation states; 2) couple histology results with annual scale growth information at the individual level, within specific age cohorts across seasons, to understand if scale growth patterns reflect reproductive investment; 3) assess whether annual scale growth patterns can be used to infer age at maturity at the individual level across age cohorts given results from objectives 1 and 2, and 4) assess inter-annual variability in age at maturity based on coupled histology and scale growth over a five-year period by focused, increased sampling during the optimal seasonal period given results from objectives 1-3.

PROJECT HYPOTHESES AND OBJECTIVES (FY17)

The work for FY17 was focused on testing the following hypothesis:

(H1) Precise determination of previously spawned and maturing female herring (age 3-5), based on ovary histology to determine maturation states, is similar across seasons (spring, summer, fall). Because there is limited previous work, there was no *a priori* prediction and therefore work aimed to test this null hypothesis. The FY17 proposal assumed that age 6+ fish are 100% mature, and therefore did not consider age 6 fish in the sampling design. Hypothesis 1 addressed Objective 1 listed above: to assess the seasonal timing (spring, summer, and fall) that allows for accurate determination of both previously spawned and maturing female herring based on ovary histology to determine maturation states. Thus, sampling was planned to take place during the spring spawn event (April 2017), summer (June 2017), early fall (September 2017), and possibly winter (December 2017). The following is noted in the FY17 proposal regarding methods to address Objective 1: This study will be conducted during the first two years of the five-year program. The main focus here is to resolve the time of year female fish can be

collected where post-ovulatory follicles (POFs) are still visible from an earlier spawning event, in addition to evidence of newly developing follicles in preparation for the next spawning event.

PROJECT METHODS (FY17)

Female fish will be collected at three times during the year – a) during spring (March/April) collections for age, sex and length (S. Moffitt, Alaska Department of Fish & Game [ADF&G]) and adult herring acoustics (P. Rand, Prince William Sound Science Center [PWSSC]). These collections will take advantage of existing ship time to complete the fieldwork. Aerial surveys will also be conducted during spring to identify fish outside the spawning population to sample via raft and cast net; b) during summer (late June) in association with a more limited aerial survey effort simply to identify schools of fish; and c) during fall (September/October) in association with Gulf Watch Alaska (GWA) forage fish surveys (M. Arimitsu and J. Piatt, U.S. Geological Survey [USGS]). There may also be the possibility of collecting fish in December as part of the Gulf Watch Alaska (GWA) whale/forage fish survey (R. Heintz and J. Moran, National Oceanic and Atmospheric Administration [NOAA]). Thus, it is anticipated that there will be at least three collection periods including spring, summer and fall. Any additional sampling in winter would likely only be conducted in year 1. Females aged 3-5 will be targeted for collection mainly using trawl gear. Sample sizes follow: age 3+ (n = 115 fish/seasonal collection, total 345/year), age 4+ (n = 115/collection, 345/year), and age 5+ (n = 60 fish/collection, 120/year) resulting in a total of 870 fish collected in each of the first two years of the study. In order to reach the sample sizes required for histology and scale analysis of females, over collection of herring will be required and the immediate determination of sex and age in the field in order to target enough female fish per age cohort. Once collected, fish will be processed immediately aboard charter vessels. First, a scale will be removed for aging using a dissecting scope. Once age is determined, an individual fish between the ages of 3+ - 5+ will be further processed. All fish within these ages will be measured for length (mm) and wet weight (g). Gonads will be dissected from the body and a gonadosomatic index (GSI) will be developed by weighing the gonad separately where GSI = (ovary weight/whole wet weight)*100 (see Hay and Outram 1981). For female herring, a small mid-section of ovary will be dissected and preserved in formalin for slide mounting and pathology analysis (H. Snyder, President and CEO, and J. Kramer, DVM, Histologistics, Worcester, MA) for discerning maturity states following criteria outlined by Brown-Peterson et al. (2011). Several additional scales from the lateral side of the body for both males and females will be collected and mounted on slides. These scales will be used to measure individual scale annuli of females only using imaging software by an ADF&G Cordova technician. By additionally collecting scales from males, we will archive these samples for any future analyses of male herring scale growth. It is entirely possible that it will be difficult to meet targeted sample sizes, as we do not know in advance what the age structure of fish schools are ahead of sampling.

It is expected that females collected during the spring spawn surveys will have evidence of developed follicles as part of the current spawning event. It is unclear whether POFs will be evident at this time or not. Some proportion of females collected during summer should have evidence of POFs from the prior spring spawning event, while others may not, particularly for age 3 fish. Whether developing follicles for the next spring's spawning event will be evident at this time is not known. Females collected during the early fall likely have the greatest potential to show both evidence of POFs from previous spawning the spring prior as well as developing follicles for the next spawning event. These collections are expected to help resolve the seasonal timing most optimal for understanding both the immediate spring season's spawning history and the future spring's spawning decisions of individuals.

PROJECT RESULTS (FY17, SPRING AND SUMMER)

Spring 2017

Herring (*n* = 937) were collected from the PWS spawning population near Gravina (Fig. 1) on April 4 and 9, 2017 in association with fieldwork for ADF&G's herring age, sex, and length collections (April 4), and PWSSC's adult herring acoustic assessment (April 9). The Gravina spawning group was the earliest group to begin spawning in PWS in 2017, which began on April 13, 2017 (S. Haught EVOS PI Meeting Presentation, November 2017). Herring were also observed spawning in Canoe Passage during 2017, ~5 days later around April 18, 2017 (S. Haught EVOS PI Meeting Presentation, November 2017). These were the two primary areas for PWS herring spawn in 2017, which was the lowest mile-days of milt (9.5), aside from 2016 (also ~9.5), since 1980 based on ADF&G's survey data (S. Haught EVOS PI Meeting Presentation, November 2017). Due to limited logistics, the project was unable to capture herring outside the PWS spawning population. Thus, all fish processed for spring 2017 should be considered representative of the spawning stock.

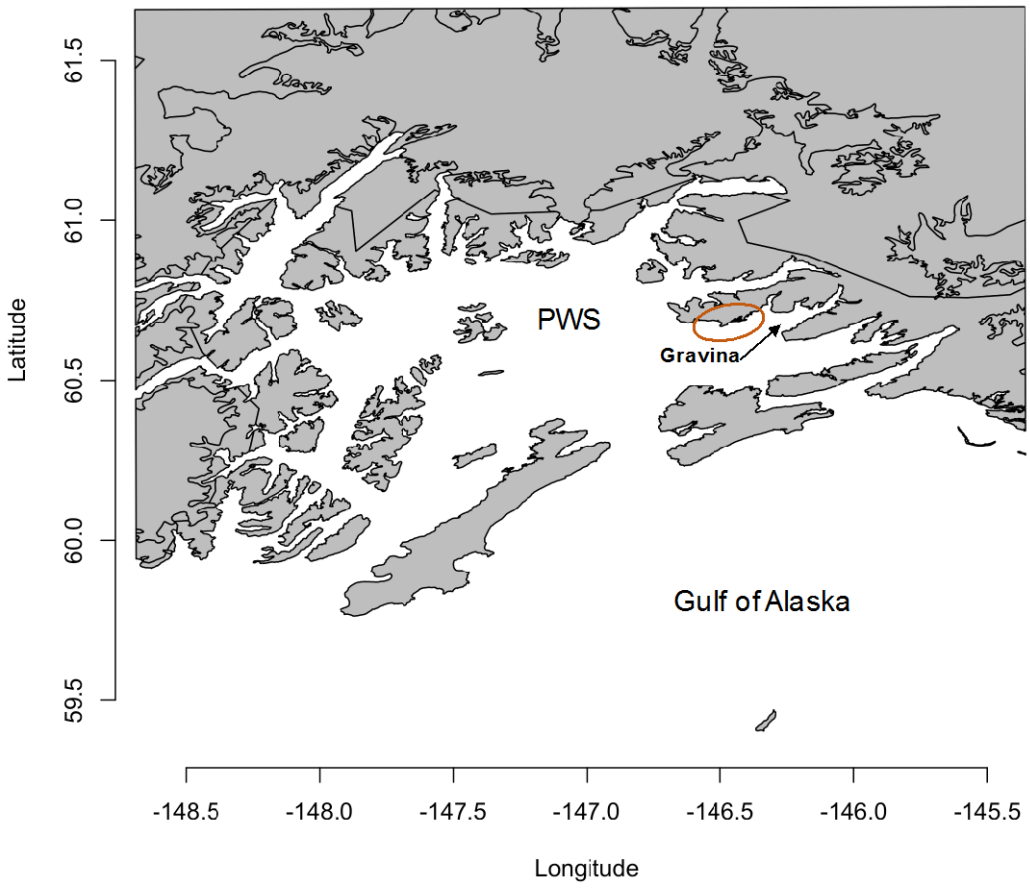

Figure 1. Prince William Sound (PWS) study area showing the location of spring Pacific herring samples collected from the spawning population at Gravina during April 2017. Shaded circle shows near-shore location where fish were collected.

Target sample sizes (n = 115 female herring for ages 3 and 4, n = 60 for age 5 female herring) for spring 2017 collections were met for age 3 (n = 243) and 4 (n = 134) female herring, but not for age 5 (n = 38) female herring (Fig. 2). Data indicate that age 3 and 4, and to a lesser extent age 5, herring made up the largest proportion of the female spawning stock in 2017 (Fig. 2). Further, the great majority of the female herring caught from the spawning population in early April, ~10 days prior to spawning, had developed ovaries that were 15-25% the weight of the entire body (Fig. 3).

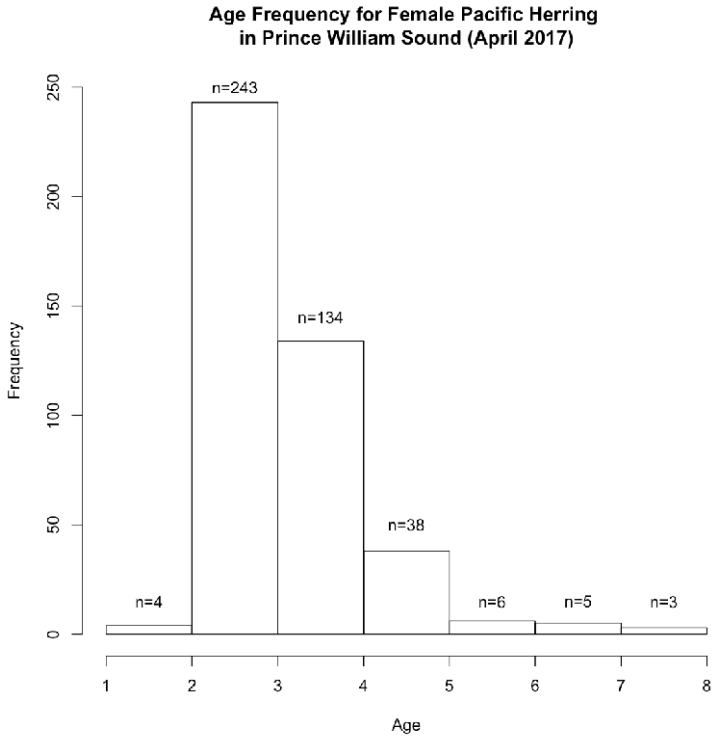

Figure 2. Age structure of female Pacific herring caught in the Prince William Sound spawning population during April 2017. Note the age of each bar is represented by the number to the right of the bar. For example, the first bar represents age 2 female herring, the last bar represents age 8 female herring.

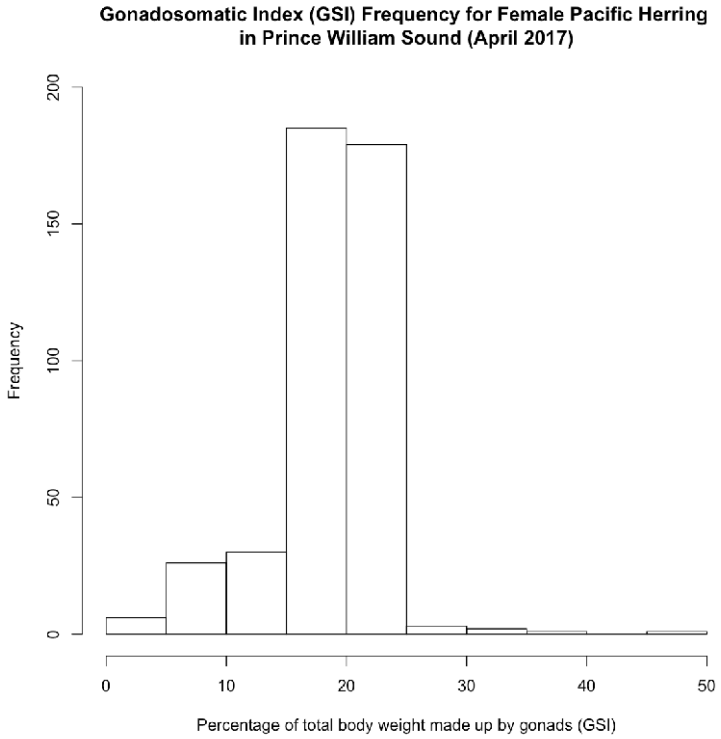

Figure 3. Frequency of gonadosomatic index values (in bins of 5%) of female Pacific herring caught in the Prince William Sound spawning population during April 2017.

In examining variability in the frequency of GSI values by age, it appears that age 3 and age 4 female herring comprised a large percentage of the fish with GSI values between 15-25%, with age 5 female herring being the next largest age class with GSI values between 15-25% (Fig. 4). Interestingly, a larger proportion of age 3 female herring had a GSI value less than 20%, while a larger proportion of age 4 female herring had a GSI value greater than 20% (Fig. 4b, c), which suggests that older fish might mature more quickly.

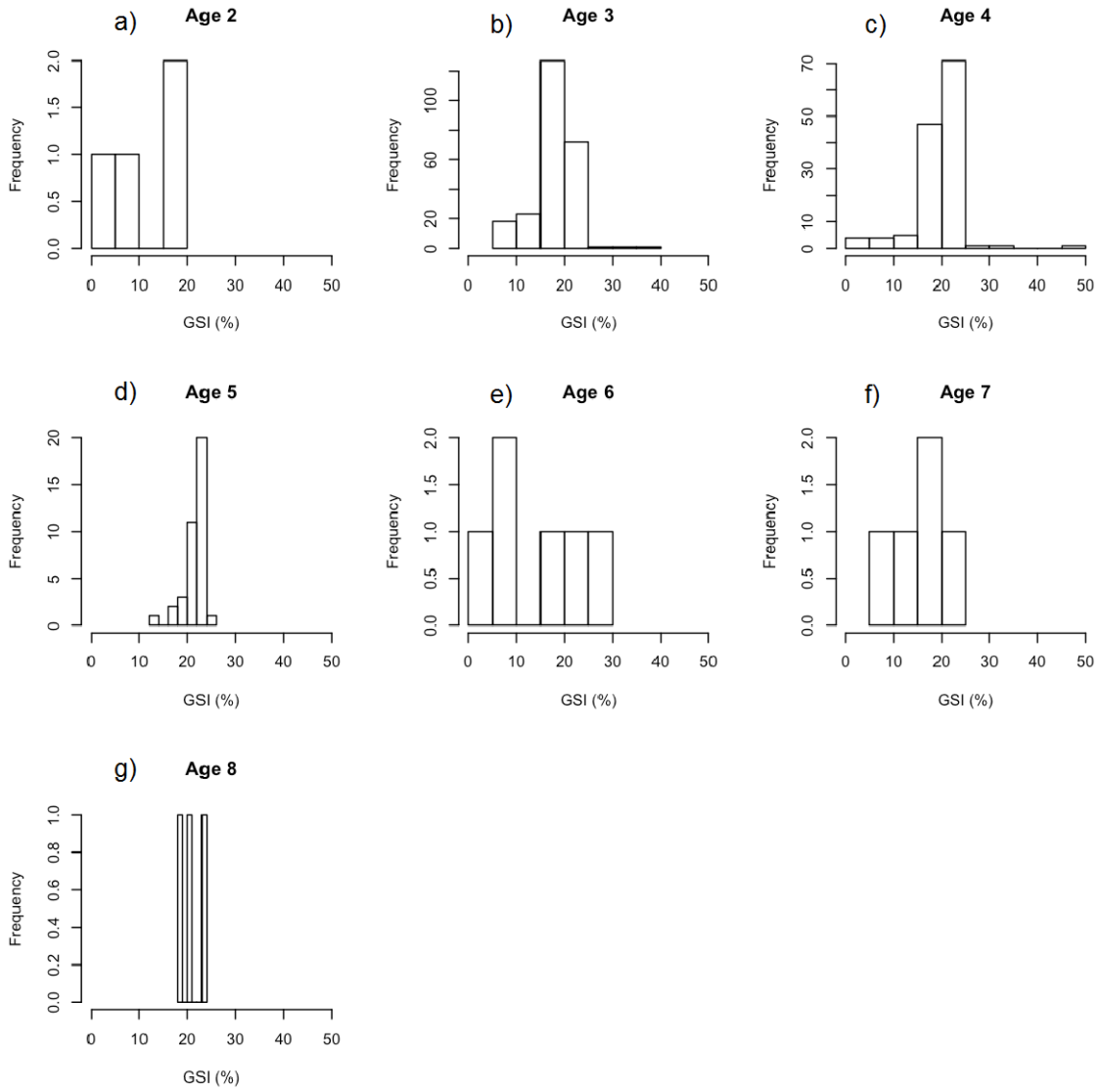

Figure 4. Frequency of gonadosomatic index values by age class of female Pacific herring caught in the Prince William Sound spawning population during April 2017.

Relationships between female herring body length and GSI values per age cohort indicated that only very small percentages of herring caught from the spring spawning population were reproductively immature as defined by Hay and Outram (1981) and Hay (1985) where herring sexual maturation begins when ovary weight exceeds 5% of the total body weight (Fig. 5). Specifically, the proportion of immature and mature female herring per age cohort collected from the spawning population is reported in Table 1.

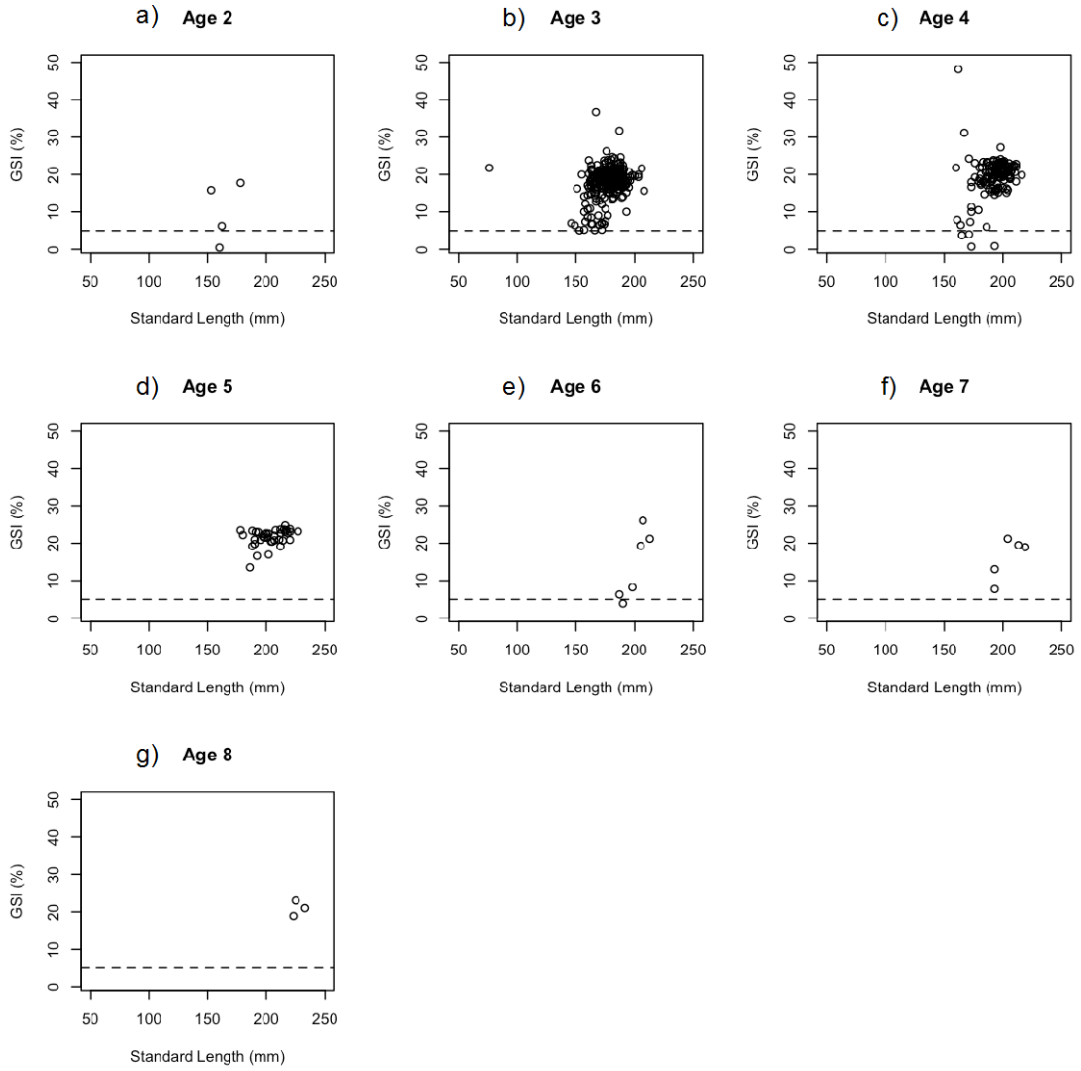

Figure 5. Relationships between body length and gonadosomatic index (GSI) by age cohort for female Pacific herring caught from the spawning population during April 2017. Dashed line indicates the GSI threshold between reproductive immaturity (<5%) and maturity (>5%).

Table 1. Proportion of immature and mature female Pacific herring caught from the spawning population during April 2017.

Age	No. Immature	No. Mature	% Immature	% Mature	Range of GSI (%)
2	1	4	25	75	0.45 - 17.75
3	0	243	0	100	5.09 - 36.66
4	4	130	3	97	0.71 - 48.13
5	0	38	0	100	13.56 - 24.77
6	1	5	20	80	3.90 - 26.02
7	0	5	0	100	7.74 - 21.22
8	0	3	0	100	18.91 - 23.01

In summary for the spring 2017 collections, research confirmed that the PWS spawning population is primarily composed of reproductively mature female herring, as would be expected. Age 3 and 4 fish dominated the female spawning stock and there was some evidence that age 4 females matured more quickly given that a larger percentage of age 4 females had GSI values over 20%, unlike age 3 females. Based on the first year's work, it appears that catching fish from the spawning population is relatively easy and there were no issues obtaining data of interest regarding age, body and ovary mass, and body length, and ovary samples for histology. Results from the histological analysis are not reported here as data have not been received as of February 2018. Histology samples were sent in January 2018 for analysis. The reason for the delay in sending histology samples was related to the significant revision of this proposal during fall 2018, and the fact that few fish were caught during summer and fall 2017, which is described in more detail below. In addition, it is noted that spring 2017 analyses are restricted to females only as this was the focus of the FY17 proposal that was supported by EVOSTC.

Summer 2017

PI Gorman along with two technicians chartered the *F/V Montague* for five days between June 14–18, 2017 to catch Pacific herring for age at maturity analyses throughout PWS. Our plan for this cruise was to primarily use a mid-water trawl to catch adult herring, and to jig for herring in the evening while at anchor. Eleven trawl events were conducted over four days at locations throughout PWS (Fig. 6). Only during a night-time trawl in Gravina were we able to catch any herring, which included many age 1 fish that were not the target of our study on adult age at maturity. We were unable to locate any schools of adult herring during this cruise, which may not be surprising given the extremely low abundance of spawning herring observed in PWS since 2015.

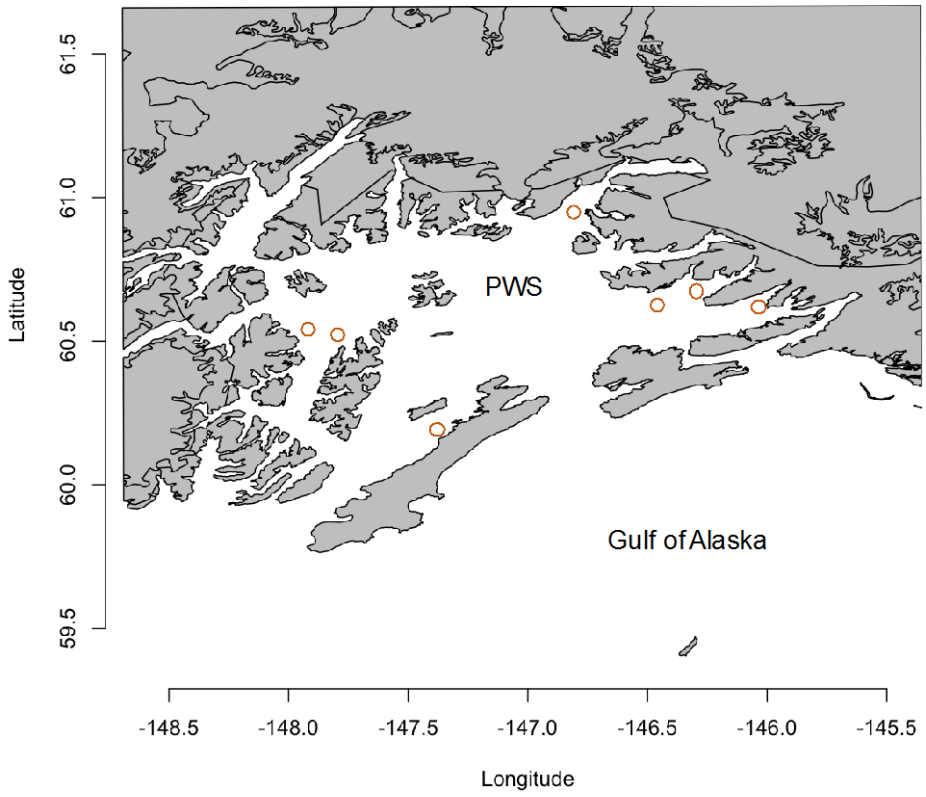

Figure 6. Prince William Sound (PWS) study area. Shaded circles show the location where trawls were conducted during June 2017 to catch Pacific herring.

Further, telemetry data by Mary Anne Bishop, as part of the EVOSTC HRM program, indicate that adult herring leave PWS after spawning and return in the fall, thus, summer appears to be a difficult time to catch adult herring in PWS. Given the difficulties of catching adult herring PWS during summer, plans for FY18 summer sampling now include collecting herring during a NOAA cruise in the Gulf of Alaska during July 2018. Hopefully, the access to fish caught as part of this larger cruise will allow for increasing summer sample sizes in comparison with FY17 in order to assess male and female gonad maturity, age, and scale growth based on the revised FY18 proposal.

Fall 2017

PI Gorman joined the EVOSTC predator-prey (whale and forage fish) cruise led by J. Moran (NOAA) and M. Arimitsu (USGS). This cruise was conducted between September 16-24, 2017 aboard the M/V *Island C*. The cruise used NOAA trawl and acoustic gear to identify and catch forage fish including adult herring primarily at Bainbridge, Montague entrance, and Gravina regions of PWS (Fig. 7). Again, similar to summer 2017 collections during June, very few schools of adult herring were observed. The only region adult herring were caught in any real numbers (n = 17) was near Gravina (Fig. 7). A few adult herring (n = 3) were also caught near Latouche Island closer to Montague entrance.

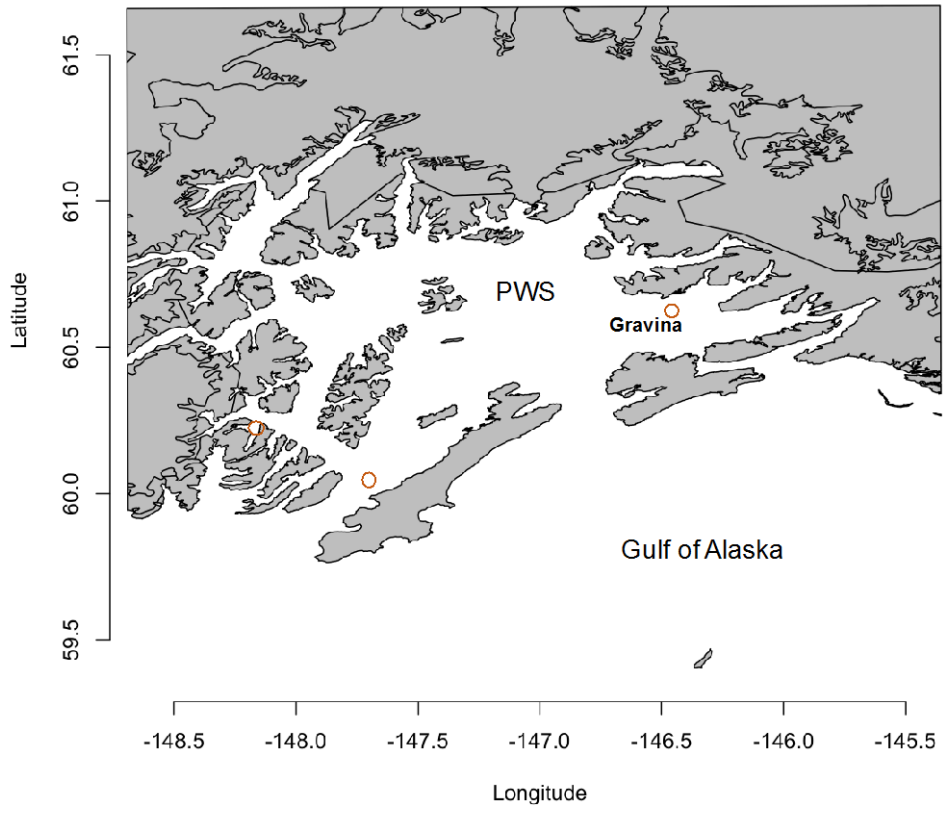

Figure 7. Prince William Sound (PWS) study area. Shaded circles show the location where trawls were conducted during September 2017 to catch Pacific herring. Adult herring were primarily caught in the Gravina region of PWS.

Because sample sizes were generally low for September 2017 collections, males and females were pooled for preliminary analyses. The ages and histological assessment of herring caught in fall 2017 have not yet been determined as lab work for this project was essentially suspended pending the FY18 proposal approval by the EVOSTC Science Panel. Preliminary analyses indicated that the majority of the fish collected were reproductively immature as GSI values were less than 5% except for one individual (Figs. 8 and 9). Standard lengths of the herring caught in September 2017 should be within the 3-4 age range based on similar measures for spring caught fish (Fig. 5).

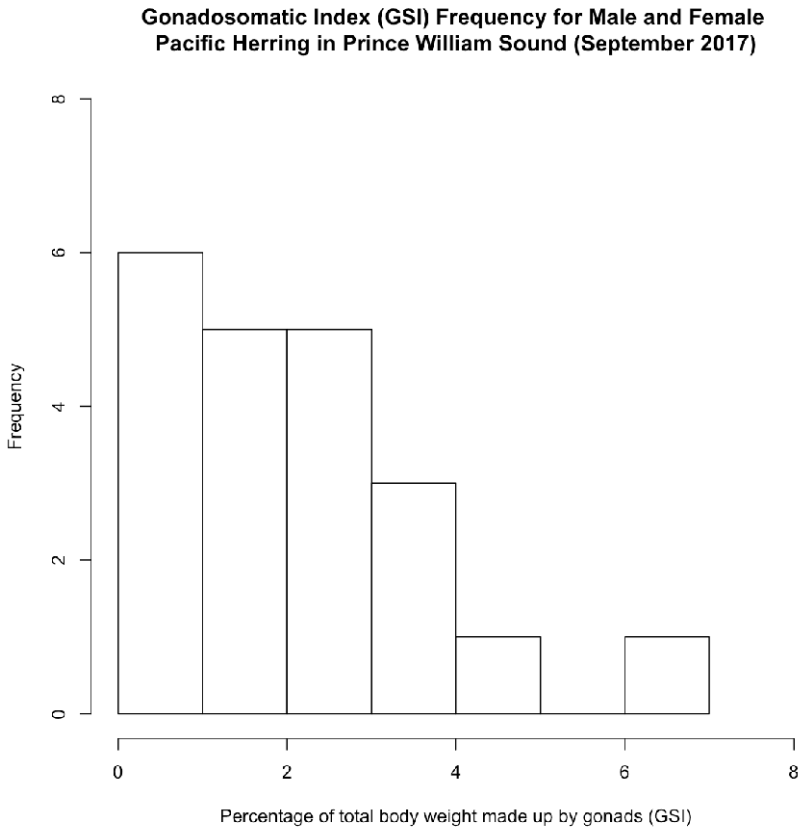

Figure 8. Frequency of gonadosomatic index values of male and female Pacific herring caught in Prince William Sound during September 2017.

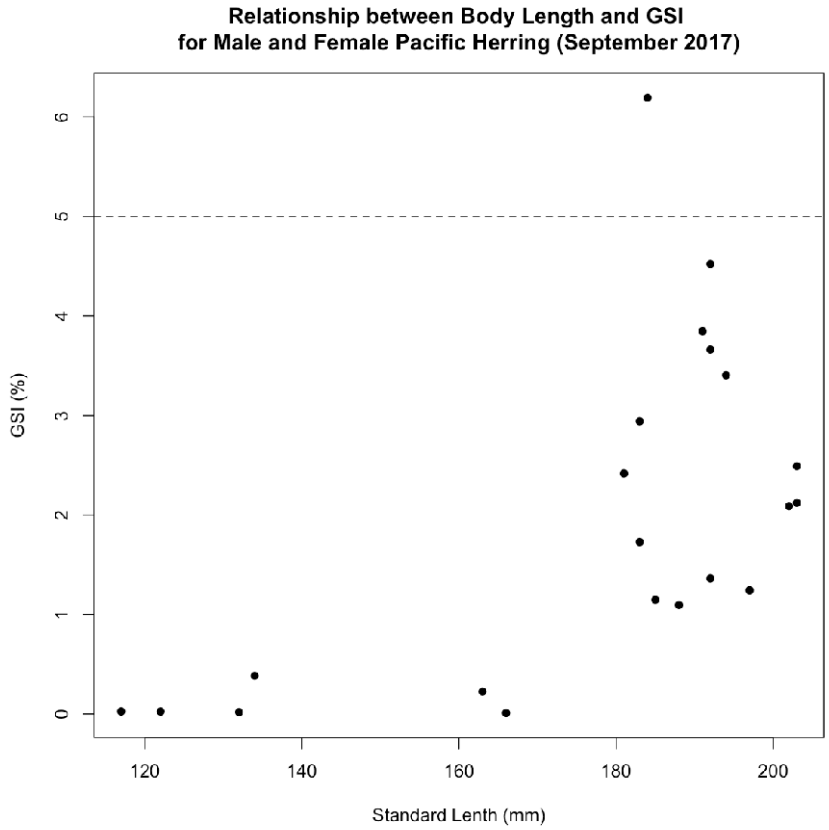

Figure 9. Relationship between body length and gonadosomatic index (GSI) for male and female Pacific herring caught during September 2017. Dashed line indicates the GSI threshold between reproductive immaturity (<5%) and maturity (>5%).

In summary, although sample sizes were small for fall 2017 collections, the data suggest that at this point in the season adult herring do not show considerable reproductive maturation as the proportion of immature herring was 95% (20/21), while the proportion of mature herring was 5% (1/21) (Fig. 9) based on criteria outlined by Hay and Outram (1981) and Hay (1985).

PROJECT HYPOTHESES AND OBJECTIVES (FY18)

During fall 2017, the FY 18 proposal for this project was completely revised. A summary is provided below to compare with the text above concerning the original proposal's hypotheses and objectives.

The overall goal of the proposed Herring Research and Monitoring Program (2017-2021) is *to improve predictive models of PWS herring stocks through observations and research*. To this end, the goal of the project described here is ***to test the PWS herring Bayesian Age-Structured Assessment model's age at maturity function with empirical data.*** First, proposed research will focus on adult female and male herring caught in PWS to provide annual estimates of the proportion of immature and mature herring for age cohorts of interest to the ASA model (ages two through five) using simple and direct measures of gonad maturation such as a gonadosomatic index (GSI) following Hay and Outram (1981), the Hjort criteria as outlined by Hay (1985), and ovary histology of females (Brown-Peterson et al. 2011). As a secondary effort, studies will continue to validate the use of scale growth measures as a technique for discerning age at maturation for both female and male herring in PWS. The advantage of using scale growth as a measure of age at maturity for herring, if accurate, is that it allows for sampling the entire

population after individuals have recruited, as opposed to direct measures of gonad maturity that require sampling of younger fish that may be located differently in time or space from the spawning population.

Hypothesis 1: There is no seasonal variability (spring, summer, fall, and winter) in the determination of both previously spawned and maturing female herring, and maturing male herring, (ages two through five) based on direct measures of gonad maturation (GSI and Hjort indices, ovary histology).

Objective 1: Assess the seasonal timing (spring, summer, fall, and winter) that allows for accurate determination of both previously spawned and maturing female herring, and maturing male herring, based on direct measures of gonad development to determine maturation states and the proportion of immature and mature herring among ages cohorts of interest (ages two through five) in PWS (FY17-18). Although a laboratory study by Vollenweider et al. (2017) of post-spawn female herring collected in Southeast Alaska indicated that the presence of post-ovulatory follicles were a reliable indicator of past spawning activity within 3 months, I continue to test the null hypothesis so that these relationships can be established specifically for PWS herring. This proposal assumes that age 6+ fish are 100% mature and therefore are not considered in the sampling design. The proposal also assumes that evidence of gonad maturation indicates that an adult herring will in fact spawn in the spring. It is understood that for some herring systems (i.e., Norwegian Spring-Spawn herring) there is evidence that females may not abandon ovary development until very close to the spawning event (Kennedy et al. 2011). Since there is no indication late abandonment of gonad development is true for PWS herring, this proposal assumes that gonad maturation indicates that spawning will be attempted in the spring.

PROJECT RESULTS (FY17, WINTER)

It is noted that results for winter 2017 collections follow the revised proposal for FY18 and therefore results for males and females are reported, including estimates of gonad maturation based on the Hjort scale.

Winter 2017

A revised FY18 proposal for this project was approved in December 2017 by the EVOSTC Science Panel. As PI Gorman addressed concerns by the EVOSTC Science Panel throughout fall 2017, the approach for FY18 became clearer (see Section 10 below). PI Gorman was able to collect many adult herring (n =158) in the Gravina region of PWS on November 21, 2017 (Fig. 10) using a fish finder and jig gear. Samples collected were processed following the approach now outlined in the FY18 proposal. The main difference in processing samples between FY17 and FY18 proposals is that the FY18 work focuses on both male and female herring. Further, in addition to histology and GSI, maturation criteria following the Hjort scale (Hay 1985) are used to assess gonad development. Currently, age and histological data are not yet available for herring caught in November 2017.

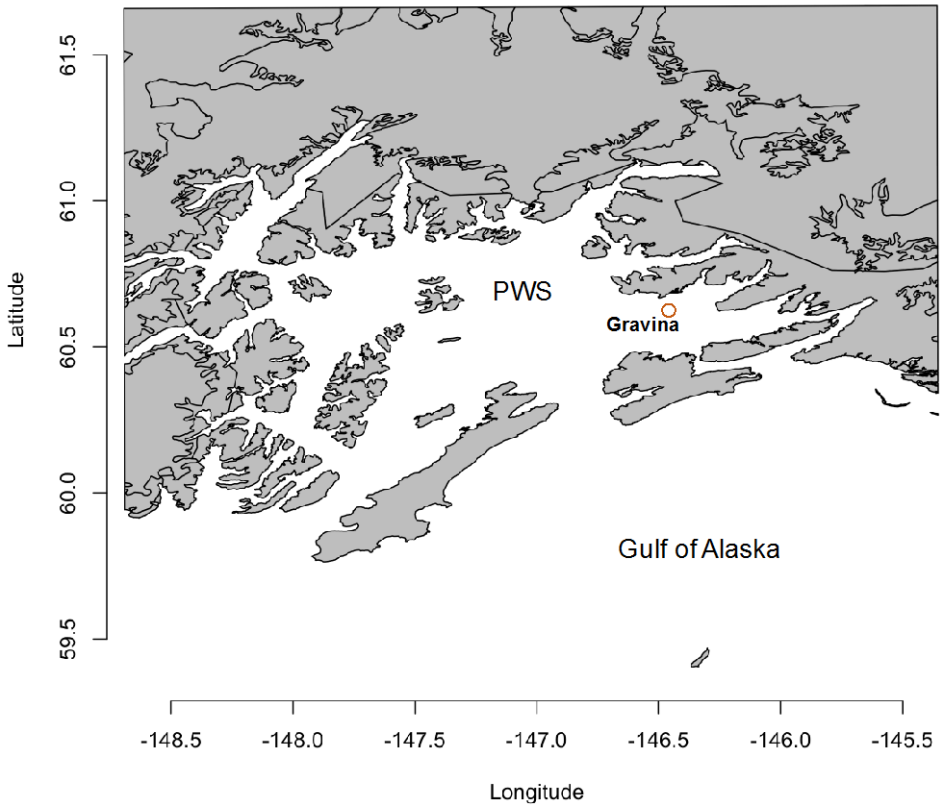

Figure 10. Prince William Sound (PWS) study area. Shaded circle shows the location were sampling was conducted during November 2017 to catch Pacific herring. Adult herring were only caught in the Gravina region of PWS.

Data from November 2017 indicated that just over half of the herring samples were immature in late November 2017 as a high frequency of fish has GSI values below 5% (Fig. 11). Relationships between fish body length and GSI demonstrated a similar pattern (Fig. 12). The proportion of reproductively immature and mature herring caught in November 2017 was 56% and 44%, respectively. Further the size of fish caught in late November was within the range of fish sizes caught in spring 2017 (Figs. 5 and 12). What is interesting to note, is that male herring in November are close to obtaining GSI values that were documented for females in spring 2017, i.e., 15-25%. Females caught in November, appeared to be barely reaching reproductive maturity at this time (Fig. 13b).

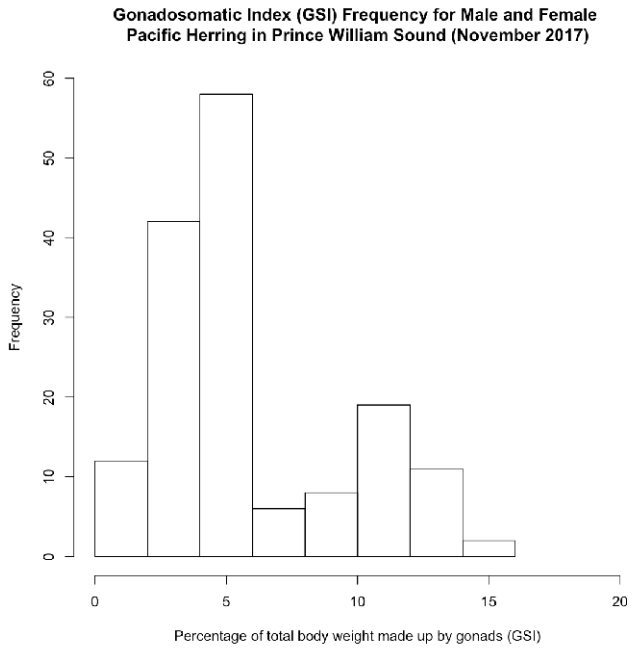

Figure 11. Frequency of gonadosomatic index values of male and female Pacific herring caught in Prince William Sound during November 2017.

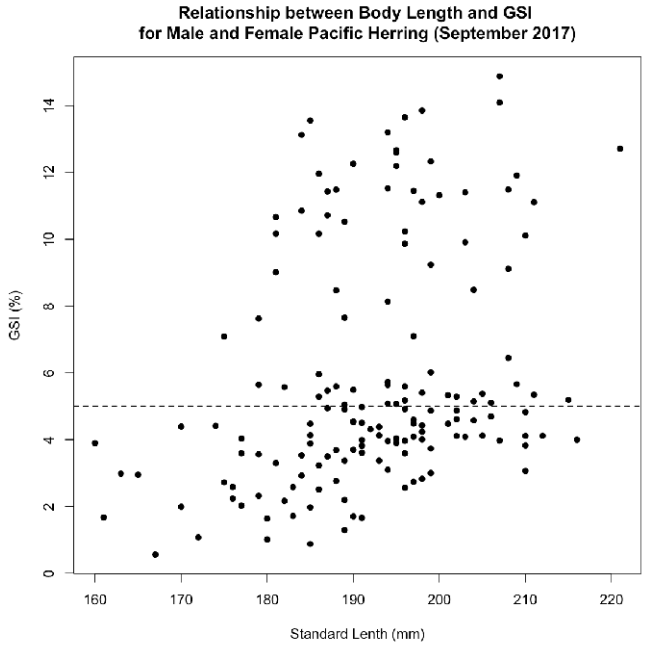

Figure 12. Relationship between body length and gonadosomatic index (GSI) for male and female Pacific herring caught during November 2017. Dashed line indicates the GSI threshold between reproductive immaturity (<5%) and maturity (>5%).

Upon closer examination, it appears that males were more reproductively developed than females in November 2017 (Fig. 13a, b).

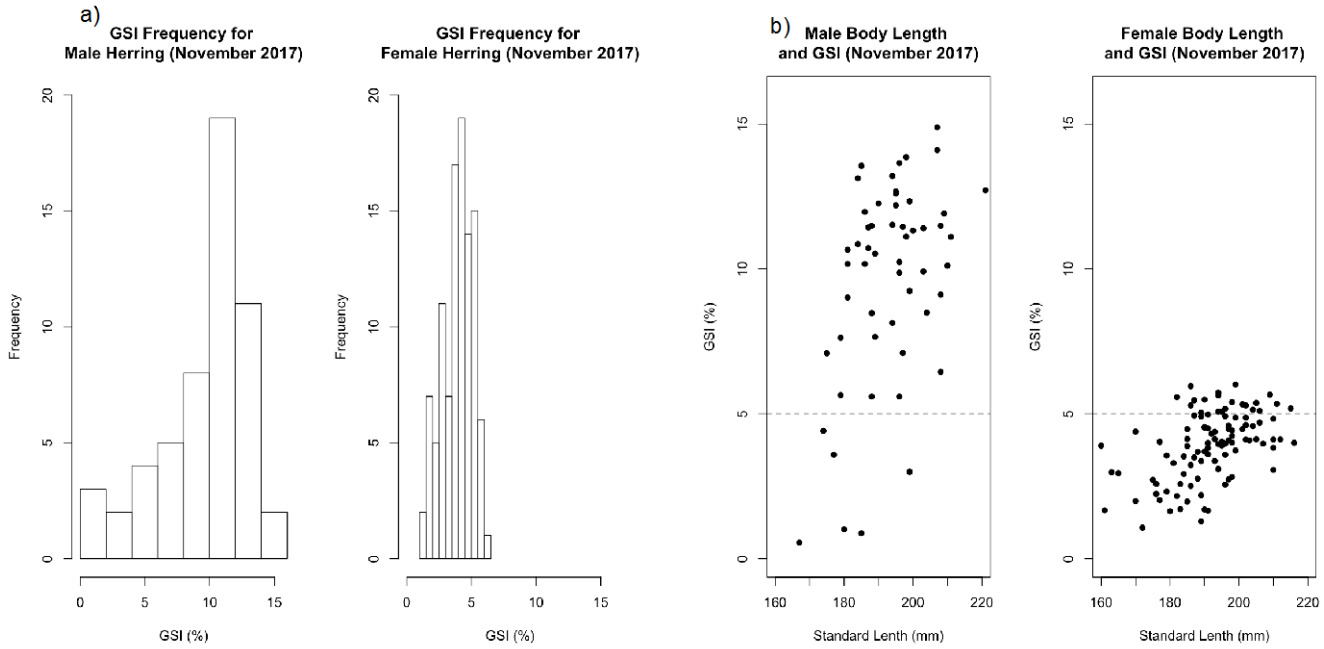

Figure 13. (a) Frequency of gonadosomatic index values of male and female Pacific herring, separately, caught in Prince William Sound during November 2017. (b) Relationship between body length and gonadosomatic index (GSI) for male and female Pacific herring, separately, caught during November 2017. Dashed line indicates the GSI threshold between reproductive immaturity (<5%) and maturity (>5%).

Finally, data suggest a correlation between GSI values and Hjort criteria determined for male and female herring collected in November 2017 (Fig. 14).

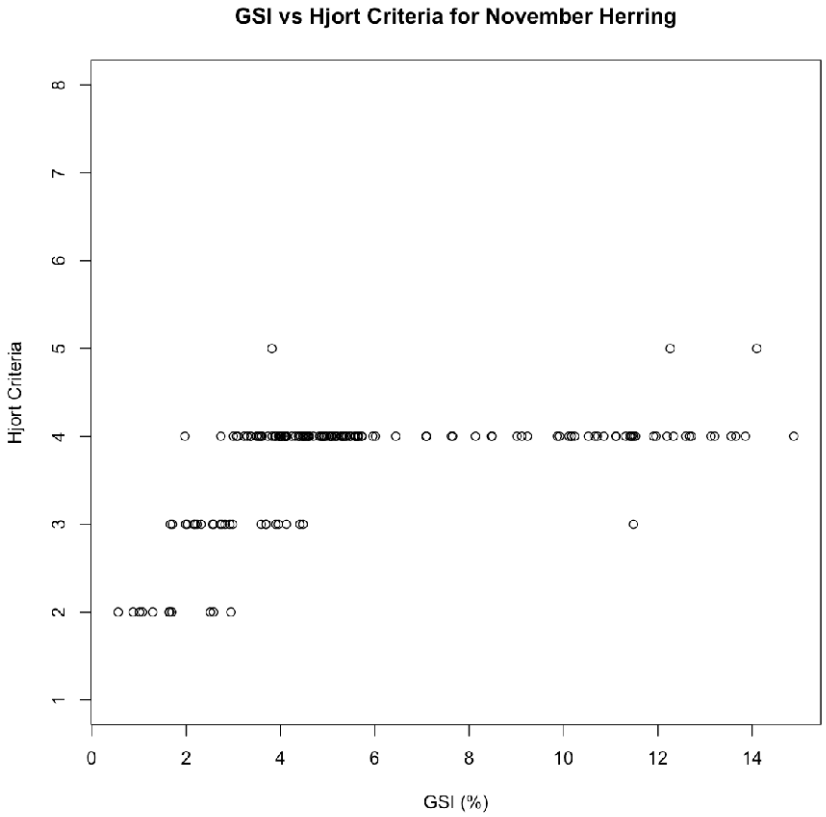

Figure 14. Comparison of GSI values and Hjort criteria for discerning reproductive maturity of Pacific herring caught in November 2017.

In summary, just under half of the herring samples in November 2017 were reproductively mature, and it appeared that a great majority of mature fish were male. This result suggests that it may seasonally take longer for female herring to reach reproductive maturity. Of note, Hjort criteria were not specifically assessed for herring caught in spring 2017 as this was not part of the original FY17 proposal.

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

This project coordinated with several other EVOSTC supported projects. First, spring samples were collected in conjugation with the ADF&G age, sex, and length cruise and PWSSC's adult herring acoustic cruise. The September fieldwork was conducted with Gulf Watch Alaska's predator-prey cruise. It is anticipated that the data generated as part of this project will be available to the HRM modeling component to at least test maturity schedules, or possibly as an input in the model if solid data are available.

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

PI Gorman is currently finalizing an Access database to store the data collected as part of this project. It is anticipated that this database will be completed by the end of February 2018. In the meantime, data collected in 2017 are available on the AOOS Research Workspace for the HRM program. Prince William Sound Science Center has uploaded a description of this project to the institute's website and can be found here: http://pwssc.org/reproductive-maturity-of-pacific-herring/

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

Please see attached document, which tracks the correspondence between PI Gorman and the EVOSTC Science Panel regarding revisions to the FY18 proposal. It is noted that the overall goal of the proposed Herring Research and Monitoring Program (2017-2021) is *to improve predictive models of PWS herring stocks through observations and research*. To this end, the *revised* goal of the FY18 project is ***to test the PWS herring Bayesian Age-Structured Assessment model's age at maturity function with empirical data.*** First, proposed research will focus on adult female and male herring caught in PWS to provide annual estimates of the proportion of immature and mature herring for age cohorts of interest to the ASA

model (ages two through five) using simple and direct measures of gonad maturation such as a gonadosomatic index (GSI) following Hay and Outram (1981), the Hjort criteria as outlined by Hay (1985), and ovary histology of females (Brown-Peterson et al. 2011). As a secondary effort, studies will continue to validate the use of scale growth measures as a technique for discerning age at maturation for both female and male herring in PWS. The advantage of using scale growth as a measure of age at maturity for herring, if accurate, is that it allows for sampling the entire population after individuals have recruited, as opposed to direct measures of gonad maturity that require sampling of younger fish that may be located differently in time or space from the spawning population.

The revised FY18 proposal differs from the original FY17 proposal by focusing on direct measures of gonad investment (GSI, Hjort criteria, and histological analysis of ovaries) by both male and female herring in PWS, Alaska. The scale analysis is considered secondary. However, at the end of the FY18 proposal revision process, the Science Panel indicated that they would be interested in seeing scale growth results for the FY19 renewal proposal, along with other results from the project.

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

We appreciate that the PI responded thoroughly to Panel comments and felt that the responses dealt effectively with some of our concerns. The proposal, and responses to questions made in the Panel review, made good use of the international scientific literature. We recognize a dilemma faced by this PI, however, that is trying attempting to build on results of past EVOSTC-funded work (by other PI's in earlier projects), that do not yet have accessible reports.

PI response: NA

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

Updated Science Panel and Science Coordinator comments (11/21/2017):

The revised proposal is considerably improved and we appreciate the effort required for this revision. The objectives are presented more clearly and the technical approaches provide more detail. The study design is better explained and justified, and additional references were included. The revision demonstrates that the PI has a continued positive record of publishing journal articles and that the proposed work is well-coordinated with other concurrent projects in PWS. The Science Panel is pleased that the PI recognizes and acknowledges the risk associated with using scales to determine age at maturity in herring.

The Science Panel understands that the scale work is not proposed to begin until FY19, and the Panel will not expect to see preliminary results from Objective 3 in the FY19 proposal. However, we will expect to see preliminary results from Objectives 1 and 2 in the FY19 proposal. Looking into the future, if results from Objective 3 in FY19 offer no convincing evidence that scales can be used to evaluate or monitor age-specific sexual maturation of herring it is highly likely that this lack of evidence may compel the Science Panel to recommend a Do Not Fund for FY20.

The PI adequately addressed the Science Panel's concerns and comments and therefore, we have revised our recommendation of "Fund Contingent" to "Fund" for the FY18 proposal.

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	$71.5	$74.3	$79.4	$82.6	$85.2	$393.0	$ 35.6
Travel	$1.1	$1.1	$1.1	$1.1	$1.1	$5.5	$ 0.6
Contractual	$45.0	$44.2	$34.2	$34.2	$34.2	$191.8	$ 20.8
Commodities	$2.4	$1.8	$1.8	$1.8	$1.8	$9.6	$ 0.6
Equipment	$0.0	$0.0	$0.0	$0.0	$0.6	$0.6	$ -
Indirect Costs (*will vary by proposer*)	$36.0	$36.4	$35.0	$35.9	$36.7	$180.0	$ 17.3
SUBTOTAL	$156.0	$157.8	$151.5	$155.6	$159.6	$780.4	$74.9
General Administration (9% of	$14.0	$14.2	$13.6	$14.0	$14.4	$70.2	N/A
PROJECT TOTAL	$170.0	$172.0	$165.1	$169.6	$174.0	$850.6	
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.

Some lines are underspent because funding did not become available until May 2018, which was after the major field season. Funding from previous years were used to cover costs associated with that field season.

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