ATTACHMENT D *EVOSTC Annual Program Status Summary Form*

Form Rev. 9.14.17

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

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

17120111

2. Program Title: *See*, Reporting Policy at III (D) (2).

Herring Research and Monitoring Program

3. Principal Lead Name(s): *See*, Reporting Policy at III (D) (3).

W. Scott Pegau

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

1 February 2017 to 31 January 2018

5. Date of Summary: *See*, Reporting Policy at III (D) (5).

February 2018

6. Program Website (if applicable): *See*, Reporting Policy at III (D) (6).

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

7. Overview of Work Performed during the Reporting Period: *See*, Reporting Policy at III (D) (7).

The overall goal of the Herring Research and Monitoring (HRM) program is to: **Improve predictive models of herring stocks through observations and research**. The program objectives are to:

1) Expand and test the herring stock assessment model used in Prince William Sound.
2) Provide inputs to the stock assessment model.
3) Examine the connection between herring condition or recruitment to physical and biological oceanographic factors.
4) Develop new approaches to monitoring.

a) Progress toward addressing hypotheses and achieving goals.

We are addressing our first objective by expanding the age range used in the model. The model can now incorporate data from age-0 on. In the past the model only examined fish age-3 and older. This model expansion allows us to examine how data collected in the previous eight years can help inform our predictions. We completed a set of aerial surveys for forage fish, including age-1 herring in June. We are seeking further funding to maintain that dataset to provide a long enough time series to evaluate the value of the age-1 surveys on predicting the recruitment to the spawning stock.

The model was also run to provide an estimate of the PWS herring population.

The second objective was addressed through collection of age-weight-length data and aerial spawn surveys through projects (17160111-F, Haught), acoustic spawning biomass surveys (17120111-G, Rand), disease prevalence measurements (17120111-E, Hershberger). Data from these projects were used as inputs to the Bayesian model of herring biomass run by Trevor Branch (17120111-C).

The age-weight-length data showed that the spawning population was made up of primarily age-3 (53%) and 4 (22%) fish, with very few older age fish present. While it isn't unusual to have a large age class dominate the spawning stock, the lack of older fish in the spawning stock is unusual. There were only 9.5 mile days of spawn observed in 2017 even though the level of effort was greater than in recent years. This represents a near record

low in mile days observed (Figure 1). The area of spawning has contracted to a small portion of Port Gravina and Canoe Pass on Hawkins Island.

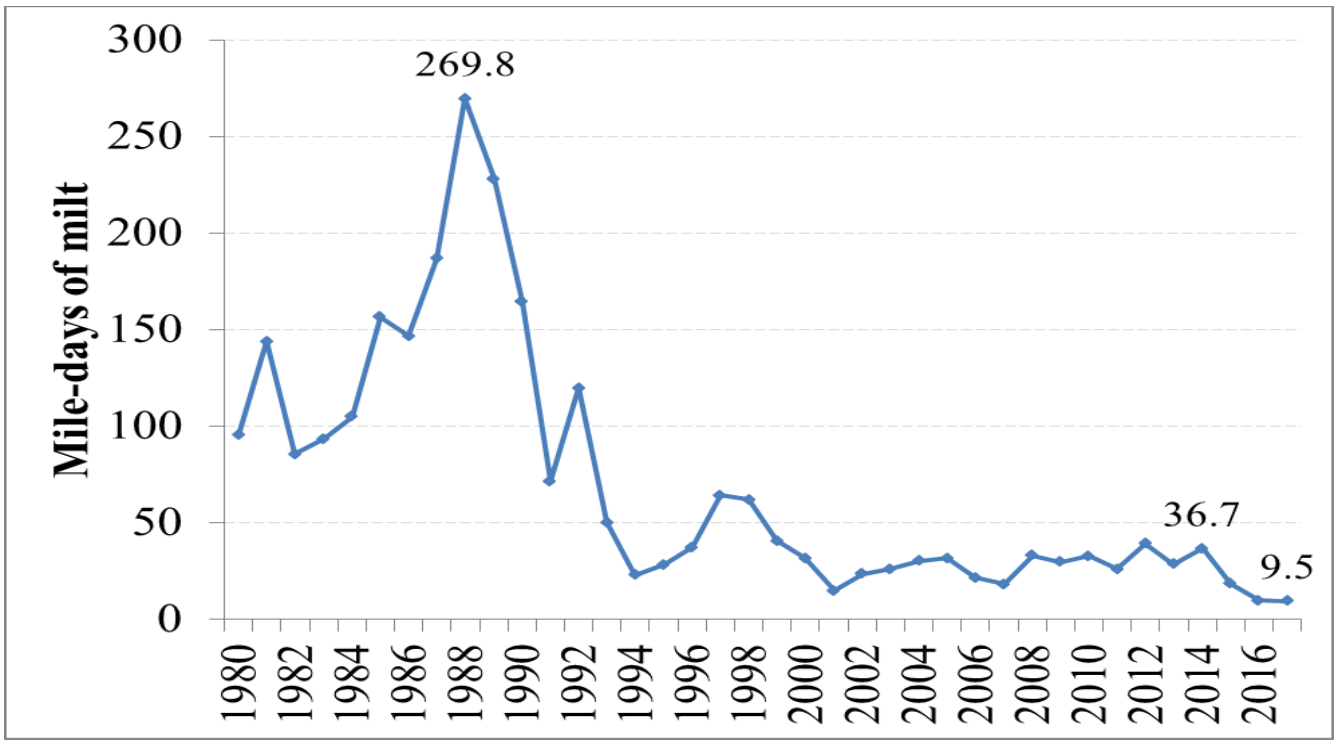

Figure 1. Mile-days-milt observed in Prince William Sound.

The acoustic surveys found a slight increase in the estimated spawning biomass in 2017 compared to 2016. The estimated spawning biomass was approximately 10,000 MT.

Disease prevalence measurements continue to record low levels of viral hemorrhagic septicemia (VHSV) and viral erythrocytic necrosis virus (VENV) in the spawning populations. The new approach developed in this program to detect the presence of VSHV antibodies provides a different result for the potential impact of VHSV on the PWS herring population (Figure 2). It shows that a large portion of the herring population has been exposed to VHSV, which has a very high mortality rate. The disease outbreak is likely to have passed through the population and just not been detectable during the prevalence sampling period.

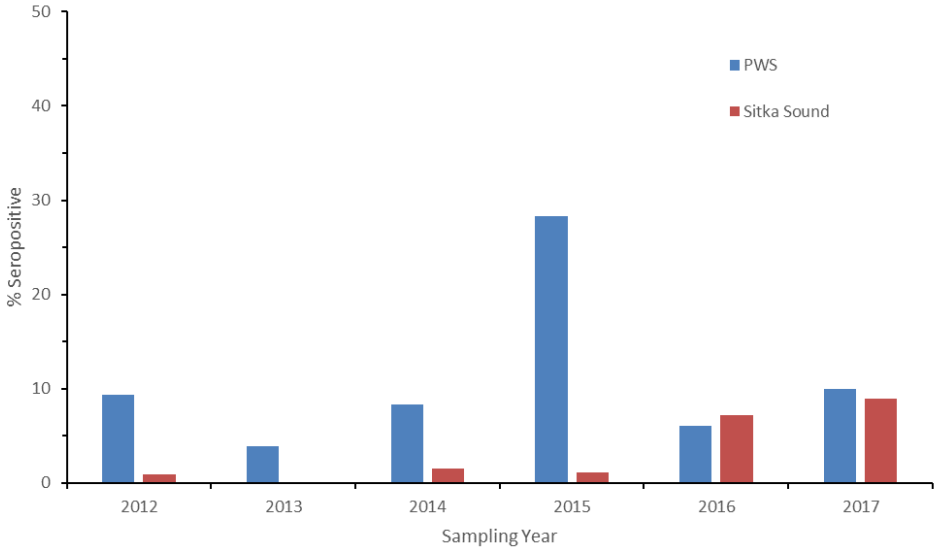

Figure 2. The presence of VHSV antibodies in herring collected in PWS and Sitka.

We addressed our third objective by examining the relationship in the crashes in PWS herring population to others around the globe. We found that the magnitude and duration of the low population levels currently observed are highly unusual (Figure 3). The global analysis is being used to help set the stage for examining the PWS herring population and their connection to other environmental conditions. A preliminary result of analysis of the global populations suggests that low biomass may be associated with sea surface temperature and sea surface height anomalies.

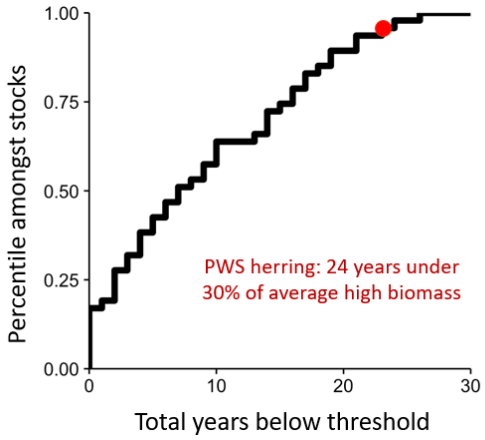

Figure 3. The red dot shows where Prince William Sound herring fall among global herring populations in terms of the duration of the current period of low biomass.

During the past year we identified two postdoctoral research projects that are designed to further address the objective. One project is designed to examine the linkages between diseases and environmental conditions. The other uses a broad suite of biotic and abiotic data to look for linkages to herring condition and recruitment through spatial and temporal analysis. These new researchers are joining the program in FY18. Dr. Maya Groner will lead the disease related project as part of the coordination project. Dr. David McGowan will lead the spatio-temporal analysis within the modeling project.

Our tagging project addresses both our third and fourth goal. We need to understand where the herring are through the year to connect them with the appropriate environmental conditions. Therefore, the tagging helps guide our efforts to connect the PWS herring population to environmental variables. The acoustic tags also represent a relatively new approach to monitoring the population. This past year we were able to tag 124 fish in

nine batches. The fish were all from the Port Gravina area. We were able to detect 97% of the fish in Port Gravina and 58 of the fish were detected at one of the entrances by September. This is a lower percentage than what we achieved in the pilot project conducted earlier. The fish were smaller than in the past and we are noticing tilt issues with receivers that have been in place for over four years. Interestingly, we detected nine fish in the Port Gravina some five to six weeks post spawn (Figure 4). Eight of those nine were later detected at one of the entrances.

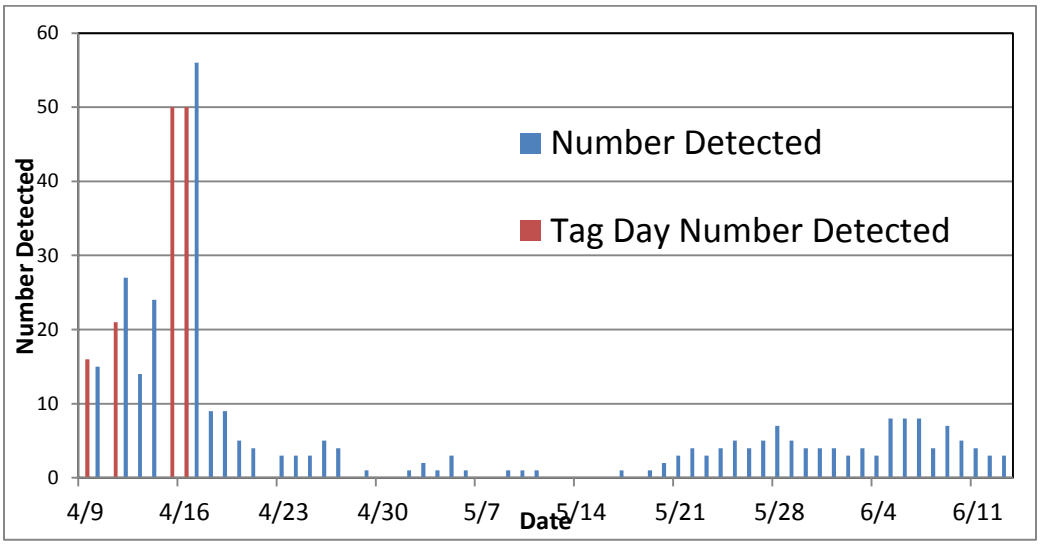

Figure 4. Number of tagged fish detected by day at Port Gravina. Spawning occurred in the area between 13 and 21 April. This is data based on three receivers that were retrieved from a ten-receiver array.

We also continued to make improvements in our ability to detect the exposure history of Pacific herring to VHSV (Figure 2). It is through this effort that we are likely to be able to change how disease information is incorporated into the biomass model and provide better understanding of the impact of disease on the population.

Research on the influence of temperature on the efficacy of DNA vaccines against VHSV in Pacific herring is providing insights in mechanisms that allow vaccination of fish in the laboratory environment.

The herring maturity project collected herring at several times through the year. Most of the effort this past year was in trying approaches to collect fish outside of the spawning season. We think we will be able to collect the required number of fish using jigs and gill nets provided we can locate the fish. Almost all fish sampled during the spawning season were found to be mature or maturing with the younger fish maturing more slowly. There was no evidence of a strong mix of mature and immature herring in the spawning stock samples, suggesting that if there is a large portion of immature fish, particularly at age-3, they are not in the schools preparing to spawn.

b) Highlights and noteworthy issues

The herring biomass may be increasing slightly from the minimum in 2016, but the mile-days-milt observed remained nearly the same due to the young age of the fish that make up the spawning population in 2017. The model captured the younger population structure but provided an unobserved increase in biomass in 2017 without inclusion of the acoustic biomass data. It is expected that inclusion of the acoustic biomass estimates would help constrain the model and remove the modeled increase.

All of our efforts indicated that the herring population is dominated by young fish with relatively few older fish. This happens when there are large recruitment events, but the numbers of age-3 fish in 2017 were not that unusual. Instead the lack of older herring made the age-3 fish a large percentage of the population.

Advances that allow us to examine the presence of antibodies to VHSV are providing a new perspective on that disease within PWS. The annual prevalence monitoring has not shown any unusual levels of disease during the spawning season. The antibodies are indicating that the PWS herring are being exposed to VHSV at a greater rate than in Sitka and had unusually high levels in 2015, which coincides with the start in the recent decline in observed herring biomass. It is through the use of antibodies that we can better understand if there may have been disease outbreaks at times we are not monitoring for prevalence. The antibody information that is likely to be a

better measure of disease exposure for the model to estimate mortality from than the prevalence information that has been used in the past.

We were able to retrieve and refurbish nine acoustic receivers from an old array in Port Gravina. We are looking to deploy these receivers to cover critical areas and to increase the number of areas we can detect fish in PWS to better identify the seasonal movements of the herring.

c) Efforts to achieve community involvement/traditional ecological knowledge and resource management application

The Alaska Department of Fish and Game (ADF&G) statewide herring coordinator serves on the HRM science oversight group and participated in the HRM PI meeting, so she was able to directly interact with all of the researchers in the HRM program. The local ADF&G fisheries biologist with responsibilities relating to herring is also a member of the HRM program and therefore directly connected to the various projects.

d) Problems and unusual developments

The small size of fish that were spawning and the limited amount of spawning made it difficult to collect the number of fish of a size appropriate to tag. Our plan for FY18 is to tag fish from two spawning locations. We originally thought that they would be Port Gravina and Montague Island or Port Fildago. We are now looking to tag in Port Gravina and Canoe Pass.

Biofouling of the Offshore Tracking Network receivers appears to have caused some of the receivers to tilt over and be ineffective at detecting passing fish. We are looking to deploy new receivers at critical locations and retrieve and repair receivers that are not functioning properly.

We had difficulty finding and capturing adult herring during the summer. We have since shifted away from using the trawl system used during the summer and are now jigging and gillnetting herring. We expected that we would have to refine our sampling system during the first two years to ensure we were able to collect large enough samples at the most appropriate time of year. We added sampling effort through the fall and winter to refine our approach to give us a better chance of obtaining our desired samples in the upcoming year.

e) Other significant information

PWS Pacific herring populations remain at record low numbers. We believe that with the new information about the presence of antibodies to VHSV we have a likely explanation for the recent population decline, but are working to incorporate the disease information into the model to confirm the changes in herring numbers are within the expected range once accounting for disease mortality.

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

This project works with all projects within the HRM program. Coordination is primarily through email and the annual PI meeting. Work with projects includes ensuring reporting is completed promptly and assisting the coordination of sampling logistics. Dr. Pegau works with individual projects to provide the samples needed and as a source of information about existing data and results.

Dr. Pegau serves as the primary contact for the HRM program with the GWA and Data Management (DM) programs. Coordination includes having the leads to all the programs on the HRM general mailing list, so everyone is aware of any information going out to the HRM PIs. We reached out and are working to include Dr. Whitehead, who has a herring related lingering oil project, to include him as possible. He was able to attend the HRM PI meeting remotely.

We anticipate greater connection with the GWA program as the new postdoc projects come on line. Those projects are dependent on the environmental data collected in the GWA program.

Sherri Dressel (ADF&G) is on the HRM scientific oversight group. Sherri, along with Stormy Haught of the Cordova office of ADF&G, are the primary contact points between the HRM program and the trustee agency with oversight of herring in PWS. The monitoring work of the HRM program provides the data necessary for ADF&G to monitor the Pacific herring population in PWS and determine if the population is at a fishable threshold. The exchange of information with ADF&G is important for being able to track similar research efforts ongoing at ADF&G and in the HRM program.

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

a) Publications

Aderhold, D. G. R., M. R. Lindeberg, K. Holderied, and W. S. Pegau. 2018. Spatial and temporal ecological variability in the northern Gulf of Alaska: What have we learned since the *Exxon Valdez* oil spill? Deep Sea Research II 147:3-8. https://doi.org/10.1016/j.dsr2.2017.11.015

Bishop, M.A. and J. H. Eiler. 2018. Migration patterns of post-spawning Pacific herring in a subarctic sound. Deep-Sea Research Part II 147:108-115. http://dx.doi.org/10.1016/j.dsr2.2017.04.016

Gorman, K. B., T. C. Kline, M. E. Roberts, F. F. Sewall, R. A. Heintz, and W. S. Pegau. 2018. Spatio-temporal variation in stable carbon and nitrogen isotope signatures and condition of juvenile herring (*Clupea pallasii*) in Prince William Sound, Alaska: teleconnections with the Gulf of Alaska. Deep Sea Research II 147:116-126. https://doi.org/10.1016/j.dsr2.2017.10.010

Hart, L.M., M.K. Purcell, R. Powers, A. MacKenzie, P.K. Hershberger. 2017. Optimization of a plaque neutralization test to identify the exposure history of Pacific Herring to viral hemorrhagic septicemia virus (VHSV). Journal of Aquatic Animal Health 29: 74-82.

Hart, L.M., N. Lorenzen, K. Einer-Jensen, M. Purcell, P.K. Hershberger. 2017. Influence of temperature on the efficacy of homologous and heterologous DNA vaccines against viral hemorrhagic septicemia (VHS) in Pacific herring. Journal of Aquatic Animal Health 29: 121-128.

Hershberger, P.K., J.L. Gregg, C. Dykstra. 2017. High prevalence and low intensity *Ichthyophonus* infections in Pacific Halibut (*Hippoglossus stenolepis*). Journal of Aquatic Animal Health 30:13-19. https://doi.org/10.1002/aah.10011

Muradian ML, Branch TA, Moffitt SD, Hulson P-JF. 2017. Bayesian stock assessment of Pacific herring in Prince William Sound, Alaska. PLoS One 12:e0172153

Ward EJ, Adkison M, Couture J, Dressel SC, Litzow MA, Moffitt S, Hoem Neher T, Trochta J, Brenner R. 2017. Evaluating signals of oil spill impacts, climate, and species interactions in Pacific herring and Pacific salmon populations in Prince William Sound and Copper River, Alaska. PLoS One 12:e0172898

b) Presentations/Workshops

Bishop, M.A., attended AOOS Animal Telemetry Workshop, Dec 5-6, 2017. Anchorage, Alaska

Hershberger, P.K. Invited Talk. July 5-6, 2017. Washington State Disease Co-Managers Meeting. Long term shedding of VHS virus from Pacific herring: Demonstration of a marine reservoir host. Olympia, WA.

Hershberger, P.K., A.H. MacKenzie, J.L. Gregg, M.D. Wilmot, R. Powers, M.K. Purcell. June 20-22, 2017. Platform. Long term shedding of viral hemorrhagic septicemia virus from Pacific herring. 58th Western Fish Disease Workshop. Suquamish, WA.

MacKenzie, A.H., J.L. Gregg, M.D. Wilmot, T. Sandell, D. Lowry, P.K. Hershberger. June 20-22, 2017. Poster. Temporal and spatial patterns of *Ichthyophonus* in Pacific herring throughout the southern Salish Sea. 58th Western Fish Disease Workshop. Suquamish, WA.

Pegau, W. S., et al., Prince William Sound Herring Research and Monitoring. Poster presentation. PICES Drivers of Dynamics of Small Pelagic Fish Resources, March 6-11, 2017.

Pegau, W. S., An update on the Herring Research and Monitoring program. Oral presentation. Prince William Sound Regional Citizens' Advisory Council, September 2017.

Sitkiewiz, S.E., B.P. Harris, P.K. Hershberger, N. Wolf. June 20-22, 2017. Poster. Effects of the parasite *Ichthyophonus* on groundfish growth and condition. 58th Western Fish Disease Workshop. Suquamish, WA.

Sitkiewicz, S., B. Harris, P. Hershberger, N. Wolf. March 19-23, 2017. Poster. Impacts of the Parasite *Ichthyophonus* (sp.) on Groundfish Growth and Condition. Joint Meeting of the American Fisheries Society, Alaska Chapter American Water Resources Association, Alaska Section. Fairbanks, AK.

Stinson, M.E., B.C. Hall, B.C. Stewart, P.K. Hershberger. June 20-22, 2017. Poster. Validation of improved *Listonella* (*Vibrio*) *anguillarum* vaccine in coho salmon. 58th Western Fish Disease Workshop. Suquamish, WA.

c) Information products

The HRM website (http://pwssc.org/research/?research_topic=herring) was updated with pages added for new projects and updated materials for continuing projects. Four Field Notes radio program/podcasts were developed. Several project profiles – print optimized versions of the project webpages – were constructed for sharing at the Alaska Marine Science Symposium.

d) Datasets

The data and logs from the aerial surveys were uploaded to the workspace. This includes the spreadsheet with the number of schools of age-1 herring and their size and the raw survey data.

The tagging project provided a tagging log with accompanying age, sex, and length of each herring tagged along with a unique tag ID number. These data were recorded in April 2017 and have been uploaded to the project workspace. Preliminary detection data were uploaded from receivers at Hinchinbrook Entrance and Montague Strait during September 2017. These files include detections of the unique tag ID numbers at each receiver with the accompanying time and date.

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.

PI Haught uploaded aerial survey (routes and biomass, spawn, bird, mammal observations) shapefiles and ASL 1973-2017 ASL data (.csv) to the research workspace.

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

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

This is a complex proposal with many integrated parts. A key strength of the proposal is the required collaboration and cooperation of PI's from very different disciplines. This cohesion was an initial requirement for the herring program and Dr. Pegau has met this challenge successfully. There were, however, many questions and comments following the initial proposals presented earlier this year. The Panel appreciated the responses of Dr. Pegau and the PI's within the revised Herring Program. Most questions or comments requested clarification or more information, and were not necessarily

intended to point out shortcomings or errors. In this regard, the Panel was pleased and generally satisfied with the responses that we considered to be constructive and informative.
There was one aspect of the revised proposal that elicited some concerns: the brevity of scientific context and rationale for the herring program, as a whole. We acknowledge that this is a demanding request: it is difficult enough to provide such context for individual proposals, let alone a collection of proposals such as the integrated herring program. Nevertheless the Panel would like to have seen more attention provided to explaining how the composite set of proposals addressed basic scientific issues. The two general hypotheses listed in the opening pages of the Herring program (i) bottom-up forcing and (ii) age-specific migration are fine, but there are many other fundamental questions in the literature that are germane to the projects in the herring program. For example, within the initial overview of the herring proposals, there is scant reference to the potential impacts of climate change, as a factor that could affect herring or the research efforts directed at herring. We note, however that this specific issue is mentioned specifically in two projects. The Panel was somewhat reassured, however, when we heard directly from Dr. Pegau during a telephone conversation when he indicated that he shares some of this perspective but is constrained by time and assistance. There is some promise that the additional of a post-doc position may provide some assistance in this regard.

PI Response: None

Science Panel Comments and Responses on FY18 Work Plans, September 2017

Overall, the Panel is pleased with the Program's progress. The Panel strongly recommends that all proposals include hypotheses, highlights and figures reflecting progress made during the previous year(s), as did PIs for two of the proposals (18120111-C Branch and 18120111-E Hershberger/Purcell). The LTM proposal provide good examples of what the Panel is looking for, as they nicely addressed our previous request for this information. They also included a list of publications and datasets uploaded during the previous year, which we endorse and recommend that all proposals now include. This information is very helpful to determine whether changes are warranted in study plans for the upcoming year. Toward this end, improvements to the proposal forms will help. The Panel supports Scott's request to hire Maya Groner for the Post-doc position.

PI Response (10/11/2017)
As the program lead I will review the proposals to ensure they have the hypotheses, goals, and highlights as requested.

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

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM 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	$515.1	$741.7	$768.2	$786.7	$462.0	$3,273.8	$362.7
Travel	$37.1	$47.9	$42.8	$40.0	$36.4	$204.1	$19.3
Contractual	$198.7	$221.9	$203.4	$143.4	$134.0	$901.4	$117.1
Commodities	$192.6	$160.6	$87.5	$79.4	$78.6	$598.7	$94.8
Equipment	$5.9	$0.0	$0.0	$0.0	$14.4	$20.3	$17.1
Indirect Costs (*will vary by proposer*)	$200.1	$276.5	$254.9	$237.7	$110.5	$1,079.6	$382.5
SUBTOTAL	$1,149.5	$1,448.5	$1,356.8	$1,287.2	$835.9	$6,077.9	N/A
General Administration (9% of subtotal)	$103.5	$130.4	$122.1	$115.8	$75.2	$547.0	
PROJECT TOTAL	$1,252.9	$1,578.8	$1,478.9	$1,403.1	$911.1	$6,624.9	
Other Resources (Cost Share Funds)	$157.2	$159.7	$160.7	$162.7	$149.7	$790.0	N/A

COMMENTS:
This summary page provides an five-year overview of proposed 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.

The personnel line is underspent because funding to PWSSC did not arrive until May 2018, which required us to use funding from previous years to be able to support the major field season in April.

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