ATTACHMENT D ***EVOSTC Annual Program Status Summary Form***

Form Rev. 10.3.14

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

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

14120111

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

Herring Research and Monitoring Program

3. Program 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 2014 to 31 January 2015

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

February 2015

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

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

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

This report covers the third year of work associated with the Herring Research and Monitoring (HRM) program. A detailed discussion of the findings of the program can be found in the synthesis titled, "Pacific herring in Prince William Sound: A synthesis of recent findings" that was submitted to the *Exxon Valdez* Oil Spill Trustee Council.

The goal and objectives of the HRM program are as follows.

Goal: Improve predictive models of herring stocks through observations and research.

Objectives

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.*

2) *Inform the required synthesis effort.*

3) *Address assumptions in the current measurements.*

4) *Develop new approaches to monitoring.*

Program highlights

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.*

- Disease prevalence consistent with other areas
- VHS prevalence has been near zero since 2007

- Aerial surveys indicate a very small age-1 class in 2014
- 1-3 thousand tons of pre-spawn adult herring were observed off Montague Island that were not part of the primary spawning aggregation in Port Gravina.
- Condition of age-0 fish has been linked to food source through isotopes and fatty acids
- Samples from herring at Kayak and Montague Islands were collected for genetics analysis
- Age-0 herring were observed at all locations in November 2014: an early indicator that the year class may be large
- Scale growth at age-2 may provide an indication of the portion expected to spawn
- The population model is being used to examine the value of different inputs

2) *Inform the required synthesis effort.*

- The herring portal was incorporated into the Gulf of Alaska portal to connect with more data
- Historic scale growth has been connected to environmental conditions in the Gulf of Alaska
- Scales of age-0 herring were scanned to develop a scale growth to body length relationship
- Age-0 herring that do not reach 85 mm by fall are not likely to live to spawning age
- A synthesis was submitted to the EVOSTC staff

3) *Address assumptions in the current measurements.*

- Energy density decreases faster than predicted by linear model
- Fortnightly acoustic surveys show significant differences in biomass
- Fatty acid analysis shows evidence of winter feeding
- Direct capture of herring shows a significant difference in the size distribution of juvenile herring when ice is present, which indicates smaller fish remain under the ice

4) *Develop new approaches to monitoring.*

- Two new techniques for determining the historic exposure to VHSV have been developed
- Adult herring spend significant amounts of time at the southern end of Montague Strait
- The size of age-0 herring determined from the Didson matched those from trawl collections

Program summary

To address the first objective by improving inputs to the ASA model we continued to monitor for disease prevalence, expanded the acoustic surveys for adult biomass, surveyed for juvenile herring using acoustic and aerial surveys, and monitored the condition of age-0 herring. The disease prevalence is consistent with other regions where similar monitoring is taking place. The Bayesian version of the ASA model is formatted to use the same information and assumptions in the PWS version of the ADF&G ASA model. The model is being used to determine the most informative inputs and we are exploring how to

transition the model to ADF&G and whether it should be structured in a manner that provides capabilities in other ASA models used in Alaska. Preliminary results indicate that the egg deposition and acoustic biomass surveys provide the most information and that the acoustic biomass survey is more economic.

The aerial surveys for providing an index of age-1 herring continued. This year there were only 170 schools of age-1 herring observed in June. This is one of the smaller numbers of schools observed in the past five years. The project worked with the forage fish project of the Gulf Watch Alaska program to test new sampling protocols. A stratified-random sampling designed was used in July in conjunction with the forage fish surveys. This year there was more directed effort on fish identification from the aircraft and repeated surveys to help define observation variability.

To test assumptions in the ASA model we continue to work on determining the age-at-first-spawn. We examined growth rates at age-2 under the assumption that when herring prepare to spawn, energy is diverted from growth to provision their gondads. This reduced growth is reflected in their scales and has been used as a management tool to assess age at maturation for Norwegian herring stocks. This assumption leads to an expectation of a bimodal distribution on growth. Using measurements from the scales scanned by the scales as growth history project there is some evidence of the expected bimodal distribution in growth (Figure 1). The degree of the bimodality is variable.

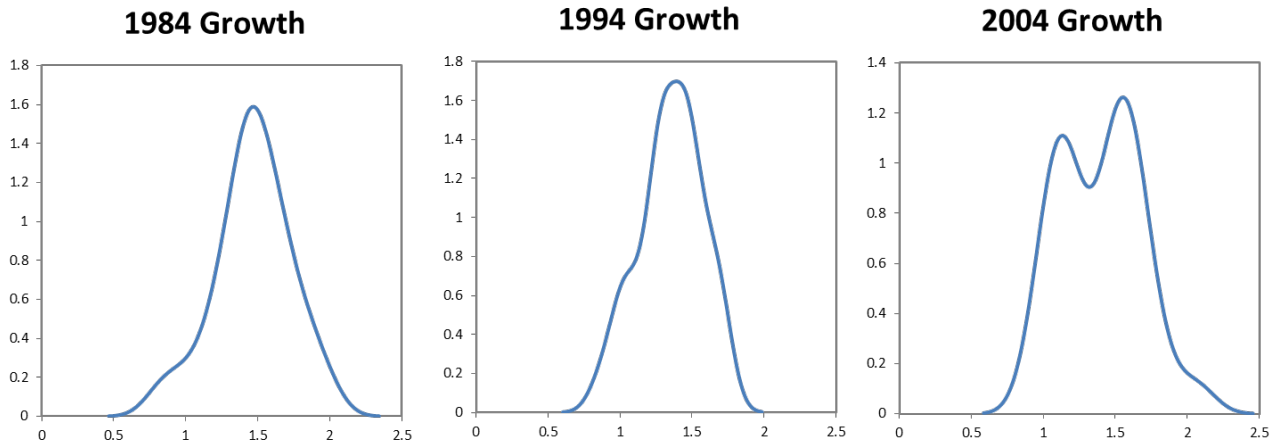

Figure 1. Scale growth increment of age-2 herring as determined from scales of spawning herring.

The second objective deals providing information for the synthesis that was submitted to EVOSTC in the past year. More details about our understanding of herring can be found in that synthesis. Data from the herring scale analysis is being used to examine the relationship between growth in the first year and environmental conditions. There is a strong correlation between growth in the first year and diatom abundance and weaker relationships to water temperature and zooplankton abundance in the Gulf of Alaska (Figure 2). The project was expanded to include imaging scales from age-0 herring to develop a scale growth to fish length data. A linear relationship was found and based on the historic growth it appears that fish need to be > 85 mm to be likely to reach an age that the fish can spawn. The growth study found that this length corresponds to a change in energetic allocation from growth to lipid storage. This suggests that herring must reach a size where they can increase lipid storage if they are to live to a spawning age.

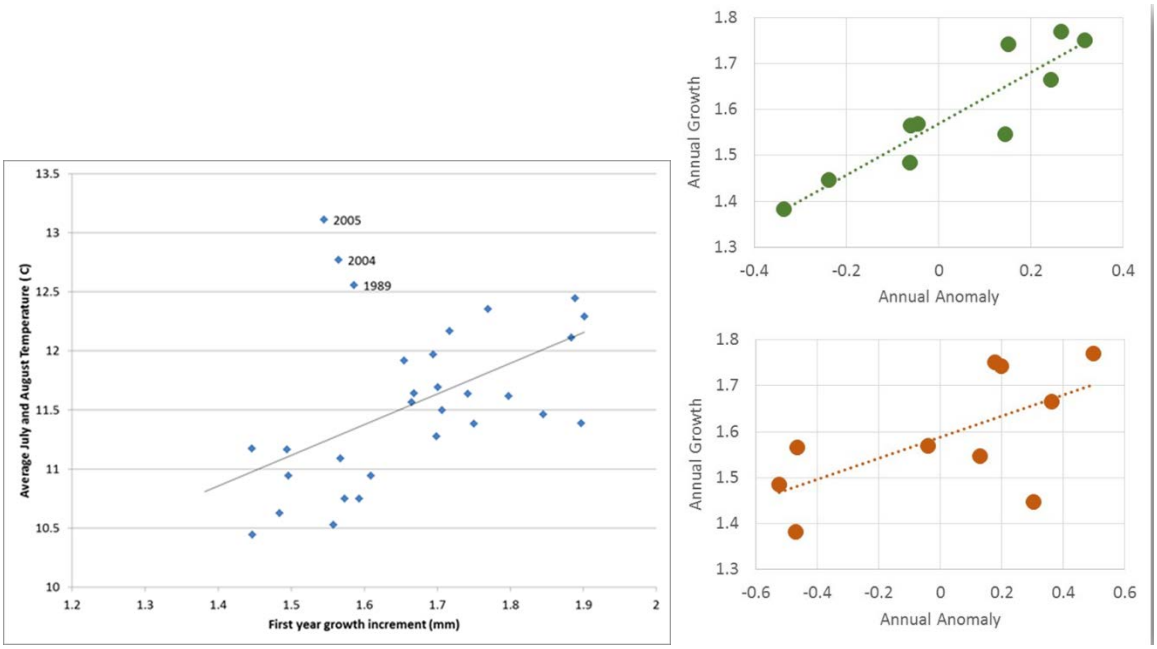

Figure 2 Age-0 growth versus temperature (left), diatom abundance anomaly from the CPR (upper right), and zooplankton abundance anomaly from the CPR (lower right). The 2004 and 2005 years that are anomalies in the temperature relationship are included in the diatom and zooplankton data.

In addressing the assumptions in measurements objective the herring energetics intensive, acoustics intensive, and fatty acid projects are completing analysis and more details can be found in their reports. The energetics information is being combined with information from the fatty acids project to determine minimum energetic and lipid levels exist in living herring to help understand conditions that border death. The information is also showing that there are spatial differences in diets that affect the condition of the herring. It also shows that feeding occurs during the winter (Figure 3) and the smaller, lipid-poor herring are feeding the most.

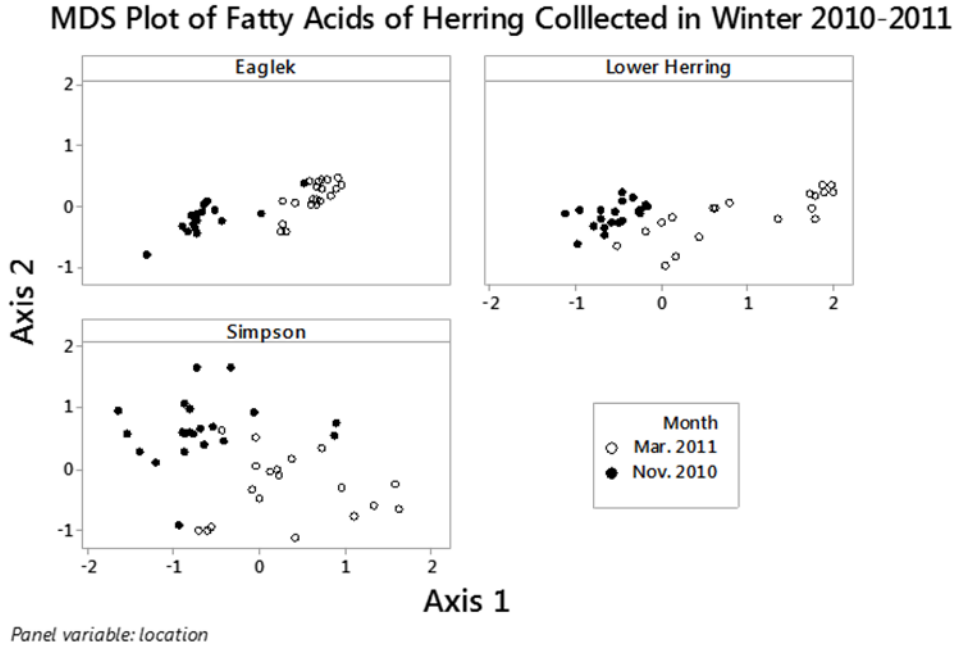

Figure 3. Fatty acid composition is observed to change overwinter, which is consistent with feeding during the winter. This is also observed in the stable isotopes.

A couple of new approaches to detecting if a fish has previously been exposed to VHSV are nearing completion of testing. If they are successful it will allow us to move from looking at prevalence at a single time each year to understanding what the disease potential is. If the fish have previously been exposed to VHSV then the population is not susceptible to an epizootic. But, if they are naive a disease outbreak may occur. Knowing that may be useful in determining if fisheries practices, such as pounding, may need to be altered to prevent the spread of disease. *Ichthyoponus* is another important disease to follow. This disease is more prevalent in older fish so it is important to have a measure of age to help interpret changes in prevalence that are seen. If few older fish are in the sample, the prevalence of *Ichthyoponus* can be artificially low (Figure 4).

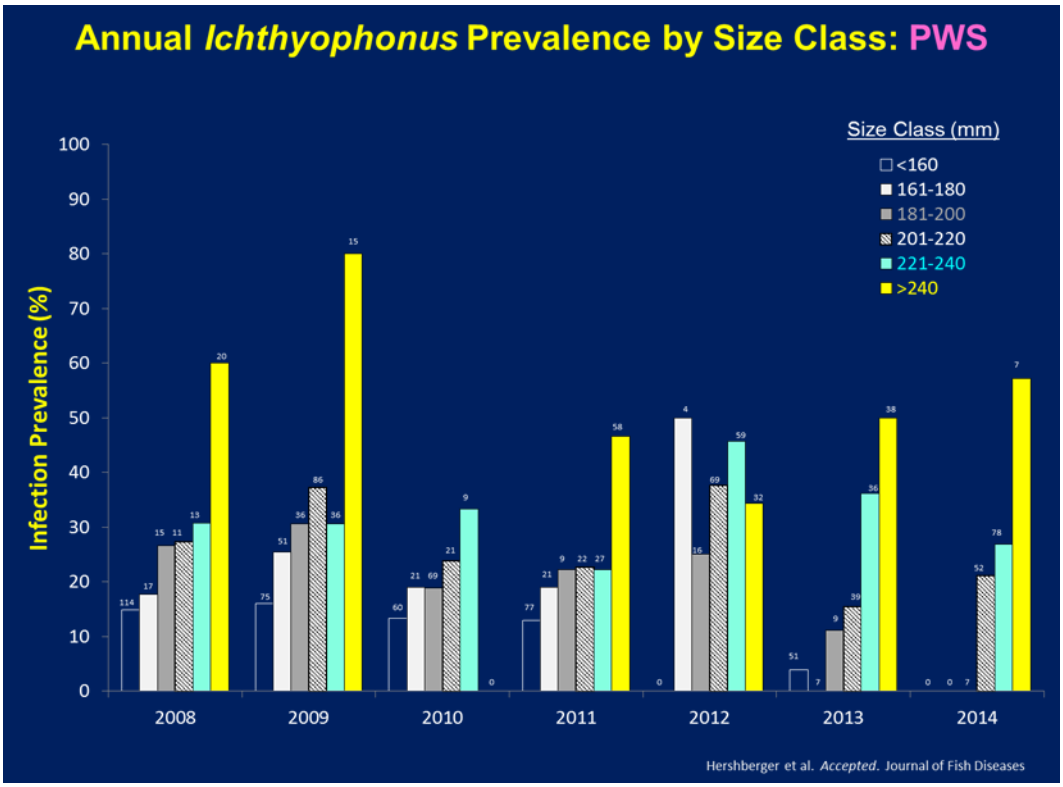

Figure 4. The prevalence of *Icthyophonus* in PWS as a function of length. Note that in 2010 there were no large fish in the sample and those fish tend to have the highest prevalence rates.

In addressing the new approaches to monitoring we deployed the remotely operated vehicle along the ice edge and were able to find schools of herring under the ice. The size distribution as measured using the acoustic system matched that determined from nearby trawls. The ice left the region the following night and the trawl was able to reach areas that had been covered by ice and found smaller fish in those regions providing more evidence that age-0 herring are using ice cover as a refuge from predation from birds.

The tagging study was able to monitor herring until December when the batteries on the tags were expected to fail. The fish were found to remain in the southwest portion of PWS during that time. A single fish was observed in the fall at Hinchinbrook Entrance and that fish was also detected in Port Gravina that winter.

Community and Resource Managers

Results from the acoustic surveys of adult spawning biomass and disease prevalence work were provided to ADF&G for use in their ASA model.

We involved the fishing community in collection of juvenile herring in March instead of a dedicated scientific cruise to collect the fish necessary for the over wintering condition studies. Results of the program were presented to the board of Cordova District Fishermen United. We worked with a local fisherman to collect a sample of spawning herring from Kayak Island. Working with both pilots and fishermen has improved

communication between the scientists and the community and we are benefiting from more rapid reports of observations.

Problems

Dr. Buckhorn departed the program this past year. Her Co-PI is taking responsibility for sampling while the PWSSC searches for a replacement for her. We arranged to contract with Dr. Boswell to provide technical support for the acoustics projects.

The expanded adult herring survey was unable to survey the main herring population in 2004 due to the fish not being aggregated during the cruise dates. We have expanded the cruise to try and ensure we are able to survey both the main and other spawning populations. ADF&G was able to solve a problem with their acoustic survey data that was identified because their data and that generated by PWSSC was different for the past few years.

Many of the spawning herring show contamination from other individuals because they are collected in areas with active spawning. We are working on techniques to clean the sample better and looking at using samples from other locations in the fish.

The age-sex-length and aerial spawn surveys have been removed in the 2016 draft ADF&G budget. These are critical inputs for our understanding of the status of herring in Prince William Sound. We will need to find a way to cover these surveys if the state is unable to conduct them.

Other Significant Information

We are collecting herring and zooplankton from the Cordova Harbor to examine when age-0 herring may be exposed to *Ichthyophonus* and what the exposure mechanism might be.

We are looking forward to seeing if the incoming year class is as large as we have been predicting. During the November cruise we were able to collect age-0 herring from all locations, which rarely happens. This may be an indicator that a second large recruit class may be coming through. We will get our second look at the 2014 brood year during the June age-1 surveys.

The ocean temperatures have been at record highs through the winter. There are a lot of questions about what this will mean for survival of the 2014 year class.

8. Information and Data Transfer: *See,* Reporting Policy at III (D) (8).

a) Publications

Kocan, R., L. Hart, N. Lewandowski, P. Hershberger. 2014. Viability and infectivity of *Icthyophonus sp.* In post-mortem Pacific herring, *Clupea pallasii*. Journal of Parasitology 100: 790-796.

Emmenegger, E.J., J.A. Glenn, J.R. Winton, W.N. Batts, J.L. Gregg, P.K. Hershberger. 2014. Molecular identification of erythrocytic necrosis virus (ENV) from the blood of Pacific herring (*Clupea pallasii*). Journal of Veterinary Microbiology 174: 16-26.

Wilson, A.E., T.L. Goldberg, S.V. Marquenski, W.J. Olson, R.F. Goetz, P.K. Hershberger, K.L. Toohey-Kurth. 2014. Development and evaluation of a blocking enzyme-linked immunosorbent assay and virus neutralization assay to detect antibodies to viral hemorrhagic septicemia. Clinical and Vaccine Immunology 21: 435-442.

Burge, C.A., C.M. Eakin, C.S. Friedman, B. Frelich, P.K. Hershberger, E.E. Hofmann, L.E. Petes, K.C. Prager, E. Weil, B.L. Willis, S.E. Ford, C.D. Harvell. 2014. Climate change influences on marine infectious diseases: implications for management and society. Annual Review of Marine Science 6: 249-277.

An additional five papers are currently in preparation and expected to be submitted this coming year. A synthesis of our current understanding of herring was provided to the EVOSTC. Articles about the herring research were published in National Fisherman, Aquaculture, and Fishermen's News. Five articles were published in the Delta-Sound Connections and there were numerous other popular press articles that examined herring as part of the 25th anniversary of the *Exxon Valdez* Oil Spill.

b) Conferences: Four presentations were made at the 7th International Symposium on Aquatic Animal Health. Six presentations or posters were presented at the Alaska Marine Science Symposium. Several presentations were presented during the Cordova weekly seminar series. Other presentations were given to the National Science Foundation Research Coordination Network, University of Washington, International Marine Conservation Congress, and Tribal Climate Change Webinar Series.

c) Data and information products: Disease prevalence numbers and acoustic estimates of adult herring biomass were provided to Alaska department of Fish and Game. Several new project profiles were developed and available through the web page. Two videos were produced about the aerial survey effort. A synthesis was provided to the EVOSTC.

d) Data sets and metadata uploaded to data portal: A little over three thousand files were uploaded to the Ocean Workspace in the past year. The majority of those files were the historic acoustic files associated with adult herring surveys and acoustic files from the herring intensive surveys and herring index cruises. Updated data was provided by the energetics and conditions projects, herring scale analysis, aerial surveys, age at first spawn, disease, acoustic validation, and tracking projects.

9. Coordination and Collaboration: *See,* Reporting Policy at III (D) (9).

a) Within the HRM program fish captured by the validation project is provided to the acoustics, genetics, energetics, and disease projects. Data from the direct capture efforts are also used by the non-lethal sampling project. The energetics project processes juvenile herring for the disease project. They are also capturing and processing fish from the Cordova harbor to provide a time series of disease prevalence. The disease project is working with the population modeling project to evaluate the best methods to incorporate disease prevalence data and how to bridge the change in methodology that occurred in 2007. The aerial survey project assists in collection of fish for the genetics project. The herring scale project provided hundreds of scale images to the age at first spawn project for their analysis. The expanded adult survey project provided information about errors needed by the population modeling effort. The coordination, outreach, and data management projects work with all other projects.

Vessels were shared between the HRM and Gulf Watch Alaska (GWA) programs for collection of fish during a humpback whale cruise, bird observations during the November herring cruises. The aerial survey project is a collaboration between the herring program and the forage fish project in GWA. Aircraft time, survey methods, and results are shared between the projects. The HRM program has begun using data and expertise from the environmental drivers projects, particularly the continuous plankton recorder and PWS oceanography study to examine how environmental conditions affect growth of herring and to explain the migration patterns of tagged herring and the spatial patterns in stable isotopes and fatty acids. The disease component is receiving zooplankton from Dr. Campbell do determine if zooplankton may be a source of the ichthyophonus disease. We continue to follow the research of the bird and mammal projects to understand how to best incorporate their observations for understanding the predation pressure on herring.

b) We do not have direct collaboration with other EVOSTC funded projects. We are following the efforts of the Cordova Clean Harbor project to see if there are opportunities to work together.

c) There are investigators from US Geological Service and the National Oceanic and Atmospheric Administration that provide a link to those trustee agencies. Most of the collaboration is with Alaska Department of Fish and Game through Steve Moffitt at the Cordova office and Sherri Dressel as the statewide herring coordinator. ADF&G supports sampling for disease prevalence in adult herring,

provides samples for the genetics projects, and provides several datasets and model results used for management. Data from the acoustic surveys of adult populations and disease prevalence data is provided to ADF&G for use in their age-structure-analysis (ASA) model. We are in discussion with ADF&G to determine the most appropriate manner to transfer the Bayesian version of the ASA model to them. Adult herring collected from locations not sampled by ADF&G are provided to them for age-sex-length analysis. We provide information about findings to ADF&G and seek input on their needs.Publications: Conway, C.M., M.K. Purcell, D.G. Elliott, P.K. Hershberger. In Press. Detection of Ichthyophonus by chromogenic in situ hybridization. Journal of Fish Diseases

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

See review, recommendations, and responses below. Responses are in italics.

Next year, the Panel would like to see improvements in:

Inclusion of fundamental information

The Panel would like to see the inclusion in proposals of information regarding the 1) approach, design and analysis of studies and 2) explicit statements of how analyses are answering major questions. This key information is essential to evaluating proposals, and we expect to see brief descriptions included in the next set of proposals. We are not requesting that detailed descriptions be provided to the degree exhibited in original proposals or publications; PIs should use their expertise to identify and include essential, fundamental information that should be included to facilitate review. Good examples of the level expected detail include the GulfWatch proposals by Carls, Jones, and Piatt and the Marine Debris Removal proposal by Pallister (available on the EVOSTC website).

This remark references future proposals and will be addressed in August when the year 5 proposals are produced.

The Science Panel would also appreciate having more detail about how the herring programs contribute to the existing and proposed herring assessment process and model. In particular it would be useful to have a short paragraph on each of the tuners used in the model: spawn assessments and acoustic data.

Descriptions of the ADF&G and Bayesian models were provided to the EVOSTC staff for distribution to the Science Panel.

The Panel appreciates that any additional requests for information in proposals can be perceived as onerous and that the Panel had indicated in prior years that they did not want the entire original proposal text included every year. However, the minimal, essential information requested should not take long to incorporate and could remain in subsequent proposals. From a Panel perspective, proposals cannot be evaluated without key, fundamental information on major hypothesis and models, in part so changes to the design can be placed in proper context. We appreciate your efforts in refining your multi-year proposal submissions.

Planning Succession Necessitated by Attrition of Experienced Personnel

This continues to be an area of concern for the Panel. The departure of Michele Buckhorn, who serves as the lead PI for three of the twelve submitted projects, could have a large impact on the overall success of the Program. We understand from our discussion with Scott that they are working to address the issue but feel that this highlights the issue of a need for junior scientists to be trained within the projects so smooth transitions in scientific personnel.

The Panel continues to support efforts to increase future capacity with regard to PIs turnover and continues to encourage that post-docs be integrated into the programs.

We are trying to ensure we have a means to replace personnel if they leave the program. For each project a person has been identified to cover for a PI if they depart. There will be impacts during the

transition, but we feel we can ensure critical components continue while a new PI is brought on. Dr. Buckhorn was a junior scientist that was under the tutelage of Dr. Thorne. Unfortunately, the junior scientists are most likely to move as they find other opportunities. At this point the post-docs are funded through NCEAS and we don't have the ability to influence their projects to provide benefit to our program.

Improved data submission by Herring Program PIs

We understand that many PIs in the Herring program are behind in providing metadata and data to the central data repository. With the new forms that have been developed, and the availability of assistance from Axiom staff, it is important for each PI to comply with the data submission requirements set forth as a condition of their funding.

Data submission to the Ocean Workspace is up to date and the PIs are getting better at ensuring data is updated on a regular basis. At this point we need to work on the metadata submission. We look forward to seeing what Axiom is able to contribute in meeting that need.

Coordination & Collaboration/Synthesis

The Panel appreciated the programs' explicit statements recognizing the synergisms among project efforts. It is clear that most projects are already working together where it is practical or advantageous to the achieving the goals of individual projects. We also appreciated that the programs recognized the need to integrate data across projects to arrive at a synthetic view of the status and trends of herring populations in PWS. However progress in these areas will need to be more explicit and fully developed. Details provided to the Panel were too limited to be able to truly evaluate progress in this area. Discussion on the conference call with the PI was encouraging in that details of the stock models will be provided to the panel in advance of the February synthesis meeting.

The details on the stock models were provided as requested. Hopefully the level of detail provided in the synthesis, during the science review, and in this report helps to make the collaborations more obvious. There have always been close ties between the two programs at the administrative level, but we are gaining connections between individual projects. The requirement of the synthesis as a deliverable this past year was a great driver for developing those connections.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$201,500.0	$377,300.0	$535,700.0	$506,700.0	$518,000.0	$2,139,200.0	$715,886.0
Travel	$26,800.0	$31,500.0	$47,000.0	$47,300.0	$46,600.0	$199,200.0	$61,866.0
Contractual	$336,960.0	$544,799.0	$456,188.0	$435,116.0	$362,757.0	$2,135,820.0	$1,300,299.0
Commodities	$81,600.0	$33,700.0	$104,100.0	$102,700.0	$67,100.0	$389,200.0	$168,963.0
Equipment	$187,200.0	$0.0	$0.0	$0.0	$0.0	$187,200.0	$221,569.0
Indirect Costs (*will vary by proposer*)	$108,500.0	$173,030.0	$168,200.0	$161,100.0	$144,370.0	$755,200.0	$357,779.0
SUBTOTAL	$942,560.0	$1,160,329.0	$1,311,188.0	$1,252,916.0	$1,138,827.0	$5,805,820.0	$2,826,362.0
General Administration (9% of subtotal)	$84,830.4	$104,429.6	$118,006.9	$112,762.4	$102,494.4	$522,523.8	
PROJECT TOTAL	$1,027,390.4	$1,264,758.6	$1,429,194.9	$1,365,678.4	$1,241,321.4	$6,328,343.8	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	N/A

COMMENTS:
This summary page provides an five-year overview of proposed funding and actual cumulative spending. The column titled 'Actual Cumulative' should be updated each fiscal year to 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.

Most of the discrepancy in spending can be traced to projects that lost personnel that led to reduced spending during the transition. The spending in those projects is expected to catch up because additional effort is required to catch up on deliverables as new personnel are brought on.

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