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.

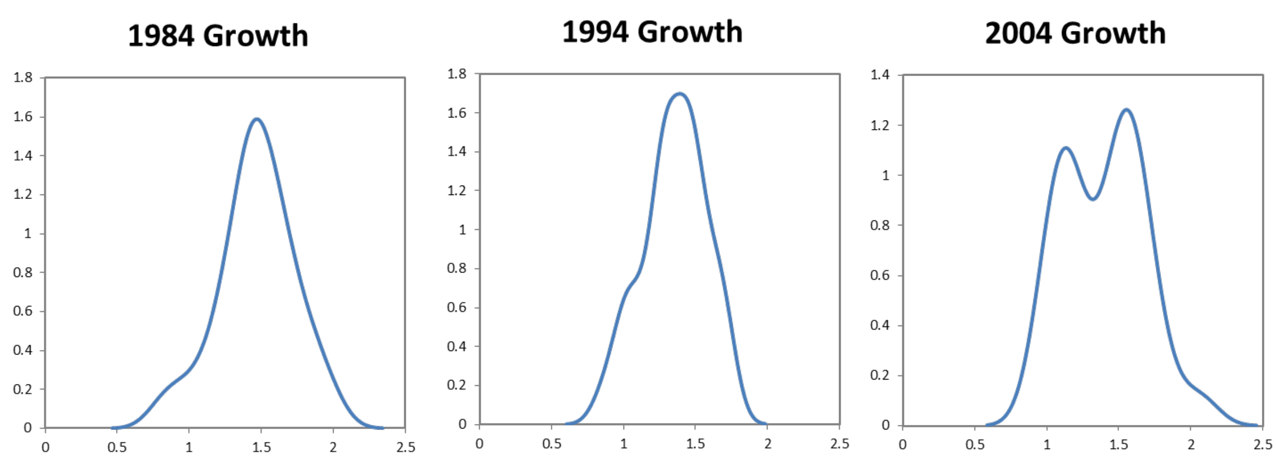

Figure 1. Scale growth increment of age-2 herring as determined from scales of spawning herring.

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.

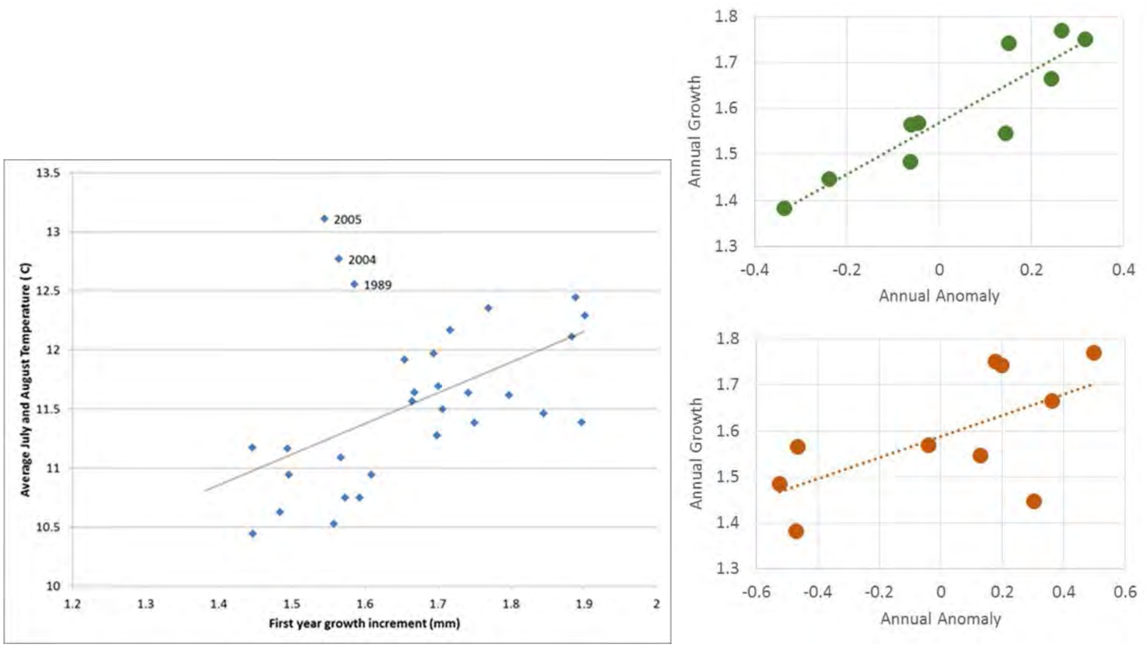

Figure 2 Age-0 growth versus temperature (left), diatom abundance anomaly from the CPR (upper right), and zooplankton abundance anomaly from the CPR (lower right). The 2004 and 2005 years that are anomalies in the temperature relationship are included in the diatom and zooplankton data.

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.

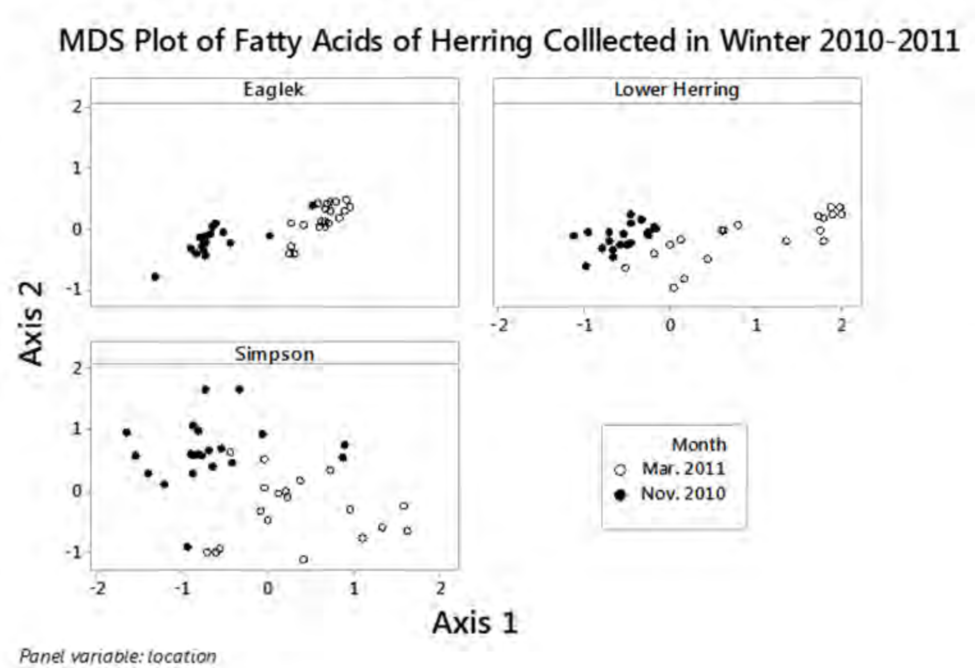

Figure 3. Fatty acid composition is observed to change overwinter, which is consistent with feeding during the winter. This is also observed in the stable isotopes.

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).

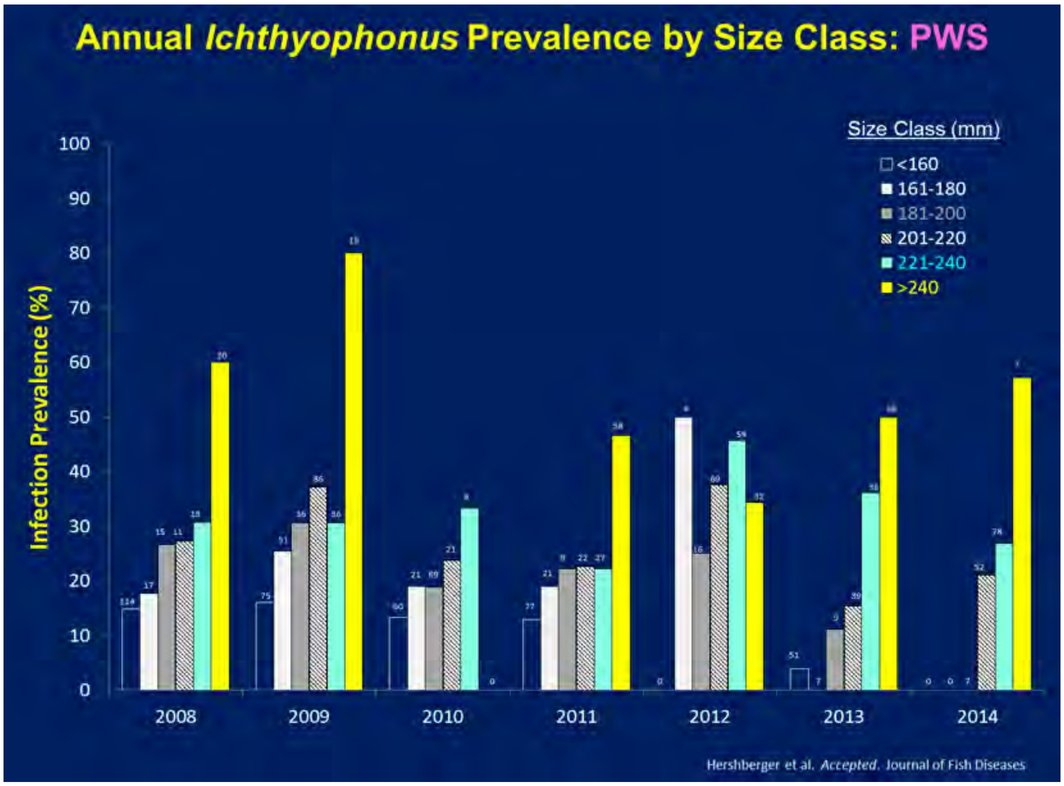

Figure 4. The prevalence of *Icthyophonus* in PWS as a function of length. Note that in 2010 there were no large fish in the sample and those fish tend to have the highest prevalence rates.

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.

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

Form Rev. 10.3.14

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

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

14120111-A

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

PWS Herring Program: Validation of Acoustic Surveys for Pacific Herring

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

Mary Anne Bishop, Ph.D., Prince William Sound Science Center
Report Prepared by: Sean Lewandoski and Megan McKinzie

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

February 1, 2014 – January 31, 2015

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

February 2015

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

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

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

Fiscal year 2014 marked the completion of the third year of the five-year *Validation of Acoustic Surveys for Pacific Herring Using Direct Capture*, a component of the *Prince William Sound Herring Research and Monitoring* (HRM) program sponsored by the EVOS Trustee Council. This project collects the data needed to estimate useful population level parameters for PWS Pacific herring obtained from acoustic surveys by coupling acoustic transects with direct-capture sampling efforts. Additionally, the validation project collects juvenile and adult herring samples for other projects within the EVOS HRM program, including: condition index, energetics, growth, disease, and age at first spawn (Table 1).

Field work in FY14 was extensive and included direct capture efforts associated with the following acoustic survey projects: annual juvenile herring abundance index surveys (Nov), annual expanded adult herring surveys (Mar and Apr), juvenile herring intensive surveys (Feb-Apr), and a pilot, integrated marine bird/whale/forage fish survey at Montague Strait in collaboration with the EVOS Gulf Watch Pelagic component (Sep). In addition, we collected and provided samples to the HRM projects. Here we report on work performed in FY2014 and our preliminary results.

The primary objectives for the *Validation of Acoustic Surveys for Pacific Herring Using Direct Capture* project include:

Project	**Agency**	**Species provided**
Acoustic Validation	PWS Science Ctr	All species – measurements only
Condition Index	PWS Science Ctr	Juvenile herring
Genetic stock structure	ADFG	Adult herring
Disease	USGS	Juvenile herring

1) Improve capture methods used to validate acoustic surveys.

2) Increase the sample size for identification, quantification, and measurement of juvenile (0+, 1+, 2+) and adult (3+ and older) herring schools as well as other fish schools in survey areas.
3) Provide data on species composition and length frequency to aid in the interpretation of current and historical acoustic surveys.
4) Provide adult herring samples to Alaska Department of Fish and Game for the adult herring age-structure-analyses model.
5) Provide juvenile herring samples to researchers investigating juvenile herring fitness and disease.

Sampling Methods

Juvenile Herring Surveys. During FY14 two sampling programs were implemented that target juvenile herring: 1) the annual HRM Juvenile Herring Abundance Index, which includes 8 bays in PWS (Simpson, Port Gravina, Fidalgo, Eaglek, Lower Herring, Whale (East and West), Zaikof and Windy bays; Fig. 1); and, 2) the second half of the HRM Juvenile Herring Intensive Surveys, a project designed to investigate

Table 1. Prince William Sound Herring Research and Monitoring projects that this validation project collects and provides samples to.

Energetics	NOAA Auke Bay	Juvenile herring/walleye pollock
Growth RNA/DNA	NOAA Auke Bay	Juvenile herring
Age at First Spawn	NOAA Auke Bay	Adult Herring

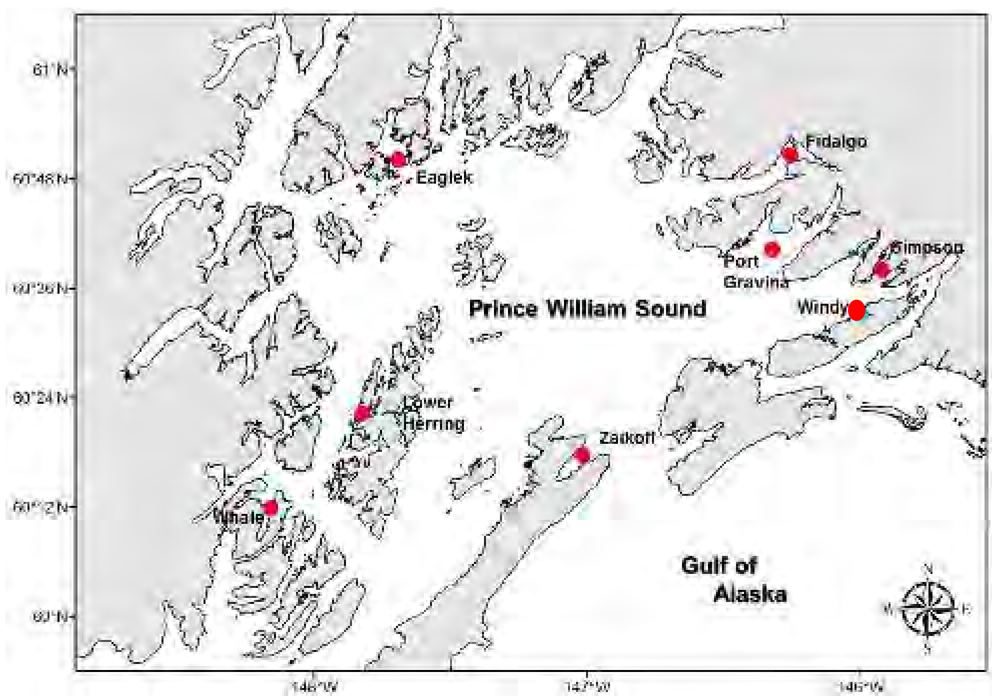

Figure 1. Location of acoustic surveys and corresponding validation efforts (red circles) conducted as part of the juvenile herring abundance index surveys, 15-24 Nov 2014. Windy and Simpson Bays were also sampled from Oct 2013 through Apr 2014 as part of the juvenile herring intensive study.

temporal changes across one winter (2013/2014) in the number and size distribution of herring in two PWS bays: Simpson and Windy. For both programs, acoustic surveys were conducted across the sampling area. Based on the acoustic surveys, "targets" were identified and returned to for short-distance (0.1-1.6 km) trawls concomitant with acoustic surveys. We used a mid-water trawl (14 X 11 X 22 m with 38-mm mesh size dropping down to 12-mm mesh at the codend). Environmental data were collected during trawl transects by attaching a Star Oddi sensor tag that collected conductivity, temperature, and depth data to the head-rope of the trawl. Additionally, a sensor tag that collected temperature and depth data was attached to the foot-rope of the trawl. In this report we use environmental data collected with the head-rope tag.

The annual juvenile herring abundance index survey was conducted from 15-24 Nov 2014. During each annual survey 2-4 transects were conducted in each study bay. The eight juvenile intensive surveys at Windy and Simpson Bays were conducted between early Oct 2013 and the first week in Apr 2014. Each survey was conducted over a three night period and consisted of nocturnal acoustic transects followed by three combined trawl and acoustic transects. All juvenile herring surveys and trawls were conducted aboard the R*/V Montague*.

At sampling bays, additional fish were collected with juvenile herring gillnets (60'X 16'; 1/4, 5/16, 3/8" mesh) and castnets (6', 3/16" mesh) to provide samples for other herring research projects. Nets were deployed opportunistically while at anchor. Data collection from captured fish consisted of measuring (SL, FL, TL; mm) and weighing (g) up to 200 fish per species. Total count and batch weight were calculated if more than 200 of a species were captured. Measured herring were grouped into three age categories based on standard length: young-of-year (YOY; <116 mm), juvenile (116-159 mm), and adults (>159 mm). Fish samples were later sent to the various HRM project for additional analysis (Table 1).

<u>Expanded Adult Herring Survey.</u> The 2014 expanded adult herring acoustic survey consisted of two cruises conducted between 25 Mar and 25 Apr aboard the *M/V Auklet*. The objective of this expanded survey was to locate schools of adult herring in PWS in areas that were not sampled during previous adult herring acoustic surveys. Our sampling protocol consisted of first, during the daytime, using the depth sounder to locate areas with acoustic noise. After target sampling areas were located, nighttime acoustic transects were conducted and large mesh (0.75", 1.00", 1.25", 1.50") gillnets (60' x 16') were deployed. During the first survey (25-28 Mar 2014) acoustic data were collected but no direct capture validation efforts were conducted.

<u>Integrated Surveys with Gulf Watch at Montague Strait.</u> An analysis of the previous seven winters of marine bird surveys (2007/08 through 2013/2014) showed that Montague Strait is a "hotspot" for marine birds. Similarly, the Gulf Watch NOAA Humpback Whale project identified this area as a "hotspot" for whales and the Herring Research Management (HRM) Post-spawn movements of Herring project previously has recorded acoustic-tagged herring reappearing in Montague Strait from Sep through Dec (M. Bishop unpubl. data). Based on these results, in Sep 2014 we collaborated with three other EVOS-funded projects (Gulf Watch NOAA

Humpback Whale, Gulf Watch PWSSC fall and winter marine bird surveys, Gulf Watch USGS forage fish) to investigate multispecies predator-prey aggregations, specifically interactions between humpback whales, forage fish, and forage flocks of seabirds, in Montague Strait. For this project, we deployed the midwater trawl during the day and at the direction of the Gulf Watch forage fish PI M. Armitsu.

Data Analysis

Juvenile herring surveys. For the juvenile herring abundance index analysis we assumed that transects within the same bay were correlated and not independent samples. Following, we included sample bay as a random effect in our modeling to address the spatial correlation in our dataset. Additionally, we were interested if environmental and geographic variables, including water temperature, salinity, and trawl depth, were associated with YOY herring catch data. To analyze these data, first catch was standardized to account for differences in trawl distance to obtain the rate YOY/km. We assumed that the log of YOY/km followed a negative binomial distribution and modeled YOY/km as a function of the environmental predictor variables using a Genera Linear Mixed Model (GLMM). This model was fit in R using the glmmADMB package.

Using a random intercept and slope mixed-model, our data could not support more than two predictor variables due to limited degrees of freedom. To select predictor variables we first fit a model for each variable and then selected the two variables that had the strongest relationship with YOY/km. Of the single-variable models, water temperature had the strongest relationship with YOY/km ($p= 0.03$), trawl depth ($p=0.12$) was weakly associated, and salinity was likely not associated with YOY/km ($p=0.73$). Based on these results, our estimation model contained trawl depth and water temperature as predictor variables.

For the intensive surveys, we investigated trends in adult herring, juvenile herring, and YOY herring catch per unit effort (CPUE) over time and between bays (Simpson and Windy). Additionally, the biomass of each herring age category as a proportion of total captured biomass was calculated to investigate temporal trends in catch composition. Finally, we were interested if the presence of an ice edge influenced CPUE or catch composition. Ice was present in Simpson bay during all trawls conducted in Feb and Mar and two of three sampling nights in Apr (number of trawls = 24) and no ice was present from Oct through Dec and one night in Apr (number of trawls = 25). Size structure was investigated by categorizing all catch data as either from “ice” or “open” periods and generating length frequency histograms for each group.

Expanded adult herring survey and Montague Strait pilot study. Catches and capture efforts were summarized by date, capture location, and gear type. Additionally, herring length data were plotted against weight to examine the relationship between these two metrics and a regression model was fit to the data. Total effort and herring catch for the Montague Strait pilot study was summarized.

Results

Juvenile Herring Surveys. Data from the 2014 Juvenile Index survey indicated that median YOY/km in the nine bays sampled in PWS was strongly related to water temperature (p=0.03) and trawl depth (p=0.06). A 0.1 degree Celsius increase in water temperature was associated with a 20% increase (95% CI: 2-42% increase) in median YOY/km, and a 1-m increase in trawl depth was associated with 12% decrease in median YOY/km (95% CI: 0-23% decrease).

Because of the spatial correlation in our data, we need to consider the relationship between these predictor variables and sample bay to interpret the biological significance of these results. We investigated these relationships graphically and determined that trawl depth covered a wide gradient in most bays and was not strongly related to sample bay (Figure 2). However, water temperature was similar for transects occurring in the same bay and was higher in bays with high YOY/km (Figure 3). Thus, the positive association between YOY/km and water temperature could be due to confounding with other unmeasured variables related to sample bay. Sampling a wide gradient of temperatures within each bay and further analysis of other environmental and geographic variables and their covariance with water temperature could help determine if the association between water temperature and YOY/km found in this analysis is due to the ecology of herring in PWS or is a result of confounding with other variables. For the juvenile intensive surveys, we calculated YOY, juvenile, and adult catch per km (Figures 4-6). Further analysis is needed to investigate possible associations between CPUE and environmental and geographic variables.

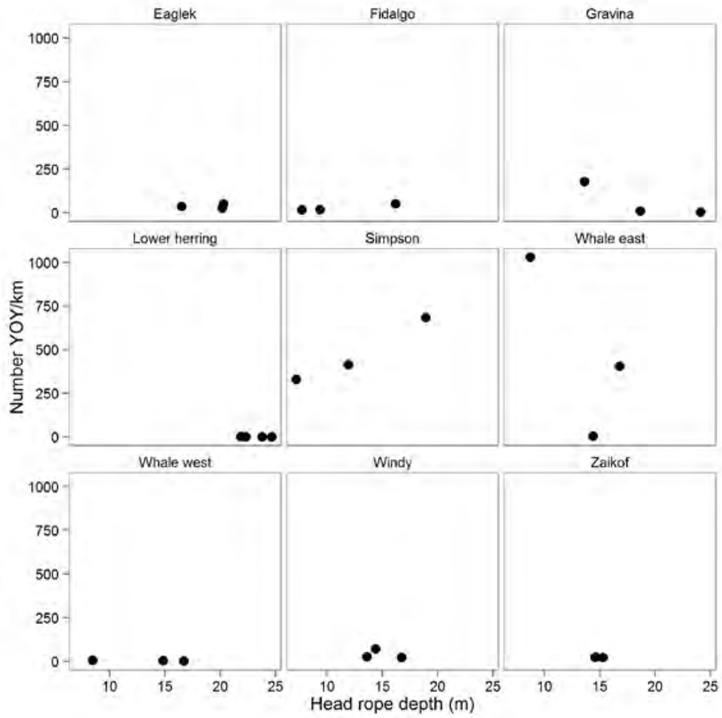

Figure 2. YOY herring (SL <116 mm) catch per km plotted against trawl head-rope depth faceted by sampling bay. Data are from the juvenile herring abundance index survey, Nov 2014.

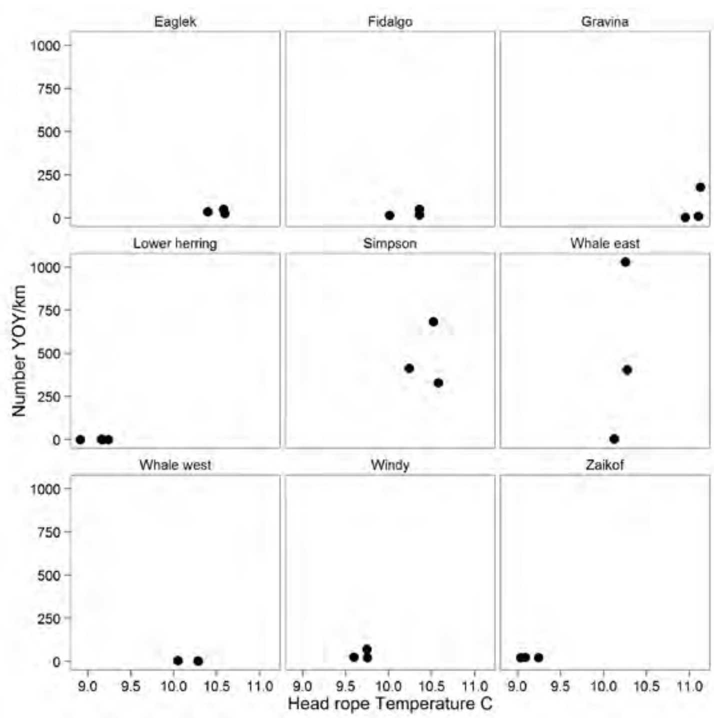

Figure 3. YOY herring (SL <116 mm) catch per km plotted against water temperature (C) faceted by sampling bay. Data are from the juvenile herring abundance index survey, Nov 2014.

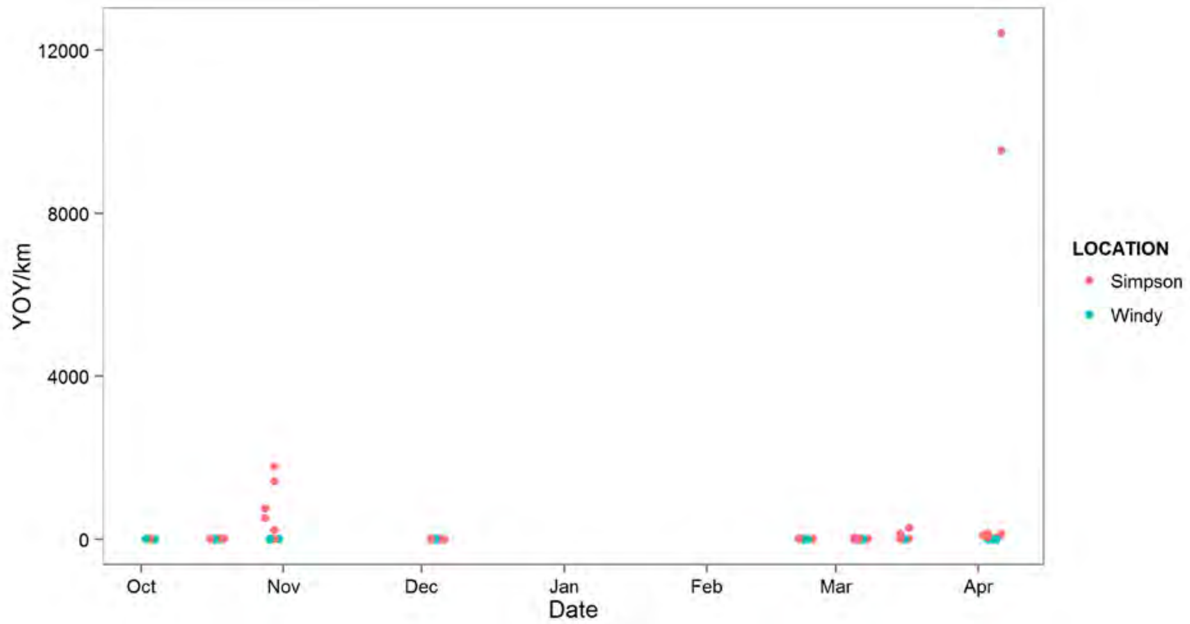

Figure 4. YOY Pacific herring (SL <116 mm) catch per km plotted against capture date. Data are from the juvenile herring intensive surveys, Oct 2013 – Apr 2014.

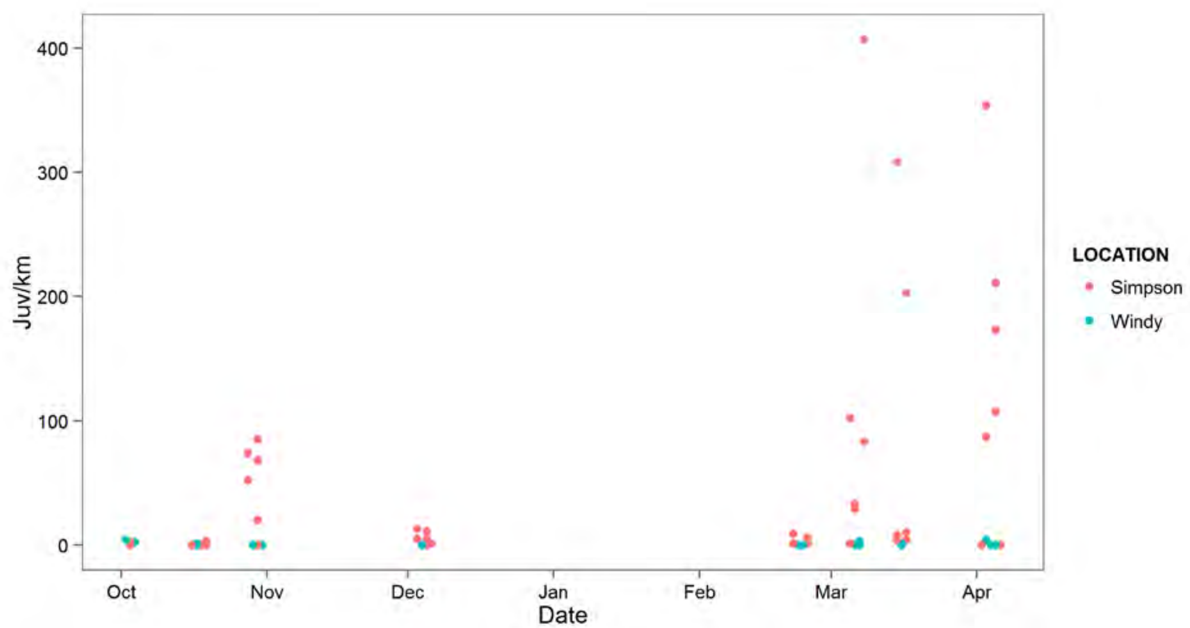

Figure 5. Juvenile Pacific herring (SL 116-159 mm) catch per km plotted against capture date. Data are from the juvenile herring intensive surveys, Oct 2013 – Apr 2014.

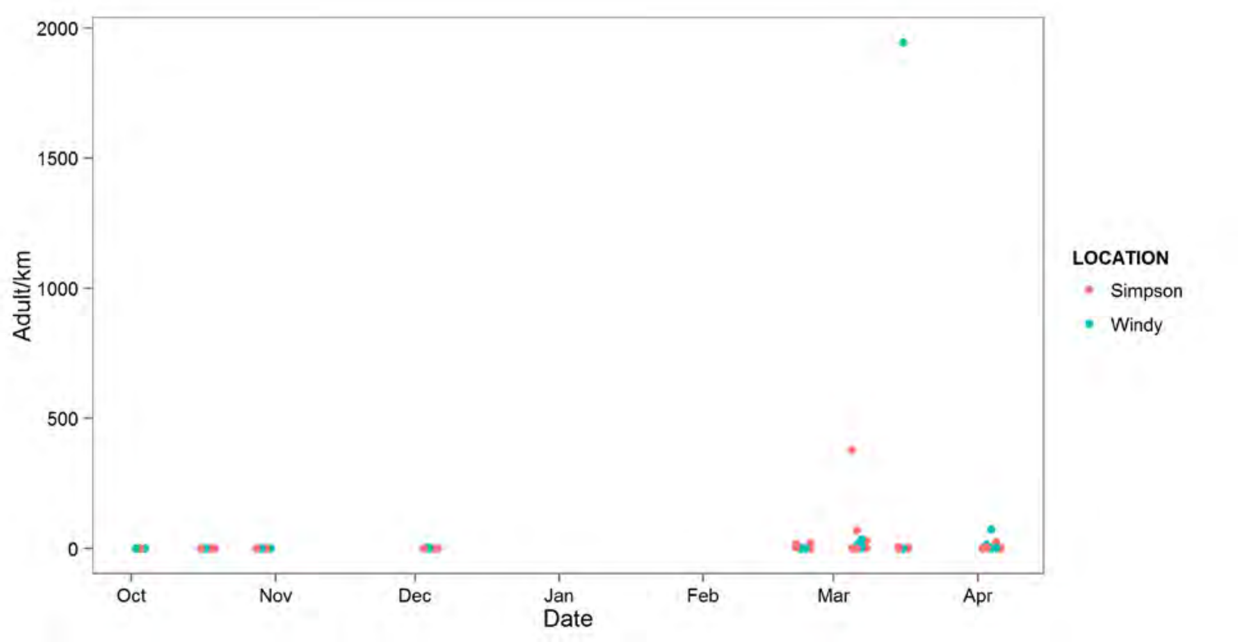

Figure 6. Adult Pacific herring (SL >159 mm) catch per km plotted against capture date. Data are from the juvenile herring intensive surveys, Oct 2013 – Apr 2014.

The number and size structure of captured herring in Simpson Bay during the intensive surveys was hypothesized to be related to the presence of an ice edge in Simpson Bay. An ice edge was present during all trawls conducted in Feb and Mar and two of three sampling nights in Apr (number of trawls = 24) and no ice was present from Oct through Dec and one night in Apr (number of trawls = 25). Size structure was investigated by categorizing all catch data as either from “ice” or “open” periods and generating length frequency histograms. During open periods YOY herring were captured in the highest proportion, fewer juvenile fish were captured, and adults were captured infrequently (Figure 7). Catches from periods with ice cover were dominated by juvenile herring, while both adult and YOY age classes were present in lower proportions (Figure 7).

During the final sampling period (2-6 Apr), ice was present the first two nights of sampling but retreated during the final night of sampling. As a result, the Apr sampling period included six tows conducted while ice was present and three when the bay was open. This allowed for a comparison of size distribution based on ice cover with data from the same time period. During the two sampling nights with ice, catches were dominated by juvenile and adult herring and contained a low proportion of YOY herring (Figure 8). However, during the final sampling night without ice, catches contained only YOY herring (Figure 8). Finally, the size distribution of herring caught during the open, no-ice sampling night in Apr 2014 was compared to the size distribution of herring caught in previous months. The size distribution is different than distributions from open periods, but is similar to the Oct 2013 distribution. From these data it appears that the proportion of YOY herring in trawl samples is higher during open water (no-ice) periods in Simpson Bay.

Finally, we calculated the proportion biomass of each trawl that was YOY, juvenile, and adult herring (Figures 9-11). Herring made up a low proportion of capture biomass during the Oct, Nov, and Dec intensive surveys, with the exception of one transect in Windy Bay in Dec (Figures 9-11). The proportion of YOY and juvenile biomass in Windy Bay catch remained low throughout the sampling period, but

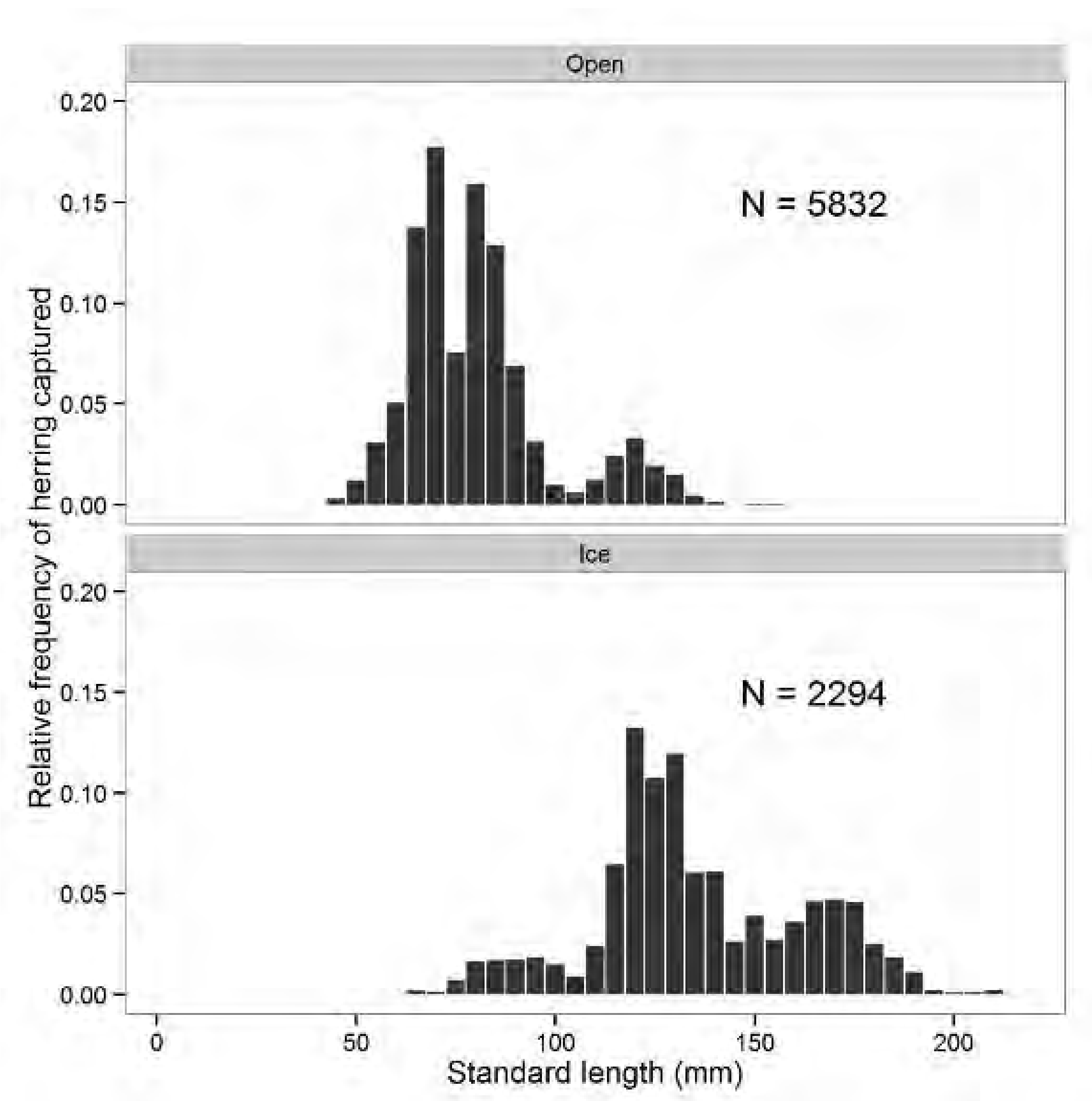

Figure 7. Length frequency histograms of the number of Pacific Herring caught by trawling in Simpson Bay, Oct 2013 – Apr 2014. Catch data are grouped in 5-mm bins by ice conditions at time of capture. Simpson Bay had ice during Feb and Mar sampling events and for three of nine tows in Apr.

the proportion of adult herring biomass increased substantially during Mar and Apr. In Simpson Bay, YOY and juvenile herring biomass made up a large proportion of catch in Mar and Apr, while adult herring biomass was a large proportion of catch in Mar but was low in Apr (Figure 9-11).

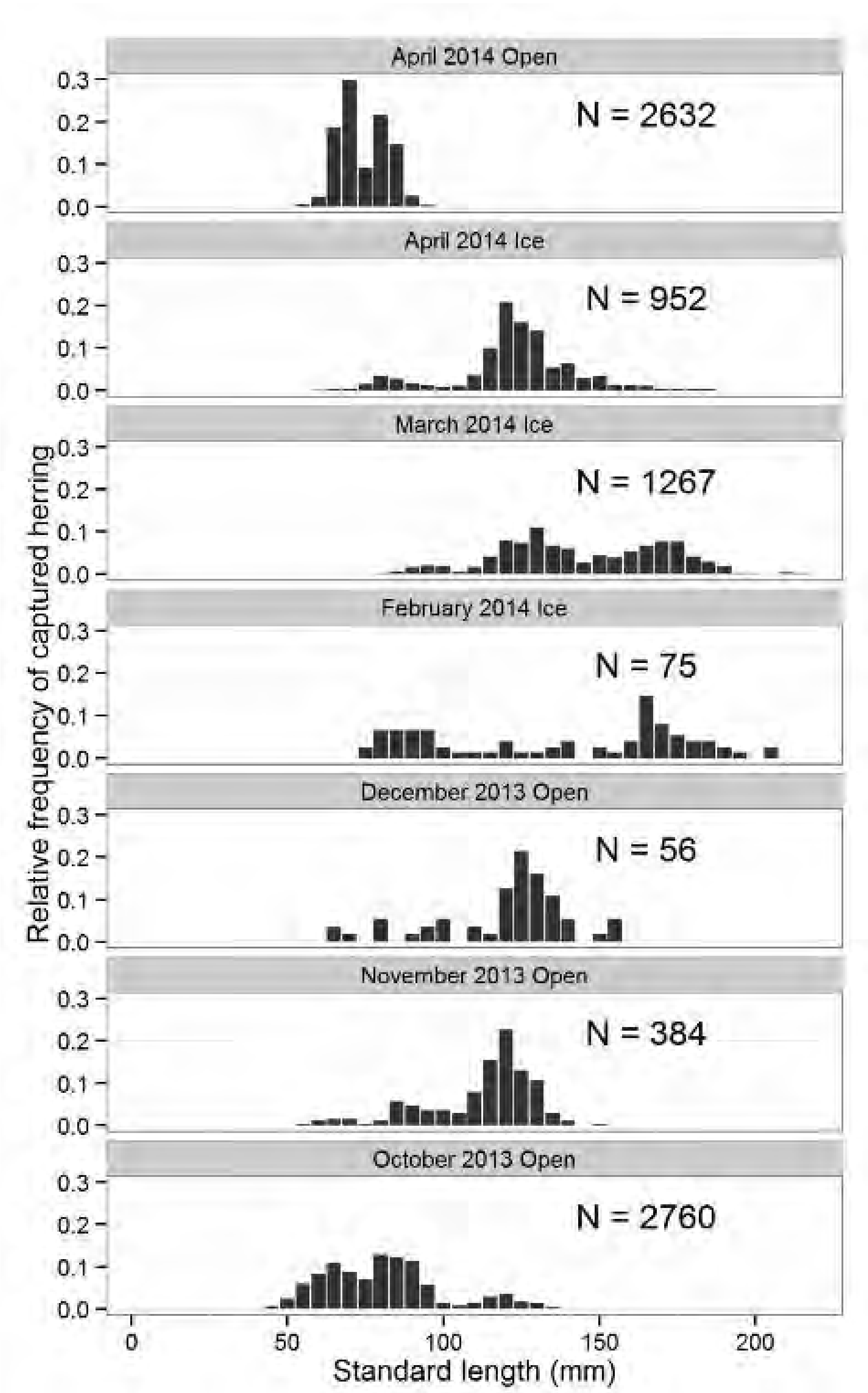

Figure 8. Length frequency histograms of herring caught in Simpson Bay from Oct 2013 through Apr 2014 with 5-mm bins.

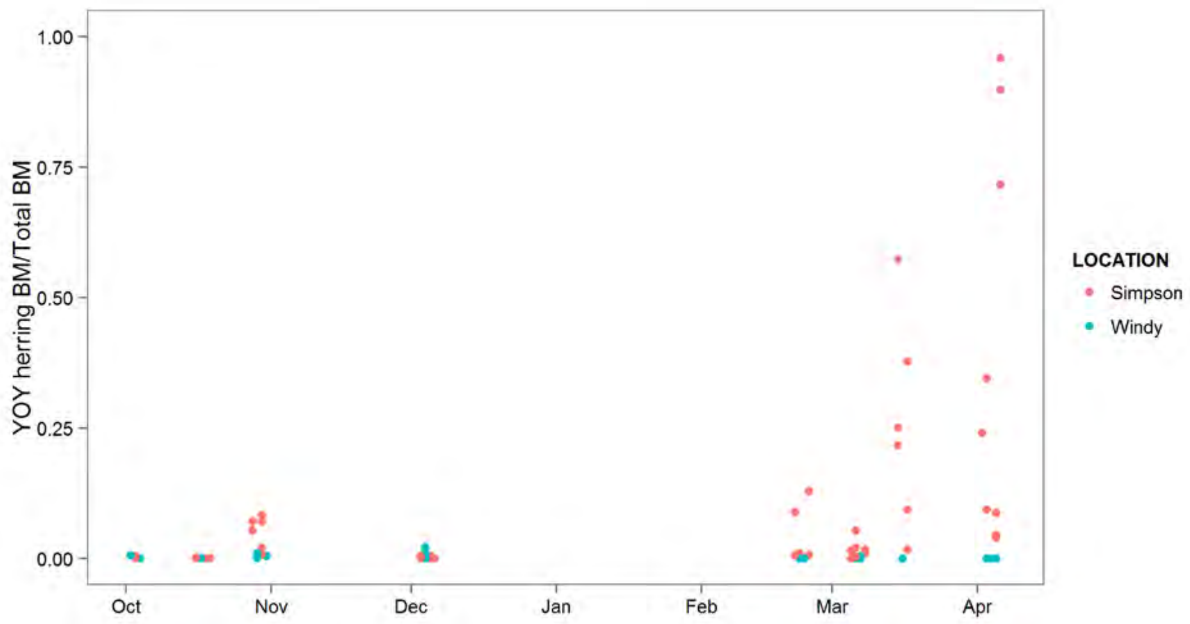

Figure 9. Proportion of YOY herring (SL <116 mm) biomass in trawl catch from the juvenile herring intensive surveys, Oct 2013 – Apr 2014.

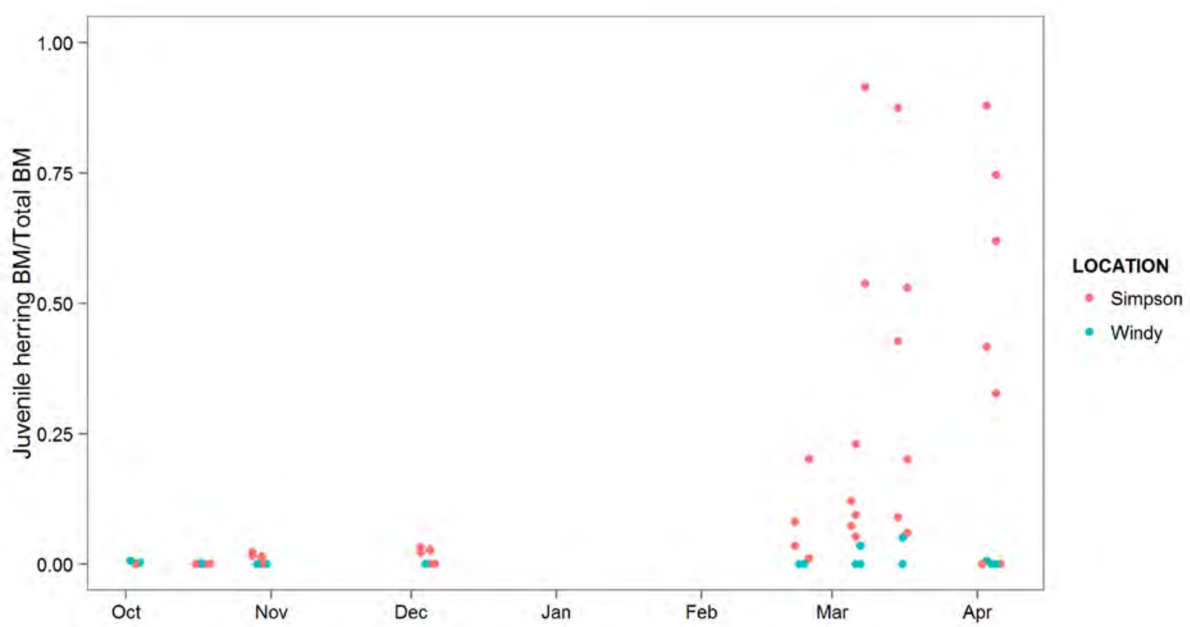

Figure 10. Proportion of juvenile herring (SL 116-159 mm) biomass in trawl catch from the juvenile herring intensive surveys, Oct 2013 – Apr 2014.

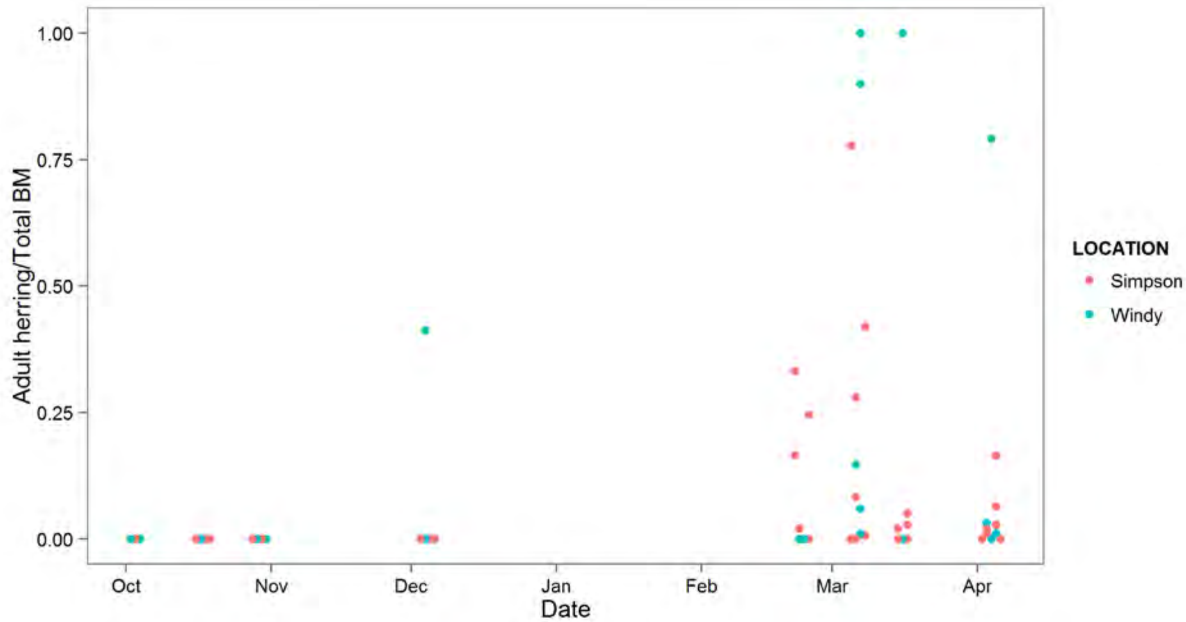

Figure 11. Proportion of adult herring (SL >159 mm) biomass in trawl catch from the juvenile herring intensive surveys, Oct 2013 – Apr 2014.

Expanded Adult Herring Surveys. During 2014 expanded adult survey 95% of the 97 captured fish were adult herring (Table 3). The majority of adult herring (85) were caught in a single large-mesh gillnet set. The mean standard length of captured adult herring was 221.9 mm (95% CI: 242.1–201.7 mm) and the mean weight was 137.6 g (95% CI: 175.3–99.9 g). The relationship between length and weight of captured adult herring was approximately linear (Figure 12). Following, we fit a linear regression model to the data and determined that the association between standard length (SL) and weight of adult herring was strong ($p < 0.001$) and SL accounted for much of the variation in weight (R^2=0.929).

Table 3. Summary of catch and capture effort for the expanded adult survey, spring 2014.

Date	Location	Gear Type	Species	No. Collected
4/4/2014	Sheep	Midwater Trawl	NA	0
4/22/2014	Port Chalmers	Gillnet	kelp greenling	1
			Pacific cod	1
			Pacific herring	6

			saffron cod	1
4/23/2014	Stockdale	Jig	NA	0
4/24/2014	Stockdale	Gillnet	great sculpin	2
			Pacific herring	1
4/24/2014	Stockdale	Gillnet	Pacific herring	85

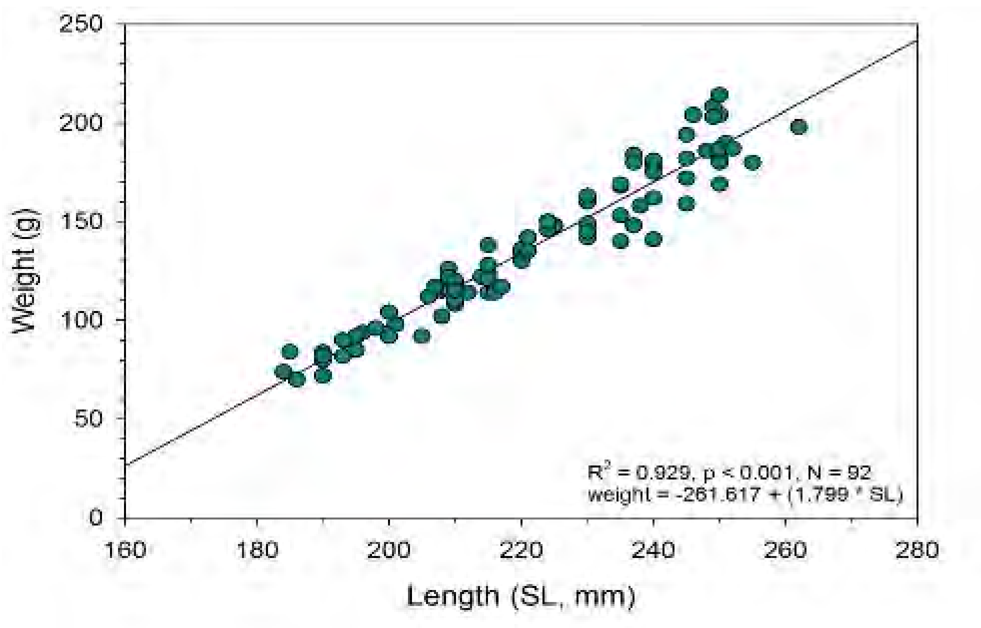

Figure 12. Length/weight regression of herring captured during the expanded adult herring cruise, Apr 2014.

Montague Strait pilot study. Multiple gear types were used during the Montague Strait pilot study and a total of 250 herring were captured (Table 4).

Table 4. Summary of the gear type and associated number of captured herring per deployment for the Montague Strait pilot study.

Date	Gear Type	Number of Herring Captured
9/24/2014	Jigging	39
9/25/2014	Mid-water trawl	0
9/25/2014	Aluette trawl	0
9/26/2014	Tucker trawl	0
9/26/2014	Tucker trawl	0
9/27/2014	Aluette trawl	17

9/28/2014	Jigging	0
9/28/2014	Dip net	104
9/28/2014	Aluette trawl	90

Milestones/Deliverables

No milestones were scheduled to be completed in FY 2014. Table 5 summarizes field work activities for this project in FY14.

Table 5. Status of project deliverables for this reporting period.

Deliverable/Milestone	**Status**
Mar/Apr *Expanded Adult Herring Survey* with validation & collections for genetics & age at first spawn	Completed, 25 Mar—25 Apr 2014
Feb through Apr *Juvenile Herring Intensive Acoustic & Validation Surveys;* collections for multiple herring projects	Completed, Intensive # 5: 21 Feb—24 Feb 2014 Intensive # 6: 5 Mar—8 Mar 2014 Intensive # 7: 15 Mar— 18 Mar 2014 Intensive # 8: 2 Apr—6 Apr 2014
Nov *Juvenile herring abundance index* with hydroacoustic & validation surveys; disease, condition index & energetics collections	Completed 15-24 Nov 2014
Pilot *Montague Strait Hotspot Integrated Study* with GulfWatch projects	Completed 23-29 Sep 2014

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

a) Coordination and collaboration is critical to this project as all our surveys are associated with other projects. During FY14 we conducted validation trawls or gillnets on EVOS-sponsored HRM juvenile herring abundance index, HRM juvenile herring intensive surveys, HRM expanded adult herring surveys, and the integrated Montague Strait study. The pilot Sep2014 surveys around Montague Strait and the southwest passages marked the first attempt to integrate Gulf Watch marine bird surveys (PWSSC), Gulf Watch forage fish acoustic surveys (USGS), Gulf Watch humpback whale (NOAA) and our and our acoustic validation project. In addition, as noted in Table 1, we collect and provide samples to several HRM projects.
b) No collaboration with other Trustee Council funded projects
c) Adult herring collected off Montague Island were provided to Steve Moffitt with Alaska Department of Fish and Game in Cordova for age-sex-length analysis.

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

Data:

Datasets and associated metadata through May 2014 have been uploaded to the HRM portal.

Popular Press:

Bishop, M.A. 2014. Age-0+ herring: only trawls and time will tell. *Delta Sound Connections* (circulation ~15,000). This annual newspaper published about the natural history of PWS and the Copper River Delta is distributed each May to airports and tourist areas in southcentral Alaska.

Meetings

Bishop participated and gave presentations at the HRM meeting for Principal Investigators in Mar 2014 (Cordova) and Nov 2014 (Anchorage).

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

No issues were raised by the most recent EVOSTC review. The Science panel stated: *There is evidence of substantial, well-executed field work, and excellent support and integration with other projects (pg. 87)*

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$32,500.0	$58,300.0	$98,100.0	$95,000.0	$98,000.0	$381,900.0	$ 137,924
Travel	$1,000.0	$1,000.0	$2,000.0	$1,200.0	$1,200.0	$6,400.0	$ 2,804
Contractual	$900.0	$1,800.0	$2,600.0	$2,200.0	$2,200.0	$9,700.0	$ 10,154
Commodities	$5,400.0	$2,800.0	$1,800.0	$1,100.0	$1,100.0	$12,200.0	$ 12,658
Equipment	$10,700.0	$0.0	$0.0	$0.0	$0.0	$10,700.0	$ 17,071
Indirect Costs (*will vary by proposer*)	$11,900	$19,200	$31,300	$29,900	$30,800	$123,100.0	$ 49,062
SUBTOTAL	$62,400.0	$83,100.0	$135,800.0	$129,400.0	$133,300.0	$544,000.0	$229,673.0
General Administration (9% of	$5,616.0	$7,479.0	$12,222.0	$11,646.0	$11,997.0	$48,960.0	
PROJECT TOTAL	$68,016.0	$90,579.0	$148,022.0	$141,046.0	$145,297.0	$592,960.0	
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 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.

We purchased a trailer for transporting and storing the trawl reel as well as a temperature/depth tag, putting us slightly over on our equipment budget.

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

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

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

14120111-B

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

PWS Herring Program – Tracking Seasonal Movements of Adult Pacific Herring

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

Mary Anne Bishop

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

1 February 2014 – 31 January 2015

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

February 2015

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

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

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

Much of the effort in the past year was in analyzing the data from fish tagged in 2012 and 2013. A summary of that analysis follows with the complete materials in a final report that will be submitted soon.

Post-spawning movements by acoustic-tagged Pacific herring were studied at Port Gravina Prince William Sound during spring 2012 and 2013, and at the entrances from the Gulf of Alaska into Prince William Sound from April 2013 through early January 2014. Our study is a component of the integrated, multi-project *PWS Herring Research and Management* program. This project was designed to inform the Herring Program's objective to: *Develop new approaches to monitoring herring.* Objectives specific to the *Seasonal Movements of Adult Herring* study include:

(1) Field test the application of recent advances in acoustic telemetry on wild adult herring.
(2) Elucidate herring movement patterns between spawning and overwinter sites.
(3) Utilize the Ocean Tracking Network acoustic arrays to monitor herring migration into and out of PWS.

We acoustic-tagged prespawning Pacific herring in Port Gravina during April 2012 and 2013. Post release, 23 of 25 (92%) tagged individuals in 2012 were detected by an acoustic receiver at the Port Gravina release site on one or more days with final detections coinciding with cessation of spawning in the immediate area. The 2013 deployment of the Ocean Tracking Network (OTN) arrays located at the entrances to the Gulf of Alaska from Prince William Sound allowed us to document post-spawn herring movements outside of the immediate release site. In April 2013 we acoustic-tagged 69 herring in spawning areas around Port Gravina. Tags had an expected life of 263 d. Post-release we detected all but 5 of the 69 tagged herring either at Port Gravina and/or the OTN arrays. Based on detections at the OTN arrays, some herring appeared to quickly move out into the Gulf of Alaska, while many remained in and around the entrances, most likely to feed on the *Neocalanus* bloom through June.

Following the decline of the *Neocalanus* bloom, herring departed from Hinchinbrook Entrance and Montague Strait, with fish at Montague often shifting west and into to the Southwest Passages. Herring schools appeared to be actively moving throughout fall in and around Montague Strait and the Southwest Passages, although no equivalent movements were detected at Hinchinbrook Entrance. Arrays detected herring around Montague Strait and the Southwest Passages right up to when tags expired in early January 2014, indicating that not all herring winter in northeast PWS and that some herring may be moving back and forth into the Gulf even during winter months.

The results of this pilot study demonstrate the exceptional opportunity to document migration patterns by PWS herring, and specifically the connectivity between the Gulf of Alaska and Prince William Sound. The Ocean Tracking Network is expected to last at least through early 2019. As currently configured, however, the Ocean Tracking Network arrays do not permit determination of movement direction by tagged fish. With a relatively small investment, this could be remedied. We found that most detections occurred at the outermost receivers, therefore placement of receivers just above and below the outermost receivers would allow for determination of the movement direction for a large proportion of the detections. In addition, by using acoustic tag programmed at low power only, battery life on acoustic tags would be increased to of ~400 d days. This would allow us to monitor acoustic-tagged herring from one spawning season to the next.

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

a) This project in the analysis phase and results are being shared with other projects. The information is of particular interest to the predator studies and forage fish projects in Gulf Watch Alaska. We are working with the environmental drivers investigators in GWA to help find an explanation for the observed behavior of the adult herring.
b) No coordination exists with other EVOSTC funded projects
c) There is no coordination with EVOS Trustee agencies other than sharing of findings.

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

a) Publications – Two manuscripts are in preparation
b) Presentations – Cordova Community Lecture series
c) Data products – there are no specific data products outside of reports and presentations.
d) Information archive. All tagging data and associated metadata are on the Ocean Workspace.

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

No project specific comments were provided.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$7,300.0	$8,900.0	$11,300.0	$0.0	$0.0	$27,500.0	$ 11,002
Travel	$5,100.0	$2,700.0	$0.0	$0.0	$0.0	$7,800.0	$ 2,028
Contractual	$400.0	$300.0	$1,000.0	$0.0	$0.0	$1,700.0	$ 19,249
Commodities	$37,100.0	$500.0	$0.0	$0.0	$0.0	$37,600.0	$ 32,813
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)	$15,000	$3,700	$3,700			$22,400.0	$ 19,490
SUBTOTAL	$64,900.0	$16,100.0	$16,000.0	$0.0	$0.0	$97,000.0	$84,582.0
General Administration (9% of	$5,841.0	$1,449.0	$1,440.0	$0.0	$0.0	$8,730.0	
PROJECT TOTAL	$70,741.0	$17,549.0	$17,440.0	$0.0	$0.0	$105,730.0	
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 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.

Some personnel funding remains unspent for preparation of the final report and submission of manuscripts. The excess spending on contractual came from the need for additional tagging cruises.

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

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

Form Rev. 10.3.14

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

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

14120111-C

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

PWS Herring Program – Data Management Support

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

Rob Bochenek

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

February 1, 2014-January 31, 2015

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

February 2015

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

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

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

From the beginning of the EVOS Herring project investigators have been focused on establishing protocols for data transfer, metadata requirements and initiating the data salvage effort. PIs have participated in several Herring Program PI meetings and coordination activities between the Herring and GWA programs. In addition, the AOOS Ocean Workspace has been in use by Herring Program PIs since 2013 for staging, organizing, and sharing their datasets. Software engineers at Axiom have worked throughout FY2014 to support the Workspace, resolving bugs and implementing new functionality in response to user feedback.

In coordination with Herring Program management, data management project PI determined the need for additional staff time beyond that currently funded for the effort the project that would be dedicated to Herring Program data management needs. Project team applied for and received funding for this new position in FY2015

Table 1. Project milestones status

Deliverable/Milestone	Status
GoA Data Portal Showcasing Herring data sets	Completed, 1 September 2013. GoA Data Portal interface updates in 2014, larger updates begun.
Continue to support the transfer and documentation of Herring data sets. Auditing and restructuring/reorganizing	Ongoing Applied for and received additional funding to support half of a data coordinator position to be dedicated to the EVOS Herring Program and

	GWA.
Continue to cultivate and support the functional capabilities of the AOOS Ocean Workspace to address Herring researcher needs	Ongoing
Improved Herring Portal project profile by exposing underlying file level metadata	Completed, 15 January 2014

Objective 1 & 4

The Gulf of Alaska Data Portal was launched in September of 2013. At that time, all of the data that had been in the dedicated Herring Portal was migrated to the Gulf of Alaska portal where it benefits from the additional context of more than 400 other data layers describing other observed and modeled parameters in the Gulf of Alaska. The Gulf of Alaska Data Portal leverages the cyberinfrastructure behind the AOOS Ocean Data Explorer, which was developed using other funding and has these additional features: an integrated search catalog which allows users to search by category or key word, ability to preview data before downloading files, and advanced visualization tools. Once the Herring Progam's data has been ingested into the Ocean Workspace, quality controlled, documented, and approved as final, it can then be ingested into the Gulf of Alaska Data Portal for full public access.

During 2014, a number of updates were made to the AOOS data system, the benefits of which are available to be shared by the EVOS Herring Program and the other research groups supported by or working with AOOS. These improvements are separated below into work completed in 2014, and work begun in 2014 and still underway.

Work Completed

The display of metadata imported from the Workspace into the Gulf of Alaska data portal was redesigned. Upon initial release of the portal, project metadata created in the Workspace was visible as an HTML webpage, while file-level metadata was available in the portal as JSON documents for users to read and understand themselves. This year, Axiom's interface designer created a stylesheet to display the Workspace metadata in a much more human readable form. This file-level metadata page in the portal underwent several design iterations based on user feedback before settling into its current form.

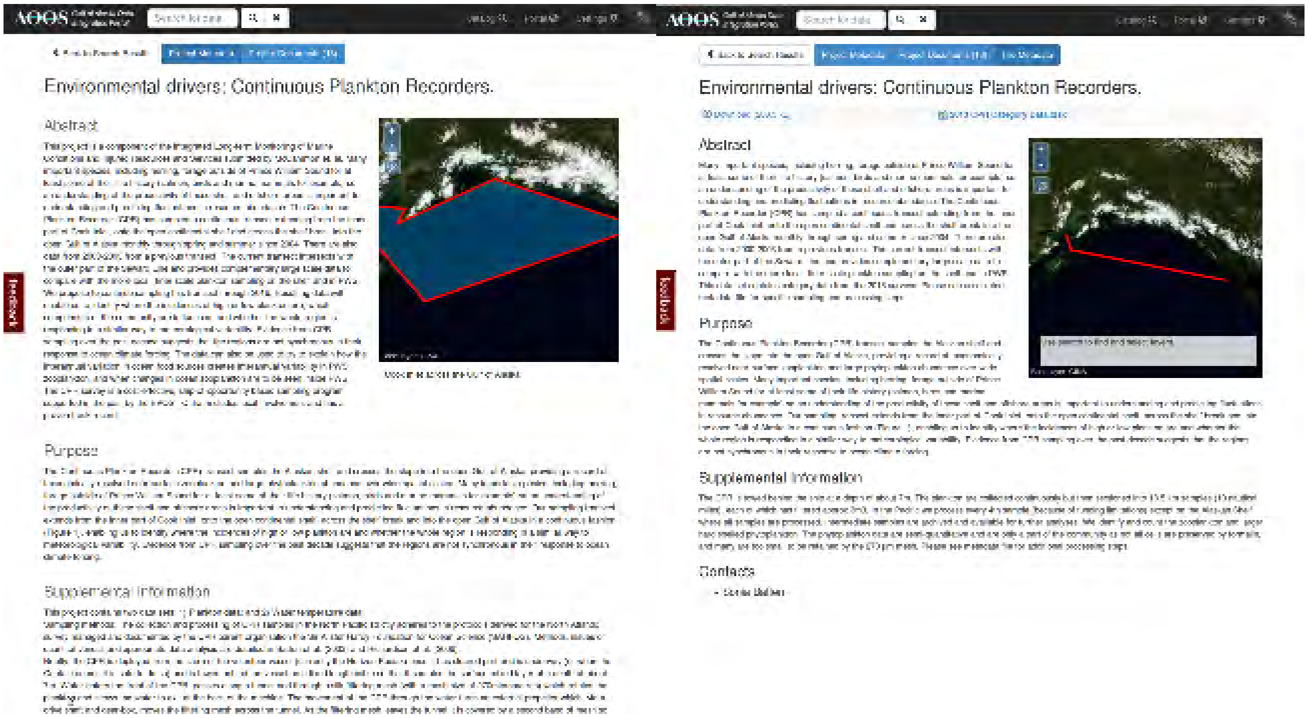

Figure 1. Screenshots of metadata imported from the Ocean Workspace into the Gulf of Alaska Data Portal. From left to right: project metadata for the Continuous Plankton Recorder (CPR) project, metadata for a single data file within the CPR project.

Work Underway

Axiom software architects and engineers have begun work to improve the data catalog user interface and portal visualization capabilities. Underway improvements to the user interface include rebuilding the search tool to improve the precision and relevancy of search results, and indexing datasets' spatial and temporal metadata to allow advanced catalog searches. These upgrades to the data system are motivated by feedback received from GWA managers as well as external sources. Improvements to the catalog search tool will expand the range of material indexed for search to include file-level metadata and the text content of files imported into the Gulf of Alaska data portal from the Workspace. It will also suggest synonymous terms for users to search based on their search queries, e.g. - the new search tool would suggest ‘sea surface temperature’ when a user searched ‘water temperature’. Indexing spatial and temporal metadata will allow users to limit the results of their searches to show only the data in the area selected during the time span indicated. Users will be able to set these limits by drawing a polygon on a map, inputting a spatial bounding box, and/or using a time slider to set a time range.

Data visualization is limited by the underlying data structures used by the data collectors. Axiom and AOOS are at work on a next-generation data portal based on a 4-dimensional data model enabled by the netCDF data format. This system is in the very early stages of development by Axiom software architects, but data analysts have already begun converting targeted datasets into the netCDF format. NetCDF is a well documented, open, and self-describing format that was designed with the needs of long term preservation in mind. Once these conversions are complete, the datasets can be more robustly visualized along standardized parameters while being ready for archiving in a long term preservation environment. In 2015, Axiom will begin working with Herring program management to identify Herring Program datasets that are ready for conversion. Figure 2, an example of a preliminary visualization of netCDF data for another program, is below.

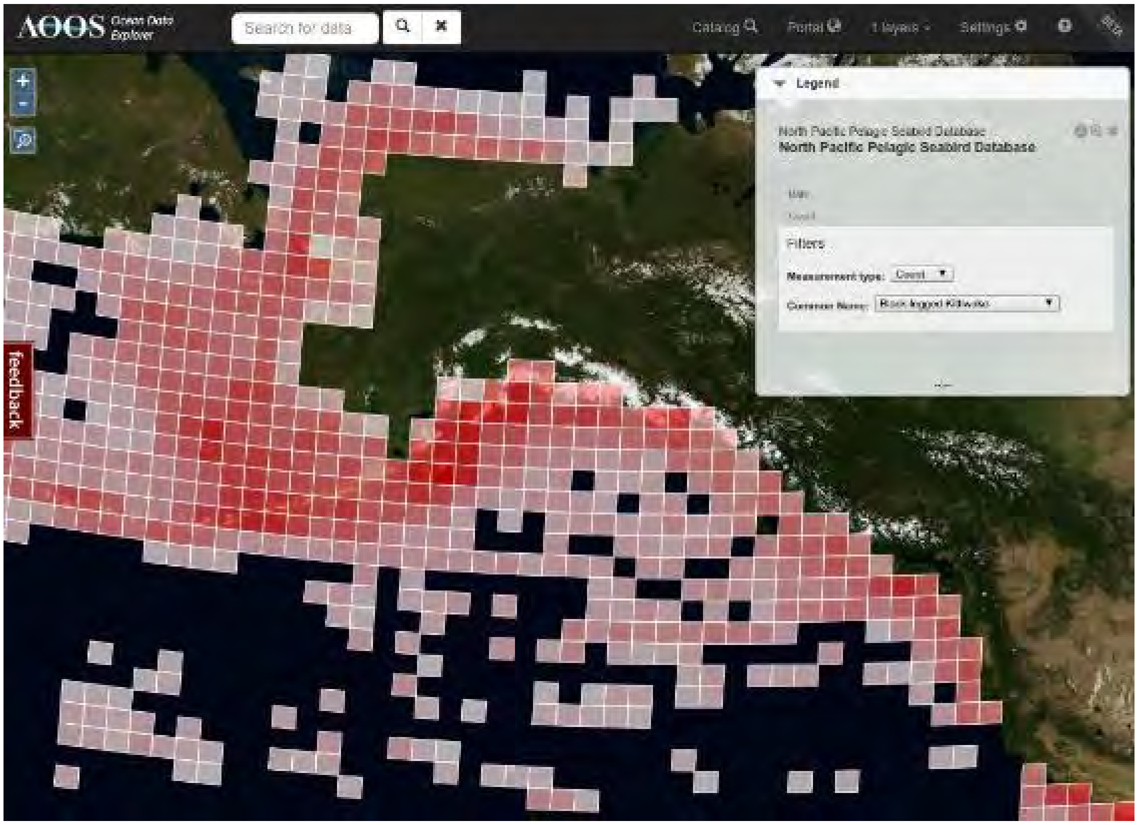

Figure 2. Screenshot of AOOS Gulf of Alaska data portal with the North Pacific Pelagic Seabird Database layer loaded. Color represents raw counts of Black-legged Kittiwake in the waters surrounding Alaska.

Objective 2 & 3

The primary results produced by this project include the acquisition and documentation of EVOS Herring Program PI-produced data sets and the aggregation of ancillary environmental data sets for integration into the AOOS GOA Data Portal. To facilitate the acquisition and documentation of Herring Program data, the project team provides Herring Program PIs with access to the Ocean Workspace, a web-based collaborative data management environment. The project team has supported the use of the Ocean Workspace for data ingestion and documentation through webinars, email support, and by making functional improvements to the Ocean Workspace based on user feedback.

The project team and the Herring Program management decided that the Herring Program required more active data management facilitation than was possible using the Ocean Workspace and leveraging work done with other research groups to develop data lifecycle and management plans. In 2014, the project team applied for additional funding from the EVOSTC to partially a full time data coordinator position at the Axiom Data Science office to provide dedicated one-on-one work with EVOS Herring Program and GWA PIs. This new member of the project team will contact individual PIs about their datasets, work in person or over the internet to help PIs develop robust metadata, and assist Herring Program management with the essential inventorying and status-checking of data submitted to the Ocean Workspace. Through identifying the Herring Program's need for this position, and in finding and being awarded the funds to pay it, the project team has increased the capacity to support Herring Program data management.

Investigators continue to improve the Ocean Workspace in response to user feedback. As a result of this, the Ocean Workspace has become more useful and easier to use. The increase in use by Herring Program PIs is represented in the figures below, followed by a description of the Ocean Workspace.

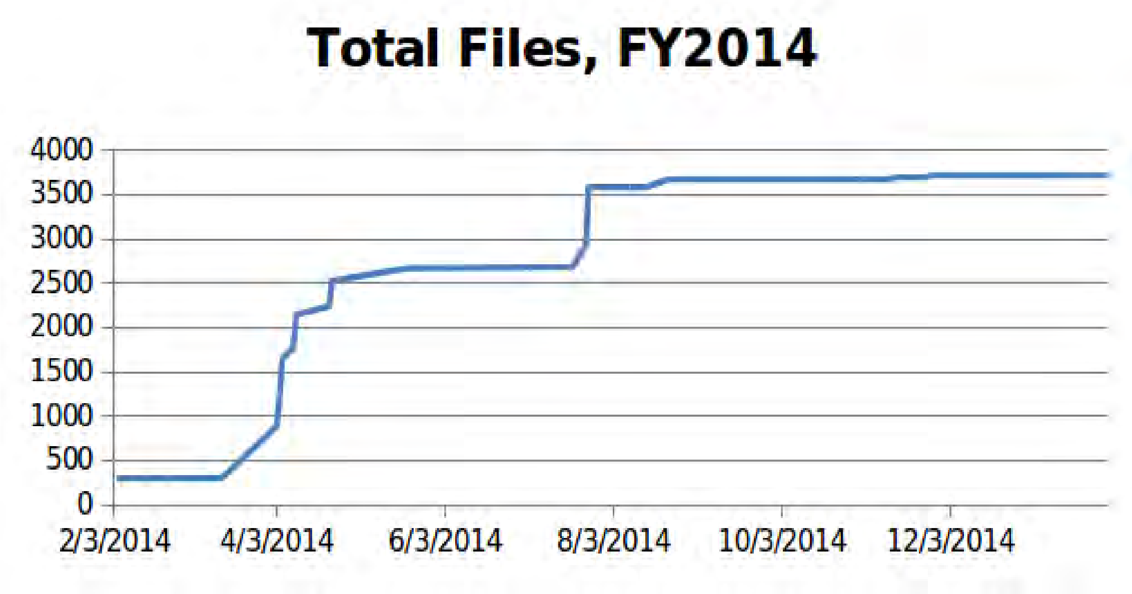

Figure 3. The number of files uploaded by Herring team members in FY2014.

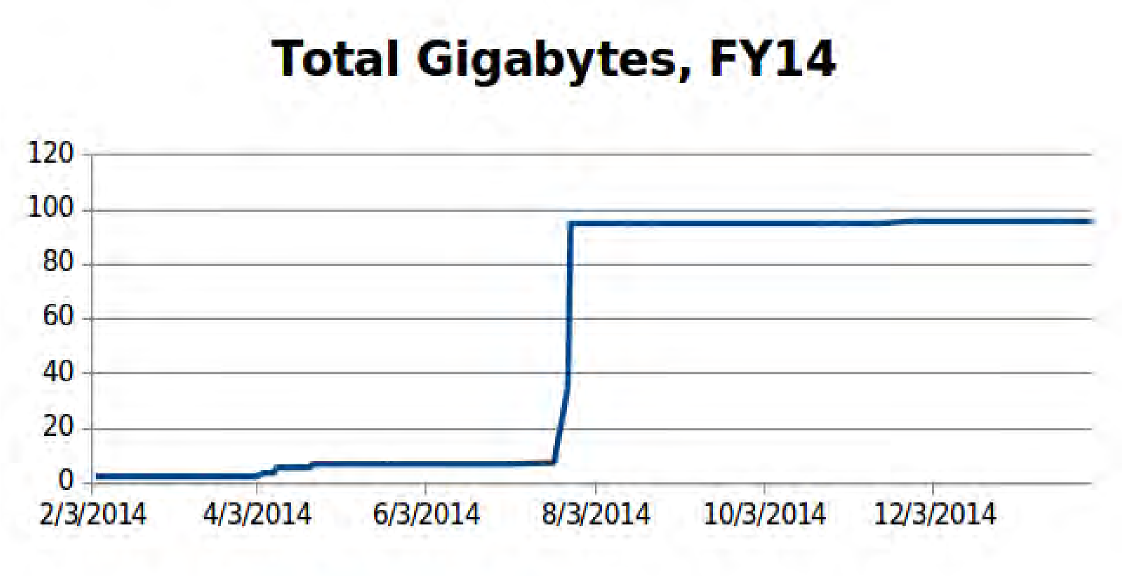

Figure 4. The amount of total storage used by Herring team members in FY2014.

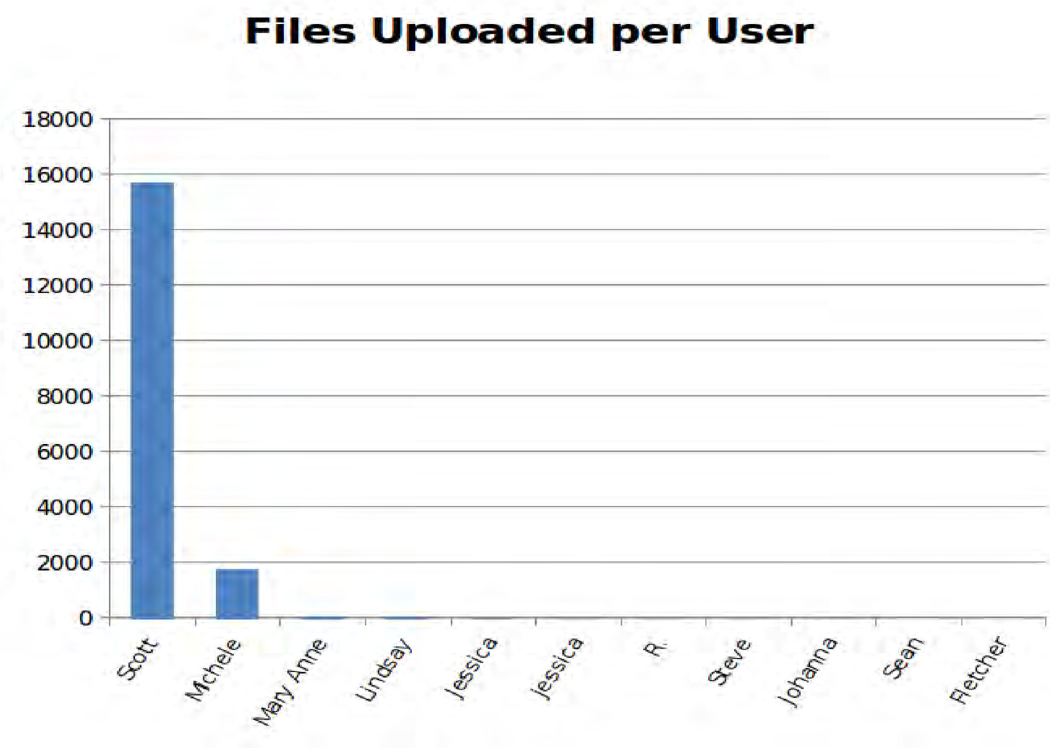

Figure 5. The distributions of file upload effort across Herring Program users.

The Ocean Workspace is a web-based data management application built specifically for storing and sharing data among members of scientific communities as an internal staging area prior to public release of data on a completely public portal. More than twenty regional, national, and private research groups currently use the Workspace, which has over 350 active individuals sharing thousands of digital files. The Workspace provides users with an intuitive, web-based interface that allows scientists to create projects, which may represent scientific studies or particular focuses of research within a larger effort. Within each project, users create topical groupings of data using folders and upload data and contextual resources (e.g., documents, images and any other type of digital resource) to their project by simply dragging and dropping files from their desktop into their web-browser. Standard, ISO 19115-2 compliant metadata can be generated for both projects and individual files. Users of the Workspace are organized into campaigns, and everyone within a campaign can view the projects, folders and files accessible to that campaign. This allows preliminary results and interpretations to be shared by geographically or scientifically diverse individuals working together on a project or program before the data is shared with the public. It also gives program managers, research coordinators and others a transparent and front-row view of how users have structured and described projects and how their programs are progressing through time. The Workspace has the following capabilities:

Secure group, user, and project profiles — Users of the Workspace have a password protected user profile that is associated with one or more disciplinary groups or research programs. The interface allows users to navigate between groups in which they are involved through a simple drop down control. Transfer of data and information occur over Secure Socket Layer (SSL) encryption for all interactions with the Workspace. The Workspace supports authentication through Google accounts, so if users are already logged into their Google account (e.g., Gmail, Google Docs, etc.), they can use the Workspace without creating a separate username and password.

Metadata authoring — Metadata elements currently available to researchers in the Workspace are common to the Federal Geographic Data Committee (FGDC) designed Content Standard for Digital Geospatial Metadata (CSDGM) and the ISO 19115 standards for geospatial metadata, extended with the biological profiles of those standards. Axiom also developed an integrated FGDC biological profile extension editor that allows users to search the ~625,000 taxonomic entities of the Integrated Taxonomic Information System (ITIS) and rapidly generate taxonomic metadata. Because the Workspace is a cloud-based service, researchers can move between computers during the metadata generation process in addition to allowing team members and administrators to simultaneously review and edit metadata in real time. The Workspace metadata editors were expanded in 2014 to include a new tool to provide detailed definitions of attributes used in tabular data files. This tool automatically reads in tabular CSV data files, recognizes column headings in the file, and provides metadata fields for defining those headers in standards compliant elements.

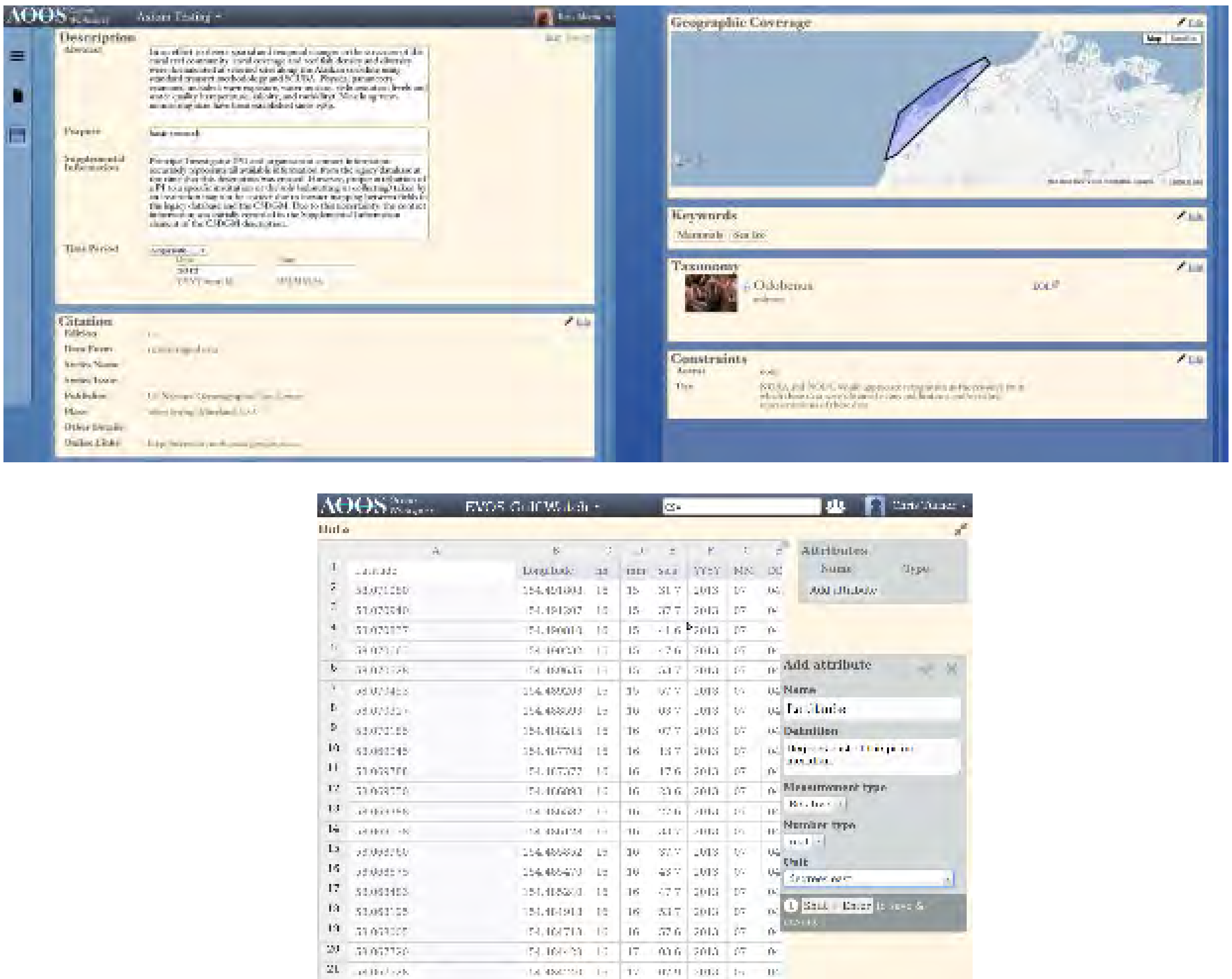

Figure 6. Screenshots of the Workspace metadata interface, clockwise from top-left: the interface to author basic descriptive and citation metadata fields, a tool which allows researchers to describe the geographic extent of the project, keywords, taxonomic information and data constraints, the new tool for editing attributes in tabular data files.

Advanced and secure file management — A core functionality of the Workspace is the ability to securely manage and share project-level digital resources in real-time with version control among researchers and study teams. Users of the Workspace are provided with tools that allow them to bulk upload files, organize those documents into folders or collections, create projects with predefined and user-created context tags, and control read and write permissions on files within projects. The Workspace also has the ability to track file versions: if a user re-uploads a file of the same name, the most current version of the file is displayed, but access is provided to past versions as well.

Figure 7. Screenshots of project and file management in the Workspace. From left to right: a list of projects to which the example user has access rights, the interface a researcher would use to organize independent files into folders, and the way two versions of the same file are tracked by the Workspace.

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

a) This project is responsible for working with all other projects in the Herring Research and Monitoring program to provide data management services. This service is the same as being provided to the Gulf Watch Alaska program and both programs benefit from shared services.
b) There is no coordination with other EVOSTC funded projects.
c) Most of the herring data provided in the Gulf of Alaska Portal is from Alaska Department of Fish and Game. We work with Steve Moffitt of the Cordova office to update data from their annual surveys.

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

- Publications produced during the reporting period;

  None completed.

- Conference and workshop presentations and attendance during the reporting period; The technology

  Several demonstrations of the Workspace have been given to a wide variety of users including PIs from the EVOS Herring Program, Gulf Watch Alaska, the Gulf of Alaska Integrated Ecological Research Program (GOAIERP), the Distributed Biological Observatory (DBO), and the Arctic Ecosystem Integrated Survey (ArcticEIS).

  The AOOS Gulf of Alaska Portal featuring Herring Program data sets was demonstrated at the Alaska Marine Science Symposium during several workshops and was on display at the AOOS booth during the AMSS poster sessions.

Project team members participated remotely in the Herring Program PI meetings in 2014.

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

It was encouraging for the Science Panel to hear via a conference call with Program Science Leads that the standardized forms for metadata submission had been recently modified, and a more refined version is now available to investigators. However, it was discouraging to learn that not all investigators were compliant on submission of both metadata and data in a timely manner (within one year of collection) as agreed upon when accepting funding from EVOSTC. In the future we see submission of required data and metadata as a condition of funding renewal.

Project Team Response

In 2015, the new data coordinator will work with the Herring Program management team help PIs achieve compliance with the EVOS requirements regarding submission of data and metadata. The data coordinator will also assess the need for a data inventory to track dataset status. This inventory could track delivery dates for Herring Program datasets, which datasets have been delivered, which PI is responsible for the dataset, and the status of data preparation, processing and metadata development.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$94,400.0	$93,700.0	$16,700.0	$17,300.0	$17,900.0	$240,000.0	$ 210,247
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Commodities	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Equipment	$3,900.0	$4,800.0	$0.0	$0.0	$0.0	$8,700.0	
Indirect Costs (*23%*)	$21,700	$21,500	$3,800	$4,000	$4,100	$55,100.0	$ 45,478
SUBTOTAL	$120,000.0	$120,000.0	$20,500.0	$21,300.0	$22,000.0	$303,800.0	$255,725.0
General Administration (9% of	$10,800.0	$10,800.0	$1,845.0	$1,917.0	$1,980.0	$27,342.0	
PROJECT TOTAL	$130,800.0	$130,800.0	$22,345.0	$23,217.0	$23,980.0	$331,142.0	
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 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.

There were no deviations from the proposed budget.

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

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

Form Rev. 10.3.14

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

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

14120111-D

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

PWS Herring Program- Non-lethal sampling

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

Kevin M. Bsowell

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

1 February 2014 to 31 January 2015

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

February 2015

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

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

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

Surveys on the cruise were conducted in Simpson and Beartrap Bays in the Prince William Sound. The DIDSON was deployed from a Seamor Marine ROV. Each site was surveyed at least in the morning and at night, encompassing crepuscular periods thought to be important in structuring herring schools. Surveys at this time were mostly exploratory and unequal search effort was expended towards school detections in each bay. Upon detecting a school in either the ROV camera or DIDSON, attempts were made to steady the ROV to enhance the quality and accuracy of the coupled video-DIDSON data to derive density and length distributions. Some schools which exhibited attraction behavior towards the ROV lights were surveyed for a disproportionately long period of time, in an attempt to lure individuals to the surface for capture. Post-processing of acoustic data were completed in the acoustic analysis software Echoview (Version 6; Myriax Ltd). School densities were derived from the estimated nominal beam volume approximated as a 14°x28° rectangular prism, and the number of single target detections per ping. Schools encountered with either ice or bottom present in the sonar data were excluded, as the DIDSON beam volume could not be estimated. Fish length as estimated by a DIDSON is dependent upon the orientation of a target to the sonar, and as such only targets that were orthogonal to the transducer face were measured for length. Though this excluded some portion of the herring school from length estimation, obtaining accurate estimations of length was deemed important enough to sample only the most appropriate targets in each school.

Beartrap Bay was surveyed in the afternoon, at night, and in the morning surrounding the crepuscular periods. Simpson Bay was surveyed at night upon arrival, and in the morning before departure. Average lengths were measured across all school events in each survey. Here we consider a schooling event to begin when five individuals or more are encountered simultaneously in the sonar data, and ends five seconds after no fish detection.

Average herring length in Beartrap Bay surveyed in the afternoon was 11.4 (± 2.3) cm, 10.4 (± 1.5) cm at night, and 11.5 (± 1.8) in the morning. Herring densities ranged from 1.172 fish/m^3 in the afternoon, dropping to 0.4067 fish/m^3 at night, and 0.4147 fish/m^3 in the morning. Densities in the afternoon at Beartrap were higher than subsequent survey times on station, however they were excluded from further analysis as there was no analog in Simpson Bay.

Simpson Bay herring lengths were measured at 12.2 (± 1.5) cm during the night survey, and 12.3 (± 1.9) during the morning survey. Densities in the bay were higher than those in Beartrap Bay, ranging from 2.566 fish/m^3 in the night survey, to 3.495 fish/m^3 in the morning survey.

Densities from the morning and night surveys at each bay were compared to each other to examine possible differences in habitat utilization. Histograms of each survey density were plotted against each other to visualize potential differences detected by the DIDSON (Figure 3). The histogram indicated that there may be differences in density estimates between each bay, and perhaps also between survey times. Each bay was individually examined for the role of survey time on the density estimates of individual schools. Beartrap Bay exhibited significant differences in density estimates based on time of day, with individual schooling events having higher densities in the morning than their night time counterparts (Time: $F_{1,23017} = 11.74$, $P = 0.0006$). Time was excluded as a factor when examining school densities in Simpson Bay as a result of too few observations. Our data show that density estimates among schools were significantly different in both Beartrap ($P < 0.0001$), and Simpson Bays (School_ID: $F_{9,3733} = 66.26$, $P < 0.0001$).

It was noted anecdotally that schools of potentially differing lengths were evident in the sonar data. Two representative schools were examined to test for the capabilities of the DIDSON to distinguish length. Though not significant, length differences were found between two schools encountered in the same survey, showing evidence to support discrimination of age classes by the DIDSON.

These preliminary and exploratory surveys have shown that a DIDSON deployed from a submersible ROV can not only find herring utilizing ice as cover, but can also measure the densities and lengths of schooling fishes. Recent trawl data show that YOY herring have a mean length of 8.28 (±1.64) cm, juvenile herring have a mean length of 14.39 (±2.14) cm, and adult herring have a mean length of 19.59 (±2.65) cm (Figure 1; PWSSC Validated Trawl Data, 2014). Although site means were homogenized by averaging across all schools and lengths, from the results we can see that a difference as small as 2 centimeters can potentially be distinguished by a DIDSON. Although differences between schools in this study were not significantly different, previous tests on estimating lengths of targets in a pool setting have proven effective in differentiating lengths that were different by only several centimeters (Zenone unpbl, 2014). It makes sense that since these length observations were extracted from fish that were potentially from the same cohort, significant length differences may simply not exist. Average length estimates of school events encountered were very close to the average length of a juvenile herring (14.39 ±2.14) that may be anticipated in these bays in the spring. These data show that a DIDSON could be a useful tool in non-lethally identifying and distinguishing herring in the Prince William Sound. The ability to characterize herring age classes could be further refined in the future by the use of the newest imaging sonar, the ARIS, which has an improvement in resolution over the DIDSON of approximately 30%.

Data collected as part of this cruise show that herring schools encountered in the morning are significantly denser than their afternoon and evening counterparts. This could be indicative of crepuscular and night time foraging behavior exhibited by the herring, resulting in a less dense aggregation as fish search for food items. We believe our data may have been skewed by unequal effort, particularly in Beartrap Bay Afternoon that is the sole exclusion from this density trend. It should also be noted that these preliminary analyses utilized single target detections in each ping to determine an average estimate of density over the entire school. This can lead to auto-correlation in our data as a result of individual fish contributing to density estimates multiple times within each school. To improve upon this, it would be useful to attempt enumeration of each individual in the DIDSON by using fish tracking algorithms that follow a single fish throughout its entire presence in the sonar beam. Future studies should also incorporate survey methodologies that allow for in depth examination of density differences among herring schools as a function of standardized time.

Although school encounter rates in Simpson Bay was low, herring densities were highest. This is in agreement with recent trawl data that show Simpson Bay to be the major contributor to herring biomass in sites targeted by the yearly herring intensive survey. This is also perhaps due to intentional targeting of a single large school for a length of time during our Simpson night survey. It was found that herring schools were attracted to the lights from our ROV, and in the interest of data validation we attempted to lure the school to the surface for capture by cast net. Other trends, though not significant, were witnessed in our exploratory data. It appeared to the analyst that fish of different size classes are utilizing disparate microhabitats in the fjords. Smaller herring seem to congregate directly under and near ice, while larger size classes appear to be more commonly encountered in deeper waters. To explore these trends, we recommend a survey design that includes an equal effort spent near ice, bottom, and in pelagic areas of a survey site. Future data collection and analysis is necessary to elucidate any potential habitat utilization patterns as a function of age class.

Further work to advance the non-lethal sampling of herring in the Prince William Sound can also aid in the systemic improvement of acoustic data collection during herring intensives. Previous efforts from the PWS Herring Survey Program have attempted to utilize nets and trawls in conjunction with acoustic surveys as a method of "ground-truthing" data output from acoustic systems, however problems with timely net deployment and mesh sizes which exclude a range of size classes still leave much to debate. The 2013 final report from the PWS Herring Survey Program recommended exploring better options for acoustic validation. We endorse the deployment of a DIDSON during herring intensive surveys to aid in the validation and identification of biomass as witnessed by a traditional acoustic survey. To this end, there exist new means besides the DIDSON to attempt to validate and improve acoustic data collection. Historically, target strength (TS) has been used as the principle parameter for discriminating among taxonomic groups detected acoustically. Target strength is a measure of the amount of energy backscattered from an ensonified target. In fish, greater than 90% of the TS response is attributable to the swimbladder, providing opportunities to exploit variance among species-specific swimbladder morphologies to facilitate discrimination (Horne, 2003). Given that TS of an individual fish is highly frequency-dependent, and scales with target size, we propose to integrate multiple frequencies to enhance the potential to classify among fishes. Specifically, we are interested in examining the relative frequency response across a continuous spectrum of frequencies to aid in guiding discrimination efforts at relevant taxonomic levels (Kang et al, 2002; Kornelieusen and Ona, 2003; Logerwell and Wilson, 2004; DeRobertis et al, 2010; Forland et al, 2014). Through the past year, the

Fisheries Ecology and Acoustics Laboratory has been evaluating the newest echosounder (Simrad EK80 Wideband Sonar) to determine the potential to collect highly-resolved acoustic data for age and species discrimination. When compared to the traditional single-frequency echosounder (i.e. nominal 120 kHz) the analogous wideband sonar will generate a 50 kHz spectrum (i.e. 100-150 kHz) across which scattering data can be collected. Previous studies have successfully implemented relative frequency response relationships for target discrimination and the wideband data shows promise for deriving an "acoustic fingerprint" for a specific target or age class (Reeder et al, 2004; Lundgren and Nielsen, 2008; Lavery et al, 2010). Along with further DIDSON surveys, we recommend the exploration of these wideband utilities for improvement of future acoustic surveys in the Prince William Sound.

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

a) Through the recent activities we have been able to complement the intensive juvenile herring surveys conducted as part of the herring monitoring plan through the deployment of the above described ROV and imaging sonar approach. Further activities will ensure enhanced coordination with the adult herring acoustic and energetic/condition surveys as well as the Gulfwatch humpback whale component to be conducted in Spring 2015.
b) No coordination with other EVOSTC funded projects.
c) No coordination with EVOS Trustee agencies.

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

Preliminary analyses have been presented at the PI meetings and we expect a contribution at the next upcoming AMSS meeting.

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

No comments provided for the non-lethal component

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$16,500.0	$21,700.0	$0.0	$0.0	$38,200.0	$ 11,902
Travel	$0.0	$8,600.0	$8,600.0	$0.0	$0.0	$17,200.0	$ 9,887
Contractual	$0.0	$0.0	$7,000.0	$0.0	$0.0	$7,000.0	
Commodities	$0.0	$6,700.0	$0.0	$0.0	$0.0	$6,700.0	$ 7,825
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)		$8,270	$9,730			$18,000.0	$ 6,270
SUBTOTAL	$0.0	$40,070.0	$47,030.0	$0.0	$0.0	$87,100.0	$35,884.0
General Administration (9% of	$0.0	$3,606.3	$4,232.7	$0.0	$0.0	$7,839.0	
PROJECT TOTAL	$0.0	$43,676.3	$51,262.7	$0.0	$0.0	$94,939.0	
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 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.

See attached budget form

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

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

Form Rev. 10.3.14

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

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

14120111-E

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

PWS Herring Program – Expanded Adult Surveys

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

Michele Buckhorn and Dick Thorne

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

1 February 2014 to 31 January 2015

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

February 2015

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

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

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

The 2013 hydroacoustic survey of adult herring in Prince William Sound was conducted between March 27 and April 5 aboard the chartered vessel Auklet. The first two days of the survey were focused on Port Gravina and Port Fidalgo, and included a survey over a substantial concentration of herring in Port Fidalgo the night of March 28. The next day was spent searching for herring in Tatitlek Narrows and Galena Bay, before returning to Port Fidalgo for a second night-time survey. Zaikof Bay and Rocky Bay were searched on March 30, and a survey was conducted on a small concentration of fish in Rocky Bay. The next two days included searches for herring off Montague Point, Stockdale, Chalmers, Green Island, Drier Bay, Herring Bay, Northwest Bay, around Naked Island and into Wells Inlet ending in a night survey on a small concentration of fish in Cedar Bay. The next day, April 2, we returned to Port Fidalgo, but the herring concentrations observed previously were absent. The last two days of the survey focused in Port Gravina and included a broad-scale survey on April 3 and a more focused survey on April 4 of a large concentration of herring between Hells Hole and Redhead.

The effort during spring 2014 expanded in time as well as space. One survey took place March 25-28 and covered areas around Montague Island as well as Port Fidalgo and Port Gravina. A second cruise took place April 21-25, later than previous years, and focused around Montague Island.

Results

Despite the expanded survey effort during the March 27-April 5 period in 2013, no appreciable adult herring were located outside of Port Gravina and Port Fidalgo. The two surveys each in those two areas did detect considerable movement from Port Fidalgo to Port Gravina, a pattern observed previous years.

The final, focused survey in Port Gravina on April 4, estimated a biomass of 16,300 metric tons with 95% confidence intervals of 13,700 to 18,800.

In contrast, the effort during March 25-28, 2014, could not locate any substantial biomass in Port Gravina and Port Fidalgo. Two large schools were detected in the vicinity of Port Fidalgo, both over 1000 mt, but the schools were migrating rapidly and were not successfully surveyed. Several whales were foraging on both schools. Some adult herring were detected and surveyed around Montague Island, but the biomass was relatively minor.

Many adult herring schools were detected around Montague Island during the April 21-25 period, extending from Chalmers to Rocky Bay. Although these herring schools were small compared to the massive schools typically seen in Port Fidalgo and Port Gravina, the densities of the herring in these schools were quite high, reaching 7 kg/m^2. The biomass of adult herring in the region was estimated to be in the range of 1-3 thousand metric tons. The schools were located close to shore, but were still targeted by several humpback whales. The whales could be seen as close as 10 m from shore.

Discussion

The accuracy of these hydroacoustic surveys is affected primarily by the ability to cover the spatial extent of the adult herring population. The fundamental assumption is that the survey design can take advantage of the spawning behavior to restrict coverage to an area that can be effectively covered and still be comprehensive. The viability of this assumption is challenged by complex and variable behavior patterns. For example, the twenty plus years of surveys documented a major change in the distributional pattern that took place between 1999 and 2004, when the spawning distribution changed from the Montague Island area to Port Fidalgo and Port Gravina. Predation by humpback whales may have been a factor in this change. Further, the timing of the movement of the herring into Port Fidalgo and Port Gravina has varied considerably over the past several years. An extensive time series during spring 2007 documented the complexity of this movement. Surveys by PWSSC in 2008, 2010 and 2011 underestimated the adult herring biomass because the dates of the surveys missed the peak of the spawning migration. Water temperature may be a factor in the timing, but again whale predation may be a driving factor in the rapid and seemingly unpredictable nature of the movements.

Table 1. Status of project deliverables for this reporting period

Deliverable/Milestone	**Status**
Analysis and biomass estimates	Completed
Submit FY 15 Work Plan for review	Work Plan submitted in August 2014
Alaska Marine Science Symposium	Attended January 2015
Submit annual report	February 2015

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

a) This project works closely with the validation project that collects samples for acoustic validation.

b) No collaboration with other Trustee Council funded projects
c) All herring biomass information was shared with Steve Moffitt at the Alaska Department of Fish and Game (ADF&G) office in Cordova. Fish collected off Montague Island were provided to ADF&G for their age-sex-length analysis. The fish were then provided to the genetic stock structure project.

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

Presentations on the HRM research program were given at the EVOSTC fall meeting. A poster titled "**Expanded hydroacoustic surveys of adult herring in Prince William Sound, 2013-2014"** was presented at the 2015 Alaska Marine Science Symposium. Raw hydroacoustic data prior to November 2014 has been uploaded to the AOOS workspace. Data upload is ongoing as processing and analysis continues.

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

We have not yet met with ADF&G personnel to determine a level of precision acceptable to them.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$49,900.0	$40,900.0	$55,300.0	$55,900.0	$202,000.0	$ 44,544
Travel	$0.0	$3,600.0	$3,600.0	$3,600.0	$3,600.0	$14,400.0	$ 4,414
Contractual	$0.0	$2,000.0	$3,600.0	$3,000.0	$0.0	$8,600.0	$ 991
Commodities	$0.0	$4,000.0	$0.0	$2,000.0	$0.0	$6,000.0	$ 426
Equipment	$6,000.0	$0.0	$0.0	$0.0	$0.0	$6,000.0	$ 6,000
Indirect Costs (*will vary by proposer*)	$0	$17,900	$14,400	$19,200	$17,900	$69,400.0	$ 15,112
SUBTOTAL	$6,000.0	$77,400.0	$62,500.0	$83,100.0	$77,400.0	$306,400.0	$71,487.0
General Administration (9% of	$540.0	$6,966.0	$5,625.0	$7,479.0	$6,966.0	$27,576.0	
PROJECT TOTAL	$6,540.0	$84,366.0	$68,125.0	$90,579.0	$84,366.0	$333,976.0	
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 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.

Spending in the Personnel category is behind due to the intended tech leaving his position and it wasn't necessary to replace the position. This funding will be used to contract with Kevin Boswell at Florida International University to provide technical services with Michele's departure. All other categories have not been billed yet. Indirect is $18.0K underspent because of the other categories currently not billed.

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

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

Form Rev. 10.3.14

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

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

14120111-F

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

PWS Herring Program – Expanded Adult Surveys

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

Michele Buckhorn and Dick Thorne

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

1 February 2014 to 31 January 2015

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

February 2015

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

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

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

We conducted the annual fall survey of 8 bays; four of which were the Sound Ecosystem Assessment (SEA) bays: Simpson, Eaglek, Whale, and Zaikof (Cooney et al. 2001) and the other four were Gravina, Figalgo, Lower Herring and Windy. The survey was conducted from November 15-24, 2014 aboard the R/V Montague. PWSSC staff aboard were: Michele Buckhorn (acoustics), Kirsti Jurica, Megan Roberts (fish capture), and Anne Schaefer (bird surveys).

Surveys were conducted using 120 kHz split-beam hydroacoustic unit in a stratified systematic survey design (Adams et al. 2006). Bays were stratified as MOUTH, MIDDLE, and HEAD. Hydroacoustic transects were conducted at night with the vessel running completely dark. Direct capture after the transects were conducted using a midwater trawl with Star-Oddi CTDs attached to the head rope and the foot rope. For safety purposes, the concurrent acoustic and trawls are conducted with the lights on. Midwater trawl samples were used to ground truth the acoustics as well as supply samples to energetics and disease studies. Samples for the energetics were weighed, measured, counted, and divided amongst the NOAA and PWSSC energetics projects. These specimens are frozen aboard the vessel. Disease samples are required to be alive in order to collect a blood smear and the heart. The remaining carcass is then placed in a whirlpak bag. The requested amount was a total of 180 age-0 samples; 60 from three separate bays. Due to the time constraint maintaining the fish alive, no weights were collected for these samples. A gillnet was deployed over the side of the vessel while at anchor each night as well as castnetting for samples. These specimens were collected in order to compare the methods of herring capture used in prior survey years before the midwater trawl was acquired.

When possible, daytime transects with the hydroacoustics were conducted in each bay for bird surveys.

During the first two nights of the survey, the acoustics vessel was shadowed by a second vessel to conduct surveys using a Didson in locations that were trawled that same night. This occurred in Simpson and Gravina bays.

PRELIMINARY RESULTS

Overall, the survey was successful. Hydroacoustic transects were conducted in all bays targeted and enough samples were collected with the midwater trawl to provide each project with the requested number of samples. Gillnetting was more successful than castnetting for collecting samples in each bay. Even with the lights on and staying up all night to castnet, few fish would come to the surface; they were usually 2-3 feet below the surface and dispersed quickly when the net hit the water. Gillnets and castnets methods were deployed in every bay except Zaikof Bay. This was due to weather and the decision was made to transit to Windy Bay while we had the window to safely cross Hinchinbrook Entrance rather than anchor up for the night. Data for the hydroacoustics and fish capture are detailed in the Survey Event Log and Fish Capture Datasheets.

The first night in Simpson, only 30 fish were able to be maintained alive for the disease processing. Since Simpson is a bay located near our final survey bay, Windy, a second attempt was made to capture fish at the end of the survey to complete a set of 60 for that bay. This was accomplished with a single trawl at the head of the bay (no acoustics) before moving onto the night transects in Windy.

Below are some sample echograms from the survey. In each echogram, the colored bar on the left is the key to the decibel (dB) level displayed in the echogram. The right axis is the depth in meters below the transducer. The numbers across the top are the ping numbers. Data is collected at three pings/second so each echogram window represents just under four minutes. Although they don't represent the entire transect or trawl, the patterns within the echogram are consistent through the entire section of the survey being demonstrated. Within each echogram, if the seafloor is within the 150m range of the transducer then it is delineated by a line in the 0-25 dB range (red through light green.

From the echograms (Figures 1-8), for the most part, the scatter patterns are very spread out in the upper layers of the water column and then larger, denser targets closer to the seafloor. The one exception was in the east arm of Whale Bay (Figures 9 and 10) where there were denser aggregations closer to the surface close to the mouth of the bay. We stopped the transects and turned around to trawl on those aggregations in order to verify if they were age-0 herring. All of the trawls captured schyphozoans, but the echograms are displayed at -70 db which is the level that typically filters them out but includes smaller fish.

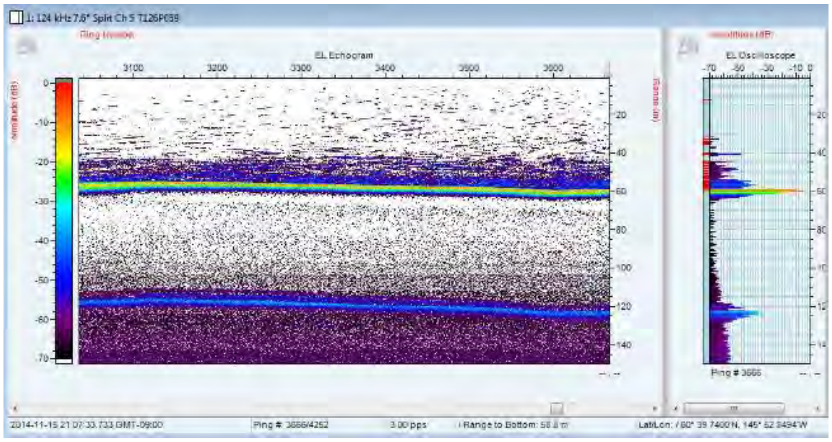

Figure 1. Simpson Bay during trawl 1 (event 3). This trawl captured 312 herring and 8 walleye pollock.

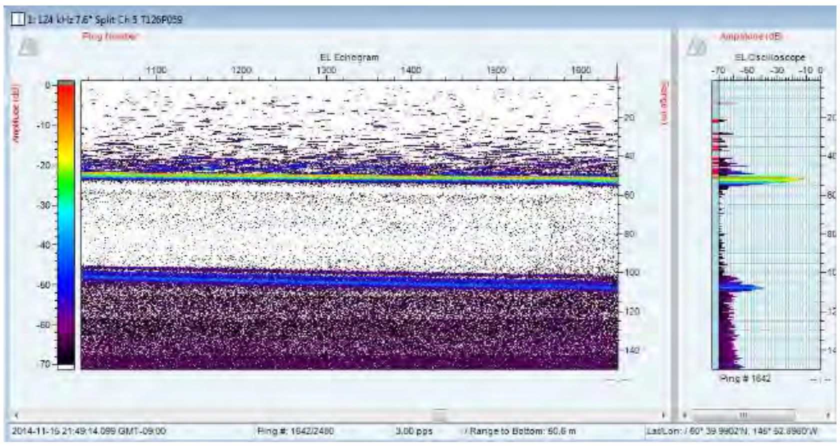

Figure 2. Simpson Bay during trawl 3 (event 7). This trawl capture 280 herring and 1 walleye pollock.

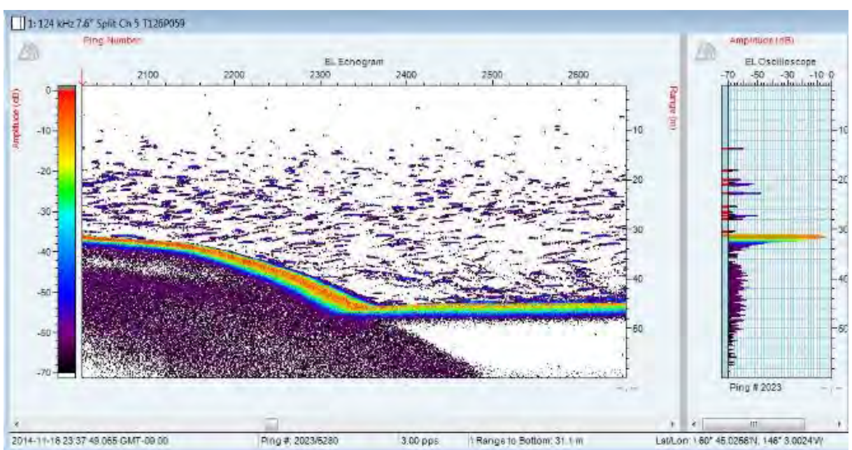

Figure 3. Gravina Bay during trawl 3. This trawl captured 148 herring and 7 capelin.

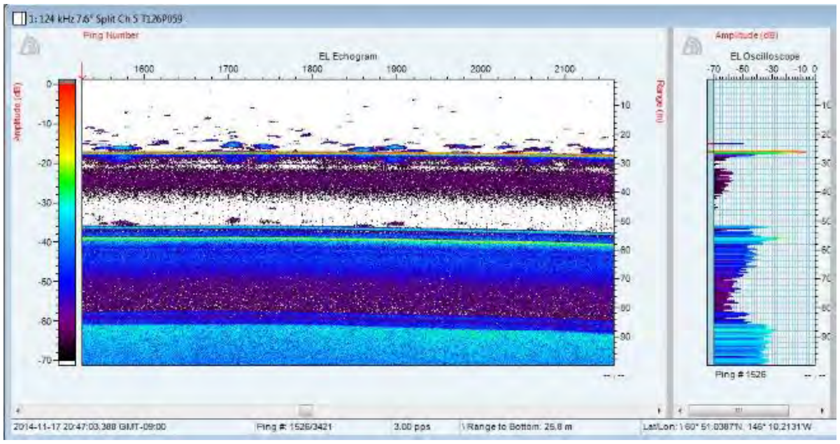

Figure 4. Fidalgo Bay during trawl 1 (event 22). This trawl captured 8 herring and 3 capelin.

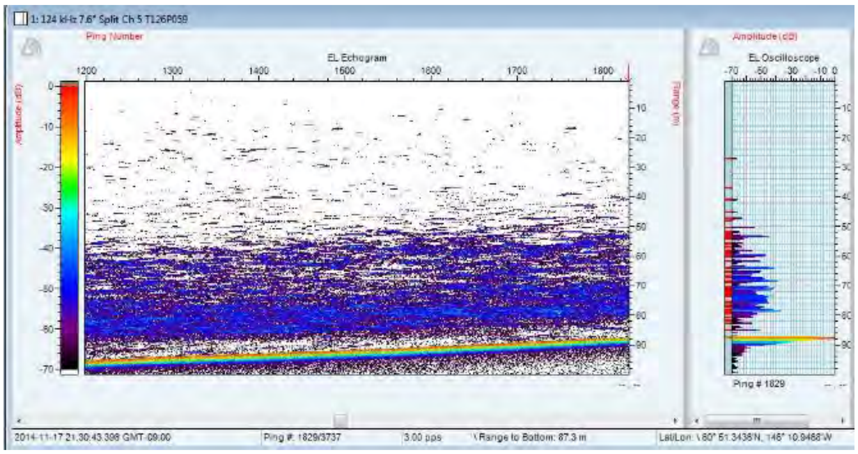

Figure 5. Fidalgo Bay during trawl 3 (event 26). This trawl captured 29 herring and 6 walleye pollock.

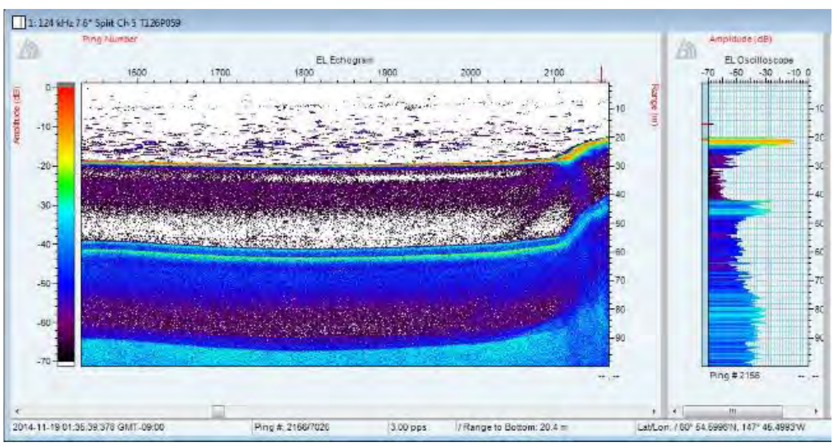

Figure 6. Eaglek bay during trawl 1 (event 33). This trawl captured 20 herring and 12 walleye pollock.

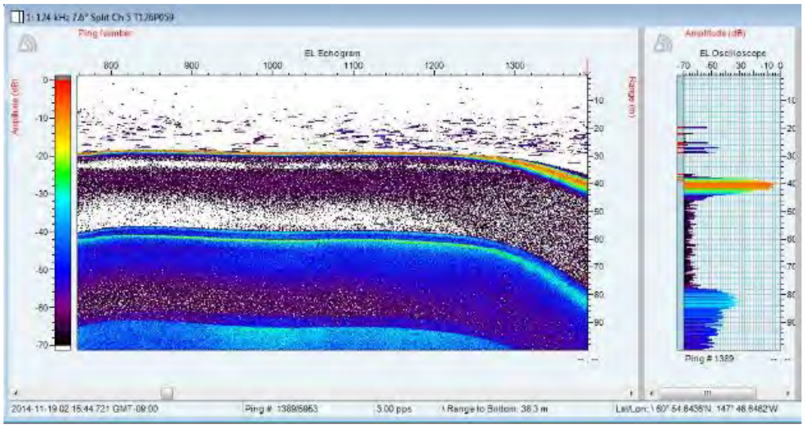

Figure 7. Eaglek bay during trawl 3 (event 37). This trawl captured 63 herring, 14 walleye pollock, and 9 capelin.

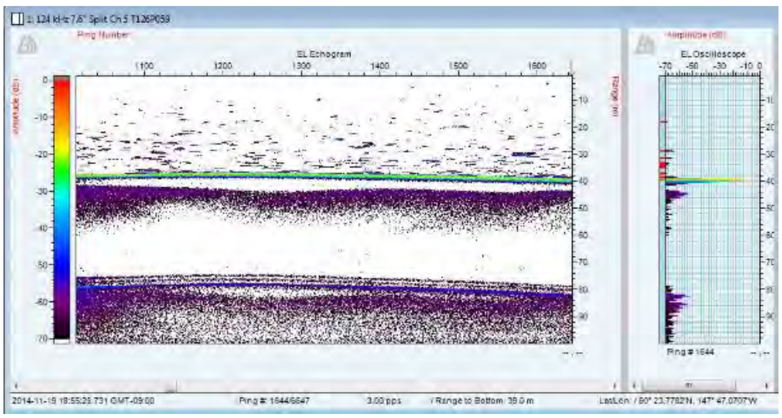

Figure 8. Lower Herring bay during trawl 1 (event 42). This trawl captured 4 herring and 1 walleye pollock.

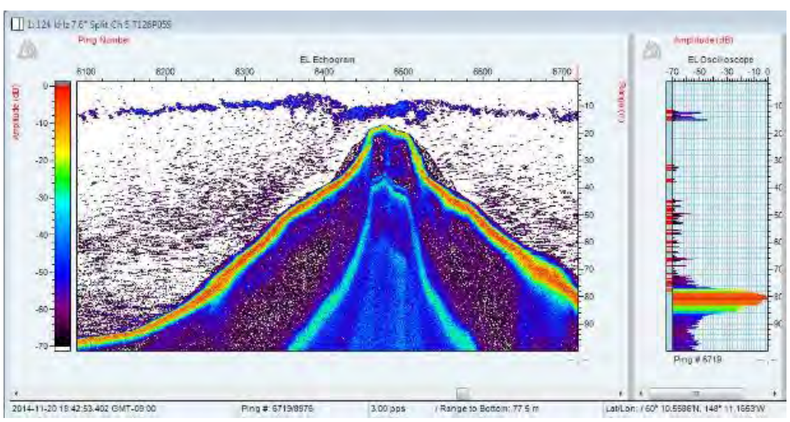

Figure 9. First transect at the mouth of the east arm of Whale Bay. This is the first time we had encountered this type of scatter on this survey that seemed indicative of age-0 herring. We turned around on this transect to trawl.

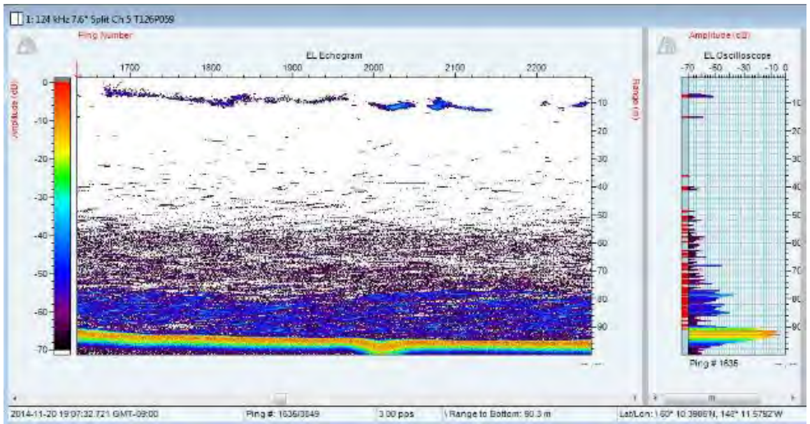

Figure 10. The first trawl in the east arm of Whale Bay. The scatter was not as dense as during the first transect but the trawl captured 744 herring and 2 capelin.

Table 1. Status of project deliverables for this reporting period

Deliverable/Milestone	Status
Post-process acoustic data from 2013	Completed May 2014
Collate trawl data with acoustic data from 2013	Completed June 2014
Analysis and biomass estimates	Ongoing
Submit FY 15 Work Plan for review	Work Plan submitted in August 2014
Alaska Marine Science Symposium	Attended January 2015
Submit annual report	February 2015

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

a) This project works closely with the validation project that collects samples for acoustic validation. Coordination occurred with the non-lethal sampling project to test that approach.
b) No collaboration with other Trustee Council funded projects
c) No collaboration occurred with Trustee agencies.

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

Presentations on the HRM research program were given at the EVOSTC fall meeting. Raw hydroacoustic data prior to November 2014 has been uploaded to the AOOS workspace. Data upload is ongoing as processing and analysis continues.

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

The figures included in this report represent the current level of data processing. With Dr. Buckhorn's departure we are examining the status of data and working with Dr. Boswell to provide technical support in catching up on processing.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$16,200.0	$49,900.0	$40,900.0	$55,300.0	$55,900.0	$218,200.0	$ 49,736
Travel	$0.0	$2,600.0	$2,600.0	$2,600.0	$2,600.0	$10,400.0	$ 3,977
Contractual	$500.0	$4,000.0	$1,600.0	$2,000.0	$0.0	$8,100.0	$ 4,632
Commodities	$1,500.0	$0.0	$1,500.0	$0.0	$0.0	$3,000.0	$ 2,295
Equipment	$59,000.0	$0.0	$0.0	$0.0	$0.0	$59,000.0	$ 57,261
Indirect Costs (*will vary by proposer*)	$5,500	$17,000	$14,000	$18,000	$17,600	$72,100.0	$ 18,181
SUBTOTAL	$82,700.0	$73,500.0	$60,600.0	$77,900.0	$76,100.0	$370,800.0	$136,082.0
General Administration (9% of	$7,443.0	$6,615.0	$5,454.0	$7,011.0	$6,849.0	$33,372.0	
PROJECT TOTAL	$90,143.0	$80,115.0	$66,054.0	$84,911.0	$82,949.0	$404,172.0	
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 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.

Spending in the Personnel category is behind due to the intended tech leaving his position and it wasn't necessary to replace the position. This funding will be used to contract with Kevin Boswell at Florida International University to provide technical services. Travel has a balance due to lag in billing. Indirect is $18.8K underspent because of the other categories currently not billed.

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

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

Form Rev. 10.3.14

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

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

14120111-G

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

PWS Herring Program – Intensive Surveys of Juvenile Herring

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

Michele Buckhorn and Dick Thorne

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

1 February 2014 to 31 January 2015

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

February 2015

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

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

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

The fall series was conducted October 1-4, 16-19, 28-31, and December 3-6, 2013. The spring series was conducted February 21-24, March 5-8, 16-18, and April 2-6, 2014. Each of the two bays (Simpson and Windy) were surveyed in three consecutive nights per survey. A sweeper mid-water trawl (14 X 11 X 22 m with a mesh size of 38 mm dropping down to a 12 mm mesh liner at the codend) was deployed to ascertain size and species composition of selected areas of acoustic transects. Trawls were performed after the completion of acoustic transects and locations chosen to target biomass observed during the transects.

Acoustic data was collected using a Biosonics DTX 120 kHz split-beam echosounder mounted on a towfin that was lowered 2-3 meters in the water alongside the survey vessel. Data was collected using Biosonics Acquisition program and Myriax ECHOVIEW was used for post processing for echo integration and analysis. Survey tracks were both binned into 20m horizontal x 10 m vertical cells as well as running the School Dectection algorithm. Target strength characteristics of herring and other common fishes captured in the trawl (when available) used for the analysis are from Parker-Stetter et al (2013). The acoustic analysis determines the biomass density of the fish. These densities are extrapolated to the appropriate area based on the GPS information that is automatically written to the acoustic data files.

Preliminary Results

The analysis of the acoustic data is currently underway, but the general observations were the acoustic surveys were highly variable between each survey for each bay. There were differences in the acoustics and fish catches between Simpson and Windy. In Simpson there was typically more biomass on the echograms and we caught more herring. When we caught herring, we rarely caught just herring, they were often mixed with walleye pollock, capelin, and sandlance. In Windy there was typically less biomass on the echograms and the majority of the fish catches consisted of walleye pollock. In the fall series, scyphozoans comprised the majority of the catch by weight in both Simpson (91-99%) and Windy (85-95%). In the spring series, the percentage dropped to 7-39% in Simpson and 0-15% in Windy.

During the spring series, ice covered the entire inner third of Simpson Bay, which prevented us from accessing that portion of the bay. Acoustic tracks were run along the ice edge and indicated potential sign of age-0 herring (Figure 1). On the last night of the last spring survey (April 4, 2014) the ice had broken up and we deployed the midwater trawl where the ice edge had previously been and caught over 3000 age-0 herring. This indicates that age-0 herring may be using the ice edge as a refuge from predators.

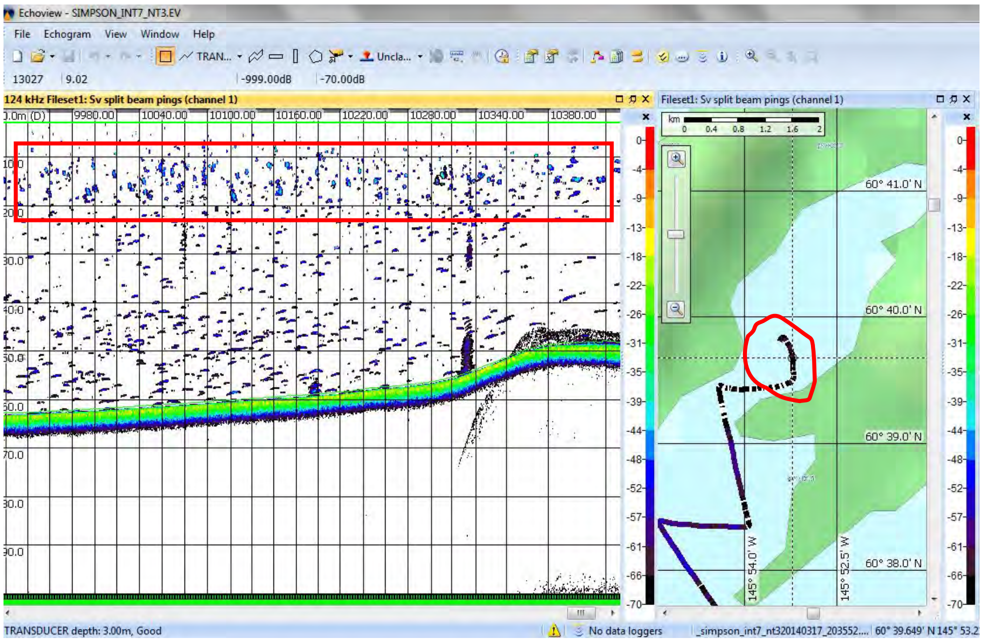

Figure 1. Echogram (left) next to survey track (right) in Simpson Bay. The red circle on the survey track indicates the portion of the survey conducted along the ice edge. The red box in the echogram indicates potential sign of age-0 herring along ice edge.

Table 1. Status of project deliverables for this reporting period

Deliverable/Milestone	**Status**
Post-process acoustic data from 2013-2014	Completed August 2014
Collate trawl data with acoustic data from 2013	Completed November 2014
Analysis and biomass estimates	Ongoing
Submit FY 15 Work Plan for review	Work Plan submitted in August 2014
Alaska Marine Science Symposium	Attended January 2015
Submit annual report	February 2015

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

a) This project works closely with the validation project that collects samples for acoustic validation. Coordination occurred with the non-lethal sampling project to test for juvenile herring under the ice.
b) No collaboration with other Trustee Council funded projects
c) No collaboration occurred with Trustee agencies.

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

Presentations on the HRM research program were given at the EVOSTC fall meeting. A poster titled "**Intensive concurrent acoustic and trawl surveys of overwintering juvenile herring (*Clupea pallassii*) in two potential nursery bays in Prince William Sound"** was presented at the 2015 Alaska Marine Science Symposium. Raw hydroacoustic data prior to November 2014 has been uploaded to the AOOS workspace. Data upload is ongoing as processing and analysis continues.

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

The comments provided appear to be more related to project 14120111-F, the juvenile index project. This project is examining the assumption that the acoustic surveys provide an index that is constant over short time periods. The ability to provide a measure of survival is dependent on the accuracy and precision of the acoustic surveys. The preliminary results indicate that it may be difficult to use the existing acoustic information to determine survival.

With Dr. Buckhorn's departure we are examining the status of data and working with Dr. Boswell to provide technical support in catching up on processing. We will work with Drs. Thorne and Boswell to ensure Michele's replacement has a senior collaborator to work with.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$21,000.0	$30,100.0	$4,700.0	$0.0	$55,800.0	$ 24,570
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$ 9
Contractual	$0.0	$0.0	$1,000.0	$100.0	$0.0	$1,100.0	$ 485
Commodities	$0.0	$0.0	$2,000.0	$0.0	$0.0	$2,000.0	$ 1,376
Equipment	$46,000.0	$0.0	$0.0	$0.0	$0.0	$46,000.0	$ 45,886
Indirect Costs (*will vary by proposer*)	$0	$6,300	$9,600	$1,400		$17,300.0	$ 7,634
SUBTOTAL	$46,000.0	$27,300.0	$42,700.0	$6,200.0	$0.0	$122,200.0	$79,960.0
General Administration (9% of	$4,140.0	$2,457.0	$3,843.0	$558.0	$0.0	$10,998.0	
PROJECT TOTAL	$50,140.0	$29,757.0	$46,543.0	$6,758.0	$0.0	$133,198.0	
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 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.

Spending in the Personnel category is behind due to the intended tech leaving his position and it wasn't necessary to replace the position. This funding will be used to contract with Kevin Boswell at Florida International University to provide technical services. Travel has a balance due to lag in billing. Indirect is underspent because of the other categories currently not billed.

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

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

Form Rev. 10.3.14

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

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

14120111-H

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

PWS Herring Program – Outreach and Education

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

Hayley Hoover

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

1 February 2014 to 31 January 2015

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

February 2015

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

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

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

Several incidents impacted the delivery of outreach materials. The principal investigator had a baby at the beginning of the 2013 and was on maternity leave for several months. She returned to work part time to complete products and then resigned in November 2013. Other members of the education department resigned about the same time or reduced their hours, which led to a search for new education personnel and a decision about how to meet the deliverables. Staff has been brought on in 2014 to complete the education deliverables and Hayley Hoover has been identified to take the lead on the HRM education and outreach component. An education coordinator was brought on at the beginning of this fiscal year, 2015, after yet more turnover occurred in 2014.

During the summer of 2013 the PWSSC made a major revision to its website. This required us to put effort to rebuilding the herring portion of the website. This effort continued through January 2015. Web edits were done in conjunction with the development of project profiles. All empty links that were on the HRM page have been filled. Keeping the web site up to date is of great importance because it connects the project's findings to a wide audience. The PWSSC also reviewed their approach and format for the *Field Notes* radio programs. It is now in an interview format instead of a narrative format. *Field Notes* interviews were conducted at AMSS this year and will be edited and on the air by the end of the March.

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

This project coordinates with the other projects within the HRM program to get materials for the various education and outreach projects. There is also coordination with the outreach projects of the Gulf Watch Alaska program. The investigator that is the lead for HRM outreach is also the lead for GWA outreach.

Table 1. Status of project deliverables for this reporting period

Deliverable/Milestone	**Status**
Develop/update *Project Profiles* based on surveys & herring data analysis	Three *Project Profiles* completed, June 2015
Participate in Principal Investigator update and outreach meeting	Meeting held in Anchorage, January 2015
Evaluate oceanography and herring *Discovery Room* program	*Discovery Room* sessions held and evaluated May 2014
Delivery of *Community Lectures* and *Field Notes* complete for FY14	Three *Community Lecture* were given. *Field Notes* were not completed.
Written outreach materials complete for FY14	Four articles in *Delta Sound Connections* and one in the *Breakwater* were published, May 2014. *Project Profiles* complete, December 2014
Deliver *Summer Field Program*	Summer programs were not delivered.
Submit semi-annual report	Completed August 2014
Continue implementing *Discovery Room*	Herring components have contented to be implemented in *Discovery Room* activities.
Develop *Field Notes* program based on fall surveys	This has not yet occurred. The *Field Notes* programs have been given a priority status for the beginning of FY14.
Attend Alaska Marine Science Symposium	Completed

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

Revised the HRM web page on the PWSSC website with articles in the *Delta Sounds Connections, Breakwater, and Project Profiles*.

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

Science Panel Comments Hoover & Pegau. Outreach 14120111-H

“The Science panel appreciates the progress made on local outreach. One of the simplest ways to do this is to keep the website updated, because it is the portal to the outside world. However, we also recommend that investigators work with the outreach program to craft presentations that could be delivered at various venues (e.g., schools, Science Pubs). There was a comment in the proposal that there has been some difficulty getting PI's to commit to outreach efforts due to logistics. The location of the PI's should have little impact on their ability to participate in outreach efforts. Involvement of PI's in outreach activities can extend the reach of the program and improve the publics appreciation of what is being accomplished. We also encourage the outreach program to call and interview PI's to get information that would be beneficial to the outreach efforts."

In regards to the web page, many updates have been made and will continue to be made into the future. Staff agrees that this is a widely accessible tool that should be kept up to date at all times. As Cordova is a very small town there are no specific 'Science pubs' at staff's disposal. However the Tuesday Night Community Lecture Series hosted by the USFS serves as an alternative to share the programs findings with the local community. Staff will continue to look for new avenues to present findings. Logistics no longer seem to be an issue. Staff will continue to pursue PI's diligently. Paul Hershberger made a trip to Cordova this fall to give a guest lecture, recordings for Field Notes were conducted at AMSS in Anchorage, and two guest lectures are tentatively scheduled for March.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$2,800.0	$16,300.0	$16,800.0	$18,900.0	$22,900.0	$77,700.0	$ 23,410
Travel	$1,400.0	$1,800.0	$3,600.0	$2,500.0	$2,000.0	$11,300.0	$ 4,107
Contractual	$400.0	$2,000.0	$800.0	$2,100.0	$1,000.0	$6,300.0	$ 3,198
Commodities	$7,000.0	$1,400.0	$1,900.0	$1,900.0	$1,100.0	$13,300.0	$ 7,832
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)	$3,500	$6,500	$6,900	$7,600	$8,100	$32,600.0	$ 11,564
SUBTOTAL	$15,100.0	$28,000.0	$30,000.0	$33,000.0	$35,100.0	$141,200.0	$50,111.0
General Administration (9% of	$1,359.0	$2,520.0	$2,700.0	$2,970.0	$3,159.0	$12,708.0	
PROJECT TOTAL	$16,459.0	$30,520.0	$32,700.0	$35,970.0	$38,259.0	$153,908.0	
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 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.

The pregnancy and subsequent departure of the former principal investigator and department turnover has led to this project being underspent. At the end of FY13 Hayley Hoover was identified as the new lead on the project and has been instructed get the project fully up to date. It has taken Hayley some time to transition into the program and figure out where the last investigator left off. Hayley anticipates catching up on spending this fiscal year because of increased efforts to catch up on deliverables.

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

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

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

14120111-K

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

PWS Herring Program - Herring Disease Program

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

Paul K. Hershberger

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

Feb 1, 2014 – January 31, 2015

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

February 2015

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

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

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

Field Findings:

A. Three samples of Pacific herring were collected from Prince William Sound (n=60 / collection) during the spring pre-spawn period from March 26 – 29, 2014:

	VHSV Prevalence	*Ichthyophonus* Prevalence	VEN prevalence
Gravina Point	2-8%*	25% (15/60)	0% (n=60)
Snug Corner Cove	0%	22% (13/60)	0% (n=60)
Red Head	0%	33% (20/60)	0% (n=60)

*Virology samples were processed in pools containing tissues from 5 fish. One pool of tissues produced cytopathic effect with very low titers after 2nd and 3rd passage. VHS virus was confirmed in the passed-material using a nested PCR and VHSV primers. Individual samples from these 5 fish were not processed, as the viral tissue titer in the pooled homogenate was <10^1 PFU / g.

B. Three samples of Pacific herring were collected from Sitka Sound Sound (n=60 / collection) during the spring pre-spawn period from March 26 – 28, 2014:

	VHSV Prevalence	*Ichthyophonus* Prevalence	VEN prevalence
Causeway	0%	25% (15/60)	2% (1/60)
Middle Island	0%	22% (12/60)	0% (n=60)
Inner Point	0%	33% (16/60)	0% (n=60)

C. Juvenile herring were collected from PWS cruises in collaboration with the PWSSC surveys:

	Date	Sample Size	VHSV Prevalence	*Ichthyophonus* Prevalence
Simpson Bay	Nov 15	35	0%	0%
Bear Trap	Nov 16	61	0%	0%
Eaglek	Nov 19	61	0%	3%
Simpson	Nov 23	25	0%	4%

D. Juvenile herring were collected by beach seine from several locations in the Jan Juan Island region of Washington State from Sept 11-12, 2014. During the seining, it was observed that some individuals demonstrated external signs of VHS including hemorrhaging around the eyes and fin bases. A subsample of these lesioned individuals were selected and processed to confirm the presence of VHSV. Note: the samples were frozen at -20°C for several months prior to processing; this is a very unsuitable preservation method for the recovery of VHSV. From the first location (Sept 21) 27% (6/22) showed CPE indicative of VHSV, and from the second location (Sept 22) 12.5% (3/24) showed CPE indicative of VHSV. Tissue titers were as high as $5x10^3$ PFU / g. VHSV was confirmed by RT-PCR and viral sequencing.

Laboratory Findings:

A. 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.

Ichthyophonus-like organisms have been reported in amphibians, reptiles, birds and invertebrates and may have been incorrectly classified under a single type species, *I. hoferi*. Although less sensitive than other detection techniques such as explant tissue culture, histopathological examination is effective for simultaneously evaluating host response and severity of *Ichthyophonus* infections. Histological sections showing positive periodic acid-Schiff (PAS) staining of multinucleate organisms 50-250 µm in diameter can be presumptive for *Ichthyophonus*, but lack of a definitive confirmatory test may lead to misdiagnosis, particularly when the organism is not cultured. We developed a chromogenic in situ hybridization (CISH) procedure that specifically detected *Ichthyophonus* ribosomal DNA in histological sections thereby complementing the histological diagnosis by providing highly specific molecular confirmation of the observed organism. A digoxigenin-labeled oligonucleotide probe was designed to target conserved portions of the 18S small subunit ribosomal gene of known *Ichthyophonus* species *I. hoferi* and *I. irregularis*. Formalin-fixed, paraffin-embedded tissues from naturally infected Chinook salmon (*Oncorhynchus tshawytscha*) and red-spotted newt (*Notophthalmus viridescens*), and experimentally infected Pacific herring (*Clupea pallasii*), rainbow trout (*O. mykiss*) and Pacific staghorn sculpin (*Leptocottus armatus*) were analyzed by CISH and PAS staining. Probe hybridization was indicated by dark purple precipitates and correlated with the distribution and morphology of parasites observed in PAS-positive tissues and also identified *Ichthyophonus* developmental stages in the presence of PAS-positive host cells. The CISH probe hybridized with PAS-positive, *Ichthyophonus*-like organisms in all host species except the red-spotted newt, supporting the hypothesis that the organism infecting amphibians is taxonomically distinct from fish-associated *Ichthyophonus*. The CISH has utility for both diagnostic and research applications.

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

Ichthyophonus-infected Pacific herring, *Clupea pallasii*, were allowed to decompose in flowing seawater, then serially sampled for 4 wk and examined for the presence of *Ichthyophonus* as determined by in vitro culture and single plane histology. The same tissues were fed to *Ichthyophonus*-free Pacific staghorn sculpins, *Leptocottus armatus*, to determine the duration of parasite infectivity. *Ichthyophonus* sp. was viable in decomposing herring viscera and muscle for at least 4 wk post-mortem and remained infectious for sculpins for up to 5 days post-mortem. Many of the morphologic changes observed were similar to those previously reported to occur during the first 24 hr following death of the host, but also included novel forms not previously described. The significance of extended survival and progressive morphologic transformation in the post-mortem host is unknown, but it could be inferred that it has survival value for the parasite.

C. 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.

Viral erythrocytic necrosis (VEN) is a condition affecting the red blood cells of more than 20 species of marine and anadromous fishes in the North Atlantic and North Pacific Oceans. Presently, VEN is diagnosed by observation of typical cytoplasmic inclusion bodies in stained blood smears from infected fish. The causative agent, erythrocytic necrosis virus (ENV), is unculturable and a presumed iridovirus by electron microscopy. *In vivo* amplification of the virus in cultured Pacific herring and subsequent virus concentration, purification, DNA extraction, and high-throughput sequencing methodologies were applied to obtain genomic ENV sequences. Fragments with the highest sequence identity to the family *Iridoviridae* were used to design four sets of ENV-specific polymerase chain reaction (PCR) primers. Testing of blood and tissue samples from experimentally and wild infected Pacific herring as well as DNA extracted from other amphibian and piscine iridoviruses verified the four assays were specific to ENV. Sensitivity testing determined a limit of detection of 0.0003 ng. Preliminary phylogenetic analyses of a 1448 bp fragment of the putative DNA polymerase gene supported inclusion of ENV in a proposed sixth genus of the family *Iridoviridae* that contains other erythrocytic viruses from ectothermic hosts. This study provides the first molecular evidence of ENV's inclusion within the *Iridoviridae* family and offers a conventional PCR assay as a means of rapidly surveying the ENV-status of wild and propagated Pacific herring stocks.

D. 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.

Currently, detection of VHSV relies on virus isolation, which is lethal to fish and only indicates current infection status. A serological method is required to ascertain prior exposure. Here, we report the development of two serologic tests for VHSV that are non-lethal, rapid, and species-independent: a virus neutralization assay (VN) and a blocking enzyme-linked immunosorbent assay (ELISA). Serum was collected from 34 uninfected fish (VHS negative group) and 28 fish that survived VHS virus infection (VHS positive group). The VN did not detect neutralizing antibodies in the serum of any of the 34 VHSV negative fish, demonstrating a test specificity of 100%. Neutralizing antibodies were detected in 12 of 28 VHS positive fish, indicating a test sensitivity of 42.9%. The anti-nucleocapsid blocking ELISA detected non-neutralizing VHSV antibodies in 4 of the 34 fish in the VHS negative group, indicating a specificity of 88.2%. Non-neutralizing antibodies were detected in 27 of 28 VHS positive fish, indicating a sensitivity of 96.4%. Used in parallel, the VN and ELISA correctly identified all survivors of VHSV infection and unexposed fish. Our VN and ELISA are valuable tools for assessing exposure to VHSV and should improve detection and surveillance efforts for both wild and commercial fish populations.

E. Burge, C. A., C. M. Eakin, C. S. Friedman, B. Froelich, 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.

Infectious diseases are common in marine environments, but the effects of a changing climate on marine pathogens are not well understood. Here, we focused on reviewing current knowledge about how the climate drives host-pathogen interactions and infectious disease outbreaks. Climate-related impacts on marine diseases are being documented in corals, shellfish, finfish, and humans; these impacts are less clearly linked to other organisms. Oceans and people are inextricably linked, and marine diseases can both directly and indirectly affect human health, livelihoods, and well-being. We recommended an adaptive management approach to better increase the resilience of ocean systems vulnerable to marine diseases in a changing climate. Land-based management methods of quarantining, culling, and vaccinating are not successful in the ocean; therefore, forecasting of conditions that lead to outbreaks and designing tools/approaches to affect these conditions may be the best tool to manage marine disease.

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

Ongoing collaborations with partners within the PWS Herring Program include:

- Collection of shared zooplankton samples with Dr. Rob Campbell

- Collection of samples from Cordova Harbor (monthly collections of juvenile herring, plankton collections, stomach samples, and bioenergetics samples) with Drs. Kristin Gorman and Scott Pegau.

- Collection of juvenile herring samples from PWS bays with the PWSSC.

Additionally, we discussed sampling contingency plans with partners (Yumi Armitsu and John Moran) from the Gulf Watch Alaska Program in the event that they encounter visibly diseased fish during their field efforts.

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

In addition to the manuscripts listed above (Section 7), the following presentations were delivered during the current reporting period:

Invited seminars

November 24, 2014: Cordova Weekly Seminar Series
Ecology of Disease in Pacific herring
August 16, 2014: National Science Foundation, Research Coordination Network
Invited Presentation - Pathogen Persistence and Perpetuation Strategies in Marine Fishes: Perspectives from Pacific Herring. Friday Harbor, WA.
May 30, 2014: School of Aquatic and Fishery Sciences, University of Washington: FISH 404.
Guest Lecture. "How Does Science Really Work? The Frustration of Dead Ends and the Satisfaction of Tiny Advancements."
May 21, 2014: Tribal Climate Change Webinar Series
Invited Webinar: Climate Change and Marine Issues
Shifting Ocean Currents and Infectious / Parasitic Diseases of Marine Fishes
Co-hosted by the Institute for Tribal Environmental Professionals – Northern Arizona University,– Pacific Northwest Tribal Climate Change Project - University of Oregon, and North Pacific Landscape Conservation Cooperative

Scientific Presentations

Conway, C.M, M.K. Purcell, D.G. Elliott, P.K. Hershberger. August 31 – September 4, 2014. Poster. Detection of *Ichthyophonus* by Chromogenic In Situ Hybridization. 7th International Symposium on Aquatic Animal Health. Portland, OR.

Garver, K.A., J. Lovy, P. K. Hershberger. August 31 – September 4, 2014. Platform. Trafficking of Viral Hemorrhagic Septicemia Virus from wild to farmed fish. 7th International Symposium on Aquatic Animal Health. Portland, OR.

Hart, L.M. C. Conway, D. Elliot, P.K. Hershberger. August 31 – September 4, 2014. Platform. A qualitative assessment of the progression of ichthyophoniasis related external signs and distribution of host response and parasite morphology in somatic tissues of Pacific herring *Clupea pallasii.* 7th International Symposium on Aquatic Animal Health. Portland, OR.

McKibben, C.L., P.K. Hershberger, M.K. Purcell, C.M. Conway, D.G. Elliott. August 31 – September 4, 2014. Poster. Influence of Temperature and Fish Stock on Progression of *Ichthyophonus* Infections in Chinook Salmon (*Oncorhynchus tshawytscha*). 7th International Symposium on Aquatic Animal Health. Portland, OR.

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

N/A

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$0.0	$170.4	$186.6	$190.8	$547.8	$ 101,940
Travel	$0.0	$0.0	$17.0	$17.0	$18.4	$52.4	$ 10,468
Contractual	$0.0	$0.0	$12.0	$12.0	$12.0	$36.0	$ 49,933
Commodities	$0.0	$0.0	$59.2	$52.2	$52.2	$163.6	$ 44,653
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)							
SUBTOTAL	$0.0	$0.0	$258.6	$267.8	$273.4	$799.8	$ 206,994
General Administration (9% of	$0.0	$0.0	$23.3	$24.1	$24.6	$72.0	$23,300.0
PROJECT TOTAL	$0.0	$0.0	$281.9	$291.9	$298.0	$871.8	
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 funding and actual cumulative spending.

Some of the 'Personnel' charges appear under the 'Contractual' category because student interns were hired as contractors Travel and commodities costs are expected to be higher in FY'2015; as such we are planning to spend the remaining balance in the next fiscal year.

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

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

Form Rev. 10.3.14

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

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

14120111-L

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

PWS Herring Program – Herring Condition Monitoring (HCM project)

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

Ron Heintz and Fletcher Sewall (NOAA/Auke Bay Labs), Scott Pegau and Kristen Gorman (PWSSC)

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

1 February 2014 to 31 January 2015

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

February 2015

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

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

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

Project Summary for this reporting period

The juvenile HCM project is a collaborative effort between the Prince William Sound Science Center (PWSSC) and the Auke Bay Laboratory (ABL). This is the third year of sampling within the Herring Research and Monitoring (HRM) program although the work is a continuation from similar efforts in the Prince William Sound (PWS) Herring Survey program. The core of this project involves the collection of age-0 Pacific herring (*Clupea pallasii*, hereafter herring) at two time periods during winter, November and March, to assess energetic strategies that might influence over-winter survival throughout PWS. Specific objectives for the HCM project follow:

Objective 1. Monitor juvenile herring condition by sampling in November.

Objective 2. Monitor juvenile herring condition by sampling in March.

Objective 3. Apply resultant observations from Objectives 1 and 2 to continue refining an overwintering mortality model with the addition of physiological indicators.

Objective 4. Monitor seasonal changes in juvenile herring diets (November vs. March) and examine relationship between diet and herring condition (objective not specifically defined in earlier proposals).

A new development in 2014 for this project was the addition of Dr. Kristen Gorman to serve as PI on this project, continuing Dr. Tom Kline's initial work with the HRM program. Dr. Kline left the PWSSC in June 2013 and Dr. Gorman joined the program in July 2014. Thus, there was a year lag in filling the

PI position, which caused some delays in sample processing and data summary. Dr. Scott Pegau (PWSSC) coordinated the HCM project in the interim between summer 2013 and summer 2014 during which time two technicians (one tech working through May 2014 and another tech working between June and August 2014) continued to make progress on sample processing in lab. Since Dr. Gorman's arrival at PWSSC, the project has hired a series of technicians (two techs between November 2014 – March 2015 and one tech to begin and continue the laboratory work in March 2015). These technicians have been tasked with 1) completing the November 2014 herring research cruise, 2) working on the backlog of bomb calorimetry samples of age-0 herring from 2012 onwards that serve as a comparison with the isotope-derived estimates of juvenile herring, 3) process samples collected in November 2014 for isotope and bomb calorimetry analyses, and 4) begin collections of age-0 herring for dual energetics and disease measurements in Cordova Harbor starting in January 2015.

During the 2014 project, samples were successfully collected in March and November 2014. March sampling was conducted in collaboration with Cordova fisherman (CDFU) where local herring fisherman use cast and gill nets to collect age-0 herring from several study sites located throughout PWS (Fig. 1).

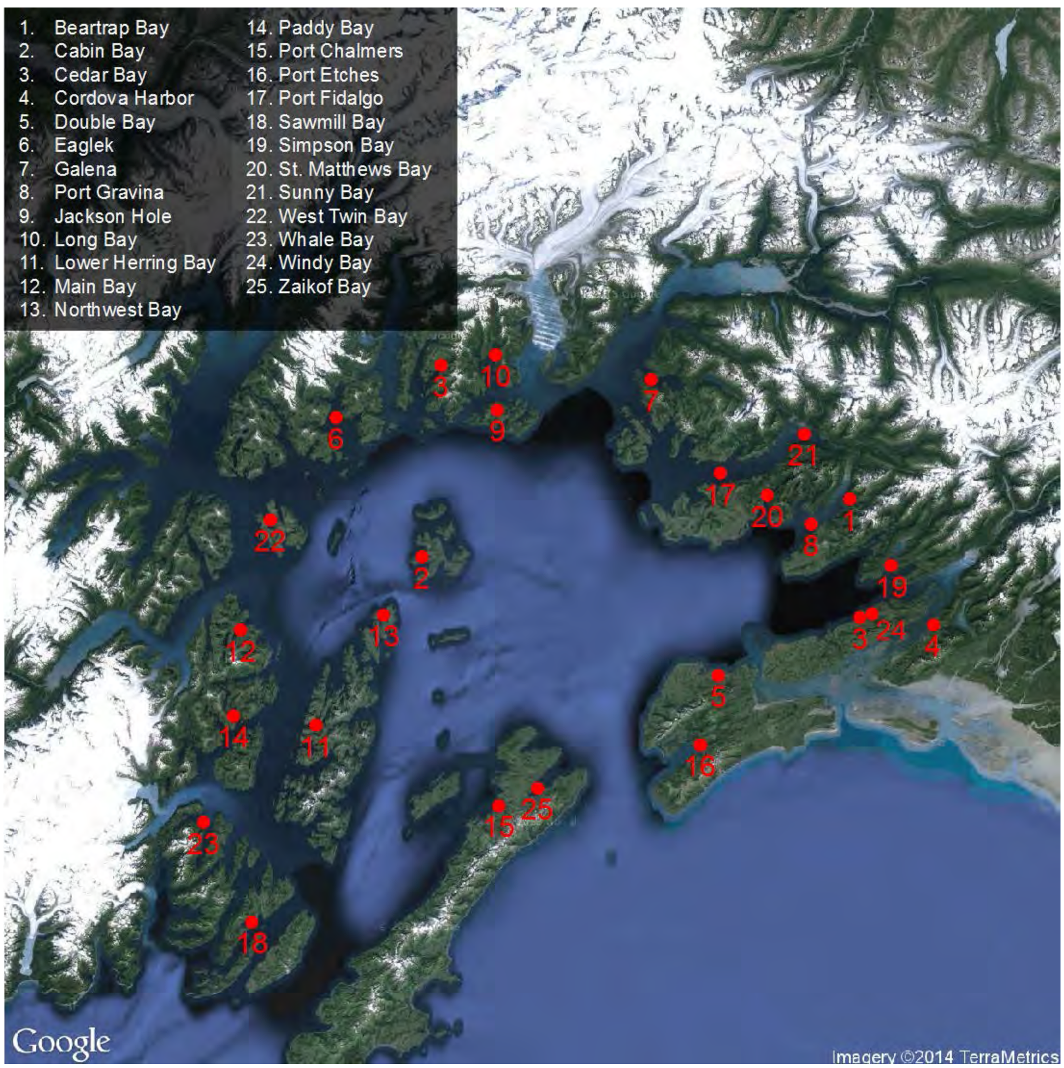

Figure 1. Sampling locations for juvenile herring condition monitoring throughout Prince William Sound.

The following samples were collected in the field during March 2014 for energetics analysis at PWSSC:

Date	*Location*	*Sample Size (n)*	*Collector*
3/16-17/2014	Fidalgo	152	CDFU
3/16-17/2014	Lower Herring Bay	146	CDFU
3/17-18/2014	Gravina	50	CDFU
3/18/2014	Zaikof Bay	94	CDFU
3/21/2014	Cordova Harbor	4	PWSSC

November sampling was conducted by PWSSC aboard a charter vessel primarily using trawl equipment, although other types of gear are sometimes used such as cast and gill nets. The following sample sizes were collected in the field during November 2014 for energetics analysis at PWSSC:

Date	*Location*	*Sample Size (n)*	*Collector*
11/15-16/2014	Simpson Bay	340	PWSSC
11/16/2014	Gravina	158	PWSSC
11/17/2014	Fidalgo	26	PWSSC
11/18-19/2014	Eaglek	121	PWSSC
11/19-20/2014	Lower Herring Bay	51	PWSSC
11/20/2014	Whale Bay	182	PWSSC
11/23/2014	Zaikof Bay	34	PWSSC
11/23/2014	Windy Bay	84	PWSSC

Monthly winter sampling to obtain disease and energetic data has been initiated during 2015 in Cordova Harbor. Cast nets are used to catch age-0 herring that are processed for disease in collaboration with Dr. Paul Hershberger's work (n = 60). An additional set of samples (n = 20) is collected and processed for coupled disease and energetics data where the energy analysis is performed at PWSSC using bomb calorimetry. The following samples have been collected for this project in the 2014 fiscal year:

Date	*Location*	*Sample Size (n)*	*Collector*
1/7/2015	Cordova Harbor	60	PWSSC

Lipid and RNA/DNA analyses as indicators of fish condition and growth were conducted at ABL on the following samples:

Date of sampling	*Location*	*Sample Size (n)*
Nov-2013	Eaglek	20
	Lower Herring	39*
	Port Fidalgo	15
	Port Gravina	20
	Simpson	20
	Whale	9
	Zaikof	15
Mar-2014	Lower Herring	20
	Port Fidalgo	20
	Port Gravina	17
	Simpson	38*
	Zaikof	20

*Sample sizes were increased to enable comparisons among multiple gear types.

Processing of stomach contents samples for identification and enumeration of prey taxa was also completed for these fish. Compilation and proofing of the diet data is in progress.

Project deliverables for this reporting period

Annual PI Meeting: A PI meeting was held in March 2014 attended by both Drs. Heinz and Pegau. Another PI meeting was held in Anchorage during November 2014 and was attended by both Drs. Pegau and Gorman. Dr. Ron Heinz and Fletcher Sewall were unable to attend the November 2014 PI meeting. However, Dr. Heinz presented results from this project at the EVOSTC Science Panel Meeting that took place in Anchorage during February 2015 in preparation for the next round of RFPs by EVOSTC.

March Juvenile Herring Collections: Completed March 2014. Samples sent to Auke Bay Labs in April 2014.

Submit FY2015 Work Plan for Review: Work Plan was submitted in August 2014 to match the current EVOSTC reporting dates.

Reporting: A semi-annual project report was submitted to NOAA in August 2014.

Submit synthesis to EVOS Science Council: The Synthesis Report was submitted to EVOSTC in November 2014, which included updated analyses of this dataset and new analysis of stable isotope data as a proxy of Gulf of Alaska carbon influence on herring energetics.

November Juvenile Herring Collections: Completed November 2014. Samples sent to Auke Bay Labs in early December 2014.

Alaska Marine Science Symposium: Drs. Scott Pegau, Kristen Gorman, Ron Heinz and Fletcher Sewell attended AMSS in January 2015. Dr. Gorman did not present on this project as when AMSS Abstracts were due, new analyses had not been finished at that time. However, new analyses were reported in the Synthesis Report that was submitted in November 2014. Dr. Heinz and Fletcher Sewell presented on this project at AMSS in 2014.

Progress Update and Results

The long-term data set for stable carbon and nitrogen isotopes, which is used to estimate energy density, is now complete with data received from the Alaska Stable Isotope Facility (http://ine.uaf.edu/werc/asif/) through Spring 2014 (Fig. 2). New data for Spring 2014 continue to confirm our understanding that age-0 herring in March hold a reduced energetic state in comparison with fish collected in November. What is interesting about the March 2014 sampling is that despite November 2013 being one of the highest months of energy density in the fall time series, March 2014 is similar to other spring months with a low energy density, suggesting that variation in energy density in the fall does not necessarily predict that of the spring.

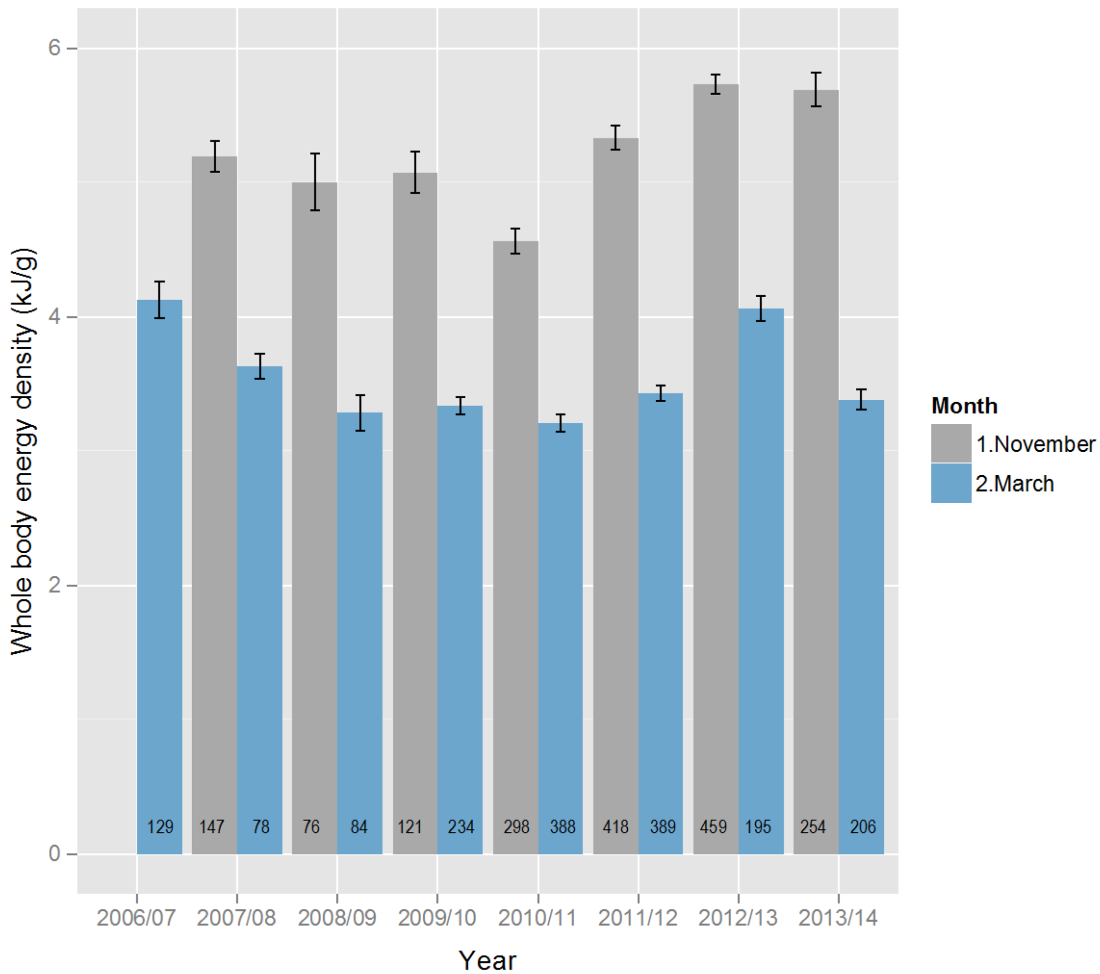

Figure 2. November and March time series of energy variation among age-0 herring collected from Prince William Sound. Sample sizes are noted at the bottom of each bar. Note the increased sample size for March 2014 (n = 206) in comparison with this figure submitted in the Synthesis Report from November 2014 (n = 51). Error bars are 95% confidence intervals.

Currently, technicians in the lab are working on processing samples from the November 2014 cruise for stable isotope analysis. Technicians have completed backlogged bomb calorimetry work through 2012 (Fig. 3) and are starting to work on 2013 and 2014 samples. Completing the 2013-14 backlog of bomb calorimetry is a priority for Spring 2015 laboratory work. Importantly, new bomb calorimetry data generated in 2014 (Fig. 3) demonstrate a strong correlation between stable isotope and bomb calorimetry energy density estimates based on these techniques, suggesting that isotope-derived values of energy density appear relatively accurate. However, we need to explore the entire bomb calorimetry dataset more thoroughly in order to assess whether the stable isotope derived values are in fact over-estimating energy density at higher levels as is suggested by the regression line falling slightly below the 1:1 equivalence line at higher energy densities.

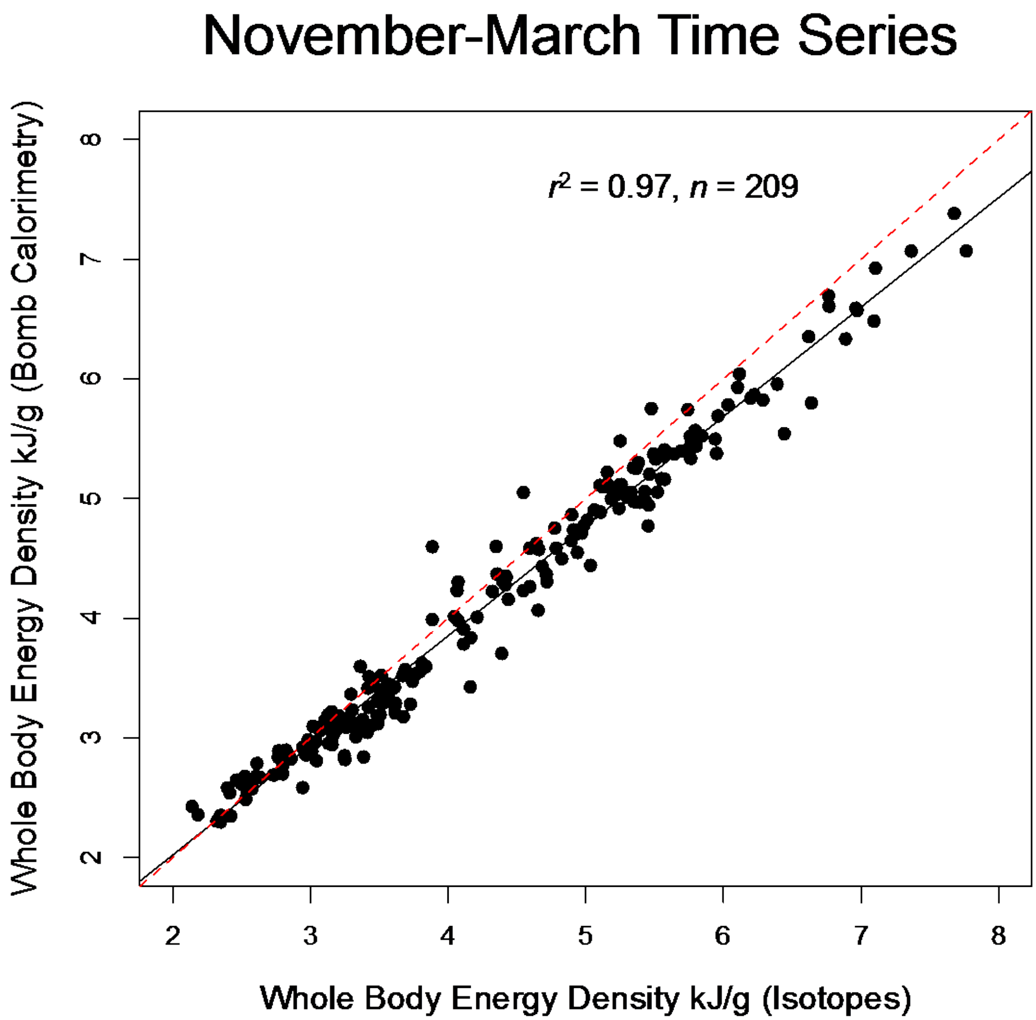

Figure 3. A comparison of energy density estimates of age-0 herring from the November and March time series using coupled stable isotope and bomb calorimetry techniques. Bomb calorimetry data were produced in 2014. The red dashed line indicates a 1:1 relationship.

In response to EVOSTC comments during summer 2014 regarding the development of better linkages between juvenile herring energetics and environmental drivers, we initiated analyses in 2014 that are examining relationships between age-0 herring energy density and naturally occurring ratios of stable carbon and nitrogen isotopes ($^{13}C/^{12}C$ [$\delta^{13}C$] and $^{14}N/^{15}N$ [$\delta^{15}N$]) that provide a biogeochemical proxy of carbon sources ($\delta^{13}C$) or the trophic level at which individual fish forage ($\delta^{15}N$). Earlier work by Dr. Tom Kline indicated that carbon in plankton originating from the Gulf of Alaska (GoA) is relatively depleted in $\delta^{13}C$ in comparison with carbon originating within PWS (Kline 1997). We examined relationships between energy density and carbon source (i.e., GoA vs PWS) among age-0 herring collected as part of the long-term November and March time series. We found a consistent negative relationship between energy density and enrichment of $\delta^{13}C$, which suggests that when juvenile herring uptake a GoA carbon source they tend to be in better energetic condition. This relationship was evident in both November and March time series, but stronger in November (Figs. 4 and 5).

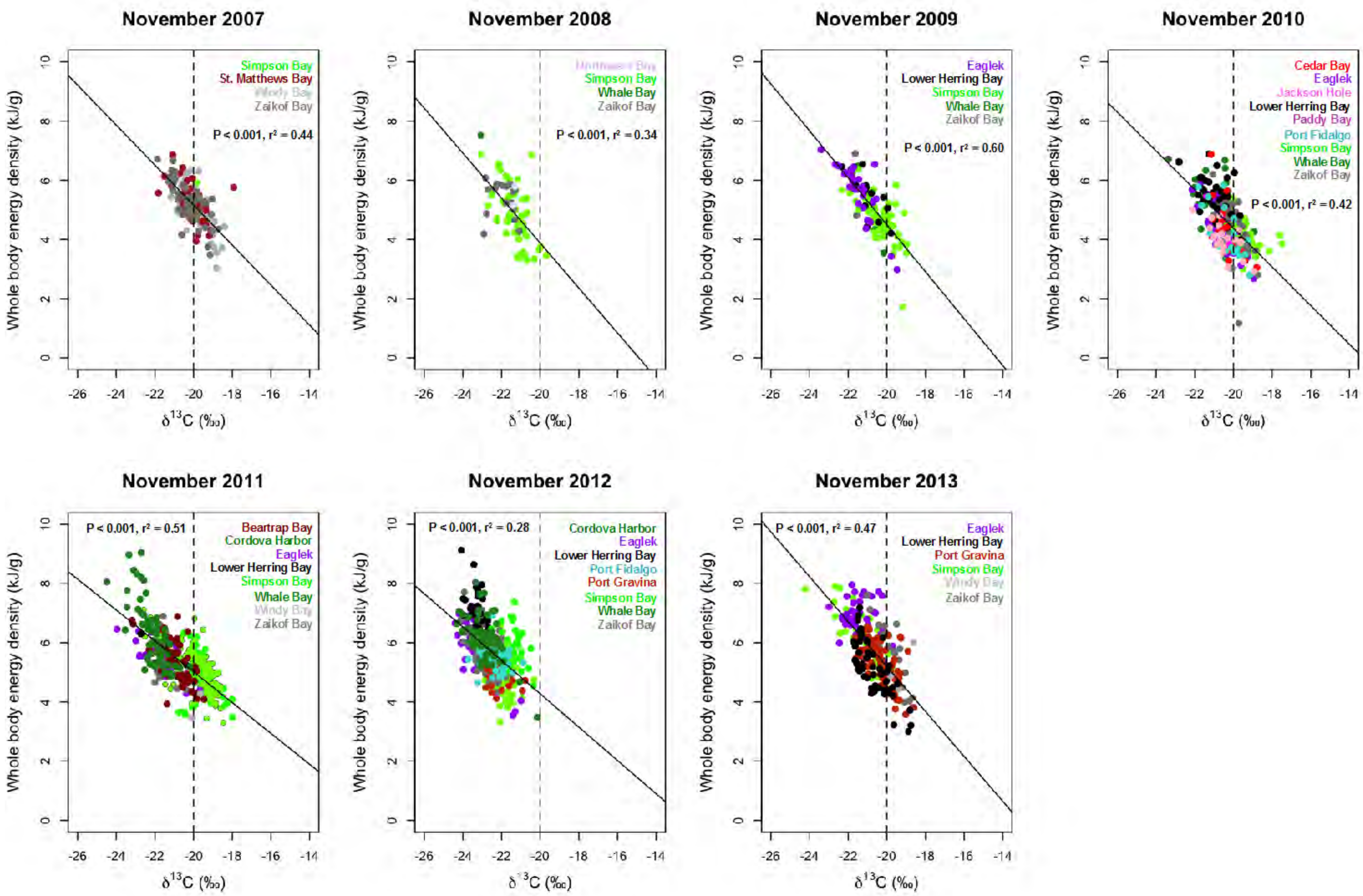

Figure 4. Long-term November monthly time series of variation in age-0 herring energy density as predicted by stable carbon signatures (δ^{13}C) of fish tissue. Fish with more depleted δ^{13}C values that reflect Gulf of Alaska carbon sources for this region are more energy dense. Sampling locations are noted in different colors. Data for November 2014 are not currently available.

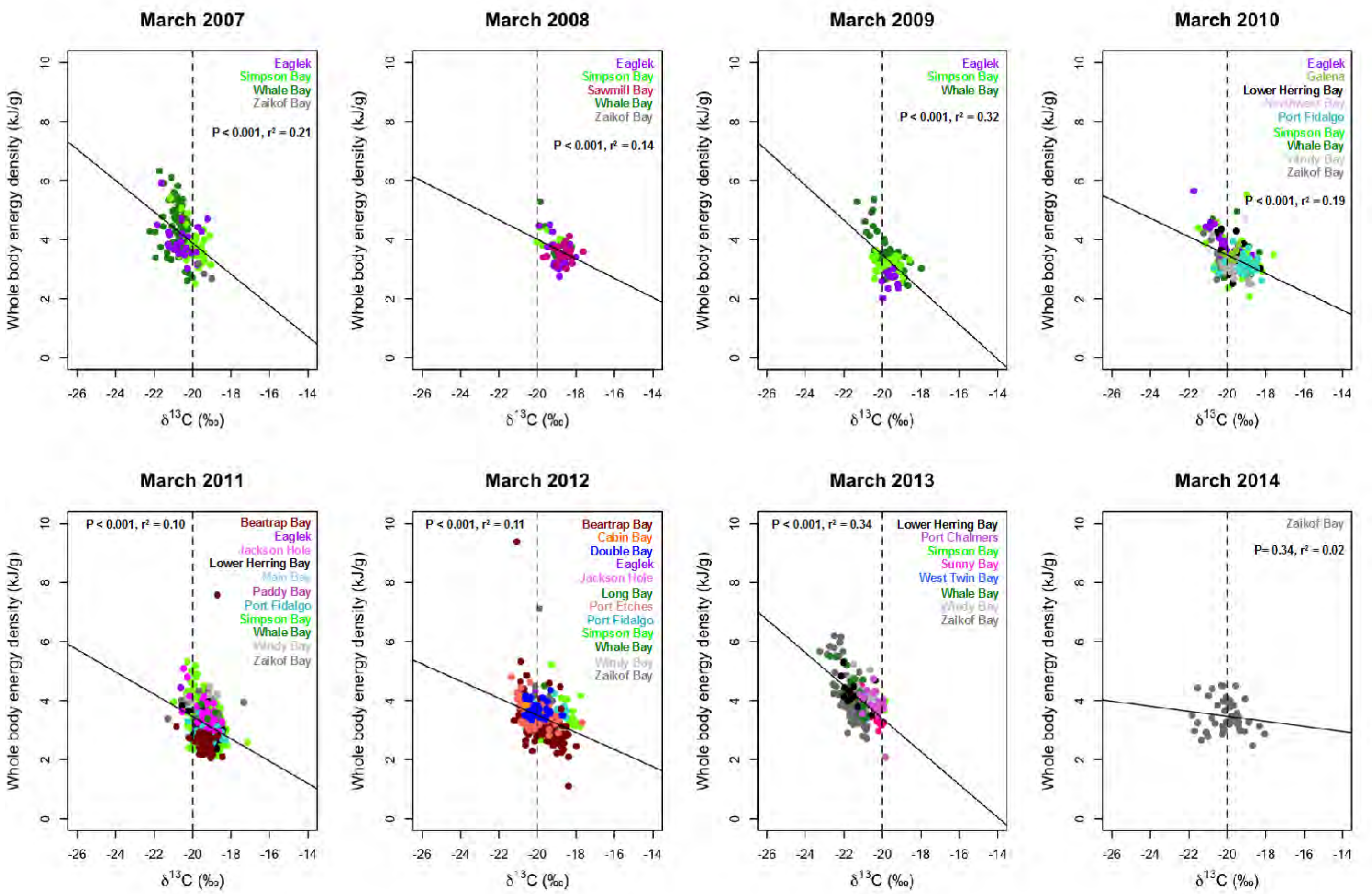

Figure 5. Long-term March monthly time series of variation in age-0 herring energy density as predicted by stable carbon signatures ($\delta^{13}C$) of fish tissue. Fish with more depleted $\delta^{13}C$ values that reflect Gulf of Alaska carbon sources for this region are more energy dense, which is more evident in years such as 2007 and 2013. Sampling locations are noted in different colors.

One aspect of this work that is particularly interesting is the apparent spatial variation throughout PWS in these relationships that is associated with large-scale bathymetric features. Fish collected from the western part of PWS, where a large marine canyon occurs acting as a conduit of GoA water into PWS, appear to be more energy dense and depleted in $\delta^{13}C$ in comparison with fish collected elsewhere in PWS (Fig. 6).

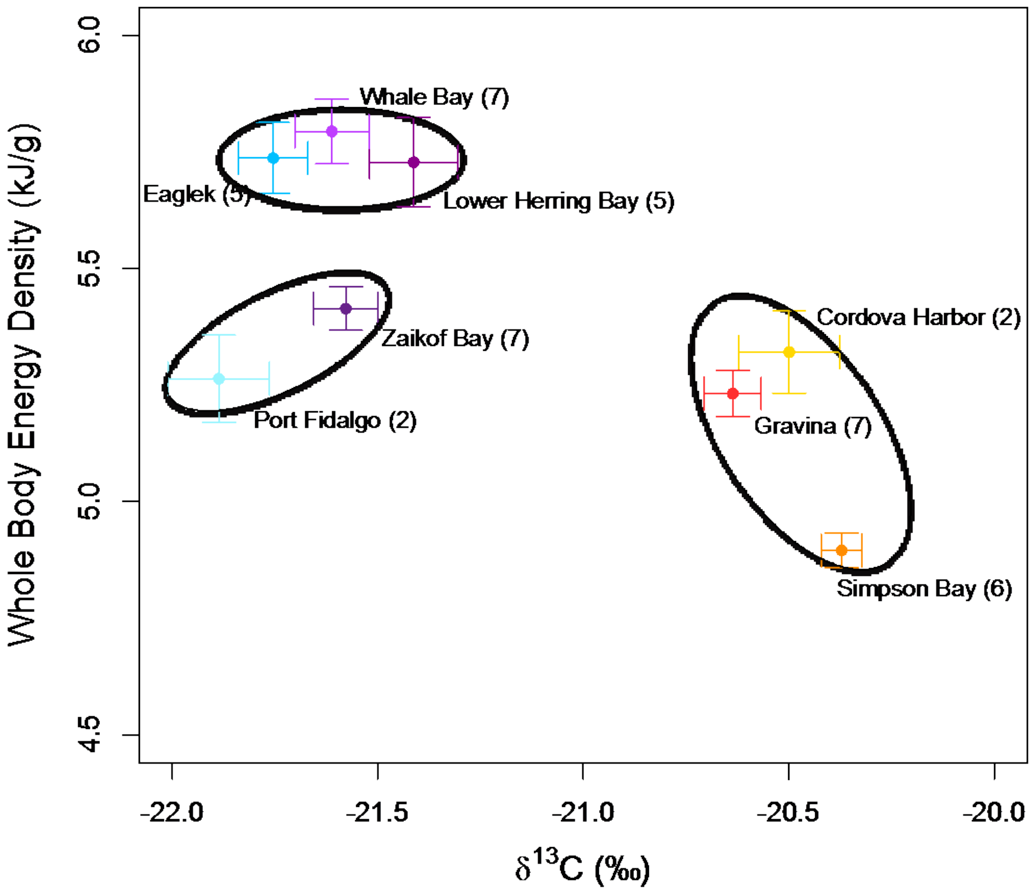

Figure 6. Spatial variation in energy density and stable carbon signatures ($\delta^{13}C$) of age-0 herring collected throughout Prince William Sound. Sampling locations and associated number of years in the long-term dataset are noted. Fish collected from western Prince William Sound appear to be more energy dense and depleted in $\delta^{13}C$, i.e., data points from Eaglek, Whale and Lower Herring Bays, see also Fig. 1.

Preliminary results from ABL work indicate that November young of the year (YOY, i.e., age-0) herring fat content (% lipid on wet tissue mass basis) increases with body size (fork length) in a relationship best described by a piecewise regression (Fig. 7).

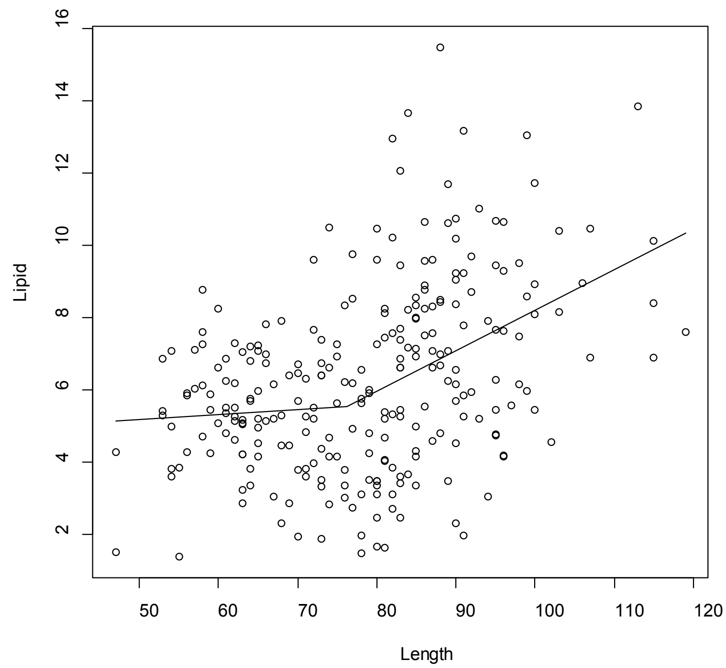

Figure 7. Lipid content (% wet tissue mass) as a function of fork length with piecewise regression line for YOY herring collected in PWS in November 2012 – 2013.

In contrast, YOY herring growth effort (RNA/DNA ratio) decreases with body size (Fig. 8).

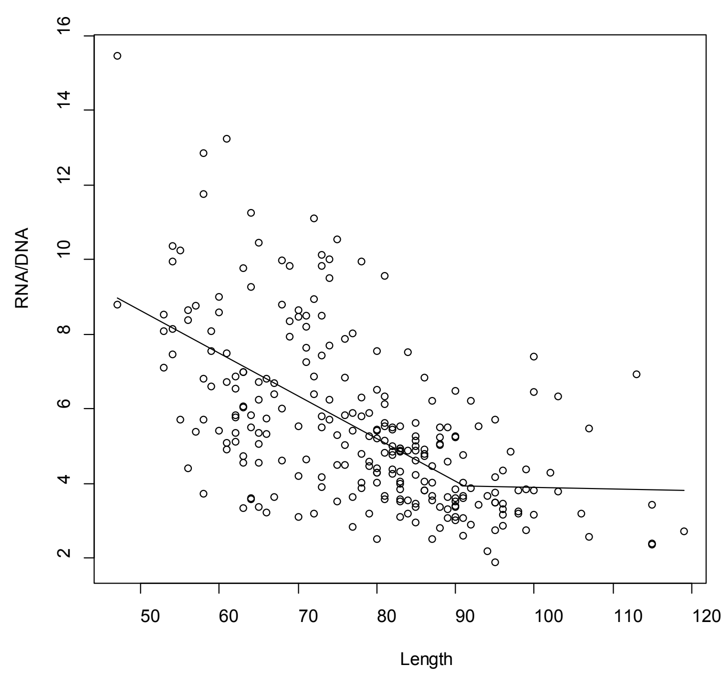

Figure 8. RNA/DNA as a function of fork length with piecewise regression line for YOY herring collected in PWS in November 2012 – 2013.

These patterns are similar to those described for November YOY herring from PWS as part of the Herring Survey program in 2009 – 2012. To compare relative condition and growth of YOY herring among years and bays within PWS from 2009 to 2013, it is necessary to compare residuals from these regression models to account for the effects of different sizes of fish captured among sampling events. Comparison of lipid and RNA/DNA residuals indicates YOY herring in 2012 were above average in % lipid and RNA/DNA over the 5 year period studied (Fig. 9).

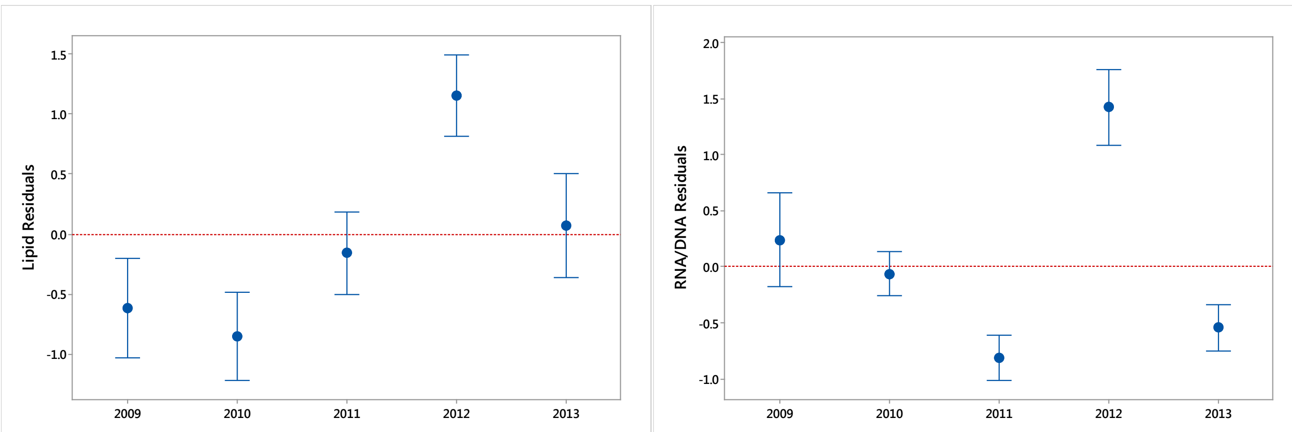

Figure 9. Residuals from the piecewise regression of lipid (left panel) and RNA/DNA (right panel) versus length of YOY herring collected in PWS in November 2012 – 2013. Means and 95 % confidence intervals shown.

The condition and growth of YOY herring in autumn varied among bays across years, such that a given bay was not generally above or below average in herring condition or growth. An exception to this was Simpson Bay tended to be below average across years (Figs. 10 and 11).

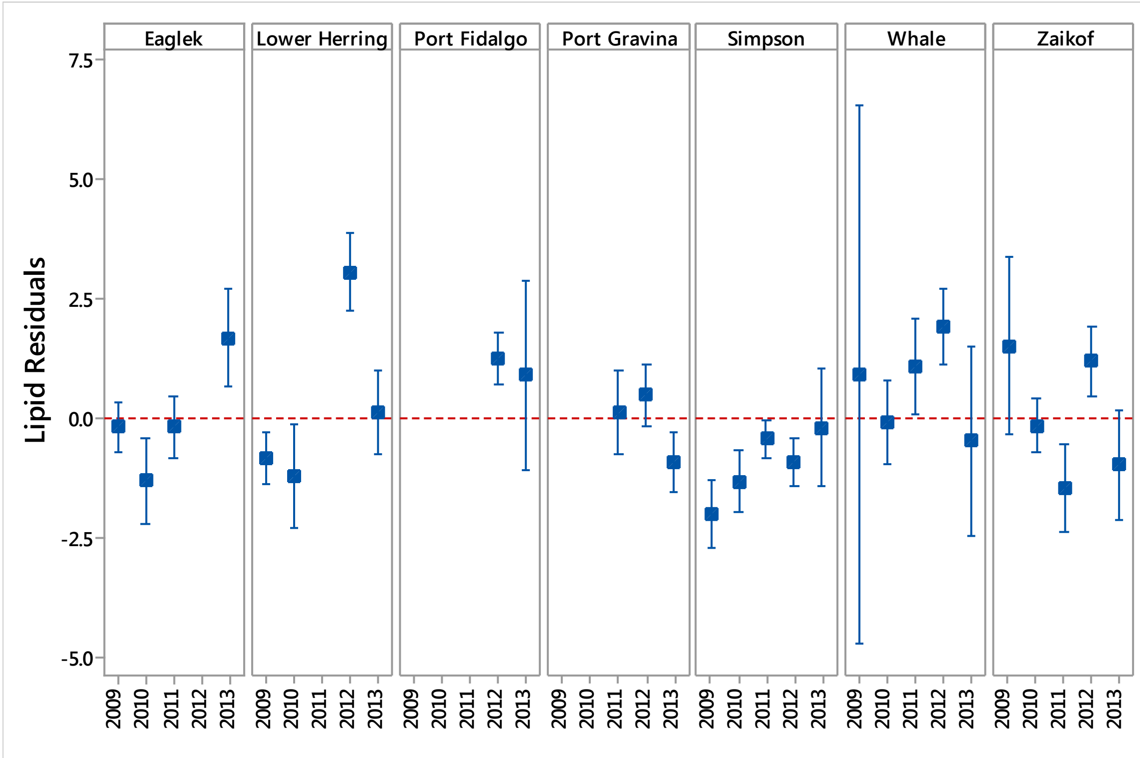

Figure 10. Residuals from the piecewise regression of lipid versus fork length of YOY herring collected in PWS in November 2009 – 2013. Means and 95 % confidence intervals shown

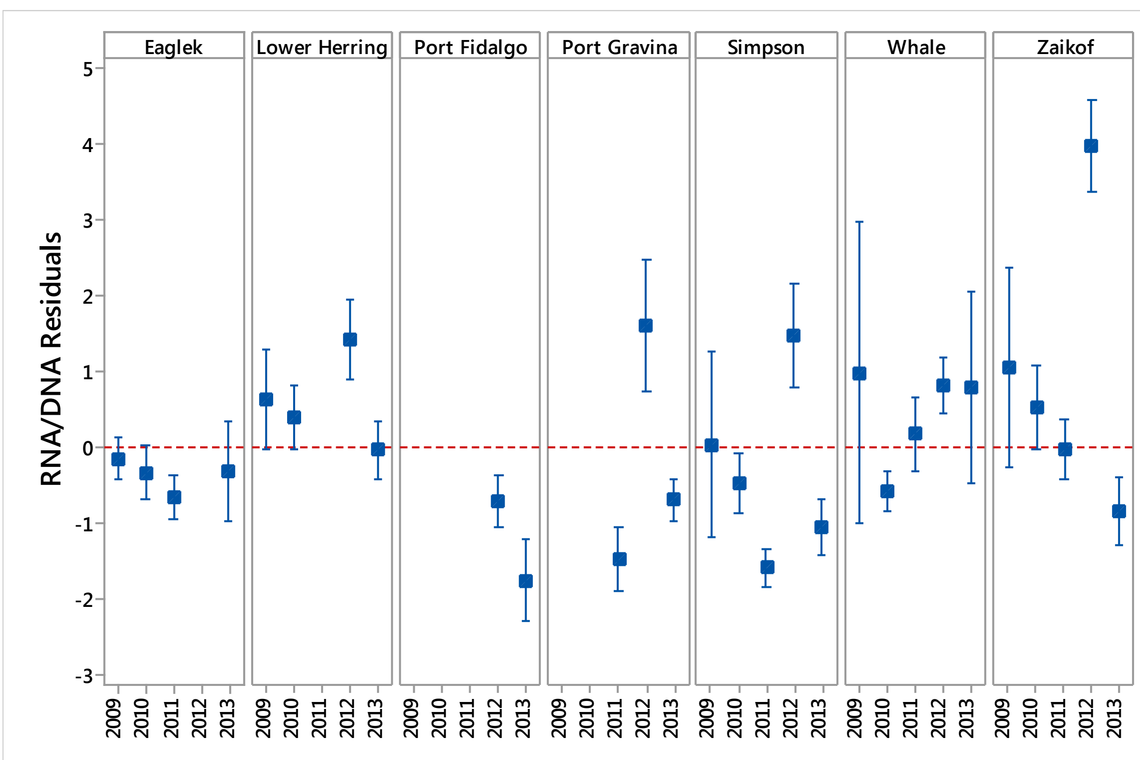

Figure 11. Residuals from the piecewise regression of RNA/DNA versus fork length of YOY herring collected in PWS in November 2009 – 2013. Means and 95 % confidence intervals shown.

YOY herring that had above-average growth rates tended to also have greater fat stores in November (Fig. 12).

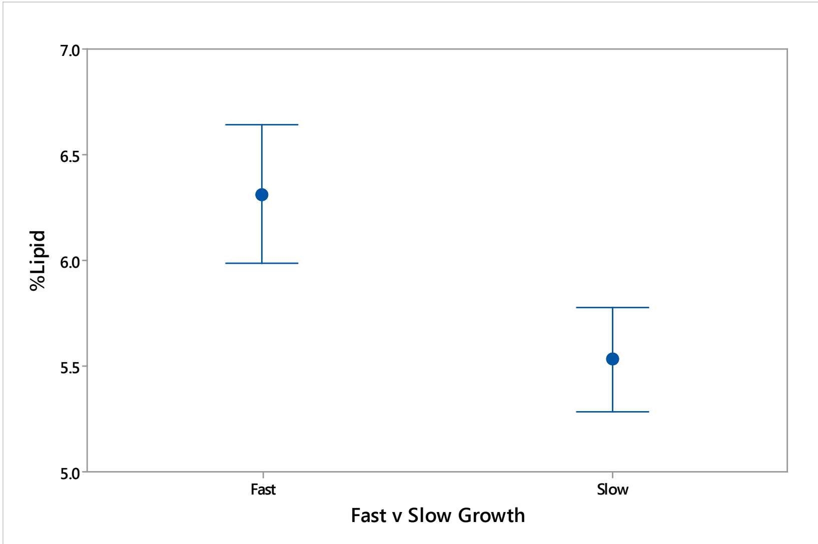

Figure 12. Comparison of lipid content (% wet tissue mass) for YOY herring collected in PWS in November 2012 – 2013 with above average growth rate versus below average growth rate. "Faster growth" group is defined as individuals with positive residuals from the piecewise regression of RNA/DNA vs. length. "Slower growth" individuals had negative residuals. Means and 95 % confidence intervals shown.

By late winter (March), YOY herring that were close to exhausting their fat stores were compelled to forage, as indicated by the higher stomach content masses (as % body weight) for herring with low % lipid (Fig. 13).

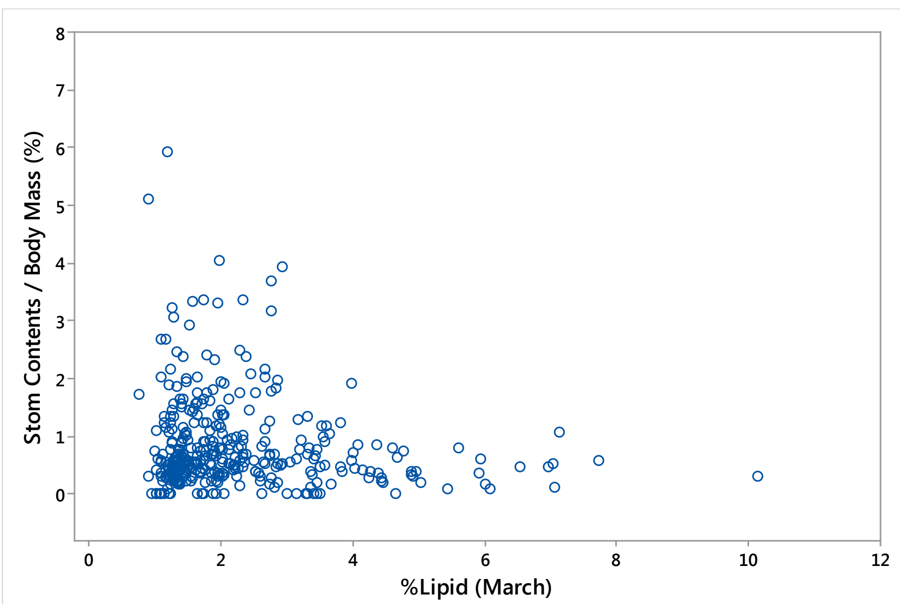

Figure 13. Stomach contents mass as a percentage of body mass, relative to lipid content (% wet tissue

mass) for YOY Pacific herring collected from PWS in March of 2013 – 2014.

An additional project proposed in the FY2105 project renewal was initiated in fall 2014 in collaboration with Alaska Department of Fish and Game (ADFG) to examine age-0 herring scale growth and the relationship with body size and energy density. These relationships will greatly expand ADFG's long-term database that includes age-0 herring growth based on scale analysis of older fish, and allow for insights on how relationships between age-0 fish size and energetic state relate to successful recruitment as adults. We have received scale measurement data back from ADFG and as expected scale increment accords well with fish length (Fig. 14). We plan to further examine this dataset and ADFG's long-term data more thoroughly in 2015 regarding relationships with energy density and recruitment.

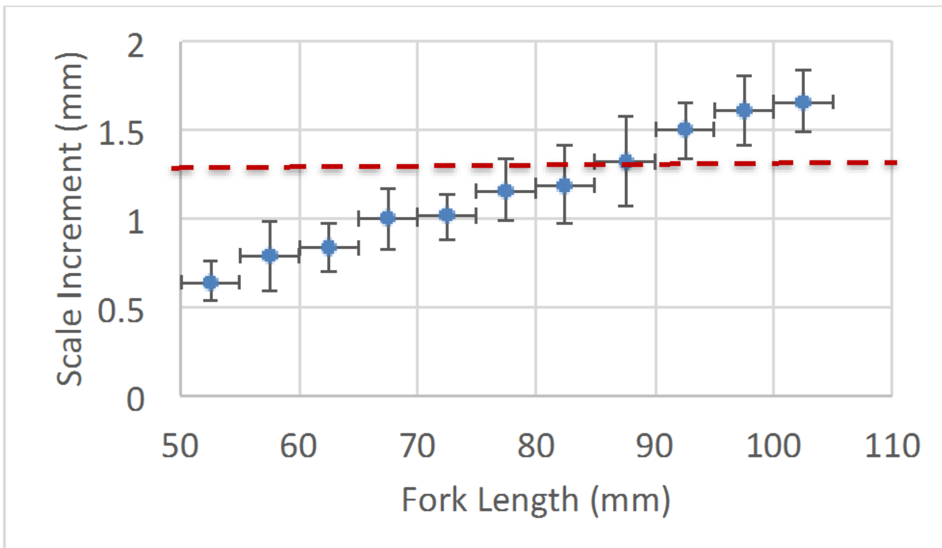

Figure 14. Relationship between age-0 herring body and scale size. Error bars are standard deviations.

Literature Cited

Kline, T. C. 1997. Confirming Forage Fish Food Web Dependencies in Prince William Sound using Natural Stable Isotope Tracers. Forage Fishes in Marine Ecosystems Alaska Sea Grant College Program AK-SG-97-01.

Summary of Future Work to be Performed

Work efforts for FY 2015 are expected to be the same as proposed. Thus, in 2015 we plan to continue with the March and November sampling, in addition to coupled winter disease and energetics sampling in Cordova Harbor.

Two major areas of focus for 2015 are to 1) continue working on the backlog of bomb calorimetry samples from 2013 and 2014 and 2) significantly update the long-term database into a more organized and user-friendly interface, i.e., possibly Access. Dr. Gorman's interest in updating the long-term database stems from needing to more easily facilitate data summary and analysis. The current dataset exists in Excel and is organized. However, because there are multiple users of the dataset, i.e., PIs using the data and technicians producing the data, there tends to be multiple copies of the dataset that are in various stages of up-dating and it can be difficult to keep only one dataset organized. Further, the current dataset includes many stages of data processing from field and initial lab analyses, to stable isotope and bomb calorimetry of a subset of samples, to otolith and scale analyses of a different subset of samples. Thus, when trying to filter the data for the various datasets of interest it can be time consuming to pair the full dataset down. It would seem that if the data were housed in a proper data system that filtering data would be much easier. Dr. Gorman would like to contract with an outside consultant on upgrading the data system used for the long-term herring energetics project at PWSSC.

Several manuscripts will be initiated in 2015 on age-0 herring energetics. First, a synthesis manuscript with Dr. Heinz and Fletcher Sewall is proposed for the next year where we plan to combine our various data types such as energetics, stable isotopes, fatty acid signatures, RNA/DNA data and diet studies. Dr. Gorman also plans to pursue a manuscript that explores environmental variables as predictors of energy variation in age-0 herring in the November and March time series. Environmental driver data will be obtained from Gulf Watch Alaska or other available regional datasets on ocean and climate variables.

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

a) Within a Trustee Council-Funded Program.
The juvenile HCM project primarily requires coordination of PIs at PWSSC and ABL. With the departure of Dr. Kline, the initial focus was on working with Dr. Pegau to coordinate sample processing and handling, which is now bring handled by Dr. Gorman as she is now on staff at PWSSC.

In 2014 we initiated a winter monthly study of disease and energetics in collaboration with Dr. Hershberger's lab at Marrowstone Marine Field Station/USGS whose work is a separate project within the HRM Program.

Further, Dr. Gorman is becoming more aware of datasets available through Gulf Watch Alaska after having attended both AMSS and the EVOSTC Science Panel meeting in February 2015 and expects to be using available regional data in future analyses of juvenile herring energetics, particularly in relation to yearly and seasonal variability in age-0 herring energetics.

b) With other Trustee Council-Funded Projects.
None

c) With Trustee or Management Agencies.
In 2014 we initiated an analysis of juvenile herring scale growth in collaboration with ADFG.

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

a) Publications produced during the reporting period.
None

b) Conference and workshop presentations and attendance during the reporting period.
March PI meeting: Pegau and Heinz attended
November PI meeting: Pegau and Gorman attended
AMSS: Pegau, Heinz, Gorman and Sewell attended

c) Data and/or information products developed during the reporting period, if applicable.
Synthesis Report submitted in November 2014.

d) Data sets and associated metadata that have been uploaded to the program's data portal.
The long-term herring dataset is being updated in its current form (Excel) with new isotope and bomb calorimetry data obtained during fall 2014 and will be added to the AOOS workspace as soon as all newly available data are entered.

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

Comment by EVOSTC September 2014

Parts of this expensive proposal/project are vague. In particular the 'new' work looking at juvenile scales is not clear. (1) Is the plan to take scales from juvenile fish? If so, this could be difficult because, depending on the time of year and fish size, scales may be incompletely developed and very fragile. (2) Have the investigators done any 'preliminary work' to examine the feasibility of their approach? (3) The project refers to 'predictive models' but is there a hypothesis? (4) Will this project build on previous 2012 EVOSTC-supported projects on scales by Moffitt?

PWSSC Response

The plan for this new project is to measure scales from age-0 fish. Our preliminary data reported in Figure 14 demonstrate this project is feasible. In terms of hypotheses, we plan to test the hypotheses that 1) increased growth in age-0 fish is associated with increased energy density based on juvenile data and that 2) larger scale growth at age-0 is associated with successful spawning based on scale data from older recruited fish where age-0 scale growth has been measured. The work will build off of previously supported EVOSTC projects.

Comment by EVOSTC Summer 2014

One of the earlier recommendations by EVOSTC during summer 2014 was to incorporate environmental drivers into data analysis of the age-0 herring energetics data. Our first response to this important recommendation is the isotope analysis presented here and in the Synthesis Report submitted in November 2014. However, as mentioned earlier, Dr. Gorman plans to continue this effort by working on a manuscript that explores environmental drivers, i.e., oceanographic and climate variables, of yearly and seasonal variation in juvenile herring energetics. This will involve compiling datasets from those already available as part of Gulf Watch Alaska or other agency data.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$64,700.0	$67,300.0	$70,000.0	$72,800.0	$274,800.0	$ 37,385
Travel	$0.0	$3,000.0	$5,900.0	$5,900.0	$6,100.0	$20,900.0	$ 2,417
Contractual	$0.0	$24,800.0	$25,600.0	$26,300.0	$28,900.0	$105,600.0	$ 29,687
Commodities	$0.0	$7,500.0	$5,000.0	$8,300.0	$6,700.0	$27,500.0	$ 636
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)	$0	$30,000	$31,200	$33,200	$34,400	$128,800.0	$ 21,038
SUBTOTAL	$0.0	$130,000.0	$135,000.0	$143,700.0	$148,900.0	$557,600.0	$91,163.0
General Administration (9% of	$0.0	$11,700.0	$12,150.0	$12,933.0	$13,401.0	$50,184.0	N/A
PROJECT TOTAL	$0.0	$141,700.0	$147,150.0	$156,633.0	$162,301.0	$607,784.0	
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 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.

Gorman's budget from FY2014 at PWSSC will carry over significant funds into FY 2015, ~$174k as of February 6, 2015. The un-used funds from FY2014 reflect the lack of a dedicated PI for 2013 and half of 2014. These funds however will be used for PI and tech salary, in addition to funding a contractor to help with updating the data management system for PWSSC's juvenile herring energetics database. Further, these funds may also allow for hiring an additional technician in 2015 to help with the continued backlog of bomb calorimetry samples from 2013 and 2014.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Travel	$0.0	$0.0	$3,900.0	$7,100.0	$4,000.0	$15,000.0	$1,774.0
Contractual	$0.0	$75,000.0	$75,000.0	$75,000.0	$75,000.0	$300,000.0	$112,700.0
Commodities	$0.0	$6,000.0	$5,000.0	$5,000.0	$5,000.0	$21,000.0	$697.0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$0.0	$81,000.0	$83,900.0	$87,100.0	$84,000.0	$336,000.0	$115,171.0
General Administration (9% of	$0.0	$7,290.0	$7,551.0	$7,839.0	$7,560.0	$30,240.0	N/A
PROJECT TOTAL	$0.0	$88,290.0	$91,451.0	$94,939.0	$91,560.0	$366,240.0	
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 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.

ABL component budget:
~$26k from FY13 was carryover into FY14. A portion of the funds to be spent on contracts and commodities in FY13 was shifted to FY14 due to acquiring samples late in FY13 and processing delays resulting from the federal government shutdown.

~$50k from FY14 will be carryover into FY15. A portion of the funds to be spent on contracts and commodities in FY14 was shifted to FY15, to be used for final processing of samples acquired in 2014, including quality assurance/quality control analysis of preliminary data, data proofing and archiving, and re-processing problematic 2014 samples. Travel expenses in FY14 were less than anticipated for the proposed travel to AMSS and principal investigators meetings. Commodities expenses were also low due to extensive use of stocked supplies on hand, which are anticipated to be replenished in FY15.

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

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

Form Rev. 10.3.14

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

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

14120111-M

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

PWS Herring Program – Juvenile herring intensive monitoring

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

Ron Heintz and Fletcher Sewall (NOAA/Auke Bay Labs), Scott Pegau and Kristen Gorman (PWSSC)

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

1 February 2014 to 31 January 2015

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

February 2015

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

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

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

Project Summary for this reporting period

The juvenile intensive HCM project is a collaborative effort between the Prince William Sound Science Center (PWSSC) and the Auke Bay Laboratory (ABL). This is the final year of this project within the Herring Research and Monitoring (HRM) program. The core of this project involved the collection of age-0 Pacific herring (*Clupea pallasii*, hereafter herring) from Simpson Bay (Fig. 1) at monthly intervals between fall and spring 2011/12. This intensive sampling was primarily designed to assess assumptions in the November - March monitoring of herring energetic that might influence over-winter survival throughout PWS.

Similar to other HRM juvenile energetic projects, this intensive project used both stable carbon and nitrogen isotope ratios, in addition to bomb calorimetry, to estimate energy density of age-0 herring. Samples for stable isotopes have been processed in previous FYs of this project. However, bomb calorimetry samples for this project were completed in 2014 and are reported here.

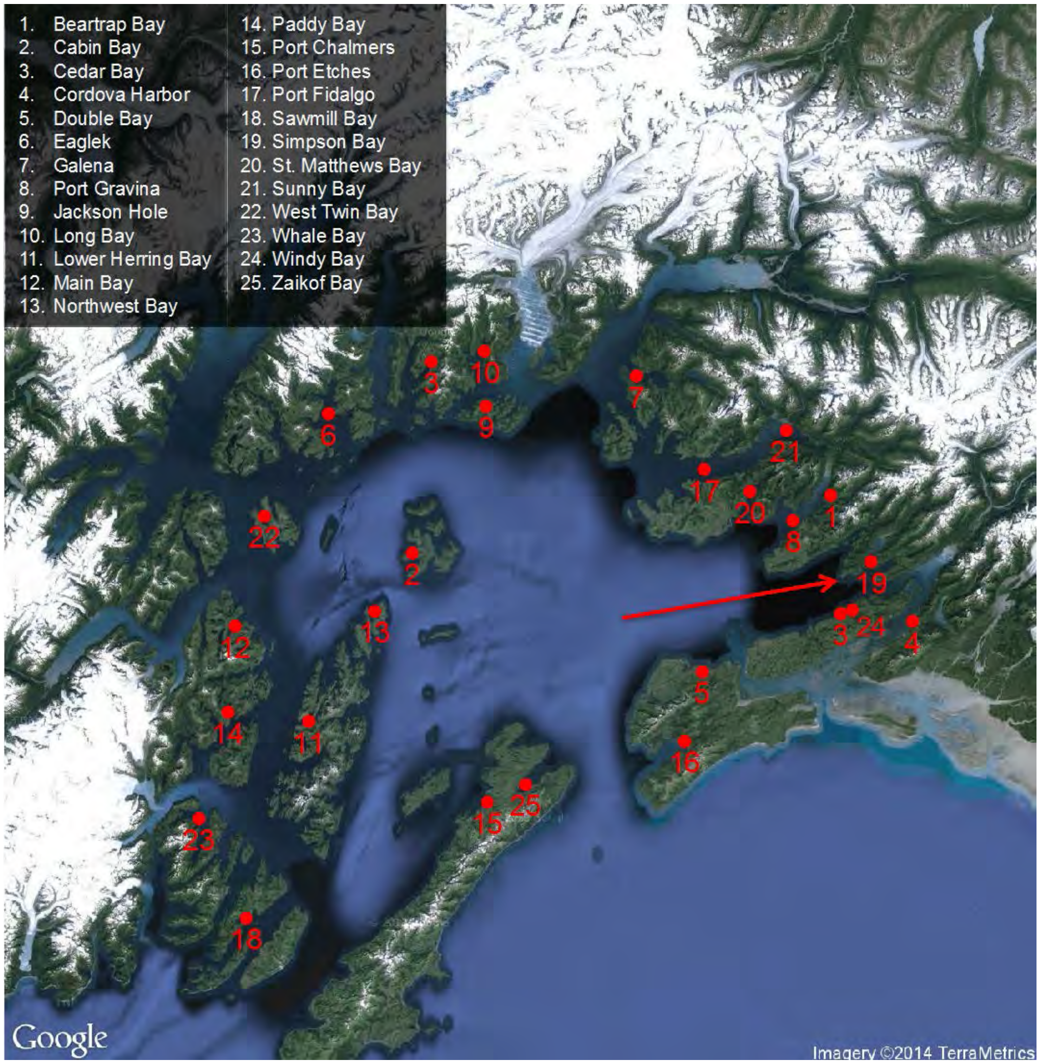

Figure 1. Sampling location in Simpson Bay for juvenile herring intensive condition monitoring noted by the red arrow. Other areas have been sampled for juvenile herring energetics as part of the PWS Herring Research and Monitoring program.

Project deliverables for this reporting period

Annual PI Meeting: A PI meeting was held in March 2014 attended by both Drs. Heinz and Pegau. Another PI meeting was held in Anchorage during November 2014 and was attended by both Drs. Pegau and Gorman. Dr. Ron Heinz and Fletcher Sewall were unable to attend the November 2014 PI meeting. However, Dr. Pegau presented results from this project at the EVOSTC Science Panel Meeting that took place in Anchorage during February 2015 in preparation for the next round of RFPs by EVOSTC.

Juvenile Herring Collections throughout winter 2011 and 2012: Completed with all samples previously sent to ABL.

Submit FY2015 Work Plan for Review: A work plan was not submitted as this project will not continue in FY2015.

Reporting: A semi-annual project report to NOAA was submitted in August 2014.

Submit synthesis to EVOS Science Council: The Synthesis Report was submitted to EVOSTC in November 2014, which included analyses of this dataset.

Alaska Marine Science Symposium: Drs. Scott Pegau, Kristen Gorman, Ron Heinz and Fletcher Sewell attended AMSS in January 2015. Dr. Gorman did not present on this project as when AMSS Abstracts were due, new analyses had not been finished at that time. However, new analyses were reported in the Synthesis Report that was submitted in November 2014. Dr. Heinz and Fletcher Sewell presented data from this project at AMSS in 2014.

Progress Update and Results

Data from this project were important for testing several assumptions of the November – March time series: 1) that the November – March sampling occurs when energy content is at its highest and lowest, 2) that feeding does not occur through the winter, and 3) that energy loss through the winter is constant (e.g., Kline et al. 2013). The intensive sampling of winter 2011/12 revealed that 1) November and March do capture early and late winter months of high and low energy density among age-0 herring (Fig. 2). However energy loss is not constant over winter, but appears to occur mostly between November and December with energy density of the late winter months being similar to that of December (Fig. 2).

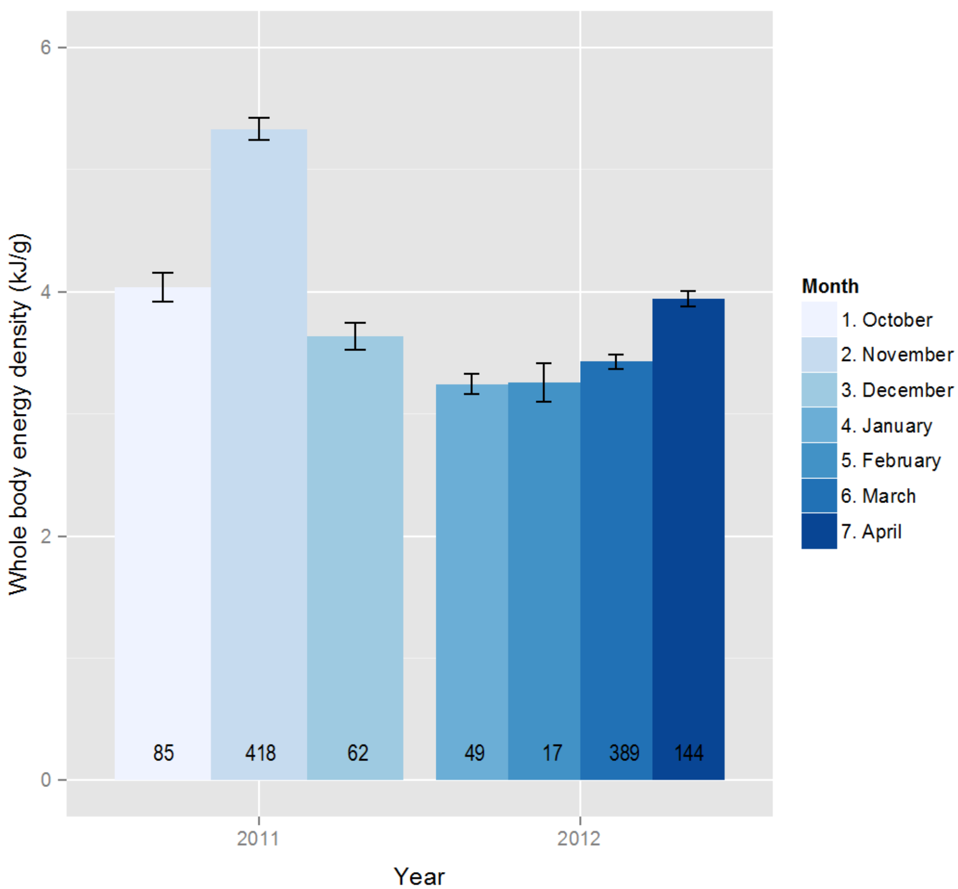

Figure 2. Monthly variation in energy density of age-0 herring during winter 2011 and 2012. Sample sizes for each month are noted at the bottom of bars. Error bars are 95% confidence intervals.

During 2014, we were able to make considerable progress in processing the backlog of bomb calorimetry samples from this dataset that serve as a comparative method for estimating energy density in comparison with stable isotope techniques. These data are presented in Fig. 3 and demonstrate a strong correlation between energy density estimates based on stable isotope and bomb calorimetry approaches, suggesting that isotope-derived values appear relatively accurate.

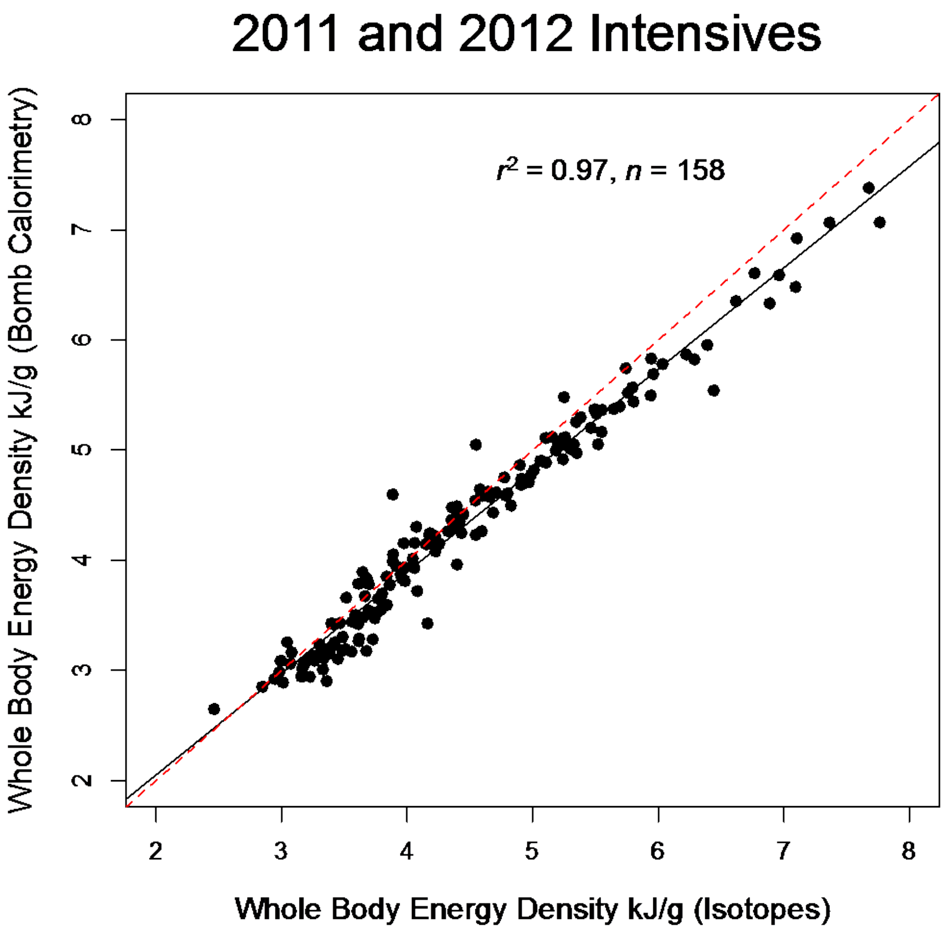

Figure 3. A comparison of energy density estimates of age-0 herring from the 2011 and 2012 intensive time series using coupled stable isotope and bomb calorimetry techniques. Bomb calorimetry data were produced in 2014. The red dashed line indicates a 1:1 relationship.

The mean size of herring captured over winter changed such that small herring were rare by March, while large herring persisted (Fig. 4), suggesting size-dependent winter mortality. The shift in sizes was unlikely due to growth, as indicated by low RNA/DNA ratios through winter (Fig. 5). Comparison of seasonal trends in RNA/DNA and lipid levels indicates a shift in energy allocation strategy prior to winter from growth to lipid storage. Herring lipid levels were largely consistent with trends in energy density, with a peak in November followed by a decline through March (Figs. 2 and 6). Larger herring captured in gillnets typically had higher lipid levels than the smaller individuals caught in cast nets, and metabolized more lipid over winter. The tradeoff between growth and energy storage is size-dependent, with smaller cast-net caught herring favoring growth more than larger gillnet-caught herring. This finding is consistent with previous data collected from multiple bays over three winters that showed smaller herring had higher RNA/DNA ratios and lower % lipid than larger herring (Sewall et al. 2013). This pattern is likely due to selective pressures favoring large size in juvenile fish (Sogard 1997).

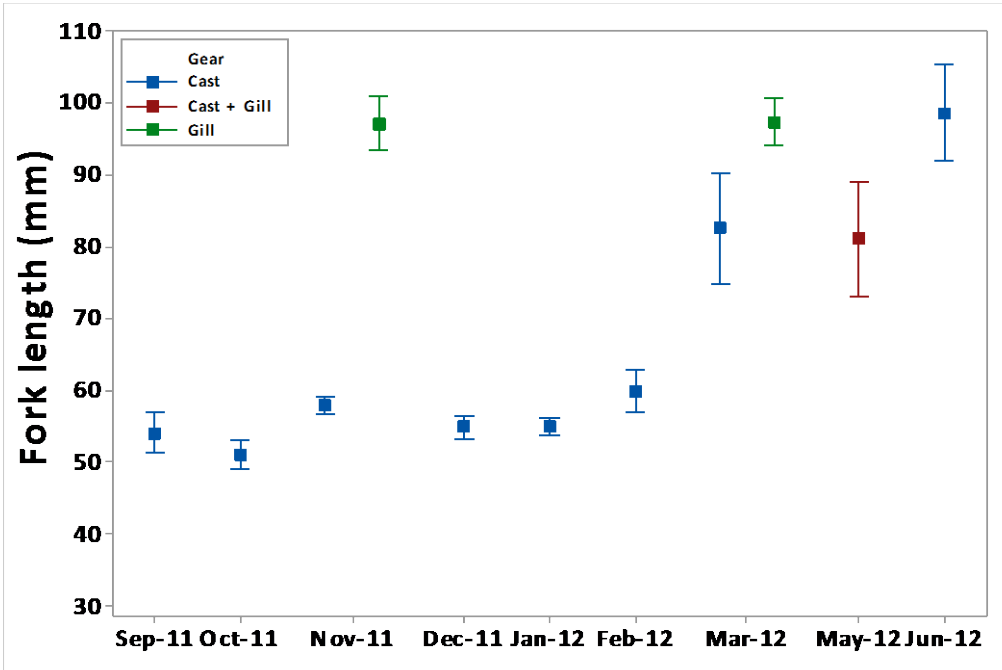

Figure 4. Fork length (mm) of age-0 herring captured in Simpson Bay, Prince William Sound, from September 2011 to June 2012, means and 95% confidence intervals. Separate cast net and gillnet samples were collected concurrently in November 2011 and March 2012. May 2012 samples by both gears were pooled.

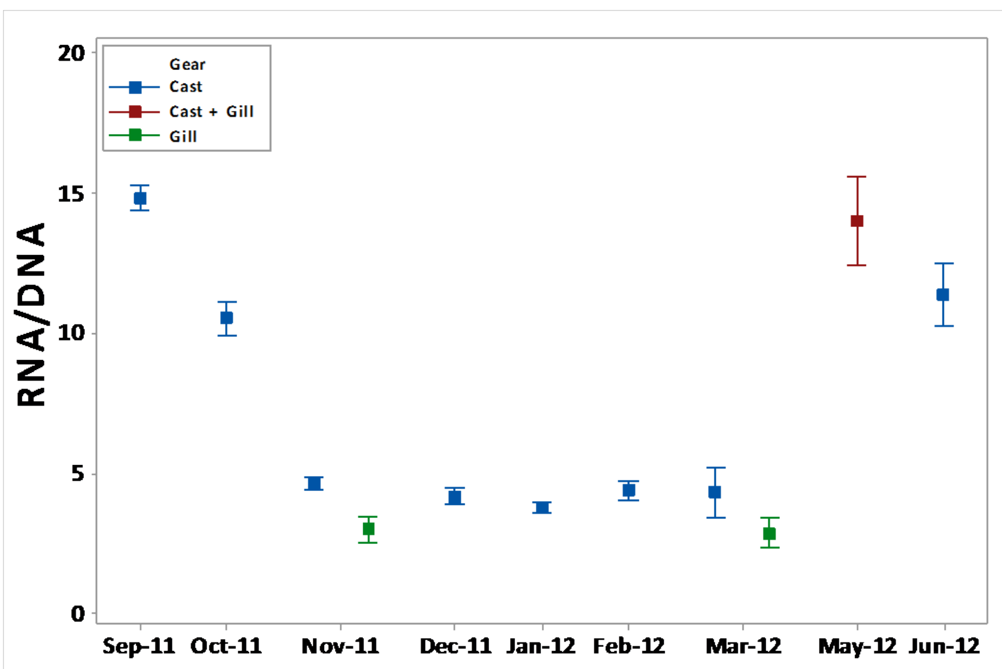

Figure 5. RNA/DNA ratio of age-0 herring from Simpson Bay, Prince William Sound, means and 95% confidence intervals. Separate cast net and gillnet samples were collected concurrently in November 2011 and March 2012. May 2012 samples by both gears were pooled.

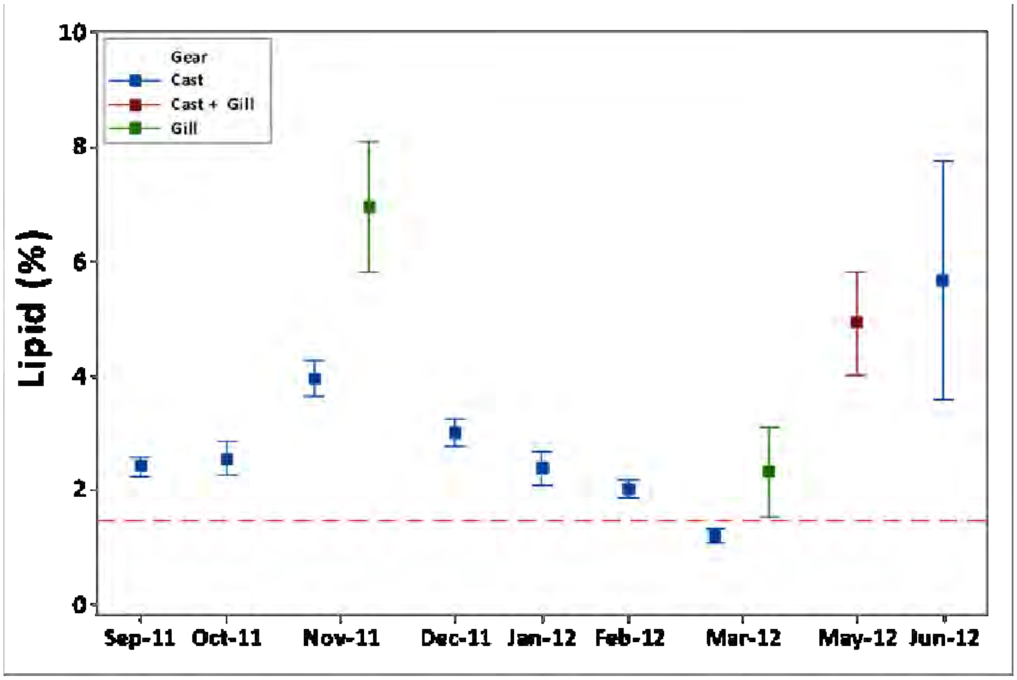

Figure 6. Lipid content (% wet mass) of age-0 herring from Simpson Bay, means and 95% confidence intervals. Separate cast net and gillnet samples were collected concurrently in November 2011 and March 2012. May 2012 samples by both gears were pooled. Red dashed line indicates minimum 1.49% lipid required for survival, as determined by previous lab study.

We examined trends in herring diets to assess the potential influence of variation in zooplankton prey quantity and quality on herring survival, and to test the assumption of no food intake for modeling winter energy loss. Interestingly, feeding was evident throughout the winter, with only 3% empty stomachs from December through March (Table 1). Stomach contents analysis showed that the level of feeding varied monthly over winter, and was influenced by fish size and condition. In autumn, all seven empty stomachs observed in November came from larger, fatter individuals captured in gill nets. Gillnet-captured herring that had eaten had lower mean stomach contents masses than castnet-captured herring (Fig. 7), reflecting the lower foraging need for large fish at that time. This pattern of higher foraging activity for small, low-lipid fish in Simpson Bay is consistent with previous reports of greater evidence of foraging among low-lipid individuals across multiple bays in PWS (Sewall et al. 2013). Mean stomach contents mass as a percentage of fish body mass tended to increase from December through February, which likely reflects greater reliance on dietary energy as lipid stores were decreasing. The sharp decline in March may indicate zooplankton had become scarce by this time, though we lack independent zooplankton density estimates as verification.

Table 1. Percent empty stomachs observed in age-0 herring captured in Simpson Bay, Prince William Sound, Alaska. *Herring caught by cast net and gillnet in May 2012 were pooled.

	Cast net		*Gillnet*	
Month	**% Empty**	**N**	**% Empty**	**N**
Sep 2011	0	60		
Oct 2011	0	20		
Nov 2011	0	30	70	10
Dec 2011	0	20		
Jan 2012	0	20		
Feb 2012	12.5	16		
Mar 2012	0	10	0	10
May 2012	25*	20*		
Jun 2012	0	20		
Total	5.93	236		

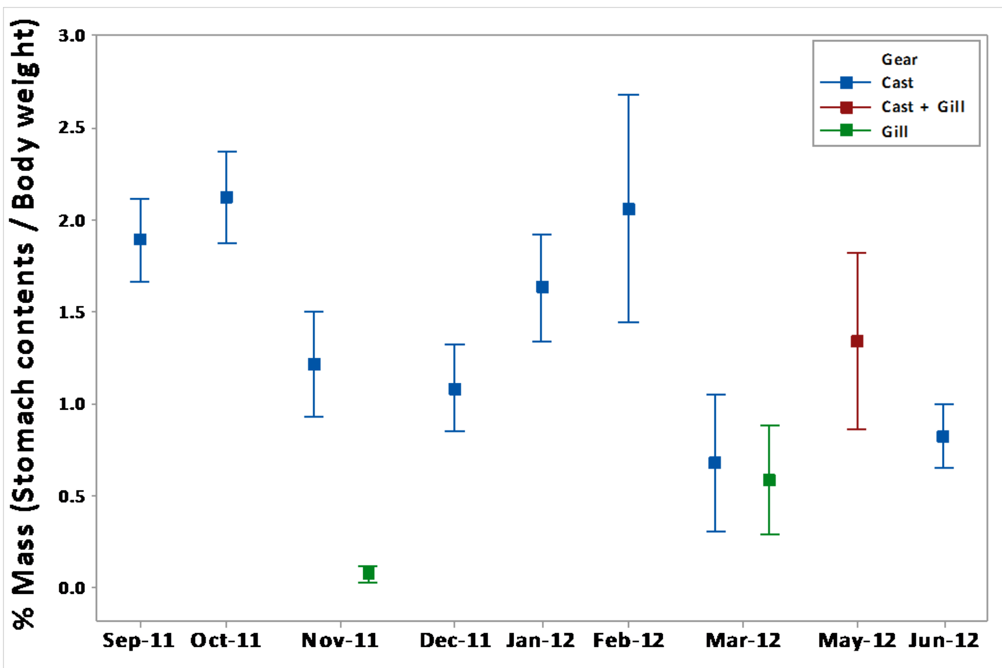

Figure 7. Stomach contents mass as a percentage of body mass for age-0 herring captured in Simpson Bay, Prince William Sound, from September 2011 to June 2012, means and 95% confidence intervals. Separate cast net and gillnet samples were collected concurrently in in November 2011 and March 2012. May 2012 samples by both gears were pooled.

The diet compositions of Simpson Bay herring were notable in the scarcity of high-energy prey such as euphausiids and mysids. Throughout the winter, relatively lower-energy prey such as larvaceans and small copepods made up the majority of herring diets, with increasing numbers of barnacle larvae (Cirripedia) in spring and summer (Fig. 8). This contrasts with the diet compositions of herring in other bays in PWS examined in November 2011, which had significant proportions of euphausiids (Sewall et al. 2013). As a result, the estimated energy density of diets for herring in Simpson Bay was the lowest among the five bays observed. This variability in diet energy among bays may be important in evaluating the relative significance of winter-feeding for herring survival.

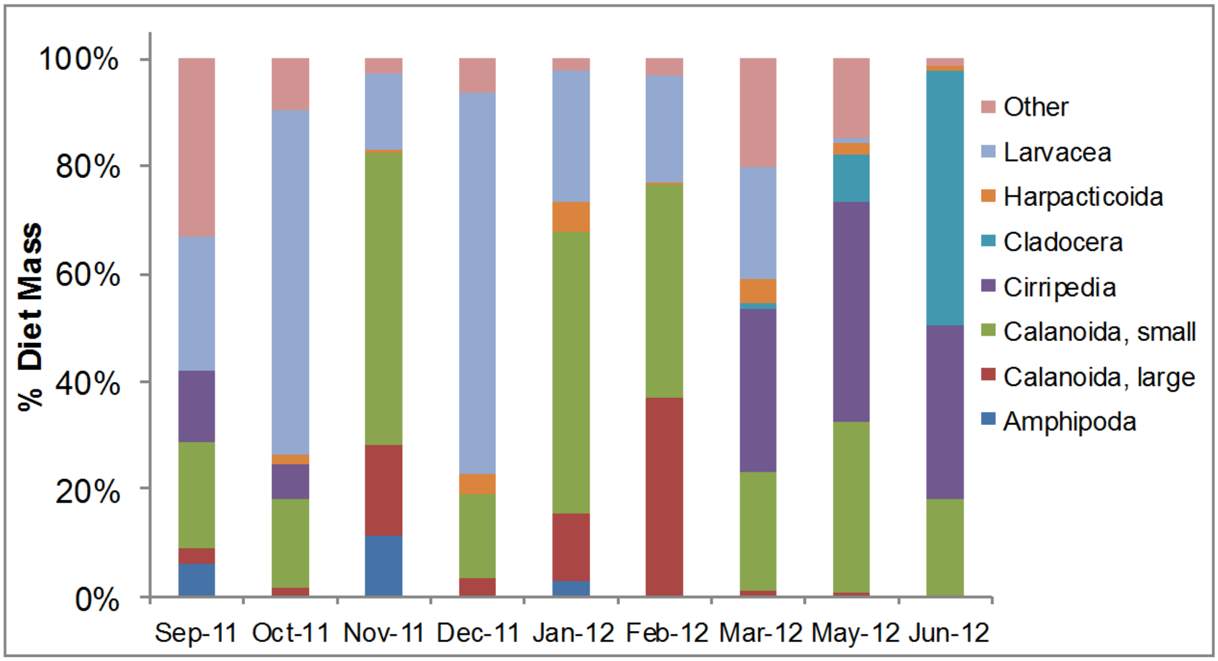

Figure 8. Diet composition (% of total mass consumed) for age-0 herring captured in Simpson Bay, Prince William Sound, from September 2011 to June 2012. Herring in November 2011, March 2012, and May 2012 were captured by cast net and gillnet; all other months were by cast net only.

Smaller fish captured in cast nets had exhausted their lipid stores by March and were reliant on diet energy for their survival. However, estimated diet energy content in March appeared insufficient to meet daily metabolic needs (Fig. 9). Assuming metabolic energy use of 23 J/g per day (Paul and Paul 1998), age-0 herring in March had less than one day of spare lipid stores and energy from consumed prey. Their actual energy use is likely higher due to foraging activity, which would further increase the risk of energy depletion. These findings suggest that smaller juvenile herring in Simpson Bay were unlikely to survive through this winter, due to a combination of low lipid stores and limited diet energy intake in March.

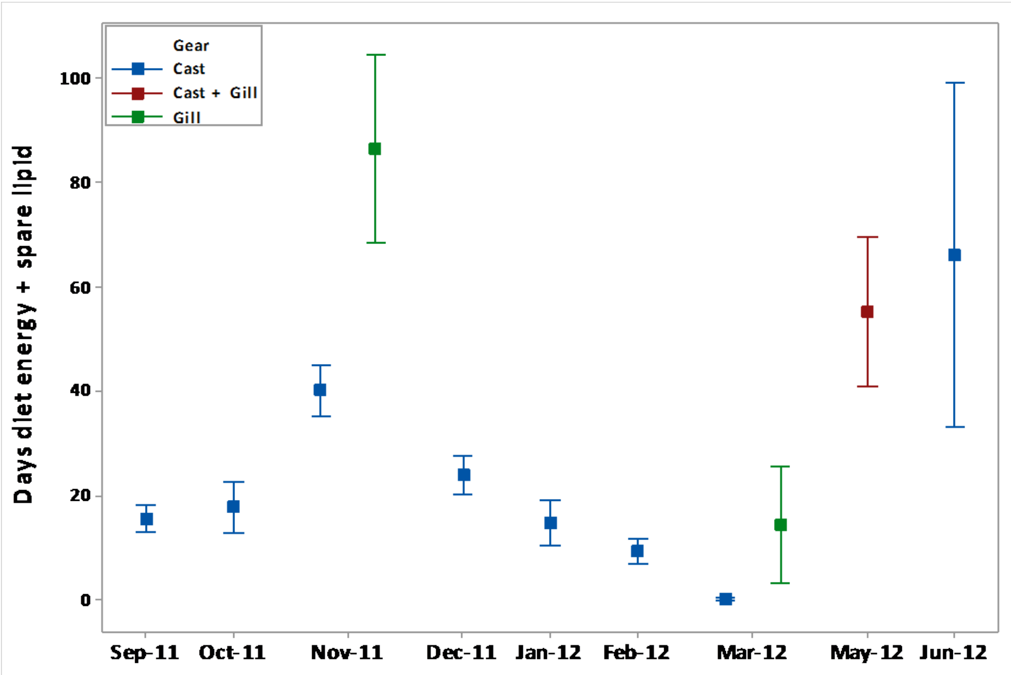

Figure 9. Days until depletion of energy from consumed prey (diet energy) and spare lipid stores (lipid stores in excess of minimum for survival) for age-0 herring captured in Simpson Bay, Prince William Sound, from September 2011 to June 2012, means and 95% confidence intervals. Separate cast net and gillnet samples were collected concurrently in November 2011 and March 2012. May 2012 samples by both gears were pooled.

Literature Cited

Kline, T.C., Jr. 2013. PWS Herring Survey: Pacific Herring Energetic Recruitment Factors, Exxon Valdez Oil Spill Restoration Project Final Report (Project 10100132-C). Prince William Sound Science Center, P.O. Box 705, Cordova, AK 99574.

Paul, A. J. and J. M. Paul. 1998. Comparisons of whole body energy content of captive fasting age zero Alaskan Pacific Herring (*Clupea pallasi Valenciennes*) and cohorts over-wintering in nature. Journal of Experimental Marine Biology and Ecology. 226. 75-86.

Sewall, F. F., R. A. Heintz, and J. J. Vollenweider. 2013. Prince William Sound Herring Survey: Value of Growth and Energy Storage as Predictors of Winter Performance in Young-of-the-year Herring from Prince William Sound. National Marine Fisheries Service, Juneau, Alaska.

Sogard, S. M. 1997. Size-selective mortality in the juvenile stage of teleost fishes: a review. Bulletin of Marine Science **60**:1129-1157.

Summary of Future Work to be Performed
This project is ending after FY2014 and therefore no future work is planned.

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

a) Within a Trustee Council-Funded Program.
The juvenile intensive HCM project primarily requires coordination of PIs at PWSSC and ABL.

b) With other Trustee Council-Funded Projects.
None.

c) With Trustee or Management Agencies.
None.

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

a) Publications produced during the reporting period.
None

b) Conference and workshop presentations and attendance during the reporting period.
March PI meeting: Pegau and Heinz attended
November PI meeting: Pegau and Gorman attended
AMSS: Pegau, Heinz, Gorman and Sewell attended

c) Data and/or information products developed during the reporting period, if applicable.
Synthesis Report submitted in November 2014 including these data.

d) Data sets and associated metadata that have been uploaded to the program's data portal.
The long-term herring dataset, which includes these intensive data, is being updated in its current form (Excel) with new isotope and bomb calorimetry data obtained during fall 2014 and will be added to the AOOS workspace as soon as all newly available data are entered.

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

None as this project is ending after FY2014.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$64,800.0	$41,200.0	$13,700.0	$0.0	$0.0	$119,700.0	$ 119,328
Travel	$2,700.0	$2,700.0	$0.0	$0.0	$0.0	$5,400.0	$ 2,965
Contractual	$41,600.0	$8,500.0	$700.0	$0.0	$0.0	$50,800.0	$ 56,157
Commodities	$13,900.0	$2,200.0	$0.0	$0.0	$0.0	$16,100.0	$ 8,613
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)	$36,900	$16,300	$4,300			$57,500.0	$ 56,068
SUBTOTAL	$159,900.0	$70,900.0	$18,700.0	$0.0	$0.0	$249,500.0	$243,131.0
General Administration (9% of	$14,391.0	$6,381.0	$1,683.0	$0.0	$0.0	$22,455.0	
PROJECT TOTAL	$174,291.0	$77,281.0	$20,383.0	$0.0	$0.0	$271,955.0	
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 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.

None

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

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

Form Rev. 10.3.14

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

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

14120111-O

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

PWS Herring Program – Coordination and Logistics

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

W. Scott Pegau

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

February 2014 through January 2015

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

February 2015

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

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

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

During the past year considerable effort was placed into the development of the synthesis that was due in November 2014. A principal investigator (PI) meeting was held in March to outline the process, set deadlines, and coordinate between projects. A second meeting occurred in November to finalize the document. The November meeting was set at the end of the Gulf Watch Alaska PI meeting to encourage investigators from both programs to interact. A meeting also occurred during the Alaska Marine Science Symposium to allow investigators another opportunity to touch base with each other.

The synthesis pulls together results from the various projects and from the Gulf Watch Alaska program to examine our current knowledge of herring in Prince William Sound (PWS). The most surprising result was the correlation between the diatom abundance anomaly measured by the continuous plankton recorder and the growth of age-0 herring in PWS. A strong positive correlation was found and a manuscript is being drafted that discuss the findings. Other important findings include the spatial and temporal patterns associated with herring condition, the evidence of overwinter feeding by age-0 herring, the importance of different inputs to the age-structure-analysis model, and the ability to track acoustically tagged adult herring. For complete findings please see 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 logistical support and reporting tasks were completed as scheduled. The final acoustic intensive surveys occurred in March. CDFU fishermen were trained and assigned areas for fish capture in March. Arrangements were made for collection of herring from the Kayak Island spawning grounds using a local fisherman. Two cruises were contracted to support the expanded adult herring surveys. We were unable to find the adult herring staging for spawn at Port Gravina. On the second cruise herring were found prepared to spawn off Montague, but there were no observations of spawn occurring. We tested satellite transmitting cameras on Montague Island as a means to detect spawn without requiring daily aerial surveys. No spawn was observed with the cameras. A cruise occurred in November for the scheduled juvenile herring sampling. A second boat was contracted for a portion of that time to allow the non-lethal sampling project to sample with the acoustic survey vessel.

A plane was contracted to support the aerial surveys for the age-1 herring index and to support the forage fish project. We worked closely with the forage fish project to establish and test new sampling protocols. Several days of overlap of the aircraft and the sampling vessel allowed for validation of the aerial observations. A collaboration with a University of Oregon journalism class was established. The class provided people to maintain the paper logs while getting the opportunity to see more of PWS. Students have also been brought on for short periods to assist with analysis of the aerial survey data.

Once Kristen Gorman arrived at PWSSC the two herring condition projects were turned over to her. We continued to work together through the year to complete the transition and ensure she understands the deliverables of her projects and the status of work on them.

We took advantage of an opportunity to work with a science writer to develop articles for three commercial fishing journals.

This project continues to support investigators in uploading their data to the ocean workspace. Updated energetics, disease prevalence, acoustic survey, aerial survey, and tagging data were submitted. Presentations from PI meetings and other meetings are also uploaded to the workspace.

We often meet with Steve Moffitt, the local herring fisheries manager. It is through these meetings that we keep track of the needs of the resource managers. We were also able to meet with Sherri Dressler of ADF&G to discuss our findings and how they might be informed by herring research in other parts of the state. The herring oversight group was brought back to full strength by the addition of Steve Martell. We were able to meet with members of the oversight group to get their feedback on concerns and suggested directions.

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

a) This project is responsible for coordination among all of the HRM projects. In the past year there have been several meeting of the investigators to coordinate work, but also to pull together a synthesis of our understanding of herring in Prince William Sound.

   There is coordination among the HRM and GWA programs in reporting, and PI meeting attendance.

   This project shares responsibility with the GWA forage fish project for analysis of the aerial survey data.

b) We follow the progress of the two other projects funded in Cordova. We use the harbor for testing herring and contribute when possible particularly to the Cordova Clean Harbor group.
c) This project works with Steve Moffitt and Sherri Dressel of Alaska Department of Fish and Game to transfer new findings to ADF&G and for guidance about the needs of the department. Investigators from the National Oceanic and Amospheric Administration and the US Geological Survey are participating in the program.

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

a) Publications – Pacific herring in Prince William Sound: A synthesis of recent findings. This synthesis was submitted to the EVOSTC staff. Articles on the herring research program were developed for three commercial fishing journals.
b) Presentations – Presented an overview of the HRM program to the EVOS PAC and Science Panel.
c) Data products – This project does not generate data.
d) Information archive - Presentations from the PI meetings are loaded on the Ocean Workspace.

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

There were no project specific comments.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$19,100.0	$27,900.0	$28,700.0	$20,900.0	$21,700.0	$118,300.0	$ 55,227
Travel	$9,500.0	$4,100.0	$5,000.0	$4,000.0	$8,700.0	$31,300.0	$ 15,973
Contractual	$216,960.0	$375,999.0	$282,288.0	$244,916.0	$243,657.0	$1,363,820.0	$ 825,463
Commodities	$2,300.0	$4,000.0	$2,300.0	$4,400.0	$1,000.0	$14,000.0	$ 9,164
Equipment	$50,500.0	$0.0	$0.0	$0.0	$0.0	$50,500.0	$ 79,851
Indirect Costs (*will vary by proposer*)	$35,700	$56,130	$37,800	$36,800	$35,570	$202,000.0	$ 144,630
SUBTOTAL	$334,060.0	$468,129.0	$356,088.0	$311,016.0	$310,627.0	$1,779,920.0	$1,130,308.0
General Administration (9% of	$30,065.4	$42,131.6	$32,047.9	$27,991.4	$27,956.4	$160,192.8	
PROJECT TOTAL	$364,125.4	$510,260.6	$388,135.9	$339,007.4	$338,583.4	$1,940,112.8	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$60,000.0

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.

This proposal contains the budgets of Bochenek-data management, Boswell-non-lethal sampling, and Branch-population dynamics within the contractual section.

Total expenditures are very close to the proposed budget at this stage. The project is overspent on Equipment due to repairs to the Remotely Operated Vehicle and the purchase of remote cameras. Funds from Personnel and Contractual Services will be used to cover the equipment expenses. The Boswell project accounts for most of the unspent contractual funds.

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

ATTACHMENT C *EVOSTC Annual Project Report Form*

Form Rev. 10.3.14

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

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

14120111-P

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

PWS Herring Program- Genetic Stock Structure

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

Sharon Wildes and Jeff Guyon

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

February 1, 2014 - January 31, 2015

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

February 2015

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

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

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

Spawning herring was collected from eastern PWS, and from locations adjacent to the Sound, including Kayak Island. DNA was extracted from all collections. Several collections were found to be contaminated with (presumably) milt. This challenge has been mostly overcome (in all but two collections), by agitating the samples in a dilute bleach solution, and re-isolating DNA from the 'clean' tissue. 15 microsatellite markers have been optimized and we are in the process of obtaining data.

Collections of spawning herring have been obtained from multiple sites and multiple years from **eastern** PWS. If samples from other areas of the Sound could be obtained this spring (or next), then we will incorporate them into the study. Kayak Island spawning adult herring samples have been collected and integrated into the study. All samples have been collected from spawning populations. We agree that late stage embryos might possibly be used from other areas of the Sound, if adult spawners are unavailable.

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

a) This study may coordinate with tagging studies in the future. This project receives fish from the validation and aerial survey projects after they have been processed by the Alaska Department of Fish and Game (ADF&G).
b) No collaboration with other Trustee Council funded projects
c) All herring from Prince William Sound in this project have been processed by Steve Moffitt of the Cordova office of ADF&G. This allows us to connect the samples to the age-sex-length information collected by ADF&G.

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

none

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

Samples from Kayak Island and other areas outside Prince William Sound are being analyzed.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$0.0	$17,500.0	$0.0	$0.0	$17,500.0	$17,500.0
Travel	$0.0	$0.0	$3,400.0	$3,400.0	$0.0	$6,800.0	$3,400.0
Contractual	$0.0	$0.0	$0.0	$17,500.0	$0.0	$17,500.0	
Commodities	$0.0	$0.0	$25,400.0	$27,800.0	$0.0	$53,200.0	$25,400.0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$0.0	$0.0	$46,300.0	$48,700.0	$0.0	$95,000.0	$46,300.0
General Administration (9% of	$0.0	$0.0	$4,167.0	$4,383.0	$0.0	$8,550.0	N/A
PROJECT TOTAL	$0.0	$0.0	$50,467.0	$53,083.0	$0.0	$103,550.0	
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 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.

As submitted

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

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

Form Rev. 10.3.14

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

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

14120111-Q

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

PWS Herring Program: Modeling the population dynamics of Prince William Sound herring.

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

Trevor A. Branch

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

1 February 2014 to 31 January 2015

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

February 2015

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

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

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

In the past year the revised Bayesian assessment model was completed, a MS defense scheduled for Melissa Muradian, and a new graduate student John Trochta taken on to continue the modeling project. The status of the four projects is as follows: Bayesian model completed; value of survey information drafted and being finalized; meta-analysis of global herring populations started with some intriguing preliminary results; and the final project, examining hypotheses for the decline of PWS herring, is scheduled for 2016-17.

Bayesian assessment model: a major milestone was reached with the completed development of a an age-structured stock assessment for Prince William Sound herring, that can be used to supplement the ADF&G assessment using the ASA model. The revised model returns results that are similar to the ADF&G model for 2013 biomass estimates, but uses likelihoods to internally weight different datasets instead of least-squares minimization. In addition, a Bayesian framework is employed from within AD Model Builder, which allows for uncertainty to be automatically calculated from the Bayesian posteriors. The implications are that ADF&G could choose management rules that directly incorporate uncertainty, in deciding how conservative they should be in opening the herring fishery in the future.

Key results of the Bayesian model: the Bayesian model provides good fits to the available time series of data (Fig. 1), and age composition data from the fishery and spawn survey (Fig. 2). Estimated pre-fishery biomass in 2013 was 19,300 metric tonnes (Fig. 3), just below the threshold for opening the fishery (22,000 short tons = 19,958 mt). The 95% probability interval was 11,400-32,400 mt, and there was an estimated 55% probability of biomass being below the threshold for opening the fishery. The last year of medium recruitment was in 2002, since then, recruitment at age-3 has been between 9 and 103 million fish, compared to recruitment of 117 to 1234 million fish in every year from 1980 to 1988. Taken as a whole, the model confirms the ADF&G assessment that the fishery should not be reopened, and that biomass and recruitment have been low for more than a decade now.

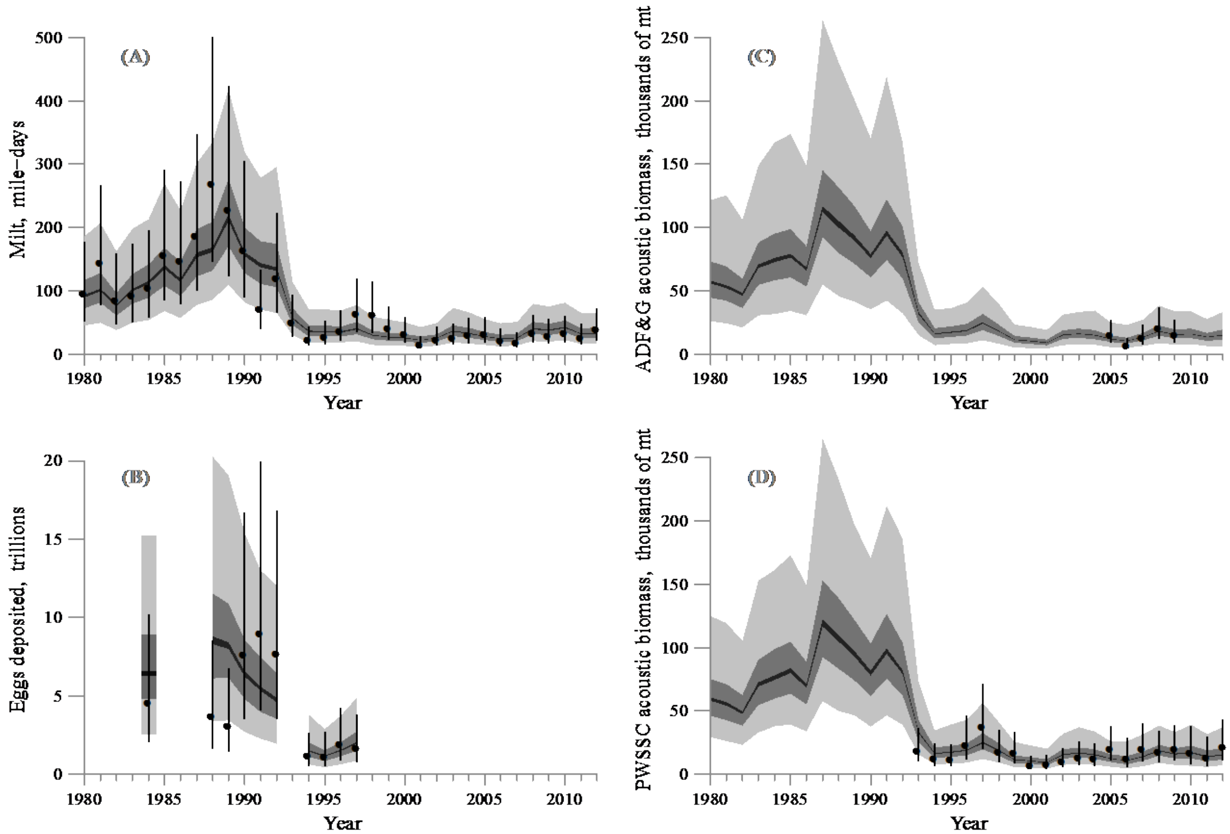

Fig 1. Model estimates fitted to the four time series of abundance estimates (1980–2012): (A) mile-days of milt, (B) egg deposition surveys, (C) ADF&G hydroacoustic estimates, and (D) PWSSC hydroacoustic estimates. The solid circles and lines represent the mean and 95% confidence intervals of the data (plus additional variance estimated by the model); the shaded polygons represent the respective posterior predictive intervals (light gray = 95% interval, darker gray = 50% interval, black = 5% interval). Source: draft MS thesis, M.L. Muradian.

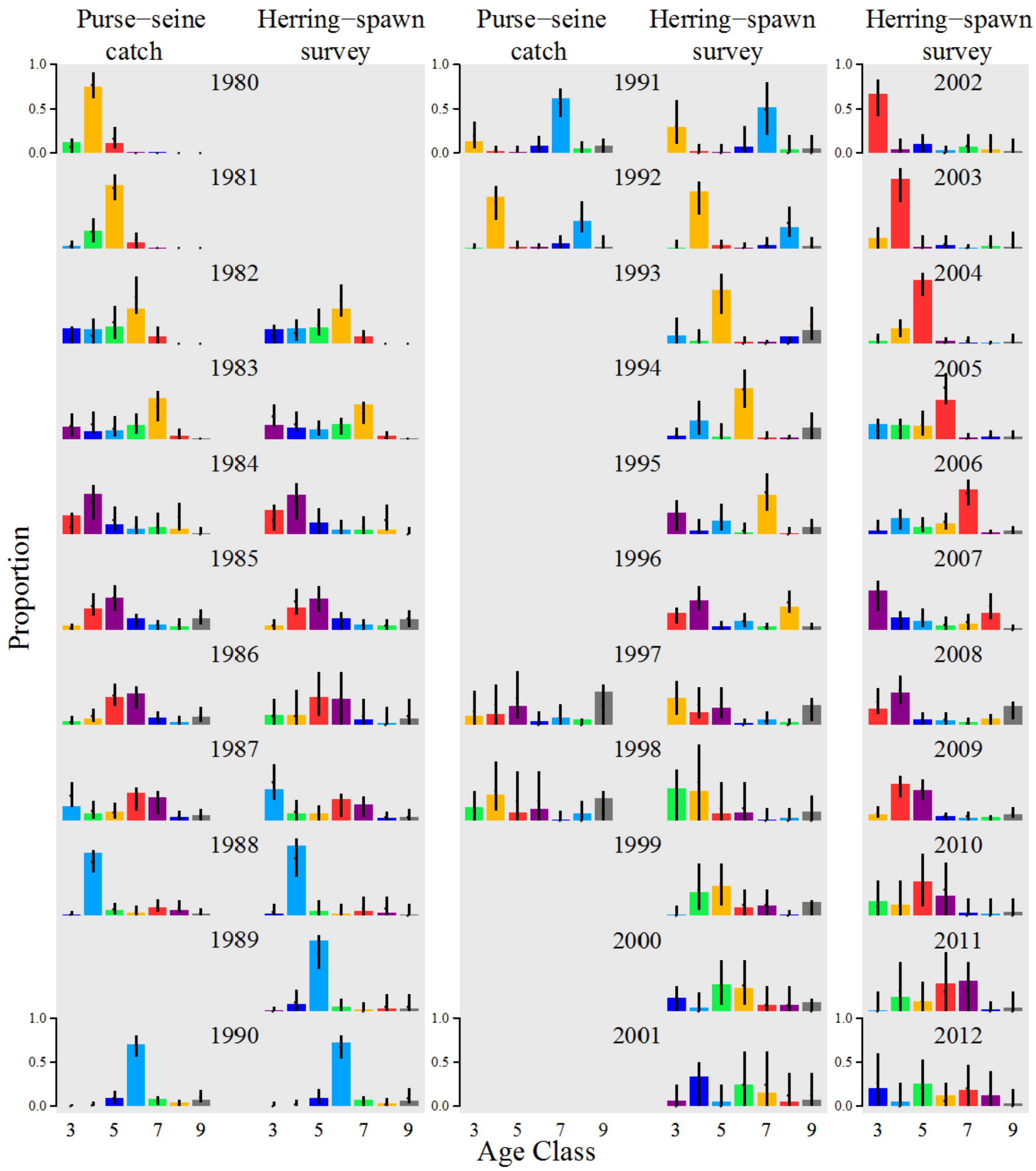

Fig. 2 Model fits to the two sets of age-composition data used: proportion of catch-at-age from the purse-seine fishery and age-composition proportions from the ADF&G herring-spawn survey. Colored bars denote data, colors track individual cohorts through time, and points show posterior median with bars showing the 95% posterior intervals. No compositions are shown for years when the spring fishery was closed (1989, 1993–1996, and after 1998). Source: draft MS thesis, M.L. Muradian.

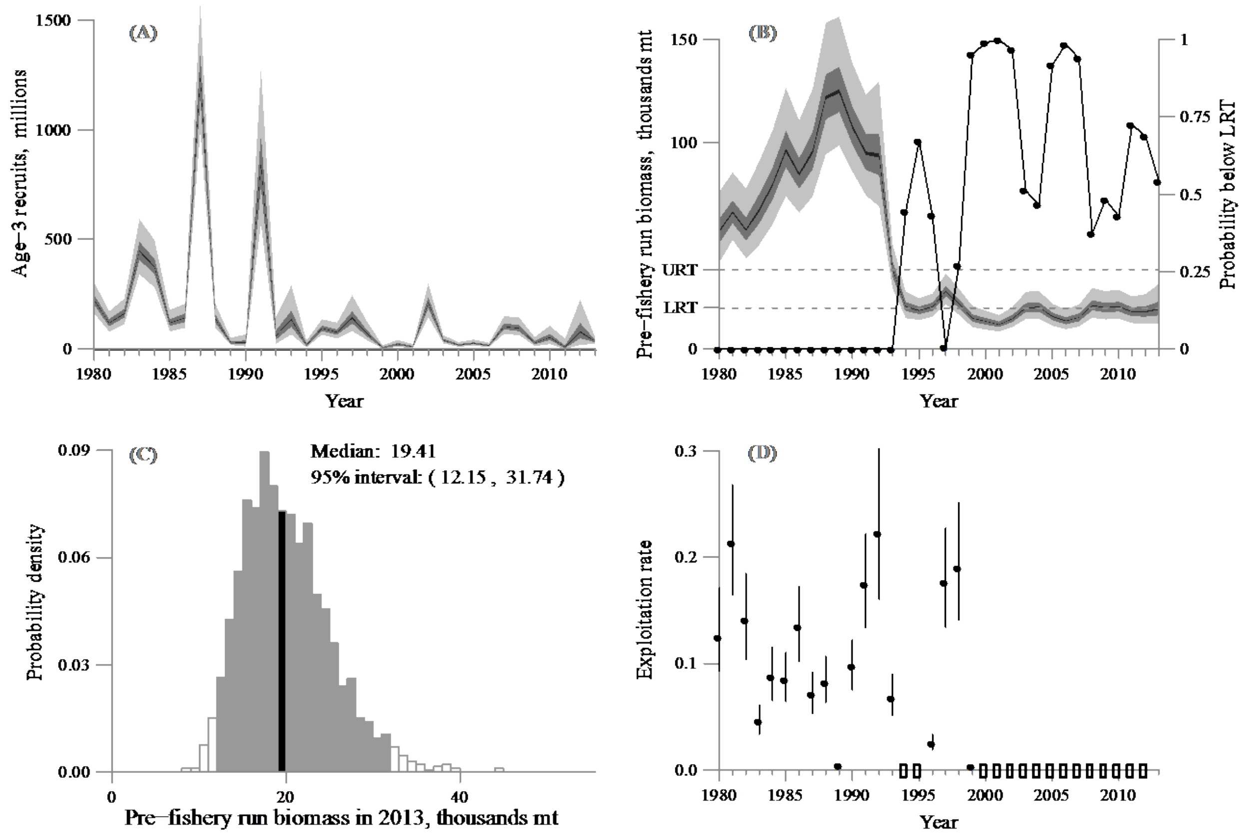

Fig. 3 The panels show (A) estimated recruitment at age-3 (posterior intervals; light gray = 95% interval, darker gray = 50% interval, black = 5% interval), (B) estimated pre-fishery biomass (posterior intervals; light gray = 95% interval, darker gray = 50% interval, black = 5% interval) and the probability that pre-fishery biomass is below the lower regulatory threshold (LRT) of 22,000 short tons (19,958 mt) (connected black points) with the upper regulatory threshold (URT: 42,500 short tons ≈ 38,555 mt) shown for reference, (C) posterior distribution of estimated pre-fishery biomass for 2013 with the 95% credible interval (light grey) and the median (black) shown, and (D) posterior median exploitation rates (black points) with 95% posterior intervals (segments) – open points show fishery closures. Source: draft MS thesis, M.L. Muradian.

Value of surveys: the revised Bayesian model is being used to determine which surveys are the most valuable for obtaining precise estimates of abundance. The model has been with multiple iterations (for each iteration, a different set of data are simulated and then fit with the model) for 7 scenarios. In the base scenario, all data are included in the assessment. For the other scenarios, data from a particular survey or data collection type, are omitted. The predictions are that estimated biomass should have broader uncertainty intervals and be more biased, when data types are left out, compared to the base scenario. The resulting deterioration in precision and bias represents a trade-off with the cost of the survey, allowing the determination of which survey provides the greatest improvement in the model for the lowest cost. Results are expected in March 2015.

Meta-analysis of herring populations: the question addressed here is whether PWS herring have collapsed and failed to recover for an unusually long period of time. Thanks to the help of Tim Essington, we have been able to analyze stock assessments for 29 herring stocks around the world. Initial analysis suggests that the 16 year long time period during which PWS herring remains under 20% of maximum biomass, is unusually lengthy, and should only occur in about 1% of all time intervals that long. These results are likely to change as we expand the compilation, add survey data for stocks without assessments, and focus on including stocks that have collapsed and not recovered (and may not have recent stock assessments).

Alternate hypotheses for PWS herring decline: work on this section of the project is scheduled for 2016.

Personnel: Melissa Muradian is expected to defend her MS thesis in March 2015. John Trochta has been taken on to join in the project and work on the herring meta-analysis and in examining hypotheses for the decline of PWS herring.

Future directions: it is anticipated that the model will be extended back in time to cover years prior to 1980, and extended to cover age groups 0, 1, and 2. This would assist in modeling hypotheses about over-winter survival, and correlates between environmental covariates and subsequent recruitment. In addition, this will allow for explicit fitting to the new time series of aerial surveys of juvenile herring conducted by Scott Pegau. This work may have funding implications since this was not explicitly envisaged in the original proposal.

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

a) Coordination with Scott Pegau for data interpretation and oceanographic hypotheses.

Close coordination with Moffitt and Paul Hershberger to revise the indices of disease incorporated in the model.

Student Muradian participated in the hydroacoustic surveys in 2014 to better understand data collection and coordinate data-model interactions

Inclusion of weight-at-age, sex ratios, hydroacoustic surveys (ADF&G and PWSSC), mile-days of milt survey, spawner-egg survey, and other data collected during the herring program, involving too many people to name individually.

b) No coordination with other EVOSTC funded projects

c) Close coordination with Steven Moffitt of ADF&G to include the data collected by ADF&G for the ASA Model, sharing of model code and results of the Bayesian model.

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

Publications: A popular article was written by Melissa Muradian for Delta Sound Connections in 2014: "Herring: How much information does a population model need?"

Six peer-reviewed publications were coauthored by PI Branch or student Muradian on broader issues related to recruitment, fisheries status, or fisheries stock assessment simulation methods, although none focused solely on Prince William Sound herring:

Hilborn, R., D. J. Hively, O. P. Jensen, and T. A. Branch*. 2014. The dynamics of fish populations at low abundance and prospects for rebuilding and recovery. ICES Journal of Marine Science 71:2141-2151.

Hurtado-Ferro, F., C. S. Szuwalski, J. L. Valero, S. C. Anderson, C. J. Cunningham, K. F. Johnson, R. Licandeo, C. R. McGilliard, C. C. Monnahan, M. L. Muradian*, K. Ono, K. A. Vert-Pre, A. R. Whitten, and A. E. Punt. 2015. Looking in the rear-view mirror: bias and retrospective patterns in integrated, age-structured stock assessment models. ICES Journal of Marine Science 72:99-110.

Johnson, K. F., C. C. Monnahan, C. R. McGilliard, K. A. Vert-pre, S. C. Anderson, C. J. Cunningham, F. Hurtado-Ferro, R. R. Licandeo, M. L. Muradian*, K. Ono, C. S. Szuwalski, J. L. Valero, A. R. Whitten, and A. E. Punt. 2015. Time-varying natural mortality in fisheries stock assessment models: identifying a default approach. ICES Journal of Marine Science 72:137-150.

Ono, K., R. Licandeo, M. L. Muradian*, C. J. Cunningham, S. C. Anderson, F. Hurtado-Ferro, K. F. Johnson, C. R. McGilliard, C. C. Monnahan, C. S. Szuwalski, J. Valero, K. A. Vert-Pre, A. R. Whitten, and A. E. Punt. 2015. The importance of length and age composition data in statistical age-structured models for marine species. ICES Journal of Marine Science 72: 31-43.

Stachura, M. M., T. E. Essington, N. J. Mantua, A. B. Hollowed, M. A. Haltuch, P. D. Spencer, T. A. Branch*, and M. J. Doyle. 2014. Linking Northeast Pacific recruitment synchrony to environmental variability. Fisheries Oceanography 23:389-408

Szuwalski, C. S., K. A. Vert-pre, A. E. Punt, T. A. Branch*, and R. Hilborn. 2015. Examining common assumptions about recruitment: a meta-analysis of recruitment dynamics for worldwide marine fisheries. Fish and Fisheries doi:10.1111/faf.12083

Presentations: Talks on the work conducted included two presentations for the PWS Herring PI Meetings in March 2014 and in November 2014; an internal University of Washington talk to the QERM program; an international conference presentation at the International Marine Conservation Congress in Glasgow, Scotland, August 2014; a talk at the Alaska Marine Science Symposium in January 2015; and a project overview presentation to the EVOSTC Long-Term Programs' Science Overview Workshop 6 February 2015.

Data transfer: The current code for the Bayesian model is available for review and use by ADF&G, and final data inputs and AD Model Builder code will be uploaded to the herring portion of the Ocean Workspace, together with the MS thesis of Melissa Muradian, when she defends (date set for March 2015).

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

The Panel acknowledges the detailed and well-rounded proposal for this project. The Panel also strongly supports the recognition in the proposal that the ASA model will have a key role in synthesis. For this reason, it is essential that all participants in the upcoming synthesis meeting have a clear description of the model as currently coded. Such a description does not exist in the published literature or previous reports to EVOSTC. The description should include (i) equations; (ii) a list of parameters assigned values before model runs; and (iii) a list of parameters estimated from data and objective functions used. It does not need to include much supporting text. We suggest a target date of December 1, 2014 for this description so that attendees have ample time to take account of the model details in preparation for the synthesis meeting.

In the Synthesis report (1 December 2014), the full specifications for the Bayesian model were provided as an Appendix 2 (Tables 2.1-2.5). Additionally, these details will be fully specified and written up in Melissa Muradian's MS thesis (defense date in March 2015), and in a scientific paper to be submitted for publication in March 2015.

A further, more technical, comment is that there was no reason given for moving to a Bayesian framework. There are many potentially excellent reasons for this decision, but they were not presented.

There are three main reasons for moving to a Bayesian framework: (1) automatic weighting of datasets based on the uncertainty in the data and their consistency with other data; (2) accurate and statistically valid estimates of uncertainty in biomass estimates; and (3) allows the ability to include probability in management rules for PWS herring (e.g. catches could be allowed at lower biomass if there was a low probability of small biomass).

Is the present ASA model used for PWS identical to the model described by Hulson et al. 2008? (See Hulson, P-J. F., Miller, S. E., Quinn, T. J. II, Marty, G. D., Moffitt, S. D., and Funk, F. 2008. Data conflicts in fishery models: incorporating hydroacoustic data into the Prince William Sound Pacific herring assessment model. – ICES Journal of Marine Science, 65: 25–43.)

The current Bayesian model does indeed build on the model by Hulson, and is very similar. Both are incorporated in AD Model Builder (Fournier et al. 2011) which allows for very fast and accurate convergence on the best estimates for model parameters. The major advance in the new model is the shift from minimizing least squares to likelihoods for each data type, and the shift from characterizing uncertainty with bootstrapping methods to the full incorporation of the model in a Bayesian framework. In combination these allow straightforward interpretation of uncertainty, and statistical weighting of different data sets.

Fournier, D.A., Skaug, H.J., Ancheta, J., Ianelli, J., Magnusson, A., Maunder, M.N., Nielsen, A., and Sibert, J. 2011. AD Model Builder: using automatic differentiation for statistical inference of highly parameterized complex nonlinear models. Optimization Methods & Software 2011: 1-17.

Objective 3 (Gathering data on clupeids of the world) is a formidable task, especially for a graduate student. More regional comparisons however may be useful if the analyses were confined to a smaller number, especially those in the eastern Pacific.

The analysis in objective 3 has proceeded at pace, with the help of current work by Tim Essington, who is gathering data on small pelagic assessments for incorporation in the RAM Legacy Stock Assessment Database (www.ramlegacy.org). So far, stock assessments for 29 stocks of herring have been compiled up to 2014. Preliminary results suggest that PWS herring have been at low levels for an abnormally long period of time compared to other herring stocks. The intent is to expand this database with more stocks; gather time series of survey indices for stocks that are do not have formal stock assessments; and prepare anecdotal evidence (catches, CPUE, historical reports) for stocks that have neither stock assessments nor survey time series.

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

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$20,734.0	$34,445.7	$35,823.5	$37,256.4	$38,746.7	$167,006.3	$ 86,146
Travel	$982.0	$3,636.0	$8,194.0	$7,812.0	$8,508.0	$29,132.0	$ 10,681
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$ 35,112
Commodities	$200.0	$16,884.0	$20,552.4	$21,286.5	$22,050.0	$80,972.9	$ 1,055
Equipment	$0.0	$4,000.0	$0.0	$0.0	$0.0	$4,000.0	$ 7,470
Indirect Costs (*will vary by proposer*)	$11,944	$20,863	$25,188	$25,761	$26,952	$110,708.0	$ 53,446
SUBTOTAL	$33,860.0	$79,828.7	$89,757.9	$92,115.9	$96,256.7	$391,819.2	$193,910.0
General Administration (9% of	$3,047.4	$7,184.6	$8,078.2	$8,290.4	$8,663.1	$35,263.7	
PROJECT TOTAL	$36,907.4	$87,013.3	$97,836.1	$100,406.4	$104,919.8	$427,082.9	
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 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.

Spending on this budget has been close to budgeted amounts for salary, tuition, and travel.

In addition to the expenses charged against the budget, in 2014-15 the current graduate student Melissa Muradian and new graduate student John Trochta have overlapped for two quarters while Muradian was finishing. In the original project it was envisaged that a single PhD student would complete the entire project. As a result, salary and tuition for Muradian came from her being a Teaching Assistant for a course Oct-Dec 2014, and she was funded as a Research Assistant on the PI's own funds Jan-March 2015. These expenses were not charged to the EVOSTC grant. It is expected that Muradian will graduate in March 2015.

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

ATTACHMENT C *EVOSTC Annual Project Report Form*

Form Rev. 10.3.14

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

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

14120111-R

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

PWS Herring Program – Aerial Survey Support

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

W. Scott Pegau

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

February 2014 through January 2015

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

February 2015

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

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

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

Flights were conducted in late March through mid-April to observe herring spawn, install remote cameras to detect spawn, and to support the collection of fish for the genetics project.

In June there were 11 flights designed to follow the coastline in Prince William Sound (PWS) and enumerate the number of schools of age-1 herring and other forage fish. We also worked with the forage fish group in the design of a stratified-random sampling design to be used in July. The protocols to be used in July were tested during June. The estimated number of schools observed during recent surveys are provided in table 1.

Table 1. The number of schools of age-1 herring observed during aerial surveys conducted in June.

	Number of schools				
Year	**Small**	**Medium**	**Large**	**Xlarge**	**Total**
2010	291	181	95	12	579
2011					75*
2012	143	104	28	4	279
2013	1904	187	27	0	2118
2014	151	19	0	0	170

* A significant portion of Eastern Prince William Sound was not flown. About 50 schools are normally observed in that area.

The proportion of small schools observed increased starting in 2013 when there was a change in one of the two observers. We are using a sighting tube to ensure this reflects a change in the school structure and not an observation error. Since we use the number of schools as the index instead of area or volume estimates a misclassification in size will not impact the results.

We flew 14 days in July to support the forage fish project and to work with them on validation. The sampling design was based on a stratified-random selection of survey sites (Figure 1) instead of the systematic sampling designed used to provide an index of age-1 herring. A 5’ by 5’grid was placed over PWS and the aerial observations from 2010-2012 used to establish areas with high, medium, and low numbers of fish observations. Blocks were then selected to minimize the variance of the population mean.

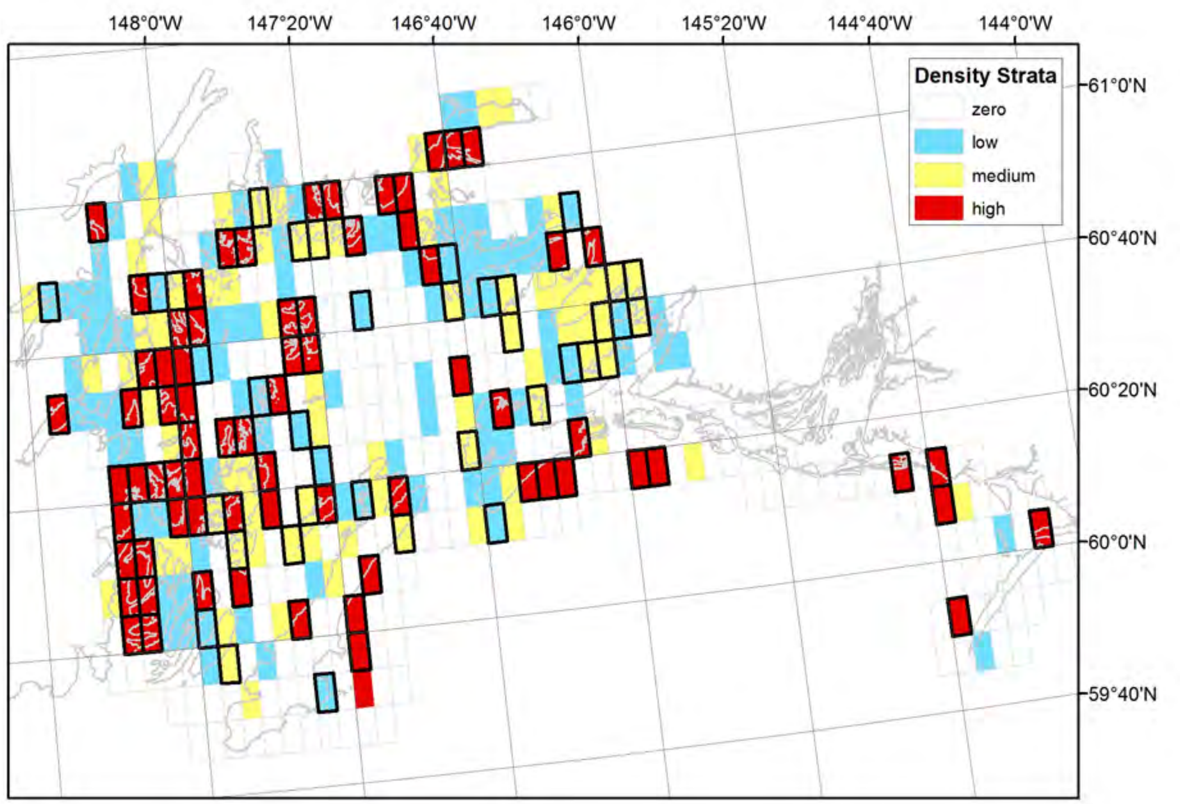

Figure 1. Blocks selected for surveying are marked with bold outlines. The school density as calculated using number of schools per kilometer of flight multiplied by a persistence factor is shown in the colors.

During each survey day one block was selected for a repeated survey. When the forage fish vessel was at sea the aerial project would identify schools near the vessel for validation of the identification and to establish acoustic biomass estimates associated with the school size categories. Preliminary analysis of the identification indicates very good classification of age-2+ herring (5 correct in 5 observations). Validation of age-1 herring classification only occurred twice. Once was age-0 herring that started to become visible midway through July. The other time it was sandlance. More effort will need to be placed on validation to get a large enough sample to determine observer identification accuracy. A difficulty is that typically only one or two schools can be validated during a day because of the distance between schools the boat must travel.

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

a) This project is a close collaboration between the Herring Research and Monitoring coordination project and the forage fish project in the Gulf Watch Alaska program. Logistics and surveys are conducted by the HRM coordination project. The forage fish project provides field computers and other recording devices. They also provide ground truth of the aerial identifications. The projects work together to determine sampling priorities and protocols. Both projects also share data analysis.

Flights were also used to guide sample collection of fish used in the genetics project and deployment of remote cameras to watch for spawn on Montague Island.

b) No collaboration with other Trustee Council funded projects

c) All herring spawn information was shared with Steve Moffitt at the Alaska Department of Fish and Game (ADF&G) office in Cordova. We have been working with Steve to identify what information is needed for non-ADF&G observations to be of value to ADF&G. The fish collected at Kayak Island were provided to ADF&G for age-sex-length analysis. We also share information about potential approaches to guide the use of aerial surveys, such as the remote cameras.

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

a) Publications – none
b) Presentations - A poster on the aerial survey effort was presented at the January 2015 Alaska Marine Science Symposium. Two videos were produced that describe the aerial survey effort. They can be seen at https://vimeo.com/108856208 and https://www.youtube.com/watch?v=OU6PVlk0Pjc&noredirect=1#t=174. The first was part of a project by a journalism class from the University of Oregon. The second was produced by the pilot that has been working on the project the last five years.
c) Data products – The number of age-1 herring schools observed in June was determined. This number is the index that we are testing as a predictor of age-3 recruitment to the spawning population.
d) The raw data collected during the flights as recorded on the Recon hand-held computer and the paper logs of observations have been loaded on the Ocean Workspace. The index of age-1 herring schools was updated to include the 2014 observations. A file with that data and metadata have been uploaded to the workspace. The sampling protocols and initial analysis of survey effort for the July work with the forage fish project have been uploaded.

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

No comments require a response.

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

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROJECT BUDGET PROPOSAL AND REPORTING FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Contractual	$0.0	$0.0	$50,000.0	$50,000.0	$0.0	$100,000.0	$ 50,000
Commodities	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)	$0.0	$0.0	$15,000	$15,000	$0	$30,000.0	$ 15,000
SUBTOTAL	$0.0	$0.0	$65,000.0	$65,000.0	$0.0	$130,000.0	$65,000.0
General Administration (9% of subtotal)	$0.0	$0.0	$5,850.0	$5,850.0	$0.0	$11,700.0	
PROJECT TOTAL	$0.0	$0.0	$70,850.0	$70,850.0	$0.0	$141,700.0	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	

Spending is consistent with the budget.

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