Herring Research and Monitoring semi-annual report

a) *Project Number: 12120111*
b) *Project Title: Herring Research and Monitoring*
c) *Team Lead Name(s):* W. Scott Pegau
d) *Time Period Covered by the Report***:** Feb 1-July 31, 2013
e) *Date of Report* – August 30th, 2013
f) *Project Website* – http://pwssc.org/research/fish/
g) *Summary of Work Performed* **–**

Work on the program continues as originally proposed. Four of the projects are nearing completion and they are providing valuable insights to means for testing the maturation model used in the age-structure-analysis (ASA) model used for forecasting the spawning biomass (addresses program objective 1). Digitizing and measuring a portion of the Alaska Department of Fish and Game's (ADF&G) herring scale library. This is providing a glimpse into the growth of herring back through the 1980's (addresses program objective 2). Fatty acid analysis is being used to determine if we can detect immigration of fish into a bay (addresses program objective 3). And adult herring have been implanted with acoustic tags allowing them to be detected by listening arrays near the spawning grounds and at the entrances of Prince William Sound (addresses program objective 4). The ASA model has been transitioned to another framework that allows it to be used to provide Bayesian estimates of population. This model also helps to tie different program components together.

Several other projects have made the transition from the PWS Herring Survey program to the Herring Research and Monitoring (HRM) program and are just now beginning to address the project and program objectives. A short description of the progress of each project is provided below. For a couple of the most mature project we are able to provide preliminary results.

Validation of acoustic surveys – Bishop

The valves on the trawl winch were replaced and the system tested in March. The tests were successful. Additional modifications are planned to ensure safe deployment and retrieval before the November sampling cruise. In April collection of fish occurred using jigs and gill nets in support of the acoustic surveys of adult biomass. Data about the fish have been entered into a database.

Tracking seasonal movements – Bishop

A large acoustic tracking array was placed at the entrances to Prince William Sound in March. A smaller temporary array of nine acoustic receivers was also installed near the spawning grounds in Port Gravina. Sixty nine herring were collected and tagged in early April in the Port Gravina area. The fish were released in three batches back into areas with large schools of herring. The temporary acoustic array in Port Gravina was retrieved in May. One receiver was lost when the acoustic release failed. Of the 69 tagged fish, 56 were detected at least eight times. Most of the detections occurred during three distinct periods: 7-9, 15-16, and 20-26 April (Figure 1). The majority of the tagged

individuals were last observed on 30 April, however three individuals were still being observed by the array when it was retrieved on 21 May. Note that major spawning events in Port Gravina occurred around April 6th and 20th. Approximately 40 percent of the tagged fish were no longer detected within a week after the first spawn event and most of the rest left within a week of the second spawning event. We are still awaiting the data recovery from sensors at the entrances to Prince William Sound to determine if the fish left the Sound. This project has demonstrated that it is possible to tag and follow herring over time providing, which demonstrates a new method for understanding the movement of fish. This addresses the program's fourth objective to develop new approaches to monitoring.

Due to the timing of the placement of the acoustic array in the entrances of Prince William Sound and the fact that we found we could consistently collect fish of an appropriate size during the spawning season, but not in the fall, we delayed the schedule of this project some. We still will be retrieving data from the acoustic array either this fall or in late winter to determine if and when fish left and returned to PWS.

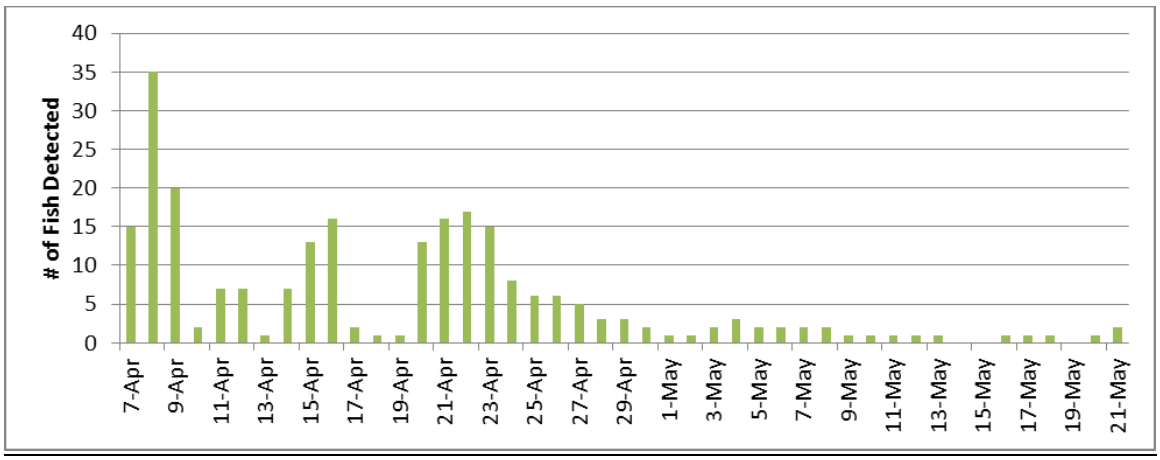

Figure 1. The number of tagged herring detected by an acoustic array near the spawning grounds near Red Head in Port Gravina. The array was installed two days after the fish tagging was completed.

Data management support – Bochenek

Data is being archived on the Workspace by investigators in the program. This work is coordinated with the effort led by the National Center for Ecological Analysis and Synthesis in the LTM program, which is collecting other historical datasets from the region. The ocean workspace has been rolled out to PIs and their user and group profiles have been created. Several training seminars have been held via webinars and PIs are beginning to use the system to organize and consolidate their project level data. Software engineers at Axiom have also been working to support workspace, resolving bugs and implementing new functionality in response to user feedback. Considerable progress has been made on the development of the Herring Portal.

Non-lethal sampling – Boswell, Pegau

Sea trials of the remotely operated vehicle occurred. The contract between PWSSC and Florida International University was set up.

Population dynamics modeling – Branch

The project took on Melissa Muradian from the QERM program at the University of Washington as a MS student. She has converted the ASA model into the statistical programming language AD Model Builder, and is changing the model from one that minimizes simple sums of squares to a Bayesian model. She has been attending classes and stock assessment conferences.

Expanded adult herring surveys – Buckhorn

Hydroacoustic surveys of adult herring schools were conducted March 27- April 5, 2013 and covered 629 nautical miles within Prince William Sound. Surveys were started in Port Gravina and Fidalgo, which have historically been surveyed by the previous hydroacoustic projects, then moved south and northwest to cover areas not previously covered.

We believe that the very cold water in the spring caused the adult herring to delay spawning so there may have been a mismatch between the cruise timing and the herring aggregating in spawning schools. We are reexamining the cruise timing to ensure it matches with expected spawn timing at various locations. The major additional spawn event in 2013 occurred at Kayak Island. Issues with boat licenses and spawn timing prevented us from being able to survey that spawning stock by boat. We were able to observe the spawn from an aircraft and land to collect samples for the genetics analysis.

Juvenile herring abundance index – Buckhorn

Post processing of raw acoustic data and analysis of data collected in November 2012 continued through this period.

Intensive surveys of juvenile herring - Buckhorn

This project is scheduled to begin surveys in October 2013 so no activity occurred during this reporting period.

Fatty acid analysis –Heintz and Vollenweider

Completed sample acquisition and participation in annual PI meeting. Lipid extraction and fatty acid sample preparation and analysis from lab study and fieldwork are ongoing. Due to limited sample availability from the high temporal and spatial resolution study in 2012, and the March 2013 herring collections for the Research and Monitoring program, sample sources from herring collections in PWS in support of the Herring Survey program were identified and analysis of these samples is ongoing.

Age at first spawning – Vollenweider and Heintz

Laboratory tests to determine if histology could detect fish that had not previously spawned were completed. Histology can identify fish that have not previously spawned and we are examining if growth indicated by the scales can be used as a marker of when a fish begins to spawn. Spawning herring were collected from spawning aggregations by

ADF&G and frozen for age/growth analysis. Herring samples were shipped to the NOAA lab in Juneau and age and growth analysis is underway. This work supports a means for determining the maturation function used by the age-structure-analysis model and addresses the first objective of the HRM program.

Herring disease project – Hershberger

This project is still transitioning from the PWS Herring Survey program to the HRM program so activities bridge the two programs. The spring herring disease surveillance collections were completed in PWS and Sitka Sound and analyzed so the data can be incorporated into the ASA model.

A new cohort of pathogen free herring are currently being reared for future laboratory experiments.

Laboratory efforts have focused on improving the detection capabilities for VEN. A cPCR for VEN has been developed and is in the final stages of validation. Other laboratory work included finishing the processing of samples from the 2nd VHSV temperature study.

A manuscript summarizing and synthesizing the past seven years of *Ichthyophonus* surveillances in herring from the NE Pacific is in preparation. Five other publications have either been published or submitted.

Wilson, A. E., T. L. Goldberg, S. V. Marquenski, W. J. Olson, R. F. Goetz, P. K. Hershberger, K. L. Toohey-Kurth. *Submitted*. Development and evaluation of a blocking enzyme-linked immunosorbent assay and virus neutralization assay to detect viral hemorrhagic septicemia antibodies. Journal of Clinical Microbiology.

Emmenegger, E.J., C.H. Moon, P.K. Hershberger, G. Kurath. *Submitted*. Virulence Assessment of viral hemorrhagic septicemia virus (VHSV) genotypes Ia, IVa, IVb, and IVc in salmonid, cyprinid, clupeid, and percid fishes. Diseases of Aquatic Organisms.

Lovy, J., P. Piesik, P.K. Hershberger, K. A. Garver. 2013. Experimental infection studies demonstrating Atlantic salmon as a host and reservoir of viral hemorrhagic septicemia virus type IVa with insights into pathology and host immunity. Veterinary Microbiology 166: 91-101.

Kocan, R, S. LaPatra, P. Hershberger. 2013. Evidence for an amoeba-like infectious stage of *Ichthyophonus* sp. and description of a circulating blood stage: a probable mechanism for dispersal within the fish host. Journal of Parasitology 99: 235-240.

Hershberger, P.K., M. K. Purcell, L.M. Hart, J.L. Gregg, R.L. Thompson, K.A. Garver, J.R. Winton. 2013. Influence of temperature on viral hemorrhagic septicemia (Genogroup IVa) in Pacific herring, *Clupea pallasii* Valenciennes. Journal of Experimental Marine Biology and Ecology 444: 81-86.

Herring condition monitoring – Kline and Heintz

Collection of samples in March was completed as scheduled. Processing of the fish to determine the energetic content and RNA/DNA has begun. The November samples should be completed later this fall and the March samples by December.

The databases containing the condition information at PWSSC have been combined into a single spreadsheet for easier sharing and access by others.

A setback to the project occurred when one of the principal investigators (Dr. Thomas Kline) left the Prince William Sound Science Center in June 2013. The Science Center is currently seeking a replacement for Dr. Kline and Dr. Pegau has taken responsibility for the project until a suitable replacement can be found. The gap in personnel may impact the completion of the analysis of this project, however Dr. Pegau worked with Dr. Kline to ensure a smooth transition of materials and is in a position to rapidly bring a new person up to speed or complete the deliverables if needed.

Juvenile herring intensive monitoring – Kline and Heintz

The milestones of sample collection and processing for this project were completed as scheduled. During late winter the numbers of samples were limited as the fish became more difficult to locate. All fish have been processed for energetic condition variables and the analysis phase is in progress. The RNA/DNA processing and analysis remain underway. Preliminary analysis shows the juvenile herring reaching peak energetic density in November with a steady decline from then until sometime around March when feeding was able to begin to restore energetic reserves. This project is addressing the program's third objective by demonstrating that we are sampling at the correct times of the year to observe the peak and minimum in condition.

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Scales as growth history records – Moffitt

Since 1 February, Pacific herring scales from the Alaska Department of Fish and Game archive have been randomly selected, scanned to a digital image, and growth increments measured with image analysis software. About 6,000 scales from spring collections in 1985–2012 were scanned and 4,793 were selected for growth increment measurements (Table 1). Scales were selected from those that were originally interpreted as age 4, 5, or 6. Through 5 August 2013, the growth increments for 1,784 scales were measured.

Documentation of scale collections is not as good in years prior to 1985. Hand written labels on slides that do not include file names has slowed the process of matching scales and age data.

A preliminary examination of the first year growth of age 6 fish indicates that growth is unlikely to be dependent on a single factor in an individual year. That is, no single factor is likely to explain the differences in growth among years. For example, the preliminary data indicate the largest average growth in the first year of age-6 fish occurred in 1993 (Figure 2). ADF&G's age structured models indicate that the herring biomass declined significantly in the winter of 1992/1993, so there would have been less competition for food resources, but 1993 was also a year with below average zooplankton production. The growth in the first year is not a good predictor of future recruitment although it might be a good indicator of survival.

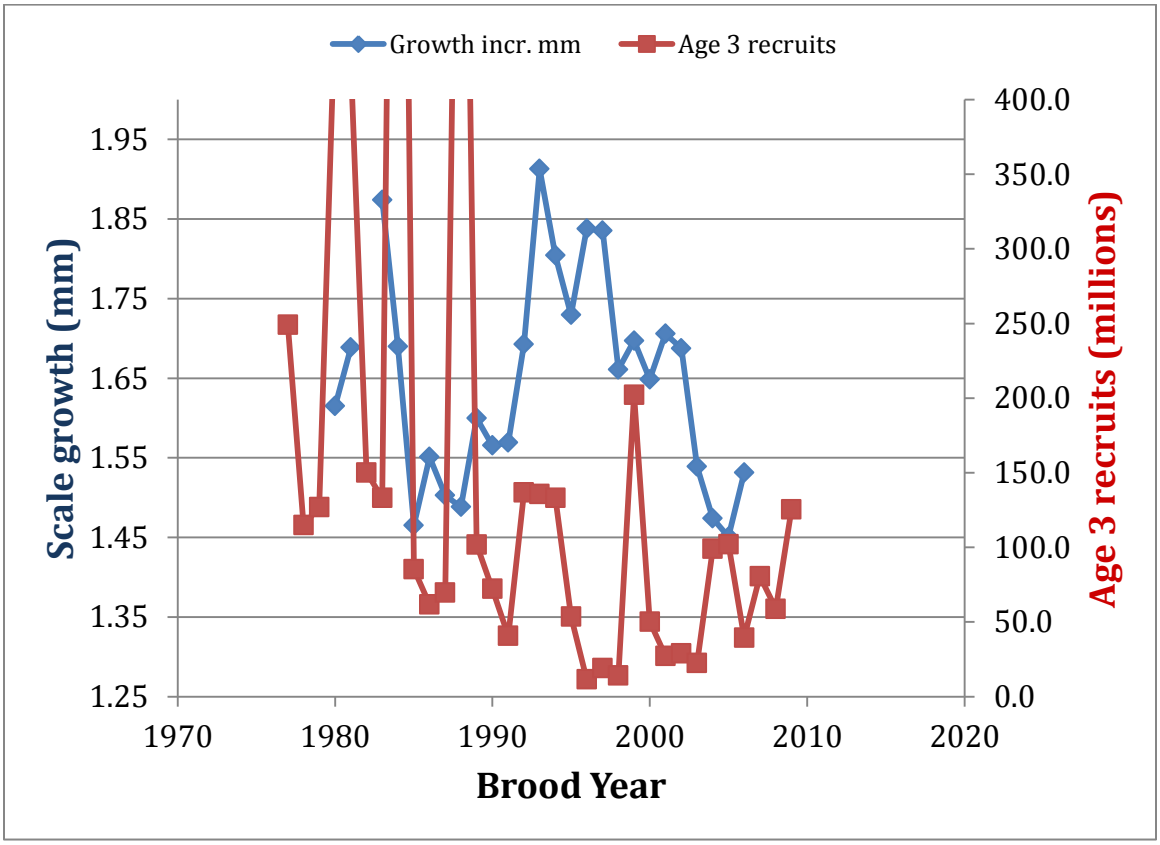

Figure 2. The blue line shows the mean growth increment of scales during the first year of life. The red line is the subsequent recruitment of age-3 fish from that brood year.

Coordination and logistics - Pegau

Three Cordova District Fishermen United vessels were contracted for juvenile herring sampling in March. The fall sampling sites were resampled and samples collected at two additional locations. The juvenile fish collected in March were stored on ice until their return to Cordova. This allowed some of them to be damaged. We have since purchased portable freezers for the fishermen to ensure the samples remain intact. Vessels were also contracted for the expanded adult herring survey and the fish tracking project.

The several meetings between the investigators in this program and the PWS herring survey program occurred through the winter with the final meeting occurring in March.

Samples were collected from Kayak Island for the herring genetics project. We worked with the forage fish project of the LTM program to provide aerial observations of forage fish while they sampled the schools to validate size and composition.

We were asked by a spotter pilot if herring spawn could be observed in satellite imagery. The information was requested to help guide when and where to send a plane to document spawn. The request was also prompted by a large spawn event at Kayak Island, which is outside the normal survey region. We determined that under certain circumstances that spawn can be observed in the visible wavelengths of satellites operating in the area (Figure 3). The region must have clear skies, the satellite needs to be close to overhead, and the spawn event must be fairly large since the pixel size of the

satellite being used is 250m. The broad shelf at Kayak Island produces large areas of spawn that make it easier to be detected by the satellites, although it does suffer from cloud cover. These images are made available within a couple hours through the Geographic Information Network of Alaska at the University of Alaska Fairbanks. The pilot was able to follow the imagery and detect a second spawn event at Kayak Island and fly out that day to document it. The satellite has been operating for several years, but only the data since 2010 is available on the GINA website. Reviewing what was available we were able to see spawn at Kayak Island one other year and could see some major spawn events within PWS, but most were too small to be observed. Cloud cover is also an extremely limiting factor for the use of this tool. We continue to look for other satellites that can fill in gaps in the temporal coverage, greater historical data records, and systems with higher spatial resolution that may observe smaller spawn events. We anticipate this information to be useful in identifying other spawning areas and the timing of spawn events that are needed in the expanded adult surveys and genetics sampling projects.

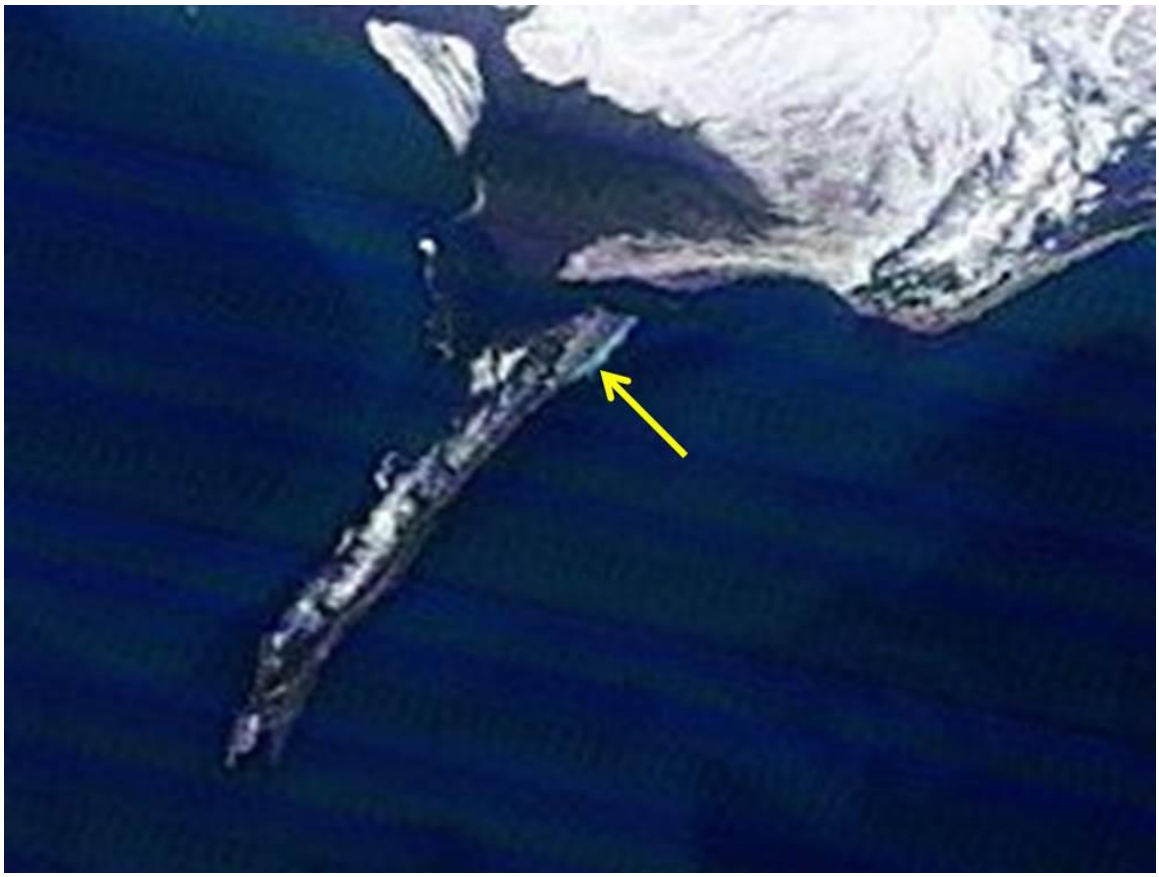

Figure 3. A MODIS color satellite image of Kayak Island showing the presence of herring spawn (yellow line points to the area of spawn).

Outreach - Butters

All outreach deliverables have been met. The outreach project transitioned the herring research webpages to the new PWSSC website. The transition allowed us to better organize the available outreach products. The new website can be accessed at

http://pwssc.org/research/fish/pacific-herring/. Project profiles, Field Notes radio program, and school programs have been developed and delivered. The herring program was highlighted at the Ocean Fest public science events in Cordova and Valdez. Individual investigators presented on their research at forums, such as the Alaska Marine Science Symposium.

h) *Summary of Future Work to be Performed* –

Work in this program is still progressing along as originally proposed. The one change in schedule of importance is in the tracking seasonal movements project. In that project the tagging period was shifted from the fall to the spring to take advantage of a larger receiving array that was deployed in March 2013 and we found it better to collect fish near the spawning grounds than during the fall as originally proposed. Project specific work descriptions follow.

Validation of acoustic surveys – Bishop
There are several cruises for the juvenile intensive survey and the juvenile abundance index survey projects that will be supported during the upcoming period. We continue to make adjustments to the deployment method for the trawl to ensure it can be deployed in a safe and rapid manner. It is expected that the trawl will be the primary method of fish capture for acoustic validation and for providing fish to the condition monitoring and disease programs. We will still have gill nets and cast nets if they are needed to provide fish for those projects.

Tracking seasonal movements – Bishop
Data analysis from the tag detections in Port Gravina remains an ongoing task. This fall or winter we will be uploading data from the Ocean Tracking Network receivers. That data will provide information on if and when herring leave and return to PWS.

Data management support – Bochenek
Data from the past two field seasons will be ingested into the data management system. We will continue to refine and expand the information available through the Herring data portal.

Non-lethal sampling – Boswell, Pegau
Initial tests of the combined remotely operated vehicle and Didson sonar units will occur in October or November. These tests will be used to determine if any changes in the deployment system are needed prior to the spring herring survey period.

Population dynamics modeling – Branch
The student will complete all required coursework by fall 2013. We will begin working on a manuscript on the revised ASA model and present results at the Alaska Marine Science Symposium.

Expanded adult herring surveys – Buckhorn
Analysis of data collected in 2013 will be completed. We will examine historic records of spawn, adult concentrations, and bird and mammal observations to identify the most likely times and locations for additional surveys.

Juvenile herring abundance index – Buckhorn

In November eight bays in PWS will be surveyed using a 120 kHz split-beam hydroacoustic unit in a stratified systematic survey design. The eight bays will include the four SEA bays to maintain continuity with previous sampling efforts. Bays will be stratified as MOUTH, MIDDLE, and HEAD. The areal extent of each strata will be based upon the variance of mean densities from previous surveys in order to reduce overall variance in abundance estimates. A midwater trawl will be used to sample randomized transects within each strata (See Bishop) and will be directed to size and species composition.

Intensive surveys of juvenile herring - Buckhorn

A series of four cruises will start in October 2014 and extend to the first week of December. We propose to conduct the surveys in two bays sufficiently adjacent to cover each bay each night, such as Simpson Bay and Windy Bay. The surveys in October will be spaced about two weeks apart. The last cruise will be in December with the juvenile herring abundance index cruise in November. Each of the two bays will be surveys in three consecutive nights. Such a design will address daily, weekly and monthly variability, including moon phase. In addition to the hydroacoustic surveys, we propose a single night of direct capture effort in each location for each of the survey weeks. The survey design will follow the historic zig zag transects run by Thorne since 1993 in order to remain consistent with that sampling design and to put the long term fall and spring surveys into context.

Fatty acid analysis –Heintz and Vollenweider

Analysis of fatty acid samples will continue and is expected to be completed by September 2013. We anticipate being able to address objectives 1 and 2 as proposed, while our ability to address objectives 3 – 5 will be limited due to fish not being caught at the necessary spatial scales in both fall and spring. Preliminary results are to be presented at the AK Marine Science Symposium, Anchorage, AK in January 2014, and future meetings of PI's for the Herring Research and Monitoring program.

Age at first spawning – Vollenweider and Heintz

We anticipate completing the age and growth analysis of scales from the spring spawning aggregation. Preliminary results are to be presented at the AK Marine Science Symposium, Anchorage, AK in January 2014, and future meetings of PI's for the Herring Research and Monitoring program.

Herring disease project – Hershberger

This project is still transitioning from the PWS Herring Survey program to the HRM and has not received funding as part of the HRM program yet. Laboratory studies of factors involved in the detection and transmission mechanisms of the primary herring pathogens remain underway.

Herring condition monitoring – Pegau and Heintz

Future work focuses on the continued collection and analysis of juvenile herring. We are not anticipating any variance from the originally proposed activities of a collection cruise in November. Sample processing will be emphasized through the fall period and we expect the existing samples from November 2012 and March 2013 will be processed during the upcoming period. With spatially-matching fall and spring collections available in only one bay in 2012-2013, most data analysis will likely involve PWS-wide pooling of samples. Data analysis and reporting findings is planned after completion of analysis of all samples in fall 2013. We are examining ways of using the same fish for processing by both portions of this project. This is important when the number of fish collected at a single location is limited.

We expect a new Primary Investigator will be named to oversee the component at the Prince William Sound Science Center.

Juvenile herring intensive monitoring – Pegau and Heintz

We expect to continue the work as originally proposed. Processing of the samples for RNA/DNA analysis will be completed. Future work is focused on the analysis of condition data collected in 2011-2012.

We expect a new Primary Investigator will be named to oversee the component at the Prince William Sound Science Center.

Scales as growth history records – Moffitt

We expect to finish measurements of scale growth increments on the scales that have been digitized.

Coordination and logistics - Pegau

Vessel contracts will be established for the November herring survey and the acoustic intensive project that begin in October. We expect to test the non-lethal sampling system this fall. We are also am exploring the opportunity to present results of the program as a whole at the Alaska Fisheries Society meeting. Coordination between the HRM and Gulfwatch Alaska (GWA) programs will occur at the November GWA PI meeting.

Outreach - Butters

Project work will proceed according to the original proposal. We will continue to update the new herring research website. In addition, the three *Field Notes* programs will be finished by December 2013 to complete this milestone for FY13.