FY16 PROGRAM PROPOSAL SUMMARY PAGE

Program Title: Herring Research and Monitoring

Program Period: February 1, 2016 – January 31, 2017

Team Lead(s): W. Scott Pegau Prince William Sound Science Center

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

Abstract*:

The goal of the Herring Research and Monitoring program is to improve the predictive models of herring stocks through observations and research. The program is designed around a twenty year time frame with changes in emphasis of the process studies every five years. During this period we have four objectives to help us move towards our goal. They are: *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model. Inform the required synthesis effort. Address assumptions in the current measurements. Develop new approaches to monitoring.*

A combination of monitoring and process studies will be used to address these objectives. The monitoring projects follow changing conditions and provide inputs to modeling efforts. The process studies are designed to be much shorter and to answer a very specific question.

The monitoring components include tracking the prevalence of disease, aerial surveys, increased adult biomass surveys, and juvenile condition and biomass surveys. All of the monitoring components address the first objective.

There are eighteen studies that range in length of one to five years designed to address the different objectives. To address the first objective we are examining the age that fish join the spawning stock, the genetic structure, and examining the approaches available to model herring stocks. To address the second objective we are working on gathering relevant datasets and providing visualization, conducting an analysis using the herring scale library owned by ADF&G, and providing coordination between projects to examine the connectivity. To address the third objective there are intensive studies of juvenile condition and acoustic estimates of juvenile populations, trying to determine if immigration may impact our surveys, providing validation to the acoustic surveys, and conducting laboratory studies of disease. We are looking to herring tagging, disease forecasting, and non-lethal acoustic validation to address the last objective.

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA)*:

FY12	FY13	FY14	FY15	FY16	TOTAL
1,027,390	**1,264,759**	**1,429,195**	**1,365,678**	**1,241,321**	**6,238,343**

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
			154,731		

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 21, 2015

I. EXECUTIVE SUMMARY

The goal of the Herring Research and Monitoring program is to improve the predictive models of herring stocks through observations and research. The program is designed around a twenty year time frame with changes in emphasis of the process studies every five years. During this period we have four objectives to help us move towards our goal. They are: *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model. Inform the required synthesis effort. Address assumptions in the current measurements. Develop new approaches to monitoring.*

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Working with investigators in the Gulf Watch Alaska program we have found that first year growth of herring is positively correlated with water temperatures in July and August. The strongest correlation between first year growth was with diatom abundance, which may be due to the essential fatty acids in those phytoplankton.

Scale analysis of age-0 herring demonstrated that the scale growth increment is a good predictor of age-0 length. The analysis of historic adult herring scales indicates that the juvenile herring must reach a critical size if they are to survive to spawning age. This critical length corresponds to the length where the RNA/DNA analysis shows a shift from growth to lipid storage. If the fish are not able to begin lipid storage they are likely to reach a critical lipid level during the winter. At that point they must forage, increasing their risk for predation, or are likely to starve.

The fatty acid analysis and stable isotope work show that there are regions and years when the condition of the fish are better than others. This improvement in condition may be linked to changes in the available diet.

Previous sampling showed that age-0 herring had unusually high *Ichthyophonus* prevalence in the Cordova Harbor. From that it was discovered that *Ichthyophonus* could be transmitted through offal. This led to a collaboration between the energetics and disease projects to sample herring in the Cordova harbor for a year providing a dataset for understanding the connection between disease and condition.

Sampling using direct capture and non-lethal systems indicate that age-0 herring prefer to remain under ice shelves in the winter.

Based on aerial surveys of age-1 herring and other indicators we predicted a large age-3 recruitment class this year. Unfortunately a majority of the spawn occurred after sampling was completed. Since younger fish tend to spawn a little later than older fish it is not clear if the late spawn was these younger fish. At least one large spawn event on Montague Island was dominated by age-3 herring. Both Sitka and Kodiak also noted the unusually large numbers of age-3 herring in their spawn samples.

The Bayesian version of the age-structure-analysis model was used to examine the importance of different input variables. Repeated Bayesian analysis were conducted with each major historical data set left out, one at a time. The full stock assessment was assumed to be the "truth", and then the accuracy and precision of model estimates of abundance were compared for the alternative scenarios where data had not been collected. The results are calculated in terms of cost effectiveness: dollars spent per precision gain. The results suggest that the disease survey reduces bias and imprecision most cost-effectively, because they are relatively cheap, and without them, the model is unable to explain the drop in biomass in the early 1990s. The dive surveys for eggs were the second most valuable surveys because they provide the only time series that is assumed to be an absolute abundance estimate in the past: the mile-days of milt and acoustic surveys are assumed to be relative indices. Without the absolute biomass estimates in those years, the model is unable to accurately estimate total biomass. However, these results also highlight the fact that past data collection methods may not be required in the future, and further simulation work is needed to determine which data sources would be most valuable to conduct in the future. The diver egg surveys, for example, may not be needed for future evaluation since the mile-days of milt and acoustic surveys provide more precise time series of relative abundance.

The modeling effort is shifting its effort to understanding how often, and for how long, herring populations collapse.

The disease related work has been successful at infecting Pacific herring by feeding with infected tissues, with transmission efficacy increasing through the use of multiple feedings. This is an important step in understanding potential sources of transmission. The project also demonstrated that external signs of ichthyophoniasis on juvenile Pacific herring (i.e. pigmented ulcers on the flank) persist for extended periods and are not necessarily precursors of mortality. The project continues to work at developing new methods for detecting the potential for disease outbreaks in the herring population.

More results can be found in the synthesis provided to the EVOSTC office this past year.

Dr. Gorman has been able to fully catch up on the backlog of samples that occurred with the departure of Dr. Kline. Dr. Rand is working to ensure completion of the processing of herring acoustics data for the projects he took over from Dr. Buckhorn.

We agree with the Science Panel about the importance having a good population assessment as a basis for understanding changes in the population. We feel that projects such as the acoustic surveys and population modeling components are addressing this concern. The comments seem to suggest that there

isn't an existing reviewed model. The model used by ADF&G is well established and published in peer review literature. We have focused on shifting that model to a Bayesian structure and then testing to examine the importance of the various inputs to the model. Hopefully the description of the ASA model that was provided to the Science Panel this past year will clarify the capabilities of the existing model. As we better understand the ASA model, we are discussing how alternative modeling approaches might be used in the future.

We apologize that the proposal format doesn't bring out the connectivity of the programs. We try to get the PIs together a couple times a year. We try to meet during the Alaska Marine Sciences conference and as HRM PIs or together with the GWA PIs as well. We did try to highlight the connections in the synthesis presentation to the Science Panel. We are finding new connections between projects, such as the connection between the disease and energetics projects that developed this past year.

A potential gap associated with otolith microchemistry was proposed by the Science Panel. The program is not set up to bring on totally new projects in the middle of the program. This will have to be considered during the next proposal. There are opportunistic opportunities to do some of the suggested research and we are collecting otoliths to take advantage of the opportunities that arise.

There are many similarities among the work of the forage fish project of GWA and the HRM program. The connections between the programs continue to develop and will help build our understanding of herring along with other forage fish. Sampling by the two programs is similar and the differences are being examined to determine the best approach.

II. COORDINATION AND COLLABORATION

A. Within the Program

Coordination within the HRM program includes scheduling of projects to ensure the maximum sharing of vessel time so that projects dependent on results or samples from another project are in the correct order. Coordination is primarily through email and teleconference, but each year all the investigators are required to meet in person. The Validation of Acoustics Survey project collects fish for the three different acoustic survey projects, the disease project, condition monitoring, and the genetics project. Fish are shared between the acoustic surveys, genetics, herring condition, and disease projects. The energetics project processes fish for the disease program and collected samples to examine the timing of disease onset in the Cordova Harbor.

Coordination between the HRM and GWA programs is accomplished through the HRM coordinator attending the Gulf Watch Alaska principal investigator (PI) meetings and teleconferences. The team leads of both programs coordinate reporting and proposal documents. Ideas and field opportunities are coordinated. The aerial surveys are coordinated between the two programs to maximize benefit to both programs. The HRM coordination PI is working with investigators in the environmental drivers portion of GWA to examine relationships between the environmental conditions and herring growth and condition. There is a bird observer from the GWA program is on the vessel during the November herring survey cruise. The PWS oceanography project provides zooplankton to the HRM disease project. We are working with Axiom to improve the data management capabilities.

B. With Other Council-funded Projects

None.

C. With Trustee or Management Agencies

The HRM program is conducted in close collaboration with ADF&G. The long-term goal and objectives of the program are designed to benefit ADF&G by improving information and testing assumptions of the age-structure-analysis model. Steve Moffitt in Cordova (local area biologist) and Sherri Dressel in Juneau (statewide herring coordinator and member of the HRM oversight group) are our primary two contacts in ADF&G. The HRM program includes a project that is scanning in a portion of the ADF&G scale library so it is preserved in a form that can be used within and external to ADF&G. HRM provides some aerial survey time to document herring spawn in areas or at times that ADF&G are unable to fly. We coordinated with them the location of remote cameras for testing their ability to provide an indication of when spawn may occur in remote locations. We have also supported the collection of herring at Kayak and Montague Islands to provide some indication of the age structure at those locations. ADF&G has provided an opportunity for the HRM disease project to sample the adult spawning population. The prevalence of the three major diseases are then reported back to ADF&G. We also coordinate with ADF&G in providing acoustic estimates of the adult herring spawning biomass.

The National Oceanographic and Atmospheric Administration (Ron Heintz) and the United States Geological Service (Paul Hershberger) also are participants in the HRM program. As participants in the program they are involved in the coordination efforts.

III. PROGRAM DESIGN – PLAN FOR FY16

A. Objectives for FY16

The long-term goal of the program is to 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.* (Synthesis completed in FY 15)

3) *Address assumptions in the current measurements.*

4) *Develop new approaches to monitoring.*

B. Changes to Program Design

We are contemplating small changes to the program design. The changes are minor enhancements within the existing budget that will increase the probability of succeeding in addressing our assumptions. One change we are considering is looking for means to improve our success in finding adult herring aggregations prior to the acoustic surveys. In 2015 the spawn occurred later than anticipated and the fish were in much smaller aggregations. A large portion of the spawn occurred on Montague Island and it isn't clear that those fish were surveyed. The genetics project will continue into this fiscal year to allow for additional fish to be analyzed.

V. SCHEDULE

A. Program Milestones for FY 16

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

All projects will be completed in this year.

Objective 2. Inform the required synthesis effort.
Data management is an ongoing effort. The synthesis was delivered in FY 15.

Objective 3. Address assumptions in the current measurements.
All projects will be completed in this year.

Objective 4. Develop new approaches to monitoring.
There will be continued work on new approaches in the disease project.

B. Measurable Tasks for FY 16

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)

February:	*Submit annual report*
March:	*Spring juvenile herring collection*
April:	*Conduct adult herring survey*

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)

May:	*Conduct annual PI meeting*
May:	*Complete written outreach materials*
July:	*Complete annual aerial surveys*

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)

September:	*Complete genetics analysis*
September	*Complete outreach efforts*

FY 16, 4th quarter (November 1, 2016- January 31, 2017)

October:	*Assess data submitted to data management*
November:	*Conduct juvenile index survey, validation and sampling for energetics and disease.*

V. PROJECT PERSONNEL – CHANGES AND UPDATES

There are no anticipated changes to the team lead. Dr. Buckhorn who has led the acoustic projects was replaced by Dr. Peter Rand in June 2015. He is working with Dr. Kevin Boswell of FIU to complete a backlog of data analysis and ensure continuity in data collection.

VI. BUDGET

A. Budget Forms

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	$466,000.0	$2,087,200.0	
Travel	$26,800.0	$31,500.0	$47,000.0	$47,300.0	$46,600.0	$199,200.0	
Contractual	$336,960.0	$544,799.0	$456,188.0	$435,116.0	$414,757.0	$2,187,820.0	
Commodities	$81,600.0	$33,700.0	$104,100.0	$102,700.0	$67,100.0	$389,200.0	
Equipment	$187,200.0	$0.0	$0.0	$0.0	$0.0	$187,200.0	
Indirect Costs (*will vary by proposer*)	$108,500.0	$173,030.0	$168,200.0	$161,100.0	$144,370.0	$755,200.0	
SUBTOTAL	$942,560.0	$1,160,329.0	$1,311,188.0	$1,252,916.0	$1,138,827.0	$5,805,820.0	
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

B. Changes from Original Proposal

The only change in the total budget is the funding for the aerial surveys that were added in FY14. The budget for the Genetic Stock Structure project has be restructured because the laboratory processing is being done by NOAA contractors rather than NOAA personnel as originally proposed.

C. Sources of Additional Funding

The projects led by Heintz and Hershberger are able to leverage off of funding from NOAA and USGS respectively. The program coordination receives additional support through the Oil Spill Recovery Institute. The data management is able to leverage funding from several other sources that support the design and improvements to the basic infrastructure that the herring workspace benefits from. The education and outreach efforts receive funding through multiple sources.

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM 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	$201,500.0	$377,300.0	$535,700.0	$506,700.0	$466,000.0	$2,087,200.0	
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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.

FY12-16

Program Title: Herring Research and Monitoring
Team Leader: W. Scott Pegau

FIVE-YEAR OVERVIEW

Date Prepared: 05/15/2014

FY16 PROPOSAL SUMMARY PAGE
Continuing, Multi-Year Projects

Project Title: PWS Herring Research and Monitoring :Validation of Acoustic Surveys for Pacific Herring Using Direct Capture

Project Period: February 1, 2016 – January 31, 2017

Primary Investigator(s): Mary Anne Bishop, Ph.D., Prince William Sound Science Center, Cordova
mbishop@pwssc.org

Study Location: Prince William Sound

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

Abstract: Acoustic surveys provide a relatively low-cost, remote sensing tool to estimate species-specific fish biomass and abundance. Interpreting acoustic data requires accurate ground truthing of acoustic backscatter to confirm species and length frequency of insonified targets. Pelagic trawls are the recommended method for validating species composition and for obtaining relatively unbiased information on length frequency distribution, age, and other biological information. Here we propose to use a low-resistance, light-weight midwater sweeper trawl capable of towing speeds (up to 3 knots) as a method to ground truth acoustic surveys for juvenile herring. Our pelagic trawl surveys will take place in conjunction with and onboard the same vessel as two studies in the *PWS Herring Research and Monitoring* program: *Juvenile Herring Abundance Index* (years 2-5) and *Acoustic Consistency: Intensive Surveys of Juvenile Herring* (year 3). In addition, this project will validate acoustic surveys associated with the *PWS Herring Research and Monitoring Program: Expanded Adult Surveys* (years 2-5). For the adult herring surveys, Alaska Dept. Fish and Game has required gillnets and jigging for validation in lieu of trawls. Our project will provide data on species composition and length frequency to aid in the interpretation of current and historical acoustic surveys. Juvenile herring samples collected during our pelagic trawl surveys will be distributed to six projects within the integrated herring program: condition index, energetics, growth, disease, juvenile herring abundance index, juvenile herring intensive surveys. Adult herring are being collected in spring to validate the expanded adult herring acoustic surveys as well as for two additional studies in the herring research program: age at first spawn and herring genetics. Adult herring samples will also be provided to Alaska Dept. Fish and Game for the adult herring age-structure-analyses model. Our trawls will also provide fishery-independent surveys for non-herring species, thus increasing our knowledge of pelagic fishes in Prince William Sound.

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA)*:

FY12	FY13	FY14	FY15	FY16	TOTAL
$68.0K	$90.6K	$148.0K	$141.0K	$145.3K	$592.9K

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
				0	

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 14, 2015

I. EXECUTIVE SUMMARY

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement, herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Our study, *Validation of Acoustic Surveys for Pacific Herring Using Direct Capture*, is a process study that addresses **objective 3** of the *PWS Herring Research and Monitoring**: to address assumptions in the current measurements***. The goals of this project are twofold: a) to ground truth acoustic backscatter to confirm species composition and length frequency of insonified targets; and b) provide fish samples to *PWS Herring Research and Monitoring* programs.

Our project's direct capture efforts are associated with the following HRM acoustic surveys: *Juvenile herring abundance index* (Nov 2012-2016) and the annual *Expanded adult herring surveys* (Mar and Apr 2013-2016). In addition, we conducted a series of trawls associated with two other HRM projects: *Juvenile herring intensive acoustic surveys* (Oct 2013 – Apr 2014) and the pilot study, *Integrated marine bird/whale/forage fish survey at Montague Strait* (Sept 2014). The September 2014 pilot study was a new collaboration with three *GulfWatch* studies: *Humpback whale predation on Pacific herring in PWS (NOAA, UAS), Forage fish in PWS (USGS),* and *Seabird abundance and habitat use in fall and winter (PWSSC)*. Additionally, during summer 2014 and 2015 we assisted the HRM *Juvenile Herring Aerial Survey* project. Personnel from this project were trained and flew multiple times, sighting and recording forage fish schools.

For our validation efforts, we continue to use the same methodology on our cruises that we have used since November 2013. Based on acoustic surveys, "targets" are identified and returned to for short-distance (0.1-1.6 km), mid-water trawls concomitant with acoustic surveys. Environmental data (conductivity, temperature, and depth data) are collected during trawl transects. For the *Expanded adult herring surveys* we use gillnets instead of the mid-water trawl for validation component because of ADFG concerns that too many adult herring would be captured. We also collect herring for the genetic studies using jigs and gillnets, and to a lesser extent castnets.

Data analyses on ongoing. Since fall 2014, all fish capture data associated with the validation project have been assimilated into a Microsoft access relational database. Using a relational database will facilitate more efficient data management and QA/QC. Metadata for the project is currently available. We continue on track to meet our milestones, all of which have completion dates in 2016.

Within the integrated herring program, seven projects utilized juvenile herring collected as part of our trawl surveys. Another two projects within the herring program as well as ADFG utilize adult herring collected as part of our field work (see Table 2 in section II.A for more details).

2015 Popular Press:
Lewandoski, S, 2015. Survival under the ice. *Delta Sound Connections.*
With a circulation of ~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.

The Science Panel posed a few questions during the last proposal submission that we will attempt to answer.

The question of percent effort related to each project supported by this program is difficult to answer. The validation of acoustics is a large portion of the effort, but if there was not an acoustics project there would still need to be sampling for other projects and the cost of sampling would remain the same.

The general comments regarding the value of acoustic sampling techniques have been provided to that project to address. Dr. Boswell with FIU in collaboration with Dr. Rand of PWSSC are examining the potential for determining if patterns in echograms can be interpreted as different year classes of herring.

II. COORDINATION AND COLLABORATION
A. Within the Program

Table 1. Shared vessel platforms for this project.

EVOS Program/Project	**Agency**	**Dates**
PWS Herring & Research		
Juvenile herring abundance index	PWS Science Center	Nov 2012-2016
Juvenile herring intensive Acoustic Surveys	PWS Science Center	Oct 2013 – Apr 2014
Expanded Adult Herring Acoustic Surveys	PWS Science Center	Mar-Apr 2013-2016
Gulfwatch		
Long-term monitoring of seabird abundance & habitat associations during late fall & winter	PWS Science Center	Nov 2012-2016 & Sep 2014
Monitoring long-term changes in forage fish distribution, abundance, & body condition	USGS	Sep 2014
Long-term monitoring of humpback whale predation on Pacific herring in PWS	NOAA/UAS	Sep 2014

Table 2. EVOS Prince William Sound Herring Research and Monitoring and EVOS Gulfwatch projects that this validation project is collecting sample for.

EVOS Herring Research	**Agency**	**Samples provided**
Juvenile herring abundance index	PWS Science Center	All species – measurements only
Juvenile herring intensive acoustic surveys (FY14)	PWS Science Center	All species – measurements only
Expanded Adult Herring Acoustic	PWS Science Center	All species – measurements only

Surveys		
Condition Index	PWS Science Center	Juvenile herring
Genetic stock structure	ADFG	Adult herring
Disease	USGS	Juvenile herring
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
EVOS Gulfwatch		
Forage fish distribution, abundance, & body condition in PWS	USGS	All species – measurements only, Sept. 2014 cruise; Aerial surveys Jun &Jul 2014-15
Humpback whale predation	NOAA/UAS	All species – measurements only, Sept. 2014 cruise
Seabird abundance late fall through winter	PWSSC	All species – measurements only; Sept. 2014 cruise

B. With Other Council-funded Projects
None

C. With Trustee or Management Agencies

Our project, along with the EVOS Herring *Expanded Adult Herring Surveys* rely on information from Alaska Department of Fish and Game to help locate adult herring schools in spring for acoustic surveys and our sampling. To that extent, we work closely with Steve Moffitt and Dr. Rich Brenner at the Cordova office of ADFG.

III. PROJECT DESIGN – PLAN FOR FY16

A. Objectives for FY16

Objectives specific to the *Direct Capture* study include:

1) Improve capture methods used for ground truthing 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.

In addition, to providing better information on acoustic targets. this study will bolster the current understanding of pelagic species composition and abundance in PWS.

B. Changes to Project Design

When we wrote the original proposal for this project we planned to use a trawl that was part of the PWS Science Center's inventory. Unfortunately, this trawl was lost during field work on

another project, forcing us to purchase a new trawl. Due to hydraulic compatibility issues between our reel/winches and the charter vessel during the initial November 2012 survey we were unable to obtain sufficient power to successfully deploy and haul our mid-water sweeper trawl, despite several attempts at system modifications and replumbing. Therefore, within each survey bay variable mesh adult and juvenile herring gillnets were deployed and allowed to soak overnight in areas of high acoustic signature as an alternative validation method. Since Nov 2012, all problems with the trawl have been resolved, and we completed an extremely successful series of trawl surveys during November 2014 with 2,885 captured fish (87% herring).

IV. SCHEDULE

A. Project Milestones for FY 16 *(note: Milestones dates have been shifted to reflect the change in the project end date from September 30, 2016 to January 31, 2017)*

Objective 1. Improve capture methods used for ground truthing acoustic surveys.
Field work completed November 2016. Synthesis evaluating techniques, January 2017.

Objective 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.
To be met by November 2016.

Objective 3. Provide data on species composition and length frequency to aid in the interpretation of current and historical acoustic surveys.
To be met by January 2017.

Objective 4. Provide adult herring samples to Alaska Department of Fish and Game for the adult herring age-structure-analyses model.
To be met by April 2016.

Objective 5. Provide juvenile herring samples to researchers investigating juvenile herring fitness and disease.
To be met by November 2016.

B. Measurable Project Tasks for FY 16

FY 16, 1st quarter (Feb 1 – Apr 30, 2016)

late Mar Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

Apr Field cruise: *Expanded Adult Herring Survey* with hydroacoustic & validation surveys

FY 16, 2nd quarter (May 1-Jul 31, 2016)

May-Jul Process fish & analyze data

Jul Prepare mid-year report

FY 16, 3rd quarter (Aug 1- Oct 31, 2016)

Aug Submit report

Aug-Oct Analyze data

FY 16, 4th quarter (Nov 1, 2016 – January 31, 2017)

Nov Field cruise: *Juvenile herring abundance index* with hydroacoustic & validation surveys; disease & energetics collections
Nov PI meeting, herring program
Dec Process fish samples
Jan Alaska Marine Symposium
Jan Submit annual report

V. PROJECT PERSONNEL – CHANGES AND UPDATES

VI. BUDGET

A. Budget Forms

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	
Travel	$1,000.0	$1,000.0	$2,000.0	$1,200.0	$1,200.0	$6,400.0	
Contractual	$900.0	$1,800.0	$2,600.0	$2,200.0	$2,200.0	$9,700.0	
Commodities	$5,400.0	$2,800.0	$1,800.0	$1,100.0	$1,100.0	$12,200.0	
Equipment	$10,700.0	$0.0	$0.0	$0.0	$0.0	$10,700.0	
Indirect Costs (*will vary by proposer*)	$11,900	$19,200	$31,300	$29,900	$30,800	$123,100.0	
SUBTOTAL	$62,400.0	$83,100.0	$135,800.0	$129,400.0	$133,300.0	$544,000.0	$0.0
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	

B. Changes from Original Proposal

None

C. Sources of Additional Funding

None

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	$32,500.0	$58,300.0	$98,100.0	$95,000.0	$98,000.0	$381,900.0	
Travel	$1,000.0	$1,000.0	$2,000.0	$1,200.0	$1,200.0	$6,400.0	
Contractual	$900.0	$1,800.0	$2,600.0	$2,200.0	$2,200.0	$9,700.0	
Commodities	$5,400.0	$2,800.0	$1,800.0	$1,100.0	$1,100.0	$12,200.0	
Equipment	$10,700.0	$0.0	$0.0	$0.0	$0.0	$10,700.0	
Indirect Costs (*will vary by proposer*)	$11,900	$19,200	$31,300	$29,900	$30,800	$123,100.0	
SUBTOTAL	$62,400.0	$83,100.0	$135,800.0	$129,400.0	$133,300.0	$544,000.0	$0.0
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.

FY12-16

Project Title: PWS Herring: Validation of acoustics
Primary Investigator: Mary Anne Bishop

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

Date Prepared:08/15/2014

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
J. Watson	Researh Assistant-Fisheries	5.0	7200.0		36,000.0
M.A. Bishop	Principal Investigator	5.0	12400.0		62,000.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	19600.0	0.0	
				Personnel Total	$98,000.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Alaska Marine Symposium	400.0	1	4	200.0	1,200.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1,200.0

FY16

Project Title: PWS Herring: Validation of acoustics
Primary Investigator: Mary Anne Bishop

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared:08/15/2014

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

Contractual Costs: Description	Contract Sum
network & software subscriptions $150/staff mo	1500.0
communications (phone and fax) $50/staff mo	500.0
printing & copying $25/staff mo	200.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2,200.0

Commodities Costs: Description	Commodities Sum
Field, lab, office supplies	1100.0
Commodities Total	$1,100.0

FY16

Project Title: PWS Herring: Validation of acoustics
Primary Investigator: Mary Anne Bishop

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared:08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Midwater Trawl	1	PWSSC
Simrad P150 Catch monitoring system	1	PWSSC

FY16

Project Title: PWS Herring: Validation of acoustics
Primary Investigator: Mary Anne Bishop

FORM 3B
EQUIPMENT DETAIL

Date Prepared:08/15/2014

FY16 PROJECT PROPOSAL SUMMARY PAGE

Continuing, Multi-Year Projects

Project Title: Data Management Support for the Integrated Herring Research Program

Project Period: February 1, 2016 – January 31, 2017

Primary Investigator(s): Rob Bochenek, Axiom Data Science

Study Location: EVOS Spill Affected Area

Project Website (if applicable): http://pwssc.org/research/fish/pacific-herring/

Abstract*: This project supports the EVOS Integrated Herring Research Program with critical data management support to assist study teams in efficiently meeting their objectives and ensuring data produced or consolidated through the effort is organized, documented and available to be utilized by a wide array of technical and non technical users. This effort leverages, coordinates and cost shares with a series of existing data management projects, cyber-infrastructure and partnerships which contribute capacity and information to this effort. During year one and two, this project would focus on providing informatics support to streamline the transfer of information between various study teams and isolate and standardize historic data sets in the general spill affected area for use in retrospective analysis, synthesis and model development. This work would scale down in year three thru five to provide support for general project level data management and archival.

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA*):

FY12	FY13	FY14	FY15	FY16	TOTAL
130.8K	130.8K	22.3K	23.2K	24.0K	331.1K

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 10, 2015

I. EXECUTIVE SUMMARY

As originally proposed, the objectives of this project are to 1) provide data management oversight and services for EVOS Integrated Herring Research Program team data centric activities which include data structure optimization, metadata generation, and transfer of data between project teams; 2) consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development; and 3) integrate all data, metadata and information products produced from this effort into the AOOS data management system for long term storage and public use.

Project investigators continue to provide core data management oversight and services for the Long-term Monitoring Program known as EVOS Integrated Herring Research Program. The focus continues to be on establishing – and implementing - protocols for data transfer, metadata requirements and salvage of historic data, both those data funded by the *Exxon Valdez* Oil Spill Trustee Council and ancillary historic data from other projects. Investigators meet with National Center for Ecological Analysis and Synthesis investigator Matt Jones to coordinate future activities. PIs have participated in regular PI meetings, including the in-person meeting in November 2013 and the January 2014 data meeting and are coordinating activities between the Herring and LTM programs. In addition, the AOOS Ocean Research Workspace, rolled out to PIs in Year 1, continues to be used as the internal staging area for PI data and work products, with individual PI user and group profiles created. Several training seminars have been held via webinars, and PIs are now using the system to organize and consolidate their project level data. Software engineers at Axiom are providing support for the Workspace, resolving bugs and implementing new functionality in response to user feedback.

During the first half of FY15, investigators increased the data management support for the Integrated Herring Research Program through establishing a dedicated half time FTE data coordinator. The data coordinator is working with the Herring Program lead Scott Pegau to reorganize the Herring Program Research Workspace to better support investigators and ensure that data produced from the program is tracked, curated to proper data and metadata standards and made available for open use. It is expected that the new Herring Program Research Workspace structure will be finalized by the start of the FY16 project year (February 1, 2016). Data from previous year's sampling and research efforts will also be made available early in the FY16 project year via the Alaska Ocean Observing System. The following figure denotes the number and frequency of total file uploads to the Herring Program Research Workspace

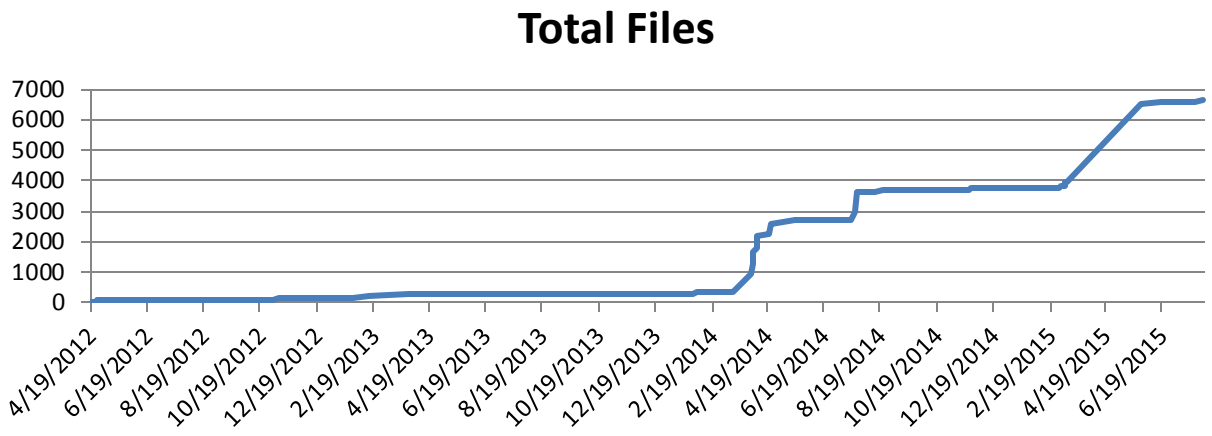

Figure 1. Total files ingested into the Herring Program Research Workspace since the onset of the Integrated Herring Program.

Investigators have been involved in several exercises and meetings to optimize approaches to managing EVOS Integrated Herring Research Program data in more effective ways. Most notable of these activities occurred in January of 2014 during an EVOSTC sponsored Data Management Meeting. During that meeting, several recommendations were made which have spurred investigators to adapt their data management approach in support of the entire EVOS Integrated Herring Research Program . Investigators have been modifying protocols defined in the EVOS Integrated Herring Research Program data management plan to address these issues.

II. COORDINATION AND COLLABORATION

A. Within a EVOTC-Funded Program

The Research Workspace technology being used for data management of the EVOS Integrated Herring Research Program is designed to help facilitate the integration of datasets across disciplines and researchers within the EVOS Integrated Herring Research Program. This technology is also being used by the EVOSTC sponsored Gulf Watch program. Teams and investigators are able to access each other's datasets in a seamless fashion.

The Research Workspace is also being used to organize and centralize data and electronic resources for historic EVOS funded projects. NCEAS and AOOS data management teams have been working together over the span of the project to salvage and document as much information as possible for historic EVOS data that is in jeopardy of being lost to time.

B. With Other EVOSTC-funded Projects

None

C. With Trustee or Management Agencies

During this year the data management team released the Alaska Ocean Observing System's Gulf of Alaska (GOA) Data Portal, which integrates a large number of additional GIS, numerical modeling and remote sensing data resources that have been centralized through efforts of this project. The team was able to leverage the AOOS Ocean Data Explorer portal which has been developed using other funding (primarily NOAA) 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. The platform provides open access to a large array of valuable scientific information that can be accessed and used by mangers and scientists with Trustee Council agencies. AOOS data management has worked with several data consumers within USGS, NPS, BOEM and NOAA in accessing and using data contained within this data portal. The Research Workspace is also being used by the North Pacific Research Board's Gulf of Alaska Integrated Ecosystem Research Program. Historic data acquired through that program is also being provided to EVOS Integrated Herring Research Program PIs.

III. PROJECT DESIGN – PLAN FOR FY16

A. Objectives for FY16

1) Provide data management oversight and services for EVOS LTM project team data centric activities, which include data structure optimization, metadata generation, and transfer of data between project teams.

2) Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.

3) Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long-term storage and public use.

B. Changes to Project Design

Small changes have been made to protocols within the EVOS Integrated Herring Research Program Data Management Plan to address concerns of the EVOSTC Science Panel and include clarification of QA/QC procedures and review of Standard Operating Procedures (SOPs) by the program's internal science advisory team.

IV. SCHEDULE

A. Project Milestones for FY 16

For each project objective listed (III.A), specify when critical project tasks will be completed, as submitted in your original proposal. Please identify any substantive changes and the reason for the changes. Please format your information as in the following example:

Objective 1. Provide data management oversight and services for EVOS LTM project team data centric activities, which include data structure optimization, metadata generation, and transfer of data between project teams.
Assess and review year 5 data sets – To be met by September 2016

Objective 2. Consolidate, standardize and provide access to study area data sets that are critical for retrospective analysis, synthesis and model development.
Data ingested in year 4 will be available via data access tools – To met by June 2016
Any additional historical data will be made available through the AOOS Gulf of Alaska portal - Ongoing

Objective 3. Integrate all data, metadata and information products produced from this effort into the AOOS data management system for long-term storage and public use.
This task is ongoing.

B. Measurable Project Tasks for FY 16

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)

March	*Submit annual report*
March	*Submit annual financial report*

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)

May	*Participate in Herring Program annual PI meeting*
June	*Release version 3 of user tool platform*

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)

September	*Oversee transfer of field year 5 data*
October	*Assess year 4 datasets and metadata submitted through Ocean Workspace*

FY 16, 4th quarter (November 1, 2015- January 31, 2016)

January	*Annual Marine Science Symposium*

V. PROJECT PERSONNEL – CHANGES AND UPDATES

None

VI. BUDGET

A. Budget Forms (Attached)

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	
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	
SUBTOTAL	$120,000.0	$120,000.0	$20,500.0	$21,300.0	$22,000.0	$303,800.0	$0.0
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	

B. Changes from Original Proposal

No Change

C. Sources of Additional Funding

AOOS brings a significant level of leveraged resources, infrastructure, regional data management projects and partnerships to this proposed effort. The data management effort for the LTM and herring projects could not be accomplished for the budgeted amount by a team without these leveraged resources.

1. AOOS – (540k to AOOS DM) Alaska oceanographic data management effort. Supports open source, standards based data system that serves up and archives real-time sensor feeds, models & remote sensing data, GIS data layers, and historical datasets. Data system developed on interoperability concepts and meets NOAA Integrated Ocean Observing System standards and protocols for streaming data feeds to national data assimilation centers. Data Management Committee chaired by Dr. Phil Mundy provides ongoing advice, prioritization and direction to the team at Axiom Consulting & Design. AOOS board is made up of federal and state agencies, and major marine research institutions in the state that have committed to data sharing. The AOOS board has committed to supporting a statewide data system for as long as AOOS exists. Federal funding is stable, although we would like to see it increase. In the event AOOS was to end, all data and data products would be transferred to the University of Alaska.
2. NPRB GOAIERP – (80K) During this project year, NPRB will be providing funding to the AOOS data management team to support the Gulf of Alaska Integrated Ecosystem Research Program, which is performing research in the same area as EVOS Integrated Herring Research Program.
3. USFWS Seabird Data System – ($50K) Project involves the creation and population of a series of new seabird metric databases (diet and productivity) and integrating these new databases with legacy seabird databases (species distribution and abundance at seabird colonies, pelagic species distribution and abundance, USGS seabird monitoring databases and NPRB's North Pacific Seabird Diet Database). Modern spatially explicit, web based data entry interfaces have and continue to be developed to assist researchers existing in distributed agencies to contribute their historic and current seabird metric data into standard data structures. Project will result in vastly increasing the amount and quality of seabird species distribution, diet and other seabird data

available for use in retrospective analysis and management. Though data includes areas around all of Alaska, most available data is located in GOA and PWS.

4. AOOS – collaborator with Alaska Data Integration Working Group – an initiative with the Alaska Climate Change Executive Roundtable – to develop protocols for serving up project data to increase data sharing among federal and state agencies.
5. AOOS and NOAA – initiatives to develop data sharing agreements with private sector, including oil & gas companies.
6. Kenai Fish Habitat Partnership/Cook Inlet Regional Citizens Advisory Council (28K) – contract with Axiom to develop a data management system for their oceanographic and contaminants data in Cook Inlet.
7. NOAA – Project to Axiom to develop a Cook Inlet beluga sightings database.

FY16 PROPOSAL SUMMARY PAGE
Continuing, Multi-Year Projects

Project Title: PWS Herring Research and Monitoring: Expanded Adult Herring Surveys

Project Period: February 1, 2016 – January 31, 2017

Primary Investigator(s): Peter S. Rand, Ph.D., Dick Thorne, Ph.D.; Prince William Sound Science Center, Cordova, AK

Study Location: Prince William Sound, AK

Project Website (if applicable): http://pwssc.org/research/fish/pacific-herring/

Abstract*:

Prince William Sound herring stock biomass estimates from hydroacoustic surveys provide a direct measure of the stock abundance for use in the age-structured assessment (ASA) model that is the forecasting tool used for management. Prior to 2001, the hydroacoustic surveys were conducted exclusively by the Prince William Sound Science Center (PWSSC). Since 2001, the effort has been shared between PWSSC and the Cordova office of Alaska Department of Fish and Game (ADF&G). While the ADF&G considers the hydroacoustic surveys to be critical (Steve Moffitt, personal communication) the lack of a commercial herring fishery in PWS since 1998 has reduced management priorities for herring. Thus the PWSSC contribution has become critically important for the long-term, especially if a future fishery appears only a remote possibility. With the level of effort available over the past several years, PWSSC and ADF&G individually have achieved herring biomass estimates with a precision of about ±30%, which is insufficient for management purposes. However, the combined effort currently meets management requirements for precision. Current stock assessment efforts by ADF&G resource managers in PWS focus on the largest spawning aggregations. The objective of this study is to increase the current survey area of adult spawning beyond the Port Gravina and Fidalgo areas to provide a more precise estimate of spawning biomass. We propose to extend the PWSSC acoustic surveys to help identify the relative contributions of additional spawning aggregations over temporal and spatial scales. This will help establish more accurate estimates of the total herring biomass in PWS and provide an alert to changes in biomass in different regions. Beginning in FY2013 and continuing until 2016, hydroacoustic surveys will be conducted in late spring (April-May) to assess adult spawning biomass. ADF&G will continue to conduct direct sampling for age/length/weight. Additional direct capture will be conducted at adult spawning sites (See Bishop proposal).

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA*):

FY12	FY13	FY14	FY15	FY16	TOTAL
$6.5K	**$84.4K**	**$68.1K**	**$90.6K**	**$84.4K**	**$334.0K**

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 14, 2015

I. EXECUTIVE SUMMARY

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

The current management of the Prince William Sound (PWS) herring stock by the Alaska Department of Fish and Game (ADF&G) includes information from hydroacoustic surveys. Biomass estimates from these surveys provide a direct measure of the stock abundance and are provided for input into the age-structured assessment (ASA) model that is the primary forecasting tool. The hydroacoustic surveys were initiated in 1993 when fishers were unable to locate concentrations of herring despite a forecast for high abundance. Over time period the hydroacoustic survey has shown to be an early and accurate measure of the herring stock abundance and compares well with the recent ASA model estimates that now can incorporate hydroacoustic survey information as well as an index of male spawning abundance.

Prior to 2001, the hydroacoustic surveys were conducted exclusively by the Prince William Sound Science Center (PWSSC). Since 2001, the effort has been shared between PWSSC and the Cordova office of Alaska Department of Fish and Game. Over the past 5 years, the PWSSC effort has been supported by EVOS TC. The cooperative effort has been critical since both PWSSC and ADF&G have limited resources for this effort. While ADF&G considers the hydroacoustic surveys to be critical (Steve Moffitt, personal communication) the lack of a commercial herring fishery in PWS since 1998 has reduced management priorities for herring during a time of overall limited funding for the state agency. Thus the PWSSC contribution has become critically important for the long-term, especially if a future fishery appears only a remote possibility.

With the level of effort available over the past several years, PWSSC has achieved herring biomass estimates with a precision of about ±30%. This level of precision is insufficient for management

purposes. There is concern that some concentrations of fish are not located and surveyed under current levels, in which case the estimate is biased, a factor not incorporated into variance calculations for precision.

The Science Panel posed a few questions during the last proposal submission that we will attempt to answer.

Questions were raised regarding the validity of the acoustic data, whether the acoustic equipment is well suited for the job, and how the acoustic data is used in the ASA models. The acoustics results are an index incorporated into both the Bayesian and ADF&G ASA models. There is an underlying assumption that the majority of the fish in the Sound are being surveyed and the work proposed here examines that assumption. We propose here to continue existing surveys to allow us to track the status of the population, but we also want to extend our survey to ensure we are not missing an important component of the population. There have been shifts in the sampling area over time as the main spawning population moved from Montague Island to Port Gravina. Similarly, there have been shifts in effort related to other observations such as the spawn surveys and sampling. When we change equipment we are comparing old and new sensors to ensure that biomass estimates remain consistent with the transition. We do the same when examining new processing algorithms. All acoustics data from adult herring surveys are stored on the herring program's workspace so reprocessing can occur if necessary.

The completion of the acoustic survey analysis requires the collaboration with ADF&G for information on the length and weight of individuals in the spawning population. There has been discussion related to survey and processing approaches. A deviation between estimates from ADF&G and PWSSC led to the discovery of an error in the areas used by ADF&G in their processing. Once that error was corrected the estimates in overlapping regions were within the error margins. Survey timing, location, and overall findings are communicated before and during the survey effort. Given the movement of the fish it is beneficial to have multiple boats trying to determine the location of major portions of the biomass and if there is potential movement of fish that may cause errors in the biomass estimates.

There is a database of historic observations on the herring program workspace. Prior to 2000 the data were not collected in a digital format so it is necessary to go to reports to determine the location and timing of spawn surveys. Transitions in effort caused by changes in spawn timing and location have been a point of discussion with the program coordinator and other investigators in the program.

While the comments seem to refer to the departure of Dr. Thorne, he has remained integrally involved in the adult herring surveys. He has been involved in all of the surveys through 2015. Dr. Buckhorn did leave the program the past year. Dr. Thorne worked with a technician from Dr. Boswell's lab in 2015 and is expected to contribute during the transition to Dr. Rand.

II. COORDINATION AND COLLABORATION

A. Within the Program

This project is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System. The project works

closely with the validation project of Bishop to collect fish in areas outside of those sampled by ADF&G. Additional acoustic sampling throughout the Sound during spring 2015 was carried out through a contract with Florida International University in collaboration with NOAA whale surveys as part of the Gulf Watch program.

B. With Other Council-funded Projects
N/A

C. With Trustee or Management Agencies
Fish biomass estimates are provided to Steve Moffitt with ADF&G in Cordova. The project relies on weight and length data collected by ADF&G.

III. PROJECT DESIGN – PLAN FOR FY15
A. Objectives for FY16

The objective of this study is to increase the current survey area of adult spawning beyond the Port Gravina and Fidalgo areas to provide a more accurate estimate of spawning biomass.

B. Changes to Project Design
N/A

IV. SCHEDULE
A. Project Milestones for FY 16
For each project objective listed, specify when critical project tasks will be completed, as submitted in your original proposal. Please identify any substantive changes and the reason for the changes. Please format your information as in the following example:

Objective 1. To increase the current survey area of adult spawning beyond the Port Gravina and Fidalgo areas to provide a more precise estimate of spawning biomass.
Met by May 2016

B. Measurable Project Tasks for FY 16
Specify, by each quarter of each fiscal year, when critical project tasks (for example, sample collection, data analysis, manuscript submittal, etc.) will be completed, as submitted in your original proposal. Please identify any substantive changes and the reason for the changes. Please format your schedule as in the following example:

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)
April: *Survey*

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)
May 30: *Annual PI meeting*

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)
August: *Submit Annual Report*
September 1: *Complete Adult Survey Analysis*

FY 16, 4th quarter (November 1, 2016- January 31, 2017)

December 15: *Report and manuscript writing*

V. PROJECT PERSONNEL – CHANGES AND UPDATES

Pete Rand was hired on at PWSSC in May 2015. Part of his responsibilities at PWSSC is to oversee the Pacific herring acoustic monitoring. Over his career he has gained experience in application of acoustics in fisheries science and management, including work in the Great Lakes, reservoirs and coastal ecosystems in North Carolina, Caribbean Sea, and river systems in Japan, Russia and Alaska. He will work with Dick Thorne on reporting results from this funding period, and he intends to oversee the adult herring acoustic monitoring at PWSSC into the future. Pete joined Dick and Adam Zenone (Florida International University) for one day on the spring 2015 survey in Gravina Bay to become familiarized with the current acoustic methods being applied in the Sound.

Peter S. Rand, Ph.D.
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EDUCATIONAL BACKGROUND

Colgate University, Biology, B.A., 1987
SUNY College of Environmental Science and Forestry, Ecology, M.S., 1990
SUNY College of Environmental Science and Forestry, Ecology, Ph.D., 1994
University of British Columbia, Fisheries Science, Postdoctoral Fellow, 1995-1997

ACADEMIC/PROFESSIONAL WORK EXPERIENCE

Research Ecologist, Prince William Sound Science Center (2015-present)
Chair, IUCN Salmonid Specialist Group (2008-present)
Senior Conservation Biologist (2003-2015), Wild Salmon Center.
Assistant Professor (1997–2003), Department of Zoology, NC State University.

SELECTED REFEREED PUBLICATIONS

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Research Fellowship Award, Japan Society for the Promotion of Science
Robert L. Kendall Publication Award, Best Paper in Transactions of American Fisheries Society
James W. Moffett Publication Award, Most Significant Paper, US Geological Survey, Great Lakes Science Center
Hydrolab Award, International Association of Great Lakes Research
Award for Excellence in Research, New York Sea Grant Institute
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Member and Red List Authority Focal Point, IUCN Salmonid Specialist Group
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I attended and presented at a joint meeting of the North Pacific Anadromous Fish Commission and the North Pacific Marine Science Organization in Jeju, South Korea.

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I have attended and contributed to sessions at two IUCN World Conservation Congresses (Bangkok, Thailand and Barcelona, Spain) and IUCN specialist group meetings (Abu Dhabi, United Arab Emirates, and Chester, United Kingdom).

VI. BUDGET

A. Budget Forms

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	$31,600.0	$177,700.0	
Travel	$0.0	$3,600.0	$3,600.0	$3,600.0	$3,600.0	$14,400.0	
Contractual	$0.0	$2,000.0	$3,600.0	$3,000.0	$24,300.0	$32,900.0	
Commodities	$0.0	$4,000.0	$0.0	$2,000.0	$0.0	$6,000.0	
Equipment	$6,000.0	$0.0	$0.0	$0.0	$0.0	$6,000.0	
Indirect Costs (*will vary by proposer*)	$0	$17,900	$14,400	$19,200	$17,900	$69,400.0	
SUBTOTAL	$6,000.0	$77,400.0	$62,500.0	$83,100.0	$77,400.0	$306,400.0	$0.0
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	

B. Changes from Original Proposal

We are requesting to shift $24,300 from Personnel to Contractual. We intend to contract with Kevin Boswell of Florida International University to provide technical support for the cruises and data processing. To do this we are moving the funds originally for a PWSSC technician (James Thorne) to contractual. James no longer works at PWSSC and by contracting with FIU we gain access to the expertise of Dr. Boswell's group.

C. Sources of Additional Funding

No additional funding is provided.

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	$94,400.0	$93,700.0	$16,700.0	$17,300.0	$17,900.0	$240,000.0	
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	
SUBTOTAL	$120,000.0	$120,000.0	$20,500.0	$21,300.0	$22,000.0	$303,800.0	$0.0
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.

FY12-16

Project Title: PWS Herring: Data Management
Primary Investigator: Rob Bochenek

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

Date Prepared:08/15/2014

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Shane StClair		0.5	9400.0		4,700.0
Luc Mehl		1.5	8800.0		13,200.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	18200.0	0.0	
				Personnel Total	$17,900.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Project Title: PWS Herring: Data Management
Primary Investigator: Rob Bochenek

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Date Prepared:08/15/2014

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

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Project Title: PWS Herring: Data Management
Primary Investigator: Rob Bochenek

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared:08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Project Title: PWS Herring: Data Management
Primary Investigator: Rob Bochenek

FORM 3B
EQUIPMENT DETAIL

Date Prepared:08/15/2014

FY16 PROPOSAL SUMMARY PAGE
Continuing, Multi-Year Projects

Project Title: PWS Herring Research and Monitoring: Juvenile Herring Abundance Index

Project Period: February 1, 2016 – January 31, 2017

Primary Investigator(s): Peter S. Rand, Ph.D.; Prince William Sound Science Center

Study Location: Prince William Sound, AK

Project Website (if applicable): http://pwssc.org/research/fish/pacific-herring/

Abstract*:

Management of the Pacific herring stock in Prince William Sound (PWS), Alaska, is based primarily on an age-structured-assessment (ASA) model. The current model, developed in 2005, incorporates both hydroacoustic estimates of the adult herring biomass and an index of the male spawning, called the "mile-days of spawn". Unfortunately, the forecast is based on measurements from the previous year and does not have a direct measure of future age 3 recruitment. Current knowledge suggests that most mortality occurs during the first winter of life, so the relative recruitment may be fixed by the end of the first year. Consequently, estimates of relative abundance of age 1 and age 2 fish should provide an index of future recruitment. An index of age 0 fish would also provide a forecast of recruitment if additional information were available on the magnitude of the first year mortality. We will conduct annual fall surveys (FY2013-2016) of 8 bays; four of which will be the Sound Ecosystem Assessment (SEA) bays (Cooney et al. 2001). This will maintain a continual database from these locations. The other 4 bays will be selected based upon the survey results of the current EVOSTC FY10 Herring Survey Project (# 10100132). Surveys will be conducted using 120 kHz split-beam hydroacoustic unit in a stratified systematic survey design (Adams et al. 2006). For this study, direct capture will be directed to size and species composition. A midwater trawl will be used to sample randomized transects within each strata.

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA)*:

FY12	FY13	FY14	FY15	FY16	TOTAL
$90.1K	$80.1K	$66.1K	$84.9K	$82.9K	**$404.2K**

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 14, 2015

I. EXECUTIVE SUMMARY

Management of the Pacific herring stock in Prince William Sound (PWS), Alaska, is based primarily on an age-structured-assessment (ASA) model. The current model, developed in 2005, incorporates both hydroacoustic estimates of the adult herring biomass and an index of the male spawning, called the "mile-days of spawn". Evidence suggests that the current model performs adequately. Unfortunately, the forecast is based on measurements from the previous year and does not have a direct measure of future recruitment. Since herring are a relatively short-lived fish, this uncertain recruitment can be a substantial component of the forecast abundance.

Herring recruit primarily as age 3. Current knowledge suggests that most mortality occurs during the first winter of life, so the relative recruitment may be fixed by the end of the first year. Consequently, estimates of relative abundance of age 1 and age 2 fish should provide an index of future recruitment. An index of age 0 fish would also provide a forecast of recruitment if additional information were available on the magnitude of the first year mortality.

Hydroacoustic surveys of juvenile herring abundance have been conducted over the past 4 years. These surveys have been conducted in both fall and late winter. The focus has been on age 0 herring, driven by interest in the extent of the critical first overwinter mortality, and has included energetics and disease research as well as research on sources of predation mortality

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

The Science Panel posed some questions during the review of the last proposal that we will attempt to answer here.

The analysis of data collected by this project has not been processed in a manner that would provide a useful index of juvenile herring population. With the transition to Dr. Rand it has been identified that getting an index is extremely important. During the transition between Dr. Buckhorn and Dr. Rand, Dr. Boswell of FIU was asked to have a technician work on processing the historic data to ensure this effort continued to move forward.

Dr. Rand is new to the conversations related to the use of a juvenile index to the population modeling effort. There are discussions between the program coordinator and ADF&G about the importance of needing a juvenile index. The age-sex-length data is consistent with the assumption in the model that in PWS the majority of herring recruit to the spawning population at age-3. This is significantly different than what is observed in Sitka and keeps the topic of determining the age of maturity near the top of conversations related to modeling efforts. The program is also using aerial surveys to provide another potential index of future recruitment and we expect to compare the aerial and acoustic indexes in the upcoming year. Conversations with the population modeling project have focused on testing the value of the index as an input in the near future.

Since we are currently only conducting a single survey a year there is not enough information to estimate survival. We are using data from the acoustic intensive project to determine if the index would have sufficient precision to estimate survival or if a change in sampling would be required to achieve that objective.

The survey design has been constant since 2012 and is expected to remain the same in 2015.

II. COORDINATION AND COLLABORATION

A. Within the Program

This proposal is part of the integrated "PWS Herring Research and Monitoring" proposal submitted by the Prince William Sound Science Center to the Exxon Valdez Oil Spill Trustee Council. It includes the collaboration and coordination described there for work within the herring research group and with the Long-Term Monitoring proposal submitted by the Alaska Ocean Observing System. This work is done in close collaboration with the validation project of Bishop. The vessel is shared with the condition monitoring and disease sampling as well. Sampling efforts were coordinated with the non-lethal sampling project of Boswell and Pegau.

B. With Other Council-funded Projects

N/A

C. With Trustee or Management Agencies

While intended to provide an index of the incoming year class strength, this data has not been provided to ADF&G.

III. PROJECT DESIGN – PLAN FOR FY16

A. Objectives for FY16

Program objectives:

We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

This project will contribute to Program Objective #1: *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.*

Project Objectives:

1. Conduct annual surveys of juvenile herring to create an index of future recruitment
2. Validate species and size composition of fish ensonified during acoustic transects (See Bishop proposal).

B. Changes to Project Design

No changes have been made.

IV. SCHEDULE

A. Project Milestones for FY 16

Objective 1: Conduct annual surveys of juvenile herring to create an index of future recruitment. *Will be conducted every November FY2013-2016.*

Objective 2: Validate species and size composition of fish ensonified during acoustic transects (See Bishop proposal). *Will be conducted every November FY2013-2016.*

B. Measurable Project Tasks for FY 16

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)

March Complete analysis of previous cruise data.

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)

May Attend annual PI meeting

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)

FY 16, 4th quarter (November 1, 2016- January 31, 2017)

November Conduct juvenile index survey
January Annual Marine Science Symposium
Complete analysis of November cruise data

V. PROJECT PERSONNEL – CHANGES AND UPDATES

Pete Rand was hired on at PWSSC in May 2015. Part of his responsibilities at PWSSC is to oversee the Pacific herring acoustic monitoring. Over his career he has gained experience in application of acoustics in fisheries science and management, including work in the Great Lakes, reservoirs and coastal ecosystems in North Carolina, Caribbean Sea, and rivers systems in Japan, Russia and Alaska. He will work with Michele Buckhorn and Dick Thorne on reporting results from previous years, and he intends to oversee the juvenile herring surveys at PWSSC into the future.

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Hydrolab Award, International Association of Great Lakes Research

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Member, Sigma Xi
Member and Red List Authority Focal Point, IUCN Salmonid Specialist Group
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Contractual	$500.0	$4,000.0	$1,600.0	$2,000.0	$27,700.0	$35,800.0	
Commodities	$1,500.0	$0.0	$1,500.0	$0.0	$0.0	$3,000.0	
Equipment	$59,000.0	$0.0	$0.0	$0.0	$0.0	$59,000.0	
Indirect Costs (*will vary by proposer*)	$5,500	$17,000	$14,000	$18,000	$17,600	$72,100.0	
SUBTOTAL	$82,700.0	$73,500.0	$60,600.0	$77,900.0	$76,100.0	$370,800.0	$0.0
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	

B. Changes from Original Proposal

We are requesting to shift $27,700 in funds from Personnel to Contractual. We intend to contract with Kevin Boswell of Florida International University to provide technical support for the cruise and data

processing. To do this we are moving the funds originally for a PWSSC technician (James Thorne) and Co-PI (Dick Thorne) to contractual. James no longer works at PWSSC and by contracting with FIU we gain access to the expertise of Dr. Boswell's group. Salary carried over from previous years will be used to cover Dr. Thorne's salary.

C. Sources of Additional Funding

None.

***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	$16,200.0	$49,900.0	$40,900.0	$55,300.0	$28,200.0	$190,500.0	
Travel	$0.0	$2,600.0	$2,600.0	$2,600.0	$2,600.0	$10,400.0	
Contractual	$500.0	$4,000.0	$1,600.0	$2,000.0	$27,700.0	$35,800.0	
Commodities	$1,500.0	$0.0	$1,500.0	$0.0	$0.0	$3,000.0	
Equipment	$59,000.0	$0.0	$0.0	$0.0	$0.0	$59,000.0	
Indirect Costs (*will vary by proposer*)	$5,500	$17,000	$14,000	$18,000	$17,600	$72,100.0	
SUBTOTAL	$82,700.0	$73,500.0	$60,600.0	$77,900.0	$76,100.0	$370,800.0	$0.0
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.

FY12-16

Project Title: PWS Herring: Juvenile herring index
Primary Investigator: Michele Buckhorn

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

Date Prepared:08/15/2014

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Peter Rand, PhD	PI	3.0	9400.0		28,200.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	9400.0	0.0	
				Personnel Total	$28,200.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Miami to Cordova - Adam Zenone	1400.0	1	6	200.0	2,600.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2,600.0

FY16

Project Title: PWS Herring: Juvenile herring index
Primary Investigator: Michele Buckhorn

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Date Prepared:08/15/2014

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

Contractual Costs: Description	Contract Sum
Technical support from Florida International University	27,700.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$27,700.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Project Title: PWS Herring: Juvenile herring index
Primary Investigator: Michele Buckhorn

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared:08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Project Title: PWS Herring: Juvenile herring index
Primary Investigator: Michele Buckhorn

FORM 3B
EQUIPMENT DETAIL

Date Prepared:08/15/2014

FY16 PROJECT PROPOSAL SUMMARY PAGE
Continuing, Multi-Year Projects

Project Title: PWS Herring Research and Monitoring: Outreach & Education

Project Period: February 1, 2016 – January 31, 2017

Primary Investigator(s): Hayley Hoover, Education Specialist, PWS Science Center (PWSSC)

Study Location: Prince William Sound (PWS)

Project Website (if applicable): http://pwssc.org/research/fish/pacific-herring/

Abstract*: The *Outreach & Education* project is designed to enhance the PWS Herring Program research activities by showcasing their relevancy, broadening their applicability and extending their impact to people in the community. PWSSC educators will work with PWS Herring Research and Monitoring principal investigators (PI) and project collaborators to prepare public education materials that communicate the purpose, goals and results of the research program to "non-scientist" audiences and stakeholders in communities in and beyond the spill affected area.

Outreach and education products will extend and transfer Pacific herring and marine ecosystem information to inform the public of local research activities and improve their ecological and ocean science literacy.

The specific objectives of this proposal, which includes the outreach and education components of the PWS Herring Research and Monitoring Program, are to:

1) Disseminate PWS herring research information and lessons learned in this program to individuals, groups, policy makers, resource managers and institutions in PWS, including the effected fishing community.
2) Extend and transfer PWS herring research-based outreach and education products to general audiences in and beyond the spill affected areas of PWS.
3) Integrate community involvement into the planning and sampling programs through citizen science opportunities and public workshops

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA*):

FY12	FY13	FY14	FY15	FY16	TOTAL
$16.5K	$30.5K	$32.7K	$36.0K	$38.3K	$153.9K

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 14, 2015

I. EXECUTIVE SUMMARY

The **Outreach & Education** project is designed to enhance the PWS herring research activities by showcasing their relevancy, broadening their applicability and extending their impact to people in communities in and beyond the spill affected areas of PWS. Outreach products and education activities will extend and transfer herring and ecosystem information to inform the public of local research activities and improve their ecological and ocean science literacy. Both formal and informal approaches to science education are used.

The PWSSC education group has experience developing and implementing a diverse array of public outreach and educational activities through its ***Headwaters to Ocean*** program. Educators will work closely with PWS herring research principal investigators and project collaborators to prepare and distribute public education materials that communicate the purpose, goals and results of the research program to "non-scientist" audiences and stakeholders in communities in and beyond the spill affected area.

The Science Panel asked if this effort was coordinated with that of Gulf Watch Alaska. The PI of this project also does some outreach for Gulf Watch Alaska as well. This allows close communication between the outreach efforts of the two programs. The Science Panel also expressed a concern about how the projects relate to each other. Much of the previous outreach efforts focused on the individual projects and we will look at emphasizing the connectivity between projects in the upcoming year. The synthesis that was completed last year will help facilitate highlighting programmatic connections.

Table 1. The informal or formal education approaches (**bold**) used to meet objectives, specific products (*italics*), and schedule and frequency/number of outreach and education products developed/delivered by our staff.

1. Written project profiles and articles for pubic information and use; appropriate for lay audiences for inclusion in newsletters or other science/education publications.		
Delta Sound Connections	15,000 copies distributed annually to residents and visitors to PWS	Contribution of articles by herring researchers FY12-16. Sponsorship and herring program feature FY13 & FY15
PWSSC Breakwater *newsletter*	emailed to 325 households/businesses in and outside of Alaska	2-3 articles per year FY12-16
Project Profiles	Distribution points: PWSSC, and website	Three profiles per year developed or updated FY12-16
2. Public presentations to general public audiences.		
Community Lecture Series	(live in Cordova, broadcast to Valdez)	Three presentations delivered by Herring researchers per year FY12-16
Field Notes radio program	(aired and archived KCHU public radio)	Three radio programs produced based on

		Herring projects per year FY12-16
3. Advertise and involve community members in opportunities to participate in herring research as "citizen scientists."		
Citizen Science Opportunities	Provide and promote opportunities for the public to become involved in research project activities	Citizen science opportunities promoted on web and during community presentations
4. Develop and advertise web-based materials to communicate the basis, goals and results of the herring research project, and provide access to outreach and education products.		
Herring Program webpage: http://www.pwssc.org/herringsurvey	Basic information about each herring project can be found and links to the annual reports on the EVOSTC website.	Continue to use this as a place to make documents associated with the herring program accessible FY12-16
PWSSC YouTube channel: http://www.youtube.com/user/PWSSC	Podcasts (based on *Field Notes* radio programs) and video clips posted on YouTube	Continue to use popular social media to outreach information associated with the herring program FY12-16
5. Educate targeted groups in the application of research information and sampling methods.		
Discovery Room	5th Grade Oceanography and Herring curriculum	6 2-hour classroom sessions/monitoring field trips delivered Oct-Apr FY12-16
Outreach Discovery	Stand-alone, hands-on herring and ocean science education programs for students in grades 3-12	1 program delivered to school group outside of Cordova per year FY12-16
Summer Field Programs	Field-based, hands-on herring and ocean science activities for participants in science and environmental camps and day programs	1 program delivered in PWSSC or partner summer program per year FY12-16

II. COORDINATION AND COLLABORATION

A. Within a EVOTC-Funded Program

This project provides outreach and education for all projects within the Herring Research and Monitoring Program. We participate on research cruises when opportunity allows. Other project investigators provide the basic materials needed through a description of their research, interviews, and other presentations. We also connect with the Gulf Watch Alaska program in areas of overlap of the two programs.

B. With Other EVOSTC-funded Projects

We participate in the Cordova Clean Harbor oversight group that is connected to the Cordova Clean Harbor project being led by the Native Village of Eyak with funding from EVOS.

C. With Trustee or Management Agencies

We work with the investigators in the HRM program from ADF&G, NOAA, and USGS to develop project profiles, *Field Notes* programs, and community lecture opportunities to provide outreach of their research.

III. PROJECT DESIGN – PLAN FOR FY16

A. Objectives for FY16

The specific objectives of this proposal, which includes the outreach and education components of the PWS Herring Research and Monitoring Program, are to:

1) Disseminate PWS herring research information and lessons learned in this program to individuals, groups, policy makers, resource managers and institutions in PWS, including the effected fishing community.
2) Extend and transfer PWS herring research-based outreach and education products to general audiences in and beyond the spill affected areas of PWS.
3) Integrate community involvement into the planning and sampling programs through citizen science opportunities and public workshops

B. Changes to Project Design

Turnover in the education department has made consistency in meeting objectives challenging. Hayley Hoover was hired in FY 14 to replace Lindsay Butters. It is Hayley's has focused on getting the education program caught up and on track with its deliverable objectives in FY 15. This has been a little slower than expected as she has had to learn some new skills. Specifically Field Notes required more time learning how to put audio programs together. The training and changes in the design of the Field Notes has put their production behind schedule.

The structure of the PWSSC summer programs is currently being revised. There were no summer programs delivered in FY 15, but we are hopeful that a new program will be in place in FY 16. The funding will be used to ensure that the herring materials can be incorporated into the revised summer programs.

We no longer anticipate maintaining the herring program facebook page. We will provide updates through the PWSSC blog. Blog posts are used in the *Breakwater* and can be forwarded to the PWSSC facebook page.

IV. SCHEDULE

A. Project Milestones for FY 16

Objective 1. Disseminate PWS herring research information and lessons learned in this program to individuals, groups, policy makers, resource managers and institutions in PWS, including the effected fishing community.
A continuing objective

Objective 2. Extend and transfer PWS herring research-based outreach and education products to general audiences in and beyond the spill affected areas of PWS.

A continuing objective

Objective 3. Integrate community involvement into the planning and sampling programs through citizen science opportunities and public workshops.
A continuing objective

B. Measurable Project Tasks for FY 16

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)

February: *Continue implementing oceanography and herring Discovery Room*
Submit annual report

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)

April: *Develop/update Project Profiles based on surveys & herring data*
May: *Evaluate oceanography and herring Discovery Room program*
Participate in Principal Investigator update and outreach meeting
Delivery of Community Lectures and Field Notes complete for FY15
Written outreach materials complete for FY15 (Delta Sound Connections, Breakwater newsletter articles, Project Profiles)

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)

August: *Submit Report*

September: *Continue implementing oceanography and herring Discovery Room*

FY 16, 4th quarter (November 1, 2016- January 31, 2017)

December: *Develop Field Notes radio program based on fall surveys*

V. PROJECT PERSONNEL – CHANGES AND UPDATES

None

VI. BUDGET

A. Budget Forms (Attached)

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	
Travel	$1,400.0	$1,800.0	$3,600.0	$2,500.0	$2,000.0	$11,300.0	
Contractual	$400.0	$2,000.0	$800.0	$2,100.0	$1,000.0	$6,300.0	
Commodities	$7,000.0	$1,400.0	$1,900.0	$1,900.0	$1,100.0	$13,300.0	
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	
SUBTOTAL	$15,100.0	$28,000.0	$30,000.0	$33,000.0	$35,100.0	$141,200.0	$0.0
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	

B. Changes from Original Proposal

No budget changes are requested.

C. Sources of Additional Funding

The delivery of Discovery Room activities, the development of the *Breakwater* and *Delta-Sound Connections* documents, Outreach Discovery, and the community lecture series are also supported by a number of different contributions including $55,000 from the Oil Spill Recovery Institute and $10,000 from Conoco-Phillips.

***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	$2,800.0	$16,300.0	$16,800.0	$18,900.0	$22,900.0	$77,700.0	
Travel	$1,400.0	$1,800.0	$3,600.0	$2,500.0	$2,000.0	$11,300.0	
Contractual	$400.0	$2,000.0	$800.0	$2,100.0	$1,000.0	$6,300.0	
Commodities	$7,000.0	$1,400.0	$1,900.0	$1,900.0	$1,100.0	$13,300.0	
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	
SUBTOTAL	$15,100.0	$28,000.0	$30,000.0	$33,000.0	$35,100.0	$141,200.0	$0.0
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.

FY12-16

Project Title: PWS Herring: Outreach and Education
Primary Investigator: Hayley Hoover

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

Date Prepared:08/15/2014

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Lindsay Butters, PI	Education Coordinator	2.5	6520.0		16,300.0
Education Specialist	Education Specialist	1.2	5500.0		6,600.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	12020.0	0.0	
				Personnel Total	$22,900.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Meeting Travel (Anchorage)	500.0	1	3	200.0	1,100.0
Education Travel (program delivery outside of Cordova)	300.0	1	3	200.0	900.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2,000.0

FY16

Project Title: PWS Herring: Outreach and Education
Primary Investigator: Hayley Hoover

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared:08/15/2014

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

Contractual Costs: Description	Contract Sum
Networking ($100/person-month)	400.0
Communications ($100/person-month)	400.0
Printing/shipping	200.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1,000.0

Commodities Costs: Description	Commodities Sum
Teaching and Outreach Supplies	1,100.0
Commodities Total	$1,100.0

FY16	**Project Title: PWS Herring: Outreach and Education** **Primary Investigator: Hayley Hoover**	**FORM 3B** **CONTRACTUAL & COMMODITIES DETAIL**

Date Prepared:08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Project Title: PWS Herring: Outreach and Education
Primary Investigator: Hayley Hoover

FORM 3B
EQUIPMENT DETAIL

Date Prepared:08/15/2014

FY16 PROJECT PROPOSAL SUMMARY PAGE
Continuing, Multi-Year Projects

Project Title: PWS Herring Research and Monitoring: Herring Disease Program (HDP)

Project Period: February 1, 2016 – January 31, 2017

Primary Investigator(s): Paul Hershberger (USGS – Marrowstone Marine Field Station)

Study Location: Wild herring will be collected from NE PWS, laboratory studies will be performed at the Marrowstone Marine Field Station

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

Abstract*:

The *Herring Disease Program (HDP)* is part of a larger integrated effort, Prince William Sound Research and Monitoring (outlined in a separated proposal by Dr. Scott Pegau). Within this integrated effort, the *HDP* is intended to evaluate the impact of infectious and parasitic diseases on the failed recovery of the PWS herring population. The framework for the 2012 – 2016 *HDP* involves a combination of field surveillance efforts, field-based disease process studies, and laboratory-based controlled studies. Field surveillance efforts will provide continued and expanded infection and disease prevalence data for herring populations in Prince William Sound (PWS), Sitka Sound, and Puget Sound. During FY 2016 we will continue the health assessments of adult herring from Prince William Sound and Sitka Sound, we will continue to rear colonies of specific-pathogen-free Pacific herring for controlled studies in the laboratory, we will compare the relative sensitivities or four newly-developed diagnostic assays that are capable of identifying prior exposure to VHS virus in Pacific herring. Additionally, by employing the qPCR and chromogenic in situ hybridization tools that were developed as products of the HDP, we will begin searching for intermediate invertebrate hosts for *Ichthyophonus*.

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA)*:

FY12	FY13	FY14	FY15	FY16	TOTAL
		$281.9K	**$291.9K**	**$298.0K**	**$871.8K**

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
				$42.1K	

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 14, 2015

I. EXECUTIVE SUMMARY

Primary efforts completed during 2015 included submission of a review manuscript describing approximately 10 years of *Ichthyophonus* surveys in Pacific herring and a synthesis manuscript describing host and environmental characteristics that govern the epizootiology of VHS in Pacific herring. The latter manuscript is expected to provide the foundation for a mathematical model capable of forecasting potential VHS impacts in wild herring populations. Additional work included reporting an expansion of *Ichthyophonus* surveillance efforts in marine and freshwater fishes and a new description of the phylogeny this parasite, which indicates that multiple parasite species exist. Additionally, we have become successful at infecting Pacific herring by feeding with infected tissues, with transmission efficacy increasing through the use of multiple feedings. Finally, we have demonstrated that external signs of ichthyophoniasis on juvenile Pacific herring (i.e. pigmented ulcers on the flank) persist for extended periods and are not necessarily precursors of mortality. During 2016, we expect to finish the optimization of an antibody test capable of assessing prior exposure to VHSV, begin screening wild and laboratory-spiked zooplankton for *Ichthyophonus* using qPCR, and perform a controlled study intended to determine the reason(s) why *Ichthyophonus* can be easily transferred fish-to-fish in rainbow trout, but not in herring; for example, are these differences the result of water type (fresh / salt water), parasite genotype, or host species susceptibility. Fish health surveillances will continue in PWS and Sitka Sound, and will be expanded to include herring and other forage fishes in Puget Sound, WA.

2015 Publications:

Hershberger, P.K., K.A. Garver, J.R. Winton. *Submitted*. Ecological Principles of viral hemorrhagic septicemia in wild marine fishes. Ecological Monographs.

Purcell, M.K., S. Pearman-Gillman, R.L. Thompson, J.R. Winton, J.L. Gregg, L.M. Hart, E.J. Emmenegger, P.K. Hershberger. *In Review*. Identification of the major capsid protein of erythrocytic necrosis virus (ENV) and development of a real-time PCR assay for quantification of ENV DNA. Journal of Veterinary Diagnostic Investigation.

Gregg, J.L., R.L. Thompson, M.K. Purcell, C.S. Friedman, P.K. Hershberger. *In Review*. Phylogeny of parasites in the genus *Ichthyophonus*, and their prevalence in several fish hosts. Diseases of Aquatic Organisms.

Hershberger, P.K., L.M Hart, A.M. MackKenzie, M.L. Yanney, C. Conway, D. Elliott. *Accepted*. Infecting Pacific herring with *Ichthyophonus sp*. in the laboratory. Journal of Aquatic Animal Health.

Hart, L.M., C.M. Conway, D.G. Elliott, P.K. Hershberger. *Accepted*. Persistence of external signs in Pacific herring *Clupea pallasii* with ichthyophoniasis. Journal of Fish Diseases.

Hershberger, P.K., J.L. Gregg, L.M. Hart, S. Moffitt, R. Brenner, K. Stick, E. Coonradt, T. Otis, J. J. Vollenweider,K. A. Garver, J. Lovy, T.R. Meyers. *In Press*. The parasite *Ichthyophonus* sp. in Pacific herring. Journal of Fish Diseases.

Conway, C.M., M.K. Purcell, D.G. Elliott, P.K. Hershberger. 2015. Detection of *Ichthyophonus* by chromogenic *in situ* hybridization. Journal of Fish Diseases 38: 853-857.

- 4 additional manuscripts are currently in preparation; submission is anticipated in 2015

II. COORDINATION AND COLLABORATION

A. Within a EVOTC-Funded Program

1) Samples of wild herring are being collected in collaboration with both ADF&G spring herring assessment surveys and with surveillance efforts from the PWSSC.
2) Zooplankton samples are being provided by Dr. Rob Campbell in an effort to screen for intermediate hosts of *Ichthyophonus*.
3) Dr.'s Kristin Gorman and Scott Pegau (PWSSC) are providing monthly samples of juvenile herring from Cordova Harbor for heightened *Ichthyophonus* surveillance

4) Juvenile herring samples from PWS were provided by Yumi Arimitsu of Gulf Watch Alaska for additional *Ichthyophonus* sampling.

B. With Other EVOSTC-funded Projects

None

C. With Trustee or Management Agencies

1) Field samples are being processed by the ADF&G Fish Pathology Laboratory in Juneau
2) Samples of pre-spawn adult herring are provided by the very generous support of ADF&G herring biologists in Cordova and Sitka

III. PROJECT DESIGN – PLAN FOR FY15

A. Objectives for FY15

- Provision of disease prevalence data necessary for the ASA herring model
- Provision of disease process studies intended to investigate the seasonality of herring diseases in PWS
- Collection of novel disease forecasting data
- Production of Specific Pathogen-Free Pacific herring intended as laboratory hosts for controlled experiments intended to determine cause-and-effect disease relationships
- Compare sensitivity of recently-developed assays capable of identifying prior herring exposure to VHSV
- Collect and screen zooplankton for *Ichthyophonus*

B. Changes to Project Design

No changes in project design.

IV. SCHEDULE

A. Project Milestones for FY 16

Objective 1. Provision of disease prevalence data necessary for the ASA herring model
To be met by June 2016

Objective 2. Provision of disease process studies intended to investigate the seasonality of herring diseases in PWS
To be met by December 2016

Objective 3. Collection of novel disease forecasting data
To be met by June 2016

Objective 4. Production of Specific Pathogen-Free Pacific herring intended as laboratory hosts for controlled experiments intended to determine cause-and-effect disease relationships
To be metamorphosed by August 2016

Objective 5. Compare sensitivity of recently-developed assays capable of identifying prior herring exposure to VHSV
To be met by May 2016

Objective 6. Collect and screen zooplankton for *Ichthyophonus*
Collections will continue to occur throughout the year, processing by qPCR will start in the summer of 2016; any qPCR-positive samples will be confirmed by CISH by May 2016.

B. Measurable Project Tasks for FY 16

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)
Field sampling, egg collections, laboratory experiments, manuscript preparation

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)
Larval rearing, laboratory experiments, manuscript preparation

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)
Juvenile rearing, laboratory experiments, manuscript preparation

FY 16, 4th quarter (November 1, 2016- January 31, 2017)
Juvenile rearing, laboratory experiments, manuscript preparation

V. PROJECT PERSONNEL – CHANGES AND UPDATES
N/A

VI. BUDGET
A. Budget Forms
USGS

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	$170,400.0	$186,600.0	$190,800.0	$547,800.0	
Travel	$0.0	$0.0	$17,000.0	$17,000.0	$18,400.0	$52,400.0	
Contractual	$0.0	$0.0	$12,000.0	$12,000.0	$12,000.0	$36,000.0	
Commodities	$0.0	$0.0	$46,000.0	$39,000.0	$39,000.0	$124,000.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$0.0	$0.0	$245,400.0	$254,600.0	$260,200.0	$760,200.0	
General Administration (9% of	$0.0	$0.0	$22,086.0	$22,914.0	$23,418.0	$68,418.0	N/A
PROJECT TOTAL	$0.0	$0.0	$267,486.0	$277,514.0	$283,618.0	$828,618.0	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$42,100.0	$0.0	

ADF&G

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	$0.0	$0.0	$0.0	$0.0	
Commodities	$0.0	$0.0	$13,200.0	$13,200.0	$13,200.0	$39,600.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$0.0	$0.0	$13,200.0	$13,200.0	$13,200.0	$39,600.0	
General Administration (9% of	$0.0	$0.0	$1,188.0	$1,188.0	$1,188.0	$3,564.0	N/A
PROJECT TOTAL	$0.0	$0.0	$14,388.0	$14,388.0	$14,388.0	$43,164.0	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	

B. Changes from Original Proposal
No Changes proposed

C. Sources of Additional Funding
$42,100 In kind contribution from USGS includes salary and benefit contributions (20%) for P. Hershberger ($26,400) and J. Gregg ($15,700)

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	$170,400.0	$186,600.0	$190,800.0	$547,800.0	
Travel	$0.0	$0.0	$17,000.0	$17,000.0	$18,400.0	$52,400.0	
Contractual	$0.0	$0.0	$12,000.0	$12,000.0	$12,000.0	$36,000.0	
Commodities	$0.0	$0.0	$46,000.0	$39,000.0	$39,000.0	$124,000.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$0.0	$0.0	$245,400.0	$254,600.0	$260,200.0	$760,200.0	
General Administration (9% of subtotal)	$0.0	$0.0	$22,086.0	$22,914.0	$23,418.0	$68,418.0	N/A
PROJECT TOTAL	$0.0	$0.0	$267,486.0	$277,514.0	$283,618.0	$828,618.0	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$42,100.0	$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.

FY12-16

Project Title: Herring Disease
Primary Investigator: Paul Hershberger
Agency: USGS

FORM 4A
TRUSTEE AGENCY
SUMMARY

Date Prepared: 08/15/2014

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
New Hire	GS-8, Step-1 Lab Technician	12.0	5300.0		63,600.0
New Hire	GS-9, Step-2 Post Doc	12.0	6100.0		73,200.0
New Hire	Student intern (student services contract)	12.0	3200.0		38,400.0
New Hire	Summer Intern (student services contract)	6.0	2600.0		15,600.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17200.0	0.0	
				Personnel Total	$190,800.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Nordland, WA - Anchorage (presentation @ AK marine Science Symp.	1200.0	2	5	200.0	3,400.0
Nordland, WA - Cordova (adult and juvenile herring sampling)	1400.0	4	10	200.0	7,600.0
Nordland, WA - Sitka (adult herring sampling)	1200.0	2	4	200.0	3,200.0
Nordland, WA - Cordova (participate in PI integration meeting)	1400.0	2	7	200.0	4,200.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$18,400.0

FY16

Project Title: Herring Disease
Primary Investigator: Paul Hershberger
Agency: USGS

FORM 4B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08/15/2014

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

Contractual Costs: Description	Contract Sum
Subcontract: assistance with laboratory studies	12,000.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$12,000.0

Commodities Costs: Description	Commodities Sum
Fish food, enrichments, and live feed production for SPF herring	17,000.0
Laboratory supplies (cell culture, histology, molecular biology, parasitology, virology, etc.)	22,000.0
Commodities Total	$39,000.0

FY16

Project Title: Herring Disease
Primary Investigator: Paul Hershberger
Agency: USGS

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

Date Prepared: 08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Project Title: Herring Disease
Primary Investigator: Paul Hershberger
Agency: USGS

FORM 4B
EQUIPMENT DETAIL

Date Prepared: 08/15/2014

***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	$0.0	$0.0	$0.0	$0.0	
Commodities	$0.0	$0.0	$13,200.0	$13,200.0	$13,200.0	$39,600.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$0.0	$0.0	$13,200.0	$13,200.0	$13,200.0	$39,600.0	
General Administration (9% of subtotal)	$0.0	$0.0	$1,188.0	$1,188.0	$1,188.0	$3,564.0	N/A
PROJECT TOTAL	$0.0	$0.0	$14,388.0	$14,388.0	$14,388.0	$43,164.0	
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.

FY12-16

Project Title: Herring Disease
Primary Investigator: Hershberger
Agency: ADFG contract

FORM 4A
TRUSTEE AGENCY
SUMMARY

Date Prepared: 08/15/2014

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Project Title: Herring Disease
Primary Investigator: Hershberger
Agency: ADFG contract

FORM 4B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08/15/2014

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

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Laboratory confirmation of infection and disease prevalence in wild PWS and Sitka herring ($31.35 / sample x 420 samples)	13,200.0
Includes VHSV, VEN, and Ichthyophonus diagnostics	
samples: 180 PWS adults, 180 PWS juveniles, 60 Sitka adults	
Commodities Total	$13,200.0

FY16

Project Title: Herring Disease
Primary Investigator: Hershberger
Agency: ADFG contract

FORM 4B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: 08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Project Title: Herring Disease
Primary Investigator: Hershberger
Agency: ADFG contract

FORM 4B
EQUIPMENT DETAIL

Date Prepared: 08/15/2014

FY16 PROPOSAL SUMMARY PAGE
Continuing, Multi-Year Projects

Project Title: PWS Herring Program – Herring Condition Monitoring

Project Period: February 1, 2016 – January 31, 2017

Primary Investigator(s): Ron Heintz, NOAA Auke Bay Laboratory, 17109 Pt. Lena Loop Road, Juneau, AK 99801, ron.heintz@noaa.gov and Kristen B. Gorman, Prince William Sound Science Center, 300 Breakwater Ave, PO Box 705, Cordova, AK 99574, kgorman@pwssc.org

Study Location: Prince William Sound

Project Website (if applicable): http://pwssc.org/research/fish/pacific-herring/

Abstract*: Outlined here is a single herring monitoring project that is a part of an integrative program that will enhance the current herring monitoring efforts and examine aspects of particular life stages to allow better modeling of Prince William Sound herring populations. The long-term goal of the program is to improve predictive models of herring stocks through observations and research.

This project will be continuing the development of an overwinter herring mortality model that began with an ongoing monitoring project initiated in 2007, and incorporates results from Prince William Sound herring research dating as far back as the 1990's. Accordingly, herring are sampled in November and the following March (Objectives 1 and 2). The model runs by applying herring condition observations made before and after winter (Objective 3). Proposed sampling will commence in November 2012 and end in March 2016. A future project is expected to continue the time series beginning in November 2016. The purpose of the time series is to relate overwinter mortality to herring recruitment.

Additionally, this project will be furthering the development of an overwinter herring mortality model with additional data types including proximate composition, RNA/DNA, and diet (Objective 6), as well energy levels per se. The goal is to use physiological indicators to realistically modify the daily energy loss rate in the overwintering model. The results of model improvement will be tested using the March data model validation approach that began in 2007.

We will no longer be assessing competitive effects of other juvenile fishes on condition of age-0 herring using stable isotope analysis as noted in previous proposals (Objective 4). Our experience with the sampling program is that we were unable to target the sample sizes need for other species to make this a realistic goal. This aspect of the project was not conducted in 2015 and will not be conducted in 2016.

In 2015, we examined the relationship between age-0 herring length and scale growth (Objective 5) using existing data collected as part of this program, in order to better interpret long-term scale data held by Alaska Department of Fish and Game within the context of energetics. This project will not continue in 2016 as the analysis was completed successfully.

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA)*:

FY12	FY13	FY14	FY15	FY16	TOTAL
0	$231.0K	$238.6K	$251.6K	$253.9K	$975.0K

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
0	0	0	0	$46.7K	0

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 12, 2015

I. EXECUTIVE SUMMARY

Please provide a summary of the project including key hypotheses and overall goals, as submitted in your original proposal. If there are additional highlights that you would like to include since you submitted your annual report, please include them here. Also, please list any publications that have been submitted and/or accepted since you submitted your annual report.

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the Exxon Valdez Oil Spill (EVOS) occurred. In the EVOS settlement, herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here is a single project that is a part of an integrative program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. The long-term goal of the program is to improve predictive models of herring stocks through observations and research. While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

Studies conducted since the 1990's suggest that age-0 PWS herring begin winter deficient in energy, which leads to significant overwinter mortality. Starvation was confirmed by using RNA/DNA as a physiological indicator. It is hypothesized that when these constraints are relaxed, first winter survival is much greater and this leads to enhanced recruitment. Specific objectives for the Herring Condition Monitoring (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. Assess competitive interactions with fishes using stable isotope analyses (objective not continued in 2015 or 2016).

Objective 5. Examine relationships between age-0 herring scale growth and body length (objective new in 2015 and not continuing in 2016).

Objective 6. Monitor seasonal changes in juvenile herring diets (November vs. March) and examine relationship between diet and herring condition (continuing objective although not specifically defined in previous proposals).

The Science Panel expressed a concern last year about the need to replace Dr. Kline. Dr. Gorman took over the project right after that proposal was written. During the past year all backlog of samples have been processed. The PWSSC and NOAA efforts have been collaborating and worked together on the synthesis effort. That effort identified a couple potential paper topics examining the connections between the condition and environmental conditions. The collaboration with the oceanographers working for Gulf Watch Alaska have been established.

Dr. Gorman has also been able to begin a collaboration with the disease project to examine the condition of herring with ichthyophonus. This collaboration is based on field measurements and looks at the potential transmission of ichthyophonus through offal.

II. COORDINATION AND COLLABORATION

A. Within the Program

Provide a list and clearly describe the present functional and operational relationships with other program projects. This includes any coordination that has taken or will take place and what form the coordination will take (shared field sites or researchers, research platforms, sample collection, data management, equipment purchases, etc.).

The HCM project is structured to be part of a collaborative programmatic effort being led by the Prince William Sound Science Center (PWSSC), the Prince William Sound Herring Research and Monitoring (PWS HRM) program supported by EVOSTC. The PWS HRM program also includes monitoring of disease, as well as studies of adult and juvenile biomass using acoustic techniques. As part of the PWS HRM, the HCM project interacts with virtually all other aspects of the program and personnel from multiple projects work in cooperation. For example, the HCM project will furnish one field technician for field sampling. Previous herring technicians have been simultaneously collecting, sorting, and preparing samples for multiple investigators such as Dr. Hershberger's disease program as part of research cruise duties. Field sampling is being conducted on shared research vessels, with funding for vessel charter time outside the scope of this project. We further rely on environmental data provided by the Gulf Watch Alaska program. Additionally, local fishermen associated with Cordova District Fishermen United, which is a component of the larger PWS HRM program's logistics, collects spring herring samples. Further, in 2015 forage fish work conducted by Gulf Watch Alaska (an EVOS-funded program led by Mayumi Arimitsu) provided samples collected from PWS for disease and body condition estimates of juvenile herring to compare with HCM's work on disease and energetics during spring 2015.

B. With Other Council-funded Projects
None

C. With Trustee or Management Agencies
The HCM project is an ongoing collaboration between PWSSC and NOAA. Bomb calorimetry and preparation of samples for stable isotope analyses are conducted at PWSSC under the supervision of project PI, Kristen Gorman. Proximate composition, RNA/DNA, and dietary analyses are conducted at NOAA's Auke Bay laboratory under the supervision of project PI, Ron Heintz. The proposal for 2015 also included a new collaboration between PWSSC and ADF&G in Cordova to conduct scale analyses. Steve Moffitt, Fisheries Biologist III with ADF&G in Cordova, collaborated on this component of the proposal by provided services for herring scale analysis and access to long-term herring scale datasets. This project, however, will not continue in 2016 as it was completed in 2015.

III. PROJECT DESIGN – PLAN FOR FY16

A. Objectives for FY16
The following were listed in the 2015 proposal, which includes the originally submitted objectives.

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 (continuing objective although not specifically defined in previous proposals).

Methods
Juvenile herring are caught in November of each year from a series of bays throughout PWS primarily using a trawl net, however gillnets and cast nets are also used in order to assess size selection by each gear type. In the field, a subset of fish are sampled for disease work in collaboration with Paul Hershberger's work as part of the HRM program. Fish are then allocated to condition monitoring at PWSSC and also diet studies conducted by Ron Heintz and Fletcher Sewall at NOAA in Juneau. Fish that are allocated for PWSSC are all measured and dried in the lab, with approximately 50 fish per bay and gear type prepared for stable isotope analyses at U Alaska – Fairbanks Stable Isotope Facility. Approximately 20 fish per bay are sent to Auke Bay labs for processing. Approximately 10% of the fish prepared for stable isotope analysis are also processed via bomb calorimetry to ground-truth estimates from the isotope approach. During the spring, Cordova fisherman catch juvenile herring using gillnet gear from the same suite of bays as fish caught in the fall. Again, approximately 50 fish per bay are processed for isotope analysis and 10% of these are processed using bomb calorimetry.

B. Changes to Project Design

There are no major changes planned for the design of the HCM project within the scope of energetic sampling and application to the overwinter herring mortality model (**Objectives 1-4**).

We discontinued work aimed at assessing competitive interactions between age-0 herring and other fishes (**Prior Objective 4**) in 2015. Further, in 2015 we pursued a new project that examined age-0

herring growth using scale data as a predictor of age-0 herring body size (**Prior Objective 5**). This project was completed in 2015 and will not be continued in 2016. The scale growth work was the only aspect of the project that received comments by the Science Panel in September 2014 during the 2015 proposal. There was some concern that scales from juvenile fish would be too fragile to work with, however, this project was successfully conducted, results form this work are being included in a manuscript in preparation by Pegau and Batton.

IV. SCHEDULE

A. Project Milestones for FY 16

Objective 1. Monitor juvenile herring condition by sampling in November.
Fieldwork to be accomplished by November 2016
Laboratory work to be accomplished by March 2017

Objective 2. Monitor juvenile herring condition by sampling in March.
Fieldwork to be accomplished by March 2016
Laboratory work to be accomplished by November 2016

Objective 3. Apply resultant observations from Objectives 1 and 2 to continue refining an overwintering mortality model with the addition of physiological indicators.
Analyses to be accomplished by November 2016 with data collected in November 2016 and March 2016.

Objective 4. Monitor seasonal changes in juvenile herring diets (November vs. March) and examine relationship between diet and herring condition.
Laboratory work to be accomplished by July 2017, for fieldwork samples collected in March and November 2016.

B. Measurable Project Tasks for FY 15

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)

February – April 2015:	*Ongoing laboratory work for samples collected in November 2015 and March 2016*
March 2015:	*2016 Sampling*

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)

May – July 2016:	*Ongoing laboratory work for samples collected in March 2016*

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)

August – October 2016:	*Ongoing laboratory work for samples collected in March 2016* *Application of data collected in November 2015 and March 2016 to overwinter mortality model.*

FY 16, 4th quarter (November 1, 2016- January 31, 2017)

November – January 2017:	*Ongoing laboratory work for samples collected in November 2016*
November 2016:	*2016 Sampling*

V. PROJECT PERSONNEL – CHANGES AND UPDATES

Ron Heintz will continue as PI with this program.

Kristen Gorman is a new PI at the Prince William Sound Science who is now leading projects previously coordinated by Dr. Tom Kline including the current Herring Condition Monitoring project. Kristen holds a PhD from Simon Fraser University, Vancouver BC, which she earned in January 2015.

Fletcher Sewall is a PhD candidate researching juvenile herring survival and recruitment who contributes to the project components associated with the NOAA Auke Bay Laboratory and within the purview of Ron Heintz, including sample processing, data analysis, and drafting reports and manuscripts.

Kristen B. Gorman
CV Short

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Fax: 907-424-5820

Professional Preparation

2015: Simon Fraser University, Faculty of Science; Ph.D. Major: Ecology and Evolutionary Biology.
2005: Simon Fraser University, Faculty of Science; M.Sc. Major: Ecology and Evolutionary Biology.
1996: Dickinson College, Carlisle, PA, USA; B.S. Major: Biology.

Appointments

2014: Research Ecologist, Prince William Sound Science Center, Cordova, AK.
2008: Ph.D. Candidate, Department of Biological Sciences, Simon Fraser University, Burnaby, BC.
2005: Research Assistant, Polar Oceans Research Group, Sheridan, MT.
2002: M.Sc. Candidate, Department of Biological Sciences, Simon Fraser University, Burnaby, BC.
1999: Wildlife Field Technician, Oregon State University, Corvallis, OR.
1997: Wildlife Field Technician, University of Wisconsin, Madison, WI.

Selected Publications

Gorman, K.B., T.D. Williams, and W.R. Fraser. 2014. Ecological sexual dimorphism and environmental variability within a community of Antarctic penguins (genus *Pygoscelis*). *PLoS ONE* 9(3): e90081.

Crossin, G.T., P.N. Trathan, R.A. Phillips, **K.B. Gorman,** A. Dawson, K.Q. Sakamoto, and T.D. Williams. 2012. Variation in baseline corticosterone predicts foraging behaviour and parental care in macaroni penguins. *The American Naturalist* 180(1):E31-E41.

Bestelmeyer, B.T., A.M. Ellison, W.R. Fraser, **K.B. Gorman**, S.J. Holbrook, C.M. Laney, M.D. Ohman, D.P.C. Peters, F.C. Pillsbury, A. Rassweiler, R. Schmitt, and S. Sharma. 2011. Analysis of abrupt transitions in ecological systems. *Ecosphere* 2(12):art129.

Gorman, K.B., D. Esler, P.L. Flint, and T.D. Williams. 2008. Nutrient reserve dynamics during egg production by female Greater Scaup (*Aythya marila*): relationships with timing of reproduction. *Auk* 125(2):384-394.

Gorman, K.B., P.L. Flint, D. Esler, and T.D. Williams. 2007. Ovarian follicle dynamics of female

Greater Scaup during egg production. *Journal of Field Ornithology* 78(1):64-73.

Other Relevant Publications

Schofield, O., H. Ducklow, K. Bernard, S. Doney, D. Patterson-Fraser, **K.B. Gorman**, D. Martinson, M. Meredith, G. Saba, S. Stammerjohn, D. Steinberg, and W. Fraser. Penguin biogeography along the West Antarctic Peninsula: Testing the canyon hypothesis with Palmer LTER observations. *Submitted Apr 2013*.

Crossin, G.T., A. Dawson, R.A. Phillips, P.N. Trathan, **K.B. Gorman**, S. Adlard, and T.D. Williams. 2012. Seasonal patterns of prolactin and corticosterone secretion in an Antarctic seabird that moults during reproduction. *General and Comparative Endocrinology* 175(1):74-81.

Badzinski, S.A., P.L. Flint, **K.B. Gorman**, and S.S. Petrie. 2009. Relationships between hepatic trace element concentrations, reproductive status, and body condition of female greater scaup. *Environmental Pollution* 157(6):1886-1893.

Gorman, K.B., D. Esler, R.L. Walzem, and T.D. Williams. 2009. Plasma yolk precursor dynamics during egg production by female Greater Scaup *(Aythya marila*): characterization and indices of reproductive state. *Physiological and Biochemical Zoology* 82(4):372-381.

Gorman, K.B. and T.D. Williams. 2005. Correlated evolution of maternally derived yolk testosterone and early developmental traits in passerine birds. *Biology Letters* 1(4):461-464.

Synergistic Activities

- Peer-review of manuscripts for *Biology Letters* (4), *Journal of Animal Ecology* (1), *Journal of Avian Biology* (1), *Marine Ecology Progress Series* (4), *Physiological and Biochemical Zoology* (1), *Polar Biology* (2), *Waterbirds* (1).
- Association of Polar Early Career Scientists (APECS) Council Member, Research Activities and Education/Outreach Committees (September 2012-2013).
- Graduate student representative to the US Long-Term Ecological Research (LTER) Network for Palmer Station, Antarctica LTER program (September 2010-September 2012).
- Co-organizer for *Les Ecologistes* Seminar Series, Department of Biological Sciences, Simon Fraser University (2010-2011).

Collaborators

S Badzinski (Bird Studies Canada), B Bestelmeyer (New Mexico State U), J Blum (Polar Oceans Res. Group), G Crossin (Dalhousie U), S Doney (Woods Hole), A Dawson (C. Ecol Hydrol, NERC), H Ducklow (Marine Biological Lab), A Ellison (Harvard U), E Erdmann (U Wisconsin Madison), D Esler (Simon Fraser U), P Flint (AK-USGS), W Fraser (Polar Oceans Res Group), M Hipfner (Canadian Wildlife Service), S Holbrook (UC Santa Barbara), P Horne (Polar Oceans Res Group), J Joy (Simon Fraser U), S Laney (U Texas El Paso), H Lucas (Polar Oceans Res. Group), D Martinson (Lamont-Doherty), M Meredith (Brit Ant Surv), M Ohman (SCRIPPS), D Patterson-Fraser (Polar Oceans Res. Group), D Peters (New Mexico State U), S Petrie (Bird Studies Canada), B Pickering (Polar Oceans Res. Group), R Phillips (BAS), F Pillsbury New Mexico State U), A Rassweiler (UC Santa Barbara), K Sakamoto (Hokkaido U), O Schofield (Rutgers U), S Sharma (U Wisconsin Madison), S Stammerjohn (Inst Arctic Alpine Res), D Steinberg (VIMS), P Trathan (BAS), R Vos (Simon Fraser U), R Walzem (Texas A&M), T Williams (Simon Fraser U).

Graduate Advisors (PhD)

Simon Fraser University: T. Williams, W. Fraser (Polar Oceans Res Group), D. Esler, R. Ydenberg

CURRICULUM VITAE

Fletcher Sewall
NOAA Auke Bay Laboratories, 17109 Pt. Lena Loop Rd
Juneau, AK 99801
Tel.: (907) 789 – 6024, E-mail: fletcher.sewall@noaa.gov

EDUCATION

- PhD candidate, Fisheries Oceanography 2010 – present
  University of Alaska Fairbanks
- Master of Applied Science, Marine Ecology and Fisheries Biology 2005
  James Cook University, Australia.
- Bachelor of Science, Psychology 1993
  University of Alaska Anchorage

PROFESSIONAL EXPERIENCE

Chemical/Biological Laboratory Assistant. 12/15/2005 – present NOAA-NMFS Auke Bay Laboratories Recruitment Energetics & Coastal Assessment program (independent contractor).

Eight years of research-related experience including manuscript preparation, data analyses, chemical laboratory analyses, and fieldwork in support of NOAA fisheries research at the Auke Bay Laboratories.

Publications and presentations

- Principal investigator/lead author of study concerning use of nucleic acid ratios and lipid content as indicators of winter performance of juvenile Pacific herring. In preparation for submission to peer-reviewed scientific journal. [Sewall, Heintz, and Vollenweider. In review. Value of growth and energy storage as predictors of winter survival of YOY herring in Prince William Sound.]
- Principal investigator/lead author of study concerning proximate composition and fatty acid analysis of fish embryos and larvae. Published findings in peer-reviewed scientific journal. [Sewall & Rodgveller 2009, Changes in body composition and fatty acid profile during embryogenesis of quillback rockfish (*Sebastes maliger*), Fishery Bulletin 107(2): 207-220.]
- Developing poster presentations of research findings. Alaska Marine Science Symposium, 2009 – 2014.
- Presenting research findings. Prince William Sound Herring Survey principal investigators meetings, 2011 – 2014.
- Collaborating with scientists from Auke Bay Labs and other state, federal, university, and private agencies to develop research proposals and to synthesize research findings for dissemination.

Chemical and biological laboratory analysis

- Familiarity and experience with sample preparation and extraction procedures for analysis of hydrocarbons in marine tissue and sediment samples, including use of column chromatography and high performance liquid chromatography (HPLC).
- Cleaning and maintaining laboratory glassware, analytical instruments, and other chemistry laboratory equipment to a high standard that ensures contaminant-free use in multiple applications, including fatty acid analysis and trace hydrocarbon analysis.
- Performing lipid analysis on juvenile and adult fish, marine mammal, and invertebrate samples by modified method of Folch et al (1957): extracting lipids from homogenized tissue samples using accelerated solvent extractor (ASE) and other equipment described in the analytical chemistry protocols for Auke Bay Labs lipid analysis; determining masses of lipid extracts using gravimetric analysis.
- Using microscale laboratory techniques to extract lipids from larval fish and small tissue samples and analysing using spectrophotometry with sulphophosphovanillin (SPV) reagent.
- Preparing lipid samples for fatty acid analysis by carrying out acid-catalyzed transesterification of fatty acids in lipid extracts.
- Familiarity and experience with operation of gas chromatograph-mass spectrometer (GC-MS) for fatty acid quantification in marine tissue samples.
- Determining concentrations of nucleic acids and RNA/DNA ratios in larval fish and in muscle tissues of juvenile and adult fish by protocols of Calderone et al (2001), using a microplate fluorescence spectrophotometer and ethidium bromide.

- Verifying that sample results from chemical processing are within acceptable statistical bounds for quality assurance, including reproducibility of results, comparability to standard reference materials, and minimal contaminant levels.
- Collaborating with senior chemist in ongoing refinement of standard operating procedures and quality assurance criteria for analytical chemistry processes.
- Preparing a variety of types and size ranges of sample organisms and tissues for analyses, including: using preservative solutions for small invertebrate organisms, anaesthetizing fish, and homogenizing sample tissues through physical mixing by mortar/pestle, electric tissue homogenizer, and sonification equipment.
- Organizing, storing and processing biological samples in accordance with processing needs to maintain sample integrity, including use of supercold (-80 °C) freezing, liquid nitrogen, nitrogen gas flushing of storage containers, and BHT antioxidant.
- Generating biological data on a variety of fish species at different life stages, including: lengths of adult and larval fish; wet and dry tissue masses of adult, larval, and embryonic fish; size and maturity stage of gonads; fish stomach contents; bioelectrical impedance analysis (BIA) data.
- Dissecting juvenile and adult fish and preparing samples for pathological analyses, including collecting peripheral blood smears, and aseptic removal of heart, kidneys, spleen and liver.

Data analysis and recordkeeping

- Performing univariate and multivariate statistical analyses on biological, chemical, and bioenergetics data using MS Access database, MS Excel, and Minitab software.
- Maintaining accurate, organized records including sample chain of custody information for extensive sample inventories, biological data, and chemical data, in both paper records and Access database.

Mentorship and training experience

- Training multiple personnel in various analytical chemistry procedures, including sample processing, and cleaning and maintaining scientific instruments.
- Training multiple personnel in sample chain of custody recordkeeping and entry of biochemical and biological data in Access database.
- Coordinating and overseeing completion of chemical and biological processing tasks by contractors to accomplish project objectives within specified timelines.
- Mentoring high school biology students competing in regional Intel Science Fair; advised on study design, implementation, and statistical analysis.
- Judging regional Intel Science Fair projects, involving evaluation of written and oral presentations by high school students, and student interviews.
- Assisting outreach coordinator with Sea Week activities, including conducting age-appropriate activities for pre-school through junior high students.

Wet laboratory animal husbandry

- Assisting with design and set up of equipment for use in wet laboratory experiments, e.g., carbon dioxide-enriched seawater exposure of fish embryos.
- Feeding and maintenance of live marine organisms (fish, invertebrates) in Auke Bay Labs wet laboratory facilities for bioenergetics studies.
- Assisting with maintenance of aquaria and touch tanks for public display, including feeding and care of fish and invertebrate organisms.

Fieldwork

- Collecting and identifying of a variety of Alaskan marine fishes, including forage fishes.
- Conducting fieldwork for obtaining forage fish and invertebrate samples, habitat and environmental data, and marine mammal observations, including: live-aboard marine research cruises of over two weeks' duration, traveling by small plane, transporting equipment by foot over rugged terrain, and working in remote locations in all weather conditions.
- Deploying various types of field equipment for obtaining forage fish and other biological samples and environmental/oceanographic data, including: beach seines, mid-water trawls, hook-and-line, fyke nets, cast nets, plankton nets, Niskin bottles, CTD devices, split-beam echo sounder, rotary laser level/stadia rods, and salinity/temperature/DO/pH meters.

VI. BUDGET

A. Budget Forms

PWSSC - Gorman

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	
Travel	$0.0	$3,000.0	$5,900.0	$5,900.0	$6,100.0	$20,900.0	
Contractual	$0.0	$24,800.0	$25,600.0	$26,300.0	$28,900.0	$105,600.0	
Commodities	$0.0	$7,500.0	$5,000.0	$8,300.0	$6,700.0	$27,500.0	
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	
SUBTOTAL	$0.0	$130,000.0	$135,000.0	$143,700.0	$148,900.0	$557,600.0	$0.0
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	

NOAA - Heintz

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	
Contractual	$0.0	$75,000.0	$75,000.0	$75,000.0	$75,000.0	$300,000.0	
Commodities	$0.0	$6,000.0	$5,000.0	$5,000.0	$5,000.0	$21,000.0	
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	$0.0
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	

B. Changes from Original Proposal

None

C. Sources of Additional Funding

NOAA in-kind contributions:		
Source	*Purpose*	*Amount*
NOAA staff salaries	Training and oversight of labor for sample processing, contract writing and administration	$ 44,197.16
NOAA instrument amortization	Use of instruments in sample processing, analytical chemistry	$ 2,485.95
	Total	$ 46,683.11

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	$64,700.0	$67,300.0	$70,000.0	$72,800.0	$274,800.0	
Travel	$0.0	$3,000.0	$5,900.0	$5,900.0	$6,100.0	$20,900.0	
Contractual	$0.0	$24,800.0	$25,600.0	$26,300.0	$28,900.0	$105,600.0	
Commodities	$0.0	$7,500.0	$5,000.0	$8,300.0	$6,700.0	$27,500.0	
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	
SUBTOTAL	$0.0	$130,000.0	$135,000.0	$143,700.0	$148,900.0	$557,600.0	$0.0
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.

FY12-16

Project Title: PWS Herring: Herring condition monitoring
Primary Investigator: Kristen Gorman

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

Date Prepared:08/15/2014

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

Personnel Costs:			Months	Monthly		Personnel
Name	Project Title		Budgeted	Costs	Overtime	Sum
T. Kline	Herring Condition Monitoring		3.0	12150.7		36,452.0
Tech to be named	Herring Condition Monitoring		6.0	6058.0		36,348.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			Subtotal	18208.7	0.0	
					Personnel Total	$72,800.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
January Symposium	400.0	1	4	200.0	1,200.0
Workshop	1300.0	1	4	200.0	2,100.0
Scientific Meeting	1600.0	1	6	200.0	2,800.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6,100.0

FY16

Project Title: PWS Herring: Herring condition monitoring
Primary Investigator: Kristen Gorman

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared:08/15/2014

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

Contractual Costs: Description	Contract Sum
PWSSC Network charge 9 @ $100	800.0
Mass spectrometry 1000 @ $30	24,000.0
Freeze drying 1000 @ $3	2,400.0
Printing, copying, shipping	700.0
Communications (fax and phone)	500.0
Software	500.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$28,900.0

Commodities Costs: Description	Commodities Sum
Office supplies	800.0
Sampling supplies	3,000.0
Laboratory supplies	2,900.0
Commodities Total	$6,700.0

FY16

Project Title: PWS Herring: Herring condition monitoring
Primary Investigator: Kristen Gorman

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared:08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Project Title: PWS Herring: Herring condition monitoring
Primary Investigator: Kristen Gorman

FORM 3B
EQUIPMENT DETAIL

Date Prepared:08/15/2014

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	$3,900.0	$7,100.0	$4,000.0	$15,000.0	
Contractual	$0.0	$75,000.0	$75,000.0	$75,000.0	$75,000.0	$300,000.0	
Commodities	$0.0	$6,000.0	$5,000.0	$5,000.0	$5,000.0	$21,000.0	
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	$0.0
General Administration (9% of subtotal)	$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.

FY12-16

Project Title: PWS Herring Survey: Herring condition monitoring
Primary Investigator: Heintz
Agency: NOAA

FORM 4A
TRUSTEE AGENCY
SUMMARY

Date Prepared: 08/15/2014

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Travel to annual herring meeting in Cordova	470.0	2	4	165.0	1,600.0
Travel to AMSS in Anchorage	540.0	2	8	165.0	2,400.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4,000.0

FY16

Project Title: PWS Herring Survey: Herring condition monitoring
Primary Investigator: Heintz
Agency: NOAA

FORM 4B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08/15/2014

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

Contractual Costs: Description		Contract Sum
Contract for RNA/DNA analysis		35000
Contract for lipid analysis		35000
Contract for data consolidation		5000
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$75,000.0

Commodities Costs: Description	Commodities Sum
standards, sample vials, pipette tips, reagents, dye	5,000.0
Commodities Total	$5,000.0

FY16

Project Title: PWS Herring Survey: Herring condition monitoring
Primary Investigator: Heintz
Agency: NOAA

FORM 4B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: 08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Project Title: PWS Herring Survey: Herring condition monitoring
Primary Investigator: Heintz
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

Date Prepared: 08/15/2014

FY16 PROJECT PROPOSAL SUMMARY PAGE
Continuing, Multi-Year Projects

Project Title: Herring Research and Monitoring – Coordination and Logistics

Project Period: February 1, 2016 – January 31, 2017

Primary Investigator(s): W. Scott Pegau, Prince William Sound Science Center

Study Location: Prince William Sound

Project Website (if applicable): http://pwssc.org/research/fish/pacific-herring/

Abstract*:
This project is for the coordination and logistics aspects of the proposed program titled, "Herring Research and Monitoring". The long-term goal of the program is to improve predictive models of herring stocks through observations and research. The objectives of the program are 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, and 4) Develop new approaches to monitoring.* The Coordination and Logistics project objectives are to 1) ensure coordination between projects to achieve the program objectives, 2) Provide a synthesis from existing results, and 3) provide logistical support to the various projects.

Coordination includes scheduling of projects to ensure the maximum sharing of vessel time and ensuring that projects dependent on results or samples from another project are in the correct order. Coordination will be primarily through email and teleconference, but each year all the investigators are required to meet in person. Coordination is also taking place with the existing Herring Survey program, the Long-Term monitoring program, and ADF&G herring sampling.

Logistics is primarily in providing vessel time.

A synthesis was provided to EVOSTC in early 2015.

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA*):

FY12	FY13	FY14	FY15	FY16	TOTAL
$364.1K	$510.3K	$388.1K	$339.0K	$338.6K	$1,940.1K

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL
$20.0K	$21.0K	$22.0K	$24.0K	$24.7K	$111.7K

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 14, 2015

I. EXECUTIVE SUMMARY

This project is for the coordination and logistics aspects of the proposed program titled, "Herring Research and Monitoring" (HRM). The long-term goal of the program is to improve predictive models of herring stocks through observations and research. The objectives of the program are 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, and 4) Develop new approaches to monitoring.* In support of the program the Coordination and Logistics project objectives are to 1) ensure coordination between projects to achieve the program objectives, 2) Provide a synthesis from existing results, and 3) provide logistical support to the various projects.

Coordination includes scheduling of projects to ensure the maximum sharing of vessel time and ensuring that projects dependent on results or samples from another project are in the correct order. Coordination is primarily through email and teleconference, but each year all the investigators are required to meet in person. Coordination is also taking place with the Long-Term monitoring program (Gulf Watch Alaska, GWA), and Alaska Department of Fish and Game (ADF&G) herring sampling. This coordination is accomplished through attendance in the Gulf Watch Alaska principal investigator (PI) meetings and teleconferences. The aerial surveys are also coordinated between the two programs to maximize benefit to both programs. This was the second year of the coordinated aerial survey project and we were able to achieve our objectives and continue to look for new approaches that may help refine our future protocols.

Logistics is primarily in providing vessel and aircraft time. It also includes setting up PI meetings for all projects to share information.

The synthesis was developed and delivered to EVOS Trustee Council staff.

While there were no Science Panel comments were specifically directed at this project, there were several comments in other sections that brought up the connectivity of the projects. We are hoping that some of those concerns were addressed in the synthesis.

II. COORDINATION AND COLLABORATION

A. Within a EVOTC-Funded Program

Coordination within the HRM program includes scheduling of projects to ensure the maximum sharing of vessel time so that projects dependent on results or samples from another project are in the correct order. Coordination is primarily through email and teleconference, but each year all the investigators are required to meet in person. Coordination has led to new questions to be addressed, such as the disease sampling in the harbor to examine for potential sources of Ichthyophonus.

Coordination between the HRM and GWA programs is accomplished through attendance in the Gulf Watch Alaska principal investigator (PI) meetings and teleconferences. The aerial surveys are also coordinated between the two programs to maximize benefit to both programs. The forage fish project provided equipment and protocols and the herring program provided observers. We worked with the continuous plankton recorder and PWS oceanography projects to examine how first year herring growth is dependent on the environmental variables.

B. With Other EVOSTC-funded Projects

We do not have collaborative work with EVOSTC-funded projects outside of the HRM and GWA programs.

C. With Trustee or Management Agencies

The HRM program is conducted in close collaboration with ADF&G. The long-term goal and objectives of the program are designed to benefit ADF&G by improving information and testing assumptions of the age-structure-analysis model. Steve Moffitt in Cordova (local area biologist) and Sherri Dressel in Juneau (statewide herring coordinator and member of the HRM oversight group) are our primary two contacts in ADF&G. HRM provides some aerial survey time to document herring spawn in areas or at times that ADF&G are unable to fly. We coordinated with them the location of remote cameras for testing their ability to provide an indication of when spawn may occur in remote locations. We have also supported the collection of herring at Kayak Island and at Montague Island to provide some indication of the age structure at those locations. We share reports of herring observations. This year that allowed ADF&G to sample spawn events on Montague Island. ADF&G provides an opportunity for the HRM disease project to sample the adult spawning population. The prevalence of the three major diseases are then reported back to ADF&G. We also coordinate with ADF&G in providing acoustic estimates of the adult herring spawning biomass.

The National Oceanographic and Atmospheric Administration (Ron Heintz) and the United States Geological Service (Paul Hershberger) also are participants in the HRM program. As participants in the program they are involved in the coordination efforts.

III. PROJECT DESIGN – PLAN FOR FY16

A. Objectives for FY16

This projects objectives are:

1) Ensure coordination between projects to achieve the program objectives.
2) Provide logistical support to the various projects.

B. Changes to Project Design

We are not anticipating any large changes to the design of the Coordination and Logistics project. Because the program was originally designed to end in October and now runs through January we will be supporting an additional fall sampling event. The Coordination and Logistics project is now also providing personnel to be the observer and data recorder on the aerial survey flights in June and July.

IV. SCHEDULE

A. Project Milestones for FY 16

Objective 1. Ensure coordination between projects to achieve the program objectives.
Continuing objective.
We anticipate meeting in November 2015 and January 2016.

Objective 2. Provide logistical support to the various projects.
Continuing objective

B. Measurable Project Tasks for FY 16

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)

February: *Submit annual report*
March: *Support spring collection of juvenile herring*
Support expanded adult survey cruises
April: *Support Aerial surveys of herring spawn*

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)

June: *Support Aerial surveys of juvenile herring*
July: *Support Aerial surveys of forage fish*

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)

FY 16, 4th quarter (November 1, 2016- January 31, 2017)

November: *Support fall juvenile herring survey*
January: *Attend Alaska Marine Science Symposium*

V. PROJECT PERSONNEL – CHANGES AND UPDATES

No personnel changes are anticipated

VI. BUDGET

A. Budget Forms (Attached)

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	
Travel	$9,500.0	$4,100.0	$5,000.0	$4,000.0	$8,700.0	$31,300.0	
Contractual	$216,960.0	$375,999.0	$282,288.0	$244,916.0	$243,657.0	$1,363,820.0	
Commodities	$2,300.0	$4,000.0	$2,300.0	$4,400.0	$1,000.0	$14,000.0	
Equipment	$50,500.0	$0.0	$0.0	$0.0	$0.0	$50,500.0	
Indirect Costs (*will vary by proposer*)	$35,700	$56,130	$37,800	$36,800	$35,570	$202,000.0	
SUBTOTAL	$334,060.0	$468,129.0	$356,088.0	$311,016.0	$310,627.0	$1,779,920.0	
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	$24,000.0	$24,700.0	$0.0	

B. Changes from Original Proposal

None

C. Sources of Additional Funding

OSRI provides up to two months ($24,700) of additional support for salary to Dr. Pegau to complete the coordination efforts.

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	$19,100.0	$27,900.0	$28,700.0	$20,900.0	$21,700.0	$118,300.0	
Travel	$9,500.0	$4,100.0	$5,000.0	$4,000.0	$8,700.0	$31,300.0	
Contractual	$216,960.0	$375,999.0	$282,288.0	$244,916.0	$243,657.0	$1,363,820.0	
Commodities	$2,300.0	$4,000.0	$2,300.0	$4,400.0	$1,000.0	$14,000.0	
Equipment	$50,500.0	$0.0	$0.0	$0.0	$0.0	$50,500.0	
Indirect Costs (*will vary by proposer*)	$35,700	$56,130	$37,800	$36,800	$35,570	$202,000.0	
SUBTOTAL	$334,060.0	$468,129.0	$356,088.0	$311,016.0	$310,627.0	$1,779,920.0	
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	$24,000.0	$24,700.0	$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.

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

FY12-16

Project Title: PWS Herring: Coordination and Logistics
Primary Investigator: W. Scott Pegau

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

Date Prepared:08/15/2014

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Pegau	Coordinator	1.0	12400.0		12,400.0
TBD	Assistant	1.0	9300.0		9,300.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	21700.0	0.0	
				Personnel Total	$21,700.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Advisory group travel	800.0	3	2	250.0	2,900.0
Marine Science Symposium	500.0	1	4	200.0	1,300.0
PI meeting with Long-Term Monitoring	500.0	5	10	200.0	4,500.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8,700.0

FY16

Project Title: PWS Herring: Coordination and Logistics
Primary Investigator: W. Scott Pegau

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared:08/15/2014

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

Contractual Costs: Description	Contract Sum
Information technology	200.0
printing/mailing/copying	500.0
Communication (phone, fax)	300.0
CDFU fishing effort	38,000.0
Vessel charters 32 days at $2700/day	86,400.0
Data Management	22,000.0
modeling	96,257.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$243,657.0

Commodities Costs: Description	Commodities Sum
misc office supplies	1,000.0
Commodities Total	$1,000.0

FY16

Project Title: PWS Herring: Coordination and Logistics
Primary Investigator: W. Scott Pegau

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared:08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Project Title: PWS Herring: Coordination and Logistics
Primary Investigator: W. Scott Pegau

FORM 3B
EQUIPMENT DETAIL

Date Prepared:08/15/2014

FY16 PROPOSAL SUMMARY PAGE
Continuing, Multi-Year Projects

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

Project Period: February 1, 2015 – January 31, 2016 // February 1, 2012 – January 31, 2017

Primary Investigator(s): Trevor A. Branch, School of Aquatic and Fishery Sciences, University of Washington

Study Location: Prince William Sound

Project Website (if applicable): http://pwssc.org/research/fish/pacific-herring/

Abstract*: Shortly after the Exxon Valdez oil spill, the Prince William Sound herring populations collapsed and have not yet recovered. We propose a modeling project to (1) revise and update the ASA model used to manage this population, (2) conduct simulations to test which data sources are most important in assessing the current status of this population, and (3) collect data on herring populations worldwide to find out how often these populations collapse under ordinary conditions.

Estimated Budget:

EVOSTC Funding Requested* (*must include 9% GA*):

FY12	FY13	FY14	FY15	FY16	TOTAL
$36.9K	$87.0K	$97.8K	$100.4K	$104.9K	$427.1K

Non-EVOSTC Funds to be used:

FY12	FY13	FY14	FY15	FY16	TOTAL

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: August 14, 2015

I. EXECUTIVE SUMMARY

Shortly after the Exxon Valdez oil spill, the Prince William Sound herring populations collapsed and have not yet recovered. We propose a modeling project to (1) revise and update the ASA model used to manage this population, (2) conduct simulations to test which data sources are most important in assessing the current status of this population, and (3) collect data on herring populations worldwide to find out how often these populations collapse under ordinary conditions.

Goal 1: develop a revised and updated ASA model. This has been completed, with results in Muradian (2015, MS thesis). The new model is an improvement over the current ADF&G model in that it has moved from minimizing sums of squares to fit the model to the data in Excel, to the new version where a Bayesian model is fit within AD Model Builder. The new model is fast, accurate and robust since it is

based in AD Model Builder. Additionally the likelihood basis underlying the Bayesian model allows for statistically valid weighting of different data sets (unlike sum of squares), and accurate characterization of the uncertainty about parameter estimates. Should managers desire it, management of PWS herring can now be based on probabilistic decision rules, rather than decision rules based only on the best single estimate. An example of a probabilistic decision rule would be to reopen fishing if there is an 80% probability of being above a threshold spawning biomass level.

Goal 2: conduct simulations to test which data sources are most important in assessing current status of PWS herring. This has been completed, with results presented in Muradian (2015, MS thesis). Repeated Bayesian analysis were conducted with each major historical data set left out, one at a time. The full stock assessment was assumed to be the "truth", and then the accuracy and precision of model estimates of abundance were compared for the alternative scenarios where data had not been collected. The results are calculated in terms of cost effectiveness: dollars spent per precision gain. The results suggest that the disease survey reduces bias and imprecision most cost-effectively, because they are relatively cheap, and without them, the model is unable to explain the drop in biomass in the early 1990s. The dive surveys for eggs were the second most valuable surveys because they provide the only time series that is assumed to be an absolute abundance estimate in the past: the mile-days of milt and acoustic surveys are assumed to be relative indices. Without the absolute biomass estimates in those years, the model is unable to accurately estimate total biomass. However, these results also highlight the fact that past data collection methods may not be required in the future, and further simulation work is needed to determine which data sources would be most valuable to conduct in the future. The diver egg surveys, for example, may not be needed for future evaluation since the mile-days of milt and acoustic surveys provide more precise time series of relative abundance.

Goal 3: collect time series of herring abundance worldwide to find out how often herring collapse normally. A new MS student, John Trochta, has been recruited, and started in Fall 2014, and he has now taken over the running of the revised ASA model and is also working on this meta-analysis project. Preliminary results from stock assessments suggest that PWS herring has remained at low biomass levels for an unusually long period of time. However the compiled data does not include several herring stocks that collapsed, did not recover and therefore do not have recent stock assessments.

Additional highlights: graduate student Melissa Muradian completed work on the Bayesian age-structured assessment model, and also completed the project looking at which data sources are most important in assessing current status of this population. She also successfully defended her MS thesis (Muradian 2015), coauthored several publications, and is planning to submit her two projects for peer-reviewed publication in summer 2015.

Conferences:
John Trochta gave an oral presentation at the Ocean Modeling Forum – Pacific Herring Summit in Vancouver BC, June 8-10, 2015.
Alaska Marine Science Symposium, Anchorage 19-23 January 2015 (John Trochta attended, Melissa Muradian gave an oral presentation)

Completed thesis:
Muradian ML (2015) Modeling the population dynamics of herring in the Prince William Sound, Alaska. University of Washington

Peer-reviewed and published papers:

Hurtado-Ferro F, Szuwalski CS, Valero JL, Anderson SC, Cunningham CJ, Johnson KF, Licandeo R, McGilliard CR, Monnahan CC, **Muradian ML**, Ono K, Vert-Pre KA, Whitten AR, Punt AE (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 KF, Monnahan CC, McGilliard CR, Vert-pre KA, Anderson SC, Cunningham CJ, Hurtado-Ferro F, Licandeo RR, **Muradian ML**, Ono K, Szuwalski CS, Valero JL, Whitten AR, Punt AE (2015) Time-varying natural mortality in fisheries stock assessment models: identifying a default approach. ICES Journal of Marine Science 72:137-150

Ono K, Licandeo R, **Muradian ML**, Cunningham CJ, Anderson SC, Hurtado-Ferro F, Johnson KF, McGilliard CR, Monnahan CC, Szuwalski CS, Valero J, Vert-Pre KA, Whitten AR, Punt AE (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

The Science Panel posed a few questions during the last proposal submission that we will attempt to answer.

There is fairly regular dialog between the PI, the students, ADF&G personnel, and others in the program about the proper use of data inputs, what would be needed to transition the Bayesian model to ADF&G, and the cost associated with collecting the input variables. The questions regarding acoustics data and spawn surveys were address in the thesis of Melissa Muradian and are described under the discussion related to goal 2 of this project. As suggested, the analysis described there was only possible through collaboration with other investigators in the program to understand the potential errors in the inputs and the cost of collecting the data.

II. COORDINATION AND COLLABORATION

A. Within the Program

The stock assessment acts as a synthesis of many of the components of the current program, including age-sampling, disease estimates, and hydroacoustic surveys. In summer 2014, Melissa Muradian participated in the hydroacoustic surveys, both from the Prince William Sound Science Center and ADF&G, and a similar coordinated trip is anticipated for John Trochta in summer 2016. Regular meetings between the PIs on the project ensure information sharing.

Indirectly, John Trochta has joined an NCEAS SNAP project that is looking at, amongst other things, broad hypotheses for the decline in PWS herring. He will be using the revised ASA model as the basis for analyses on herring dynamics and responses to perturbations (in PWS and in other Gulf of Alaska stocks) as part of a greater ecosystem portfolio. These analyses will include testing of different anthropogenic and environmental forcing hypotheses on herring dynamics using the ASA model, as well as discerning trends and correlations among other GOA stock dynamics using information from the meta-analysis.

NCEAS group: Applying portfolio effects to the Gulf of Alaska ecosystem: Did multi-scale diversity buffer against the Exxon Valdex oil spill?
PIs: Kristin Marshall, Anne Beaudreau, Richard Brenner, Mary Hunsicker, Eric Ward, and Ole Shelton
Website: https://www.nceas.ucsb.edu/projects/12700

B. With Other Council-funded Projects

None

C. With Trustee or Management Agencies

The stock assessment revisions and updates are regularly shared with, and collaboratively developed with Steven Moffitt and Rich Brenner from ADF&G. Sherri Dressell of ADF&G has provided extensive feedback on research methods, results and conclusions, and is keen for the revised ASA model to be implemented for other Alaskan herring fisheries. At present the Bayesian assessment developed here will be used as an alternative assessment in determining the status of Prince William Sound herring.

III. PROJECT DESIGN – PLAN FOR FY16

A. Objectives for FY16

1. Finalize gathering of time series of abundance and recruitment for herring stocks and other clupeids
2. Attend the Annual Marine Science Symposium, Anchorage, and the annual Cordova meeting with the project PIs.
3. Prepare and submit manuscript combining the stock assessment details and the project to identify the most informative datasets using management strategy evaluation.

B. Changes to Project Design

Two papers are planned to be submitted in 2015: the assessment paper, and the paper looking at the value of past data collected for the assessment of PWS herring. The intent is to submit both by the end of summer 2015. In the revised plan for December 2014, we had thought of combining these into a single paper, but it is clear that two papers would be better.

There has been a smooth transition period between MS student Muradian graduating and the new MS student Trochta taking over, with a three-quarter overlap between them. For long-term planning it would be wise in the future to budget for one extra quarter of student support to allow for a one-quarter overlap between successive students on the modeling component and thereby ensure a smooth succession.

An additional paper may result from Trochta's work, which would be looking at the relative support from the data for different hypotheses for the decline and failure to recover of PWS herring.

Otherwise all elements of the project are on the original schedule.

IV. SCHEDULE

A. Project Milestones for FY 16

For each project objective listed, specify when critical project tasks will be completed, as submitted in your original proposal. Please identify any substantive changes and the reason for the changes. Please format your information as in the following example:

Objective 1. Prepare and submit manuscript combining the stock assessment details and the project to identify the most informative datasets using management strategy evaluation.
To be met by August 2015.

Objective 2. Complete required coursework (John Trochta).
Completed by June 2015 except for one course in Fall 2015

Objective 3. Overview of hypotheses for decline (new item).
Intended for December 2015. Item added as part of coordination with NCEAS group.

Objective 4. Finalize gathering of time series of abundance and recruitment for herring stocks and other clupeids

Originally intended for December 2014, preliminary data gathering completed, but several important datasets have proven difficult to track down. Revised schedule: May 2016.

B. Measurable Project Tasks for FY 16

Specify, by each quarter of each fiscal year, when critical project tasks (for example, sample collection, data analysis, manuscript submittal, etc.) will be completed, as submitted in your original proposal. Please identify any substantive changes and the reason for the changes. Please format your schedule as in the following example:

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)

March: Draft manuscript: Meta-analysis of herring dynamics: duration of collapses and likelihood of recovery.

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)

May: Annual Cordova meeting with broader project PIs [completed]

May Finalize gathering of time series of abundance and recruitment for herring stocks and other clupeids [formerly December 2014]

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)

September: Manuscript submission: Meta-analysis of herring dynamics: duration of collapses and likelihood of recovery.

FY 15, 4th quarter (November 1, 2016- January 31, 2017)

January: Attend Annual Marine Science Symposium, Anchorage

V. PROJECT PERSONNEL – CHANGES AND UPDATES

None.

VI. BUDGET

A. Budget Forms

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	
Travel	$982.0	$3,636.0	$8,194.0	$7,812.0	$8,508.0	$29,132.0	
Contractual	$0.0	$16,884.0	$0.0	$0.0	$0.0	$16,884.0	
Commodities	$200.0	$0.0	$20,552.4	$21,286.5	$22,050.0	$64,088.9	
Equipment	$0.0	$4,000.0	$0.0	$0.0	$0.0	$4,000.0	
Indirect Costs (*will vary by proposer*)	$11,944	$20,863	$25,188	$25,761	$26,952	$110,708.0	
SUBTOTAL	$33,860.0	$79,828.7	$89,757.9	$92,115.9	$96,256.7	$391,819.2	$0.0
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	

B. Changes from Original Proposal

No change.

C. Sources of Additional Funding

None.

***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	$20,734.0	$34,445.7	$35,823.5	$37,256.4	$38,746.7	$167,006.3	
Travel	$982.0	$3,636.0	$8,194.0	$7,812.0	$8,508.0	$29,132.0	
Contractual	$0.0	$16,884.0	$0.0	$0.0	$0.0	$16,884.0	
Commodities	$200.0	$0.0	$20,552.4	$21,286.5	$22,050.0	$64,088.9	
Equipment	$0.0	$4,000.0	$0.0	$0.0	$0.0	$4,000.0	
Indirect Costs (*will vary by proposer*)	$11,944	$20,863	$25,188	$25,761	$26,952	$110,708.0	
SUBTOTAL	$33,860.0	$79,828.7	$89,757.9	$92,115.9	$96,256.7	$391,819.2	$0.0
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.

FY12-16

Project Title: PWS Herring: Population dynamics modeling
Primary Investigator: Trevor Branch

FORM 3A
NON-TRUSTEE AGENCY SUMMARY

Date Prepared:08/15/2014

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor A. Branch	Assistant Professor	1.0	12127.9		12,127.9
To be arranged	Research Assistant	12.0	2218.2		26,618.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	14346.2	0.0	
				Personnel Total	$38,746.7

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Travel Seattle to Cordova, annual PI meeting	307.0	2	6	225.0	1,964.0
Marine Science Symposium	307.0	2	14	195.0	3,344.0
AFS meeting, venue to be arranged	400.0	2	12	200.0	3,200.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8,508.0

FY16

Project Title: PWS Herring: Population dynamics modeling
Primary Investigator: Trevor Branch

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared:08/15/2014

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

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Publication charges for scientific papers, page charges and color page charges	2,000.0
Tuition for graduate student	19,850.0
Long distance telephone, photocopying, printer cartridges etc.	200.0
Commodities Total	$22,050.0

FY16

Project Title: PWS Herring: Population dynamics modeling
Primary Investigator: Trevor Branch

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared:08/15/2014

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY16

Project Title: PWS Herring: Population dynamics modeling
Primary Investigator: Trevor Branch

FORM 3B
EQUIPMENT DETAIL

Date Prepared:08/15/2014

FY16 PROJECT PROPOSAL SUMMARY PAGE

New Project

Project Title: PWS Herring Research & Monitoring: Annual Herring Migration Cycle - Expanding Acoustic Array Infrastructure

Project Period: February 1, 2016 – January 31, 2017

Primary Investigator(s): Mary Anne Bishop, Ph.D., Prince William Sound Science Center, Cordova
mbishop@pwssc.org

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

Abstract: One of the important knowledge gaps for the Pacific herring (*Clupea pallasii*) population in Prince William Sound (PWS) is understanding adult herring annual migration movements between spawning, summer feeding, and overwintering areas. In 2013 we documented post-spawn migration of herring from Port Gravina to the PWS entrances by acoustic tagging adult herring and collecting data from the Ocean Tracking Network acoustic arrays. The 2013 study, however, could not verify if herring were migrating out into the Gulf of Alaska and then returning to PWS because of the layout of the Ocean Tracking Network arrays.

The goal of this herring study is to clarify the annual migration cycle of PWS adult herring. The objectives of this FY16 proposed project are to 1) purchase and deploy additional acoustic receivers at the Ocean Tracking Network arrays so that the direction of herring movements (into or out of PWS) can be determined; and 2) purchase acoustic tags. Achieving these objectives in FY16 will then allow us in FY17 to begin to address objectives aimed at 1) documenting adult herring migration movements out from and into PWS; and 2) understanding factors that influence migration patterns including age, condition, spawning location, and residency in PWS.

Because it takes several months from the start of funding to get tags and equipment purchased, prepared, and deployed, completing these activities during FY16 will allow us to initiate acoustic tracking studies in 2017 when herring are aggregated on their spring spawning grounds. With the batteries of the Hinchinbrook Entrance and Montague Strait acoustic arrays expiring around March 2020, a tagging program starting in 2017 provides a larger time window (three seasons, FY17, 18, 19) for collecting high quality data and increases the feasibility of monitoring herring aggregations in the three major spawning areas: Port Fidalgo, Port Gravina, and Montague Island. In addition, by using acoustic tag programmed at low power only, battery life on acoustic tags would be increased to of ~400 days. This would allow us to monitor acoustic-tagged herring from one spawning season to the next.

Estimated Budget: EVOSTC Funding Requested* (*must include 9% GA*):

FY15	FY16	FY17	FY18	FY19	TOTAL
	$272.6				

Non-EVOSTC Funds to be used:

FY15	FY16	FY17	FY18	FY19	TOTAL
	$415k in-kind				

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date:
August 31, 2015

EXECUTIVE SUMMARY

Justification

One of the important knowledge gaps for the Pacific herring (*Clupea pallasii*) population in Prince William Sound (PWS) is understanding adult herring annual migration movements between spawning, summer feeding, and overwintering areas. In 2013 we documented post-spawn migration of herring from Port Gravina to the Prince William Sound entrances by acoustic tagging adult herring and collecting data from the Ocean Tracking Network acoustic arrays. The 2013 study, however, could not verify if herring were migrating out into the Gulf of Alaska (GOA) and then returning to Prince William Sound because of the single-line layout of the Ocean Tracking Network arrays.

The goal of this herring study is to clarify the annual migration cycle of PWS adult herring. The objectives of this proposed project are to 1) purchase and deploy additional acoustic receivers at the Ocean Tracking Network arrays so that the direction of herring movements (into or out of PWS) can be determined; and 2) purchase acoustic tags. Achieving these objectives in FY16 will then allow us in FY17 to begin to address objectives aimed at 1) documenting adult herring migration movements out from and into PWS; and 2) understanding factors that influence migration patterns including age, condition, spawning location, and residency in PWS.

Because it takes several months from the start of funding to get tags and equipment purchased, prepared, and deployed, completing these activities during FY16 will allow us to initiate acoustic tracking studies in FY17 when herring are aggregated on their spring spawning grounds. With the batteries of the Hinchinbrook Entrance and Montague Strait acoustic arrays expiring around March 2020, a tagging program starting in FY17 provides a larger time window (three seasons: FY17, 18, 19) for collecting high quality data and increases the feasibility of monitoring herring aggregations in the three major spawning areas: Port Fidalgo, Port Gravina, and Montague Island.

Background

Conservation concerns about the recovering Pacific herring population in PWS make it increasingly important to document migration patterns to inform our understanding of PWS adult herring survival. Little is understood about adult Pacific herring annual migration movements between spawning, summer feeding, and overwintering areas within and between PWS and the GOA

Elsewhere, it is common for large herring populations to migrate from nearshore spawning areas to coastal shelf areas for summer feeding habitat (Hay and McCarter 1997, Hay et al. 2008). Corten (2002) suggested that observed herring migration patterns are not innate, but are a learned behavior that initially occurs when the recruiting year class follows older herring. In his review of migration in Atlantic herring (*C. harengus*) Corten observed that herring migration patterns tend to be stable over years, despite environmental variation. In PWS, Brown et al. (2002) compiled local and traditional knowledge on adult herring movements. In that study, some fishers reported herring moving into PWS through Montague Strait prior to the fall bait fishery while others reported herring moving into PWS in spring through Hinchinbrook Entrance, Montague Strait and the southwest passages of Erlington and LaTouche. These observations suggest that PWS herring are regularly migrating out of PWS and onto the shelf.

During winter, adult Pacific herring along the eastern Pacific Ocean often return to coastal areas and remain close to spawning areas and in nearshore channels (Hay and McCarter 1997). This behavior has also been observed in PWS herring populations, where historically large schools both overwintered and spawned around northern Montague and Green Islands. More recently however, the major biomass of adult herring during winter has shifted to the northeast and southwest areas of PWS. Currently the

largest concentration of adult herring overwinters and spawns around Port Gravina and Port Fidalgo (ADFG herring portal http://data.aoos.org/maps/pwsherring/**).**

Previous studies of Pacific herring movements in the eastern Pacific have utilized fisheries-dependent tag recovery and CPUE data (*e.g.* Hay and McKinnell 2002, Tojo et al. 2007). Unfortunately, making inferences about herring movement from fisheries-dependent data is problematic because fishing effort may not be consistent in all locations or across seasons, and recapture rates are typically low (< 10 %). Furthermore, tag recovery and CPUE methods typically provide poor temporal and spatial resolution on the rate and timing of large scale migrations.

We propose to utilize acoustic telemetry to investigate seasonal movement patterns of Pacific herring. Post-spawn feeding, winter, and subsequent spawning migrations will be examined by tagging herring on PWS spawning grounds during spring and monitoring their movement patterns with moored acoustic arrays. The use of acoustic telemetry will allow us to look at movement patterns on a variety of temporal and spatial scales, filling in significant gaps in our current knowledge of herring migration.

Our proposed project builds on an EVOS Herring Research & Management (HRM) pilot project of the Principal Investigator M. Bishop and collaborator J. Eiler (NOAA). Our pilot project developed handling and tagging methods designed to minimize physical injuries and stress to wild herring (Eiler and Bishop *in review*). In April 2012, we successfully tagged 25 wild herring on their spawning grounds with acoustic transmitters. Post-release, 23 (92%) of the 25 tagged individuals were detected by a VR2W acoustic receiver multiple times on one or more days post release. Subsequently, the February 2013 installation of the Ocean Tracking Network's (OTN) six acoustic receiver arrays across the entrances to the GOA provided the first opportunity to detect movements from the spawning grounds to the entrances. In April 2013 we tagged 69 adult Pacific herring on the spawning grounds at Port Gravina. Tags had an expected life of 263 d. Post-release we detected 93% of the tagged herring (64 of 69) either at Port Gravina and/or the OTN arrays (Eiler and Bishop *in review*).

Based on detections at the OTN arrays, we were able to document that many of the tagged herring remained in and around the entrances to PWS from mid April through early June. By July, most tagged herring had departed from Hinchinbrook Entrance and Montague Strait areas, with fish at Montague Strait 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 at the Montague Strait array and the Southwest Passages arrays right up to when tags expired in early January 2014, indicating that not all herring winter in northeast PWS, and that some herring are highly mobile and may be moving back and forth into the GOA even during winter months (Bishop and Eiler, *in prep*.).

The results of our EVOS 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. However, we are unable to determine the directionality of tagged fish movements based on data from the Ocean Tracking Network arrays as they are currently configured because each array consists of one, east to west line of receivers. With a relatively small investment, our inability to determine the direction of herring movements could be remedied.

Our 2013 study found that at both the Hinchinbrook Entrance array (n = 16 receivers) and the Montague Strait array (n = 11 receivers) that most acoustic-tagged herring detections occurred at the outermost receivers (Hinchinbrook n = 96% of all detections at 4 receivers; Montague n = 80% at 4 receivers). When we examined final detections of tagged fish, we determined that >85% of the final detections occurred at these outermost receivers (Bishop and Eiler, *in prep.*). Therefore deploying additional receivers just below these outermost receivers would allow for determination of the movement direction

for a large proportion of the herring detections. In addition, by using acoustic tags programmed at low power only, battery life would be increased to ~400 days. This would allow us to monitor acoustic-tagged herring from one spawning season to the next.

Key hypotheses and overall goals

The overall goal of our long-term (FY16-20) study is to clarify the annual migration cycle of PWS adult herring. For FY16 we are requesting EVOS funding in order to:

1) purchase and deploy additional acoustic receivers at the Ocean Tracking Network arrays so that the direction of herring movements (into or out of PWS) can be determined; and,

2) purchase acoustic tags.

Achieving these objectives in FY16 will then allow us in FY17 to begin to address objectives aimed at 1) documenting adult herring migration movements out from and into PWS; and 2) understanding factors that influence migration patterns including age, condition, spawning location, and residency in PWS. The FY17-20 portion of the study will be part of the EVOS Herring Research and Monitoring Program and will test the following hypotheses:

H_1: Pacific herring populations in PWS make seasonal, post-spawn feeding migrations through major entrances and passages to the Gulf of Alaska.

a) Fish with poor body condition are less likely to migrate.
b) New recruits to the spawning population are less likely to migrate than older herring.

H_2: The Prince William Sound herring population is comprised of migrant and resident individuals.

a) Resident individuals remain within the confines of Prince William Sound.
b) Resident herring are associated with specific spawning grounds.
c) Migrant individuals exit Prince William Sound by mid-June and return to the Sound in either fall or spring.

H_3 Survival is related to age and body condition.

For FY16 we are requesting a total of **$272.6K** ($250.1K project costs + 22.5K general admin costs) for the purchase of equipment and tags needed to test the above hypotheses about herring movements. We need to purchase equipment in FY16 because:

- It will take several months from the start of funding to get tags and equipment purchased, prepared, and deployed.
- A February start date for FY17 funding means that equipment and acoustic tag purchases cannot be completed by the beginning of April, when herring aggregate to spawn. Capture efficiency is highest during spawning events. Spawning events are also associated with initiation of migration.
- The batteries of the Ocean Tracking Network array VR4 receivers are expected to expire around March 2020. This infrastructure (comprised of 34 acoustic receivers) is essential for collecting high quality data on herring movement and survival. Initiating studies that take advantage of existing OTN infrastructure before it expires allows for major leveraging of funds to complete EVOSTC objectives.

- If we are unable to begin tagging until 2018 we will only have two opportunities to observe annual migration patterns. A tagging program starting in 2017 provides a larger time window for collecting high quality data and increases the feasibility of monitoring herring aggregations in the three major spawning areas: Port Fidalgo, Port Gravina, and Montague Island.

II. COORDINATION AND COLLABORATION

1. Within the Program

Our study, PWS Herring Annual Migration Cycle, will be a component of the larger, EVOS-sponsored Herring Research and Monitoring (HRM) program. While the FY17-21 HRM projects are not yet finalized, we anticipate that we will coordinate with at least two other HRM projects.

EVOS Herring Research & Monitoring	
Herring disease	USGS
Hydroacoustic surveys	PWSSC

Our project will also provide information that will complement data collected by three existing projects in the EVOS Gulf Watch Alaska pelagic component:

EVOS GulfWatch	
Forage fish distribution, abundance, & body condition in PWS	USGS
Humpback whale predation	NOAA/UAS
Fall and winter seabird abundance & distribution	PWSSC

Understanding movements by adult herring throughout the annual cycle will provide valuable information on trophic interactions between herring and piscivorous waterbirds (in particular loons and common murre the major avian consumers of adult herring), humpback whales, and other forage fish competitors.

2. With Other Council-funded Projects

Except for the EVOS Herring Research & Monitoring Program and the EVOS Gulf Watch Alaska program, there are no other EVOS-funded collaborations.

3. With Trustee or Management Agencies

Our project relies on information from Alaska Department of Fish and Game to help locate adult herring schools in spring for acoustic surveys and our sampling. To that extent, we work closely with Steve Moffitt at the Cordova office of ADF&G. Information learned about herring migrations will be shared with ADF&G.

Collaborations with other organizations

This project will synergize with efforts of the Ocean Tracking Network (OTN; Fred Whoriskey, PhD Executive Director, Dalhousie University). In March 2013, OTN installed two, large-scale arrays including one across the mouth of Hinchinbrook Entrance and one across Montague Strait, and four small arrays at the southwest PWS passages of Erlington, LaTouche, Bainbridge and Prince of Whales. Equipment was assembled and configured by PWS Science Center personnel in Cordova. Currently PWSSC maintains the array for OTN on an annual basis. OTN maintains a database with detections from their worldwide network. Our data is archived in the OTN databases, as per their guidelines.

III. PROJECT DESIGN

A. Objectives

Project Objectives FY16

1) Purchase and deploy additional receivers around the Ocean Tracking Network arrays.
2) Purchase acoustic tags

Because it takes several months from the start of funding to get tags and equipment purchased, prepared, and deployed, completing these activities during FY16 will allow us to initiate acoustic tracking studies in 2017 when herring are aggregated on their spring spawning grounds.

Project Objectives for FY17-20, the second phase of this project, include:

1) Document location, timing and direction of Pacific herring seasonal migrations between Prince William Sound and the Gulf of Alaska.
2) Relate large-scale movements to year class and body condition of tagged individuals.
3) Determine seasonal residency time within PWS, at the entrances to PWS, and in the Gulf of Alaska.

The hypotheses we will test as part of the larger study include:

H_1: Pacific herring populations in PWS make seasonal, post-spawn feeding migrations through major entrances and passages to the Gulf of Alaska.

a) Fish with poor body condition are less likely to migrate.
b) New recruits to the spawning population are less likely to migrate than older herring.

H_2: **The** Prince William Sound herring population is comprised of migrant and resident individuals.

a) Resident individuals remain within the confines of Prince William Sound.
b) Resident herring are associated with specific spawning grounds.
c) Migrant individuals exit Prince William Sound by mid-June and return to the Sound in either fall or spring.

H_3: Survival is related to age and body condition.

H_4: Fine-scale spatial use patterns are associated with individual biological characteristics and vary seasonally.

B. Procedural and Scientific Methods

Acoustic receivers will be secured via a combination of static subsurface moorings and subsurface moorings with acoustic releases (depending on the individual receiver location, depth and potential interaction with commercial fishing operations; Eiler and Bishop, *in review*).

Acoustic tag data collected via fixed acoustic arrays provide presence-absence data of individual herring with very high temporal resolution; however, the spatial resolution depends upon detection range and the size and configuration of the acoustic array. The acoustic arrays currently deployed in the entrances and major passages into Prince William Sound (PWS) are configured as a 'gate' (Heupel et al. 2006) and are designed to detect fish moving through these corridors. Detection probability of this gate is likely high based on the spacing of the receivers (mean distance between receivers= 724 m; max= 835 m) and detection range data collected in 2013 using moored range tags (Fig. 1). At 400 m, 93% of the

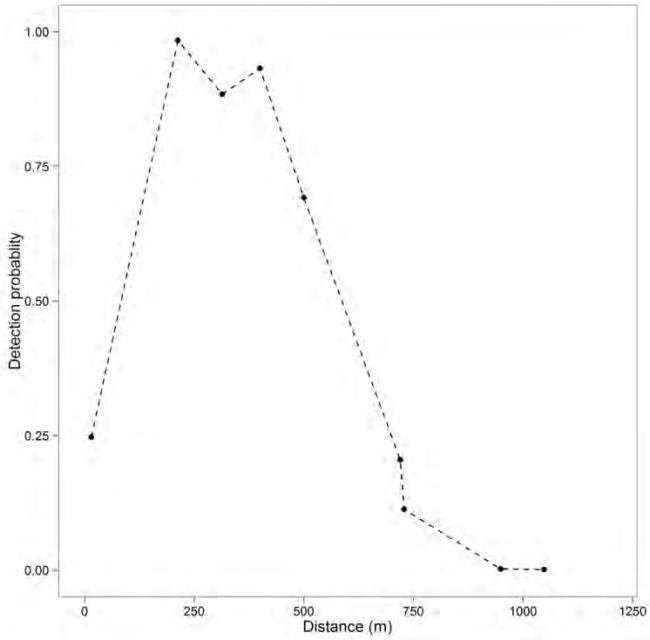

Figure 1. Proportion of reference transmitter signals detected by acoustic receivers near Hinchinbrook Entrance in Prince William Sound.

transmitted signals were recorded and 69% were recorded at 500 m; thus, all fish moving through this acoustic gate will have a high probability of being detected by at least one receiver.

However, as currently configured, the directionality of movement (north into PWS or south towards the Gulf of Alaska) after detection at any of the arrays cannot be determined. To address the objectives of this study, the detection capabilities of these acoustic arrays will be increased by deploying 16 receivers in January 2017. These additional receivers will be configured as a second gate at each array and will provide the data needed to determine directionality of movement away from the array (Fig. 2; Fig. 3). At Montague Strait and Hinchinbrook Entrance, deploying complete second lines of 11 and 16 receivers, respectively, is currently cost prohibitive. Therefore, receivers will be deployed along the east and west coastlines of these two corridors (Figs. 2, 3). These receiver configurations are based on data from the 2013 tagging study that indicate herring use nearshore habitat much more frequently than mid-channel habitat at both these sites. Specifically, 86.8% of the 26,371 detections from Montague Strait and Hinchinbrook Entrance were recorded on the outermost (nearshore) receivers (Bishop and Eiler, *in prep*.). Thus, a second gate at both Montague Strait and Hinchinbrook Entrance, though incomplete, will each have a high probability of detecting tagged herring using these corridors. Further, the detection probability of the second gate can be estimated in our data analysis and used to reduce the bias in our movement rate estimates caused by incomplete detection at the second gate.

In addition to the installation of a second gate at the major entrances and the southwest passages, an array of nine VR2W receivers located near tagging sites in northeast Prince William Sound will be deployed in order to monitor post-tagging movements and the timing of outmigration and subsequent migrations back to the area. These receivers are currently being used by PWSSC in a Pacific cod movement project that is scheduled to end shortly before the 2017 field season. The intent of our array configuration will be to maximize the detection probability of tagged fish on the spawning grounds. Data from this array will allow researcher to address questions relating spawning site fidelity, monitor post-tagging survival, increase the resolution of movement patterns within PWS, and provide data needed for robust survival estimation. These receivers will be deployed with acoustic releases and upon

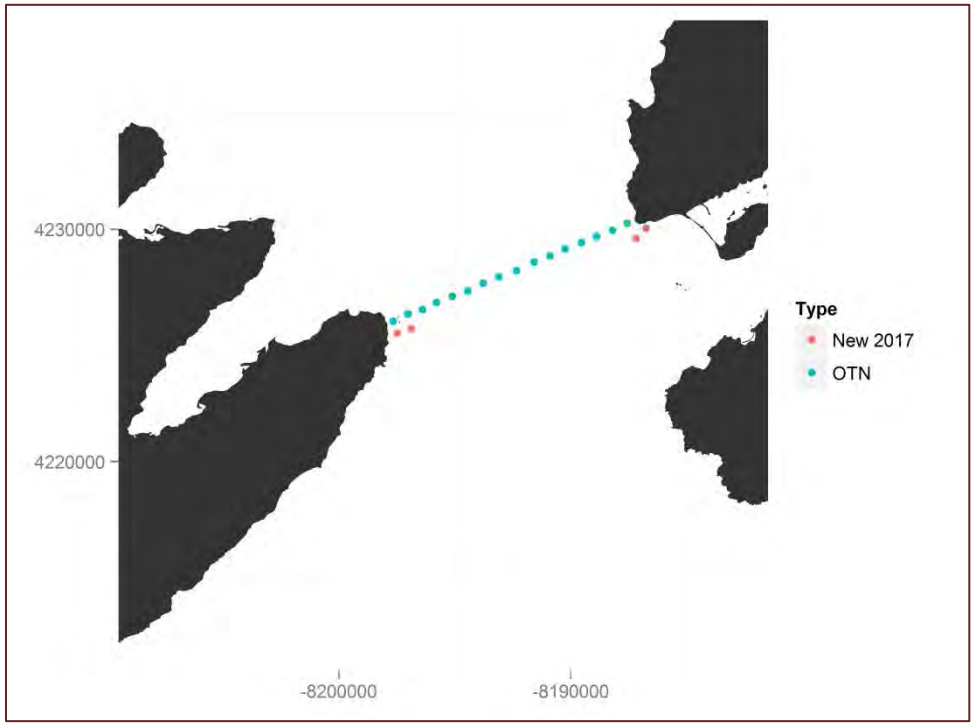

Figure 2. Location of the OTN acoustic array in Hinchinbrook Entrance and proposed locations for receivers to be deployed in January 2017.

Figure 3. Location of the OTN acoustic array in Montague Strait and the four southwest passages and proposed locations for receivers to be deployed in January 2017.

retrieval at the end of the first year of data collection (May 2018) they can be redeployed at the 2018 tagging site to monitor the 2018 tagging cohort. The feasibility of monitoring multiple spawning sites per year with the available number receivers will be assessed after the first year of data collection.

Because it takes several months from the start of funding to get tags purchased, ordering tags during FY16 will allow us to initiate acoustic tracking studies in 2017 when herring are aggregated on their spring spawning grounds. Herring will be tagged with acoustic transmitters (Model V9-2L, 69 kHz) programmed to transmit at 146 dB every 90-150 seconds with a battery life of approximately 400 days. Each transmitter emits a unique series of pings that can be decoded and recorded if the tagged herring is within the detection range of a receiver. Codes from successfully decoded transmissions are recorded and stored in the receiver memory along with the date and time they were received. Once the receiver is in hand (VR2W receivers) or connection is made with a Teledyne Benthos surface modem (VR4 receivers) a file containing the complete detection records for the duration of deployment can be uploaded.

During spring 2017 (FY17) herring will be captured and tagged in Port Gravina following the methods of Eiler and Bishop (*in review*). Using these methods, 91.4% of tagged fish (N= 94) were subsequently detected in PWS, indicating that measures taken to reduce tagging and handling related stress were successful and post-tagging survival was high (Eiler and Bishop *in review*). Based on the minimum standard length of herring tagged by Eiler and Bishop, the minimum standard length of herring considered for tagging in this study will be 190 mm (age ~3-4 yrs). To address hypotheses related to the relationship between individual biological characteristics and movement and survival, we will ensure that the length distribution of our tagged fish sample is approximately uniform over a wide size range. Specifically, 10-mm length bins ranging from 190 mm to 250 mm (the largest length bin contains fish > 250 mm) will be implemented and each length bin will constitute approximately 14% of the total tagged sample. In addition to standard length, the sex of each tagged herring will be determined and weight (g) data will be collected. Finally, a condition index ($k= weight \cdot length^{-3}$; Slotte, 1999; Kvamme et al., 2003) will be calculated for each tagged herring from individual length and weight data.

C. Data Analysis and Statistical Methods

Hypotheses $\mathbf{H_1}$, $\mathbf{H_2}$, and $\mathbf{H_3}$ pertain to herring survival rates and large scale movement rates and how these rates change seasonally or in relation to individual biological characteristics. Estimates of survival are needed to generate unbiased estimate movement rates; therefore, our ability to estimate survival will affect the quality of our movement rate estimates. Our analytical approach for addressing these hypotheses has two major components: estimating survival using discrete-time multistate Markov models (Lebreton and Pradel 2002) and estimating herring movement with continuous-time multistate Markov models (Miller and Andersen 2008). Survival will be estimated by binning detection data into discrete intervals (Barbour et al. 2013) and analyzing these data using discrete-time multistate Markov models developed using the RMark package (Laake 2013). Binning continuous-time detection data into relatively large discrete time steps is necessary for estimating survival using the well-established methods developed for convention mark-recapture experiments; however, this diminishes the quality of the data collected by fixed acoustic arrays. To efficiently utilize the high-quality data collected by the acoustic arrays, we will use continuous-time Markov models to estimate herring movement rates and fix the survival rate at the value estimated from the discrete time model. In addition to movement rates, we will use the continuous-time model to calculate seasonal mean residency time in the GOA and PWS.

As permanent emigration from the study area cannot be distinguished from mortality, the discrete-time model actually estimates apparent survival; however, apparent survival is equal to the true survival rate if tagged herring do not permanently emigrate from the study area. Herring emigration out of PWS is likely temporary, and based on the spatial coverage of our acoustic array and the extended battery life of our acoustic tags (400 days), we expect the bias in our survival estimates due to permanent emigration from the study area to be low.

Finally, our hypothesis (**H_4**) addressing fine-scale spatial use patterns will be investigated using Brownian bridge movement models (Horne et al. 2007; Pages et al. 2013) and by calculating simple summary statistics for each acoustic receiver.

Survival estimation and power analyses

To address our hypothesis relating to the relationship between individual biological characteristics and survival, we will develop discrete-time multistate Markov models with covariates for size, weight, and condition. A suite of estimation models will be developed and the most parsimonious models will be selected using Akaike's information criterion (AIC) corrected for small sample size bias (AIC*c*) (Burnham and Anderson 2002).

To further support our analytical approach and to determine the sample size needed to generate estimates of herring survival rates, we simulated datasets and conducted a power analysis using our proposed methods to estimate survival. Datasets were generated from a transition intensity matrix with instantaneous transition rates based on estimates from the 2013 pilot project. The instantaneous transition rates describe the movement of herring between states defined by the acoustic arrays. The states that tagged herring could inhabit were: present at an array, undetected in PWS, undetected in the GOA (outside of the entrance arrays), or mortality (Fig. 4). Of these seven states, there are three observable states (one for each array: northeast PWS spawning grounds, inner PWS gate, outer PWS gate), four unobservable states (three undetected states and the mortality state), and 10 instantaneous transition rates based on the spatial configuration of the arrays (Fig. 4).

Survival was assumed to be constant over the duration of the study, while movement rates changed seasonally to describe a herring population that moved towards the entrances after spawning, had a long

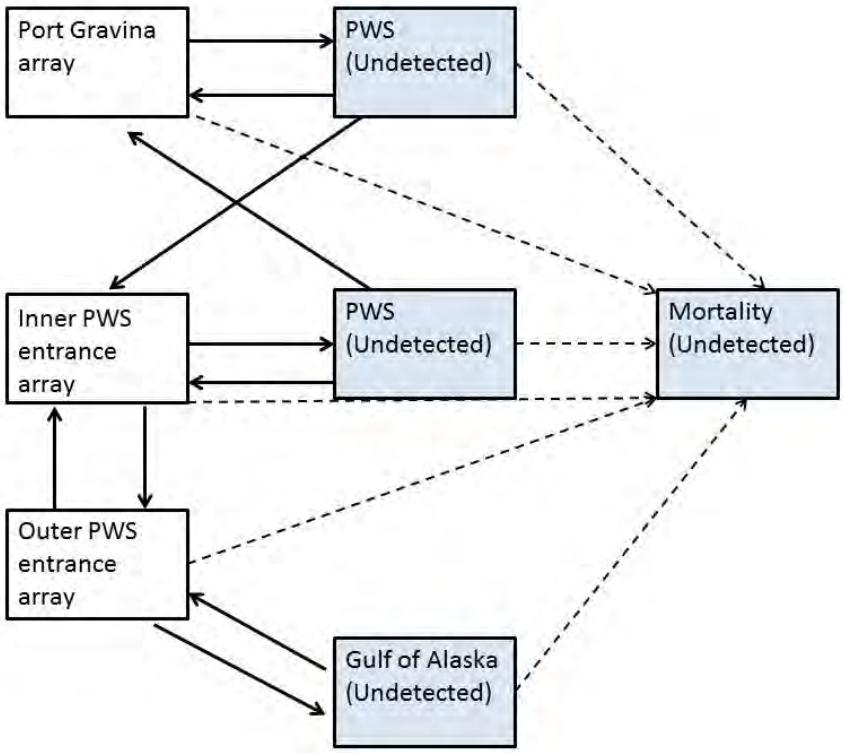

Figure 4. Schematic of the multistate model used to describe herring movements between acoustic arrays (solid line= movement; broken line= mortality).

average residency time in the GOA in the summer, and returned to the spawning area the following spring with high fidelity. Incomplete detection of herring moving through the outer entrance array (detection probability=0.85) was simulated by including an indicator variable for detection at the outer entrance array. The detection indicator variable was populated by a random binomial with a success probability of 0.85. Residency periods at the outer array with a 1 were observed, while residency periods with a 0 were undetected and removed from the dataset.

Additionally, the simulated population had different annual survival rates (S) based on group membership (two groups). Group membership was assumed to be related to length, weight, or body condition and, therefore, would be known to researchers. Two effect sizes, a moderate (S=0.85; S=0.71) or large (S=0.88; S=0.68) difference in annual survival between the two groups, and five sample sizes (60, 80, 100, 120, and 140 herring released with 50% in each group) were considered. During each simulation the data were fit to two models, the full model with two survival rates based on group (the true model) and a reduced model with a single survival rate, and AIC*c* was calculated for each model. For each simulation scenario, 350 datasets were generated and statistics relating to model convergence, model selection, and parameter estimation were recorded. Model section statistics (ΔAIC*c*= AIC*c* full – AIC*c* reduced; percent correct= the percent of simulations where AIC*c* full < AIC*c* reduced) indicate the effect size detected and the probability of selecting the true model. Parameter estimation statistics (percent bias, percent root-mean-square error, 95% CI coverage, and 95% confidence interval half-width) assess the accuracy and precision of the survival estimates (Miller 2015).

The formulas for percent bias and percent RMSE are

1) Percent bias $= 100 * \left(\frac{S_{est} - S_{true}}{S_{true}}\right)$,

2) Percent RMSE $= 100 * \sqrt{\left(\frac{S_{est} - S_{true}}{S_{true}}\right)^2}$,

where S_{est} is the estimated annual survival rate and S_{true} is the true annual survival rate of the simulated population. Finally, percent bias, percent RMSE, and 95% CI half-width values from the 350 simulations were calculated for each simulation (N = 350) and the mean value was reported. This analysis was conducted using R (R Core Team 2014) and the RMark package (Laake 2013).

Model convergence in all simulation scenarios was high (0.95–1.00) and the probability of selecting the correct model using AIC*c* increased as sample size or effect size were increased (Table 1). Using the correct model for inferences, estimates on average tended to minimally underestimate the true survival rate (percent bias ranging from 0.4% to -1.8%), while the accuracy of estimates (measured by percent root-mean-square error) improved as sample size was increased. The coverage of the 95% CI for survival (i.e. the percentage of 95% confidence intervals that contained the true survival rate) was near the expected 95% for all simulation scenarios (91-95%), though the precision of the survival estimate (measured by the 95% CI half-width) increased as sample size was increased (Table 1).

Based on these results, a minimum of 120 herring will be tagged each year. This sample size will likely provide researchers enough statistical power to detect large differences in survival in herring based on measured biological covariates. Additionally, with this sample size we expect survival estimates to be both accurate (percent RMSE<11) and precise (95% CI half-width <0.13).

Our power analysis provides an example of the statistical methodology we propose to use to estimate apparent survival and the feasibility of applying these techniques to PWS Pacific herring stocks. Apparent survival of other species with large home ranges have been estimated from fixed acoustic

Table 1. Power analysis results for survival estimation and model selection using Multistate Markov models. For each simulation scenario consisting of an effect size (moderate or large) and sample size (N=60, 80, 100, 120, or 140), model selection and survival estimation summary statistics were calculated from 350 datasets generated from a simulated herring population.

	Moderate (S_1 = 0.85; S_2 = 0.71)					Large (S_1 = 0.88; S_2 = 0.68)				
Sample size	60	80	100	120	140	60	80	100	120	140
Model convergence	94.9	97.4	99.4	99.4	99.7	94.9	97.4	99.4	99.4	99.7
Model selection										
Median ΔAICc	-1.58	-0.47	-0.01	0.73	1.46	-0.14	1.86	2.82	4.73	5.68
Percent correct	29.4	43.8	49.6	58.5	64.9	49.3	69.3	76.0	85.7	89.4
Survival estimation										
Percent bias (S_1)	-0.9	-0.3	-0.6	-0.2	-0.3	-0.5	-0.1	-0.5	-0.2	-0.1
Percent bias (S_2)	-0.6	-0.8	-1.0	-0.7	-1.3	0.4	-1.1	-1.1	-1.8	-1.6
Percent RMSE (S_1)	7.9	7.7	6.6	6.1	5.5	6.7	6.3	5.9	5.1	4.7
Percent RMSE (S_2)	12.2	10.6	9.9	8.3	8.3	13.2	11.3	10.6	10.5	9.1
95%CI coverage (S_1)	94.1	91.1	94.6	92.6	93.1	91.9	92.9	92.2	93.4	93.7
95%CI coverage (S_2)	93.5	95.4	92.6	95.7	94.9	93.4	95.0	93.1	93.4	92.6
95%CI halfwidth (S_1)	0.135	0.117	0.107	0.098	0.091	0.12	0.105	0.097	0.089	0.083
95%CI halfwidth (S_2)	0.171	0.149	0.134	0.122	0.113	0.174	0.153	0.137	0.125	0.116

receiver arrays using discreet-time multistate Markov models, including Gulf sturgeon (*Acipenser oxyrinchus desotoi*; Rudd et al. 2014) and broadnose seven gilled shark (*Notorynchus cepedianus;* Dudgeon et al. 2015); thus, this methodology has also been successfully applied to real ecological datasets.

Movement rate estimation

The rate of herring movement between PWS and the GOA will be modeled using continuous-time multistate Markov models developed with the *msm* package (Jackson 2011) in R. Continuous time Markov models are commonly used in survival analysis in the medical field (Duffy et al. 1995) and have been used in a fisheries context to model Atlantic bluefin tuna (*Thunnus orientalis)* regional migration (Miller and Andersen 2008). Our approach will be to use the multistate model depicted in Figure 4 and estimate the transition rates (solid lines) and fix the survival rate (broken lines) at the estimated rate from the discrete model output. All of the possible transitions between states form a transition intensity matrix *Q*, such that:

$$Q = \begin{pmatrix} \varphi_{1,1} & \varphi_{1,2} & 0 & 0 & 0 & 0 & \varphi_{1,7} \\ \varphi_{2,1} & \varphi_{2,2} & 0 & \varphi_{2,4} & 0 & 0 & \varphi_{1,7} \\ \varphi_{3,1} & 0 & \varphi_{3,3} & \varphi_{3,4} & 0 & 0 & \varphi_{3,7} \\ 0 & 0 & \varphi_{4,3} & \varphi_{4,4} & \varphi_{4,5} & \varphi_{4,6} & \varphi_{4,7} \\ 0 & 0 & 0 & \varphi_{5,4} & \varphi_{5,5} & \varphi_{5,6} & \varphi_{5,7} \\ 0 & 0 & 0 & \varphi_{6,4} & \varphi_{6,5} & \varphi_{6,6} & \varphi_{6,7} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

where $\varphi_{i,j}$ is the instantaneous transition rate from state i to state j. The $\varphi_{4,6}$ and $\varphi_{6,4}$ transitions are included to allow for incomplete detection at the outer entrance array (state 5). All rows sum to zero and the probability of remaining in each state (transitions with state i = state j) is solved by subtraction. All transitions to the mortality state are set to a fixed rate and the remaining 12 transition parameters are estimated via maximum likelihood using the *msm* package (Jackson 2011). Due to incomplete detection at the outer entrance array, censored states need to be included in the analyses. Herring last detected at the inner array either migrated back into PWS (state 3) or moved through the outer array undetected and migrated into the GOA (state 6); thus, these herring are considered to be in a censored state that includes states 3 and 6. Similar to our approach for modeling herring survival, our hypotheses regarding herring movement can be addressed by developing models with covariates relating to time and individual biological characteristics and conducting model selection using AIC*c*.

Seasonal residency time

The estimated mean residency time at a given state can be estimated as $-1/q$, where q is one of the diagonal entries in Q (i.e. a φ value with state i equal to state j) (Duffy et al. 1995). If transition rates change seasonally, the corresponding seasonal mean residency times can be calculated. Additionally, we will calculate a residency index for each tagged individual as the proportion of calendar days detected at an array during a season and use this index to describe seasonal habitat usage (Cagua et al. 2015).

Spatial analyses

The multistate Markov model we used to estimate herring movement rates contained the minimum number of spatial states needed to describe large-scale herring movements because these models are "data-hungry" and become unwieldy as the number of states is increased. Therefore, spatially explicit Brownian bridge movement models (BBMM) will be used to investigate fine-scale herring movement patterns. These models are commonly used in wildlife ecology (Horne et al. 2007) and have recently been applied to datasets obtained from fixed acoustic telemetry arrays (Pages et al. 2013). In brief, BBMM estimate the probability of a tagged individual occupying an area over a given time period based on known locations collected at an intervals during that time period. From this output, home range size (km^2) can be estimated and the seasonality of spatial use patterns (e.g., preferentially using Montague Strait over Hinchinbrook Entrance post-spawning) can be examined.

Finally, statistics for individual receivers will be calculated to investigate spatial use patterns. The intensity of habitat use will be measured by calculating total number of detections and total number of individual herring for each receiver. Areas primarily used as corridors will be identified by calculating the ratio between non-consecutive detections (first detection after being detected by another receiver) and total detections (Pages et al. 2013). A non-consecutive detection will be defined as the first detection of an individual at a receiver after previously being detected at a different receiver. A high proportion of non-consecutive detections will indicate the area is primarily used as a corridor. Trends in these receiver-based statistics over time will be examined to investigate seasonal and diurnal trends in spatial usage patterns.

D. Description of Study Area

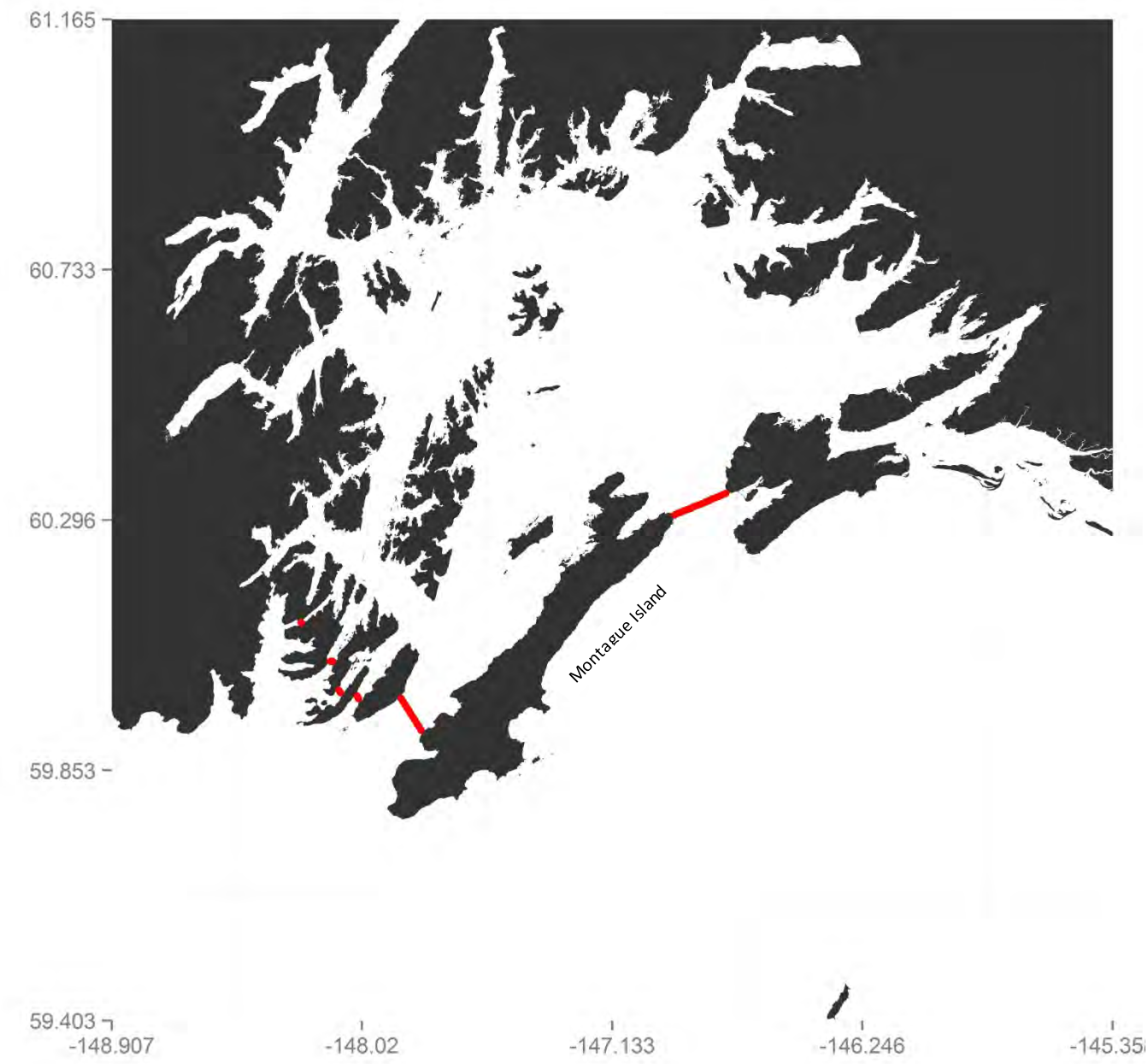

Fig. 5. Prince William Sound, Alaska. Our study will take place around spawning sites in northeast Prince William Sound and northern Montague Island and the Ocean Tracking Network acoustic arrays (noted in red).

IV. SCHEDULE

A. Project Milestones

Objectives 1 and 2 apply to this FY16 project. Objectives 3-5 apply to the next phase of this project (FY17-20).

Objective 1. Purchase and deploy additional receivers around the Ocean Tracking Network arrays.
To be met by January 31, 2017

Objective 2. Purchase acoustic tags.
To be met by January 31, 2017

Objective 3. Document location, timing and direction of Pacific herring seasonal migrations between Prince William Sound and the Gulf of Alaska.
To be met by January 2020

Objective 4. Relate large-scale movements to year class and body condition of tagged individuals.
To be met by January 2020

Objective 5. Determine seasonal residency inside PWS, at the entrances to Prince William Sound, and in the Gulf of Alaska.
To be met by January 2020

B. Measurable Project Tasks for FY 16

Specify, by each quarter of each fiscal year, when critical project tasks (for example, sample collection, data analysis, manuscript submittal, etc.) will be completed. Please format your schedule like the following example:

FY 16, 1st quarter (Feb 1 – Apr 30, 2016)
Apr Purchase acoustic receivers and acoustic release

FY 16, 2nd quarter (May 1-Jul 31, 2016)
Jun-Jul Prepare moorings

FY 16, 3rd quarter (Aug 1- Oct 31, 2016)
Aug Prepare FY17 work plan

FY 16, 4th quarter (Nov 1, 2016 – January 31, 2017)
Nov Order acoustic tags
Jan Deploy receivers at entrances in coordination with Ocean Tracking Network cruise
Jan Alaska Marine Symposium
Jan Submit annual report

V. PROJECT PERSONNEL

Curriculum Vitae

MARY ANNE BISHOP, Ph.D.

Research Ecologist,
Prince William Sound Science Center
300 Breakwater, PO Box 705
Cordova, Alaska 99574
907-424-5800 x 228; mbishop@pwssc.org

EDUCATION

Ph.D. Department of Wildlife and Range Sciences, University of Florida, Gainesville, 1988.
M.S. Wildlife and Fisheries Sciences, Department of Wildlife and Fisheries Sciences, Texas A & M University, College Station, 1984.
B.B.A. School of Business, University of Wisconsin, Madison, 1974.

RECENT PROFESSIONAL EXPERIENCE

Research Ecologist, Prince William Sound Science Center, Cordova, Alaska, Jun 1999-present
Research Wildlife Biologist, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska, 1990-1994 and 1997- May1999
Research Wildlife Biologist, Center for Streamside Studies and Dept. Fisheries, University of Washington, assigned to Copper River Delta Institute, Cordova, Alaska, 1994-1997
Acting Manager, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska, 1992-1993

SELECTED SCIENTIFIC PUBLICATIONS (10 of 53)

- = publication resulting from either acoustic or radio telemetry study (13 total)

Bishop, M.A., J.T. Watson, K. Kuletz, T. Morgan. 2015. Pacific herring consumption by marine birds during winter in Prince William Sound, Alaska. *Fisheries Oceanography*. 24:1-13.

***Bishop, M.A.**, B.F. Reynolds, S.P. Powers. 2010. An *in situ*, individual-based approach to quantify connectivity of marine fish: ontogenetic movements and residency of lingcod. *PLoS ONE* 5(12): e14267

***Bishop, M.A.**, N. Warnock, and J. Takekawa. 2004. Differential spring migration of male and female Western Sandpipers at interior and coastal stopover sites. *Ardea* 92: 185-196.

Bishop, M.A. and S.P. Green. 2001. Predation on Pacific herring (*Clupea pallasi*) spawn by birds in Prince William Sound, Alaska. *Fisheries Oceanography* 10 (1): 149-158.

***Bishop, M.A.** and N. Warnock. 1998. Migration of Western Sandpipers: links between their Alaskan stopover areas and breeding grounds. *Wilson Bulletin* 110: 457-462.

Dawson, N.M., **M.A. Bishop**, K.J. Kuletz, A.F. Zuur.. 2015. Using ships of opportunity to assess winter habitat associations of seabirds in subarctic coastal Alaska. Northwest Science. 89(2):111-128.

*Eiler, J., and **M.A. Bishop.** Determining the post-spawning movements of Pacific herring, a small pelagic forage fish sensitive to handling, with acoustic telemetry. *Transactions of American Fisheries Society (in review)*

Powers, S.P., **M.A. Bishop**, S. Moffitt, and G.H. Reeves. 2007. Variability in Freshwater, Estuarine and Marine Residence of Sockeye Salmon (*Oncorhynchus nerka*) within the Copper and Bering River Deltas, Alaska. Pages 87-99 in C. A. Woody (ed) *Sockeye salmon evolution, ecology and management*. American Fisheries Society, Symposium 54, Bethesda, MD.

Powers, S.P., **M.A. Bishop**, J.H. Grabowski, and C.H. Peterson. 2002. Intertidal benthic resources of the Copper River Delta, Alaska, USA. *Journal Sea Research* 47: 13-23.

*Reynolds, B.F., S.P. Powers, **M.A. Bishop.** 2010. Application of Acoustic Biotelemetry to Assess Quality of Created Habitats for Rockfish and Lingcod in Prince William Sound, Alaska. *PLoS One* 5(8): e12130.

Zuur, A.F., N. Dawson, **M.A. Bishop**, K. Kuletz, A.A Saveliev and E.N. Ieno. 2012. Two-stage GAMM applied on zero inflated Common Murre density data. Pages 155-188 *in* A.F. Zuur, A.A.Saveliev, E.N. Ieno (eds).

Zero Inflated and Generalized Linear Mixed Models with R. Highland Statistics Ltd, Newburgh, United Kingdom.

PROFESSIONAL COLLABORATIONS

A. Arab (Quanticipate Consulting), J. Buchanan (WDFG), M. Buckhorn (PWSSC), K. Carpenter (CRWP), N. Dawson (PWSSC), J. Eiler (NOAA), R. Heintz (NOAA), N. Hill (MIT), E.N. Ieno (Highland Statistics), J. Johnson (USFWS), K. Kuletz (USFWS), A. Lang (Memorial Univ.), F. Li (Intl. Crane Foundation), B. McCaffrey (USFWS), M. McKinzie (PWSSC), J. Moran (NOAA), T. Morgan (PWSSC), E. Nol (Trent Univ.), W.S. Pegau (OSRI), S. Powers (U. S. Alabama), B. Reynolds (PWSSC), G. Robertson (CA), D. Roby (OSU), J. Runstadler (MIT), A Saveliev (Highland Statistics), S. Senner (Audubon), Y. Suzuki (OSU), A. Taylor (UAA), R. Thorne (PWSSC), D. Tsamchu (Tibet Plateau Institute of Biology, PR China), J. Vollenweider (NOAA), J. Watson (PWSSC), M. Wille (Memorial Univ.), Z. Zuur (Highland Statistics)

VI. BUDGET

A. Budget Spreadsheet (*See Attached*)

B. Sources of Additional Funding

This project uses Dalhousie University's Ocean Tracking Network, a series of acoustic arrays that are in place at Hinchinbrook Entrance, Montague Strait, and 4 smaller southwestern Prince William Sound passages. The value of these Ocean Tracking Network acoustic arrays is estimated at $337,200.
This project also piggy-backs on the annual Ocean Tracking Network maintenance cruise which includes 5d@$3/k day. This EVOS budget only includes an additional 2d ($6k) of charter costs for deploying the new receivers.
For the FY17-20 tagging studies, PWS Science Center will also provide in-kind equipment (9 VR2-W acoustic receivers and 9 acoustic releases and 9 floats) for an array that will be deployed at the tagging site. The value of this equipment is estimated at $63k.

VII. Literature Cited

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Brown, ED, J Seitz, BL Norcross, & HP Huntington. 2002. Ecology of herring and other forage fish as recorded by resource users of Prince William Sound and the outer Kenai Peninsula, Alaska. Alaska Fishery Research Bulletin 9(2): 75-101.

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Duffy, SW, H-H Chen, L Tabar, & NE Day. 1995. Estimation of mean sojourn time in breast cancer screening using a Markov chain model of both entry to and exit from the preclinical detectable phase. Statistics in medicine 14(14): 1531-1543.

Eiler, J & MA Bishop. Determining the post-spawning movements of Pacific herring, a small pelagic forage fish sensitive to handling, with acoustic telemetry. Transactions of American Fisheries Society (*in review*)

Hay, D & SM McKinnell. 2002. Tagging along: association among individual Pacific herring (Clupea pallasi) revealed by tagging. Canadian Journal of Fisheries and Aquatic Sciences, 59(12), 1960-1968.

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Tojo, N, GH Kruse, & FC Funk. 2007. Migration dynamics of Pacific herring (Clupea pallasii) and response to spring environmental variability in the southeastern Bering Sea. Deep Sea Research Part II: Topical Studies in Oceanography 54.23: 2832-2848.

PWS Herring Research and Monitoring Program
Herring Annual Migration Cycle: Expanding Acoustic Array Infrastructure
PRINCE WILLIAM SOUND SCIENCE CENTER

PWSSC Personnel Salaries & Fringe Benefits
FY16 = $9.9
Principal Investigator Bishop 0.33 mo @ $11.0/mo; includes vessel time. For this project Bishop will oversee the project and coordinate with other studies that are part of the *PWS Herring Research & Monitoring* program. She will have primary responsibility for ordering equipment, supplies and completion of final products. She will supervise the research assistant. Bishop will be responsible for project design, and during the second phase of this project (FY17-20) statistical analyses, data interpretation preparation of a manuscripts, and contributing to the *PWS Herring Research & Monitoring* synthesis.

Research Asst. Lewandoski: 1.0 mo @ $6.4/mo; (includes vessel time). Lewandoski will prepare supplies and equipment, and will deploy the equipment. During the second phase of this project (FY17-20) he will conduct fish tagging operations, and will retrieve data from acoustic receivers as well as process acoustic tag data and assist with report writing.

PWSSC Travel
None

PWSSC Contractual
FY16 = $6.3
Computer network & software subscriptions, direct cost based on $0.15/mo x staff mo
Communications (Phone & Fax) direct cost based on $0.05/mo x staff mo
Vessel charter (in conjunction with the annual OTN maintenance cruise) 2d @ 3.0/d to deploy the new receivers

PWSSC Commodities
FY16 = $70.4
Vemco Acoustic Tags (128@ $0.35/ea); Vemco VR2W acoustic receivers (7@1.5ea), Acoustic Receiver Lithium Batteries (7 @ $0.055/ea); Acoustic Release Pins (14@ 0.90 ea); Mooring hardball floats (16@ 0.65 ea); Mooring supplies (lines, shackles) $1.5; Capture & tagging supplies $1.5.

PWSSC Equipment
FY 16 = $137.5
VR4 Acoustic Receivers 9 @ $11.0k/ea
Sport MFE acoustic releases 7@ $5.5k/ea

PWSSC INDIRECT COSTS
FY16 = $26.0
MTID is estimated at 30%. No indirect charges are applied to equipment purchases..

Total Funds requested for this project: $ 250.1 + $22.5 Gen Admin (9%) = $272.6K

Other Support/In kind Contributions for Prince William Sound Science Center

This project uses Dalhousie University's Ocean Tracking Network, a series of acoustic arrays that are in place at Hinchinbrook Entrance, Montague Strait, and 4 smaller southwestern Prince William Sound passages. The value of these Ocean Tracking Network acoustic arrays is estimated at $337,200.

This project also piggy-backs on the annual Ocean Tracking Network maintenance cruise which includes 5d@$3/k day. This EVOS budget only includes an additional 2d ($6k) of charter costs for deploying the new receivers.

For the FY17-20 tagging studies, PWS Science Center will also provide in-kind equipment (9 VR2-W acoustic receivers and 9 acoustic releases) for an array that will be deployed around the tagging site. While this equipment is currently being used in another project, it will be available by March 2017. The value of this equipment is estimated at $63k.

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel					$9.9	$9.9
Travel					$0.0	$0.0
Contractual					$6.3	$6.3
Commodities					$70.4	$70.4
Equipment					$137.5	$137.5
Indirect Costs (*will vary by proposer*)					$26.0	$26.0
SUBTOTAL					$250.1	$250.1
General Administration (9% of subtotal)					$22.5	$22.5
PROJECT TOTAL					$272.6	$272.6
Other Resources (Cost Share Funds)					$0.0	$0.0

COMMENTS: This project expands the Ocean Tracking Network, a series of acoustic arrays installed at the entrances to PWS (in place at Hinchinbrook Entrance, Montague Strait, and 4 southwestern Prince William Sound passages. The current value of these Ocean Tracking Network acoustic arrays is estimated at $337,200. This project also piggy-backs on the annual Ocean Tracking Network maintenance cruise which includes 5d@$3/k day. This EVOS budget only includes an additional 2d ($6k) of charter costs for deploying the new receivers. For the FY17-20 tagging studies, PWS Science Center will provide in-kind equipment (9 VR2-W acoustic receivers and 9 acoustic releases) for an array that will be deployed around the tagging site. The value of this equipment is estimated at $63k.

FY16

Project Title: PWS Herring Research & Monitoring: Annual Herring Migration Cycle - Expanding Acoustic Array Infrastructure
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
S. Lewandoski	Research Assistant	1.0	6.3		6.3
M. Bishop	Principal Investigator	0.3	11.0		3.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17.3	0.0	
				Personnel Total	$9.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Project Title: PWS Herring Research & Monitoring: Annual Herring Migration Cycle - Expanding Acoustic Array Infrastructure
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 12-FY16

Contractual Costs: Description	Contract Sum
Boat charter 2d@ $3k/d	6.0
network & software $150/staff mo	0.2
communications (phone and fax) $50/staff mo	0.1
shipping (tags, batteries)	
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$6.3

Commodities Costs: Description	Commodities Sum
Acoustic Tags (128@ $350/ea)	44.8
VR2W acoustic receivers (7@1.5k ea)	10.5
Receiver Batteries (7 @ $55/ea)	0.4
Acoustic Release Pins (14 @90/ea)	1.3
Hardball Floats (16 @ $650/ea)	10.4
Mooring Supplies (lines, shackles)	1.5
Capture & Tagging Supplies	1.5
Commodities Total	$70.4

FY16

Project Title: PWS Herring Research & Monitoring: Annual Herring Migration Cycle - Expanding Acoustic Array Infrastructure
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 12-FY16

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
VR4 Acoustic Receivers	9.0	11.0	99.0
Sport MFE acoustic releases	7.0	5.5	38.5
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$137.5

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Vemco VR 2W Receivers (Ocean Tracking Network Arrays)	7	OTN
Vemco VR 4 Receivers (Ocean Tracking Network Arrays)	27	OTN
Acoustic Modem (Ocean Tracking Network)	1	OTN
MFE Acoustic Releases (Ocean Tracking Network Arrays)	7	OTN

FY16

Project Title: PWS Herring Research & Monitoring: Annual Herring Migration Cycle - Expanding Acoustic Array Infrastructure
Project PI: Dr. Mary Anne Bishop, PWS Science Center

FORM 3B
EQUIPMENT DETAIL

FY15 PROJECT PROPOSAL SUMMARY PAGE

New Project

Proposals are due to the EVOSTC office by September 2, 2014. Please note that the information in your proposal and budget form will be used for funding review. Late proposals, revisions or corrections may not be accepted.

Project Title: Aerial surveys & age, sex, size processing.

Project Period: February 1, 2015 – January 31, 2016

Primary Investigator(s): Steve Moffitt, ADF&G (steve.moffitt@alaska.gov)

Project Website (if applicable):

Abstract*:

This project will conduct spring aerial surveys to document Pacific herring Clupea pallasii spawn distribution and biomass as well as the distribution and abundance data on sea lions, other marine mammals, and birds associated with herring schools or spawn. Additionally, this project will process age, sex, and size samples of Pacific herring collected by acoustics surveys, spawning surveys, PWS Herring Program disease sampling and genetics collections. Aerial survey and age, sex, and size data have collected since the early 1970s and are an essential part of the age structured model used by the Alaska Department of Fish and Game to estimate the historical and future biomass for fisheries management. This project will also provide support to other Prince William Sound herring program and Gulf Watch Alaska projects by sharing information about herring or marine mammal locations or processing samples collected by the other projects.

**The abstract should provide a brief overview of the overall goals and hypotheses of the project and provide sufficient information for a summary review as this is the text that will be used in the public work plan and may be relied upon by the PAC and other parties.*

Estimated Budget:
EVOSTC Funding Requested* (*must include 9% GA)*:

FY15	FY16	FY17	FY18	FY19	TOTAL
	$60,000.00				

Non-EVOSTC Funds to be used:

FY15	FY16	FY17	FY18	FY19	TOTAL
	$48,987.48				

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: 14 August 2015

I. EXECTUVE SUMMARY

This project will 1) conduct aerial surveys to collect data associated with spring Pacific herring *Clupea pallasii* spawning events and 2) process age, sex, and size (ASL) samples. Spring aerial survey data has been collected since 1972 (Funk 1994), and ASL data is available since 1973 (Sandone 1988); however, collections of both data sets have been more extensive since the early 1980s. Herring age data were collected in 1971 and 1972 also, but only published frequency plots (no individual fish data) are available (Pirtle et al. 1973).

Aerial surveys were used to document spring herring biomass and were the primary management tool prior to the development of the first statistical catch-at-age model or age structured assessment model (ASA) in 1988 (Brady 1987, Funk and Sandone 1990). Biomass is estimated as school surface area converted to biomass from a few paired observations of aerial observers and vessel harvests (Brady 1987, Funk and Sandone 1990). The surface area and biomass conversion methods are as described in Brady 1987 and Lebida and Whitmore (1985). Prior to 1988, the aerial survey program's primary objectives were to collect biomass data for an annual index, document the distribution and linear extent of milt, document herring temporal movements, and document commercial fishing distribution and processing work (Brady 1987). Additionally, the locations of large aggregations of sea lions and other marine mammals were often noted on paper maps.

Brady (1987) described how herring arrive on the spawning grounds over time and may be available to document on multiple aerial surveys. Therefore, the biomass over several days of surveys cannot be necessarily be added to estimate the total or peak biomass. The peak biomass was therefore calculated as the largest biomass observed in all areas on a single survey (Brady 1987). Additional biomass with a discrete time separation would also be added, but these conservative methods were required to estimate the peak biomass because the amount of time herring were available to observation by aerial surveys was unknown and likely variable (Funk and Sandone 1990).

Brady (1987) also detailed how the variable bathymetry of Prince William Sound herring spawning areas has a large influence on the ability to observe herring schools. Herring may spawn in shallow bays (e.g., Rocky Bay), shallow beaches (e.g. Hells Hole beach), or deep bays (e.g., Fairmont Bay). The influence of bathymetry on observer efficiency makes a biomass index less likely to be comparable across years. Although the Funk and Sandone (1990) indicated that peak biomass values may be a useful relative abundance, the issues with biomass observations described by Brady (1987) and Funk and

Sandone (1990) caused the department to investigate the use of an index of spawn from observations of milt.

The two indices considered for spawn documented from aerial surveys were 1) discrete miles of milt over the season and 2) the sum of miles of milt for all survey days (mile-days of milt). The advantages of milt observations compared to school biomass observations are 1) herring schools likely spawn a single time (day?), but a herring school may be observed for many days prior to, or after spawning, 2) milt is relatively easy to observe from the air on beaches and observation efficiency is generally not influenced by ocean bathymetry (Brady 1987).
Discrete miles of milt do not account for multiple spawning events in the same area, so are unlikely to be a good index of total abundance in areas with multiple spawning event days on the same beach (Brady 1987). Mile-days of milt likely provide a better index to abundance as they account for multiple spawning events on the same beach, but maybe biased if the number of surveys vary significantly across years (Funk 1994). Additionally, although bathymetry will likely not influence observation of spawn, it will influence the biomass of spawning fish for each linear mile of milt observed. Willette et al. (1998) collected paired spawn deposition survey estimates and aerial survey estimates of miles of milt, and the short tons per mile of milt were much larger on Montague Island as compared to tons per mile of milt in northern or northeastern PWS.

Funk (1994) used the discrete miles of milt index rather than the mile-days of milt index because there were few surveys flown in the early years (1970s) of the data set for the model. However, subsequent runs of the model have excluded the earlier years so allow use of the mile-days of mile index.

In 2008 the department began using a Tablet computer and GIS application to collect aerial survey data (Bochenek 2010). Because digital maps are scalable and allow much more data to be added to a small area (as opposed to paper maps), and because of interest in herring predators, additional effort has been placed on documenting numbers and locations of sea lions, humpback whales, Orca whales, Dall porpoises, and bird aggregations associated with herring schools or spawn.

Age, sex, and size data from Pacific herring have been collected from commercial fisheries and fishery independent research projects since the early 1970s. The department currently has an archive containing approximately 210,000 scales and paired size data with most of the archive collected since 1979. Summaries of many of these data have been published (e.g., Sandone 1987, Funk and Sandone 1990, Willette et al. 1998). Processing methods are similar those described by Baker et al. (1991); however, an electronic fish measuring board is used to enter all sample data and sex and size data at the time of processing.

Both the aerial survey and ASL data sets are essential parts of the current ASA model the Alaska Department of Fish and Game (ADF&G) uses to estimate the historical biomass and project pre-fishery run biomass a year ahead for management. The formulation of the current ASA model used by ADF&G is described in Hulson et al. 2008. Additionally, the mile-days of milt and ASL data are part of the Bayesian formulation of the ASA model (Muridan 2015), and the scales collected from this archive were used in a project titled "PWS Herring Program - Scales as growth history records."

This project will conduct aerial surveys to collect data related to spring herring spawning events and process herring for age, sex, and size data. The overall goal of the aerial survey and ASL processing is to collect data consistent with the long-term existing data sets used in the Alaska Department of Fish and Game's ASA model and Bayesian formulation of the ASA model.

Literature cited – Includes citations for the remainder of the document.

Baker, T.T., J.A. Wilcock, and B.W. McCracken. 1991. Stock assessment and management of Pacific herring in Prince William Sound, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries. Technical Fisheries Data Report No. 91-22, Juneau.

Biggs, E. D. and F. Funk. 1988. Pacific herring spawning ground surveys for Prince William Sound, 1988, with historic overview. Regional Information Report No. 2C88-07. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Brady, J.A. 1987. Distribution, timing, and relative biomass indices for Pacific Herring as determined by aerial surveys in Prince William Sound 1978 to 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Prince William Sound Data Report 87-14, Anchorage.

Brannian, L.K. 1988. Precision of age determination and the effect of estimates of abundance and mortality among Pacific herring. Regional Information Report No. 2A88-11. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Bochenek, R.J. 2010. PWS herring data portal, Exxon Valdez Oil Spill Restoration Project Final Report (Restoration Project 090822), Axiom Consulting & Design, Anchorage, Alaska.

Funk, F. 1994. Forecast of the Pacific herring biomass in Prince William Sound, Alaska, 1993. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J94-04, Juneau.

Funk F., and G. Sandone. 1990. Catch-age analysis of Prince William Sound, Alaska, herring, 1973-1988. Fishery Research Bulletin No. 90-01, Juneau.

Hulson, Peter-John F., S. E. Miller, T. J. Quinn, G. D. Marty, S. D. Moffitt, and F. Funk. 2008. Data conflicts in fishery models:incorporating hydroacoutic data into the Prince William Sound Pacific herring assessment model. – ICES Journal of Marine Science, 65: 25–43.

Lebida, R.C. and D.C. Whitmore. 1985. Bering Sea herring aerial survey manual. Bristol Bay Data Report, No. 85-02. Alaska Department of Fish and Game, Divison of Commercial Fisheries, Anchorage, Alaska.

Muridan, Melissa. 2015. Modeling the Population Dynamics of Herring in the Prince William Sound, Alaska. Master of Science thesis, University of Washington.

Pirtle, R. B., P. J. Fridgen, K. Roberson, and J. Bailey. 1973. Annual Management Report, 1972–1973. Alaska Department of Fish and Game, Division of Commercial Fisheries, Cordova.

Sandone, G. J. 1988. Prince William Sound 1988 herring biomass projection. Regional Information Report No. 2A88-05. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Thompson, S.K. 1992. Sampling. John Wiley & Sons, Inc., New York.

Willette, T.M., G.S. Carpenter, K. Hyer, and J.A. Wilcock. 1999. Herring natal habitats, *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 97166), Alaska Department of Fish and Game, Division of Commercial Fisheries, Cordova, Alaska.

II. COORDINATION AND COLLABORATION

1. Within the Program

1) *PWS Herring Program – Validation of Acoustics Surveys for Pacific Herring using direct capture.*
This proposed project will process adult samples collected by the currently funded project

2) *PWS Herring Program –Data Management Support.*
This proposed project will provide additional herring aerial survey and herring age data for use by other PWS Herring Program projects. Past funding and ADF&G funding has allowed us to provide aerial survey GIS data files for linear extent of spawn (1973–2015), survey routes (1997–2015), sea lion distribution and abundance (2008–2015), other marine mammals distribution and abundance (2008–2015), and bird aggregations (2008–2015).

3) *PWS Herring Program – Expanded adult herring surveys.*
This proposed project (aerial surveys) will provide additional location information for herring aggregations to be surveyed and has provided similar information in past years.

4) *PWS Herring Program – Outreach and Education.*
This proposed project will assist public outreach through public presentations of methods and results.

5) *PWS Herring Program – Herring Disease Program (HDP)*
This proposed project will help locate adult herring for disease sampling and has in past years.

6) *PWS Herring Program – Genetic Stock Structure*
This proposed project will process additional samples (collect paired age, sex, and size data and collect tissues for genetics analysis) for the genetic stock structure program. This project as funded by ADF&G has collected and processed multiple samples for this program in the past. Additionally, NOAA staff (Sharon Wildes and Jackie Whittle) helped us process fish in Cordova in June 2015 for paired age, sex, size, and genetics tissue.

7) *PWS Herring Program – Modeling the population dynamics of PWS herring*
This proposed project will provide mile-days of milt and age, sex, and size data to update the time series of data required for the Bayesian population dynamics model.

LTM Program – Long-term monitoring of humpback whale predation on Pacific herring in Prince William Sound.
This proposed project (aerial survey portion) will share information on location and abundance of humpback whales and herring with the LTM project. Additionally, this project has shared information relevant to this proposed project in the past.

2. With Other Council-funded Projects
None

3. With Trustee or Management Agencies

This work is to be conducted by a trustee agency and collaborations with other trustees are provided in the section on collaborations within programs.

III. PROJECT DESIGN
A. Objectives

These data will be collected to meet the overall goal of providing necessary inputs to the age structured assessment models of ADF&G and the *PWS Herring Program – Modeling the population dynamics of PWS herring.* There are no proposed hypotheses to be tested directly from this project.

The objectives of the project are as follows:

1.) Conduct spring aerial surveys and collect data on the survey route, location and linear extent of herring milt, classification of herring milt, herring school biomass, sea lion distribution and abundance, other marine mammal distribution and abundance, and distribution and abundance of bird aggregations associated with herring or herring spawn, and other relevant comments.
2.) Process, summarize, and distribute age, sex, and size data from herring collected during ADF&G acoustics surveys, ADF&G spawning grounds surveys, *PWS Herring Program* disease surveys, *PWS Herring Program* genetics collections, or other relevant collections.

B. Procedural and Scientific Methods

Objective 1: Aerial surveys

Methods

Aerial survey methods are similar to those described in Brady (1987) and Lebida and Whitmore (1985), but with many updates. Surveys will be conducted in a fixed-wing aircraft flying at a standard elevation of ~1,200 ft., if possible. Two observers will be used if possible for each flight. The primary observer sits in the back seat and uses a Tablet computer with a spreadsheet to enter survey metadata and an ESRI ArcPad application and blue tooth GPS to collect georeferenced data electronically (Bochenek 2010). The primary observer will also set up a GoPro camera on the back window (inside) to collect either video or a still image every 1 or 2 seconds (either appears to work…images are higher quality, but take more processing time to create a time lapse movie). The primary observer will use a sighting tube to calibrate the surface area for a few schools at the beginning of each survey, but it usually is not possible to use it on each herring school observation.

The secondary observer sits in the front passenger seat and reports observations to the primary observer, collects observations on paper maps, sets up a handheld Garmin GPS to use as a location backup, and takes photos with a DSLR and fast lens (F2.8) of spawning events, large biomass aggregations, and

large sea lion groups. Photos are georeferenced to the GPS track using software to match up the time-date stamps. This requires a photo of the GPS with the Date and time on the GPS screen. During large spawning events, several passes are necessary to collect all the data.

After each survey, data are transferred from the tablet to our network for processing with ESRI ArcMap. The handheld GPS is downloaded with DNRGarmin software, videos or images are downloaded from the GoPro camera, and DSLR images are georeferenced with the GPS data. At the end of the survey season, the spawn locations and lengths are adjusted by comparing to the GoPro imagery. The wide angle format that makes the imagery so useful for documenting milt locations makes the imagery much less useful for school observations or sea lion pod counts.

Measurements

Measurements made during the survey include 1) estimating the linear extent of milt, 2) estimating the surface area and subsequent biomass of herring, 3) estimating the count of sea lions in a large pod, and 4) estimating the count of birds at a location.

Estimates of the linear extent of spawn placed on the tablet computer are probably ± 20% (although we haven't tested this). I think our estimates that are adjusted with imagery are probably ±10%. Biggs and Funk (1988) found that skiff measurements of spawn were often larger than the aerial estimates of milt, but they attributed this to additional spawn after the survey or multiple days between surveys (citation below).

Our estimates of individual herring school biomass in short tons are likely at ±50%. Biomass is estimated in the field from a surface area to short tons conversion based on a limited number of observations that were captured by seine vessels. A sighting tube described in Lebida and Whitmore (1985; Appendix III) is used to calibrate the primary observer on a few schools at the beginning of each survey. However, it's very difficult to use the sighting tube from a plane and larger schools fill the field of view. Also the depth of schools is difficult to estimate from plane. Photos from known focal length, elevation, and angle may be used to check surface areas after the survey; however, we have not attempted this check as yet. There have been very few tests of observer estimates by seining the school after an aerial estimate (Lebida and Whitmore, 1985; ADF&G unpublished). I have less confidence in our ability to estimate the school size in short tons than the linear extent of milt along a beach.

Estimates of sea lion pod counts are likely ±5% if the pod is <50 animals. An examination of observer counts from a few large pods indicated most were underestimated by 100%, i.e., photo counts of pods of 150 were estimated on the survey at 75 animals. However, these data are currently not used in our herring assessment, so all counts in our GIS files are survey estimates.

Estimates of whales are likely ±100% or more given the dive times of most whales. Our estimates of harbor seals at haul outs are most likely ±30% although there are a few locations with groups of ~100 individuals and the estimates are probably larger. We do have some photos and estimates to examine, but once again these are not part of our herring assessment so all counts in our GIS files are survey estimates.

Given the size of many of the bird aggregations (gulls mostly), the uncertainty in our survey estimates is likely ±100% or more. Similar to sea lions and harbor seals, we have photos and survey estimates for comparison, but it is not a priority at this point.

We have also considered using a helicopter for surveys because a steadier platform would make many of the observations much easier; however, there is no helicopter service in Cordova and the cost for chartering a helicopter out of Valdez or Girdwood would be too high.

Age, sex, and size processing

These methods are outlined in Baker et al. (1991) with only a few changes. Samples are randomly collected and stratified by area, time, and gear. Sample sizes (n=450) are set to estimate the age composition of each sample to within ±5% of the true proportion 90% of the time (Thompson 1992) assuming no more than 10% of the scales are unreadable. Samples are collected in the field and frozen in large 6 mm plastic bags with labels inside the bag that document the date, time, location, gear, samplers, and the number of bags. Other information including the approximate coordinates of the sample location are collected and added to a sample log. Often more than 450 fish are collected, so an equal number of fish are randomly selected from each bag for processing to meet the sample goal. From the fish selected for processing, 10 fish are place on a tray and their length measured to the nearest mm (standard length, tip of snout to hypural plate), whole weight to the nearest gram collected from an electronic balance, sex determined from examination of the gonads (1=male, 2=female, 3= unknown), and gonad condition estimated from examination of the gonad (scale of 1, undeveloped, to 8, recovering from spawning). All these data are collected directly into an electronic fish measuring board. The precision of length measurements collected on the electronic fish measuring board have been tested and are within ±1mm. Weights are collected with an electronic balance that is checked with calibration weights (and recalibrated if necessary) prior to each sampling event.

A scale is then collected from the left side of the fish from a preferred area if possible. The preferred area is above the lateral line and 3-4 rows of scales back from the operculum. This area generally has symmetrical growth patterns and distinct annuli. Scales are cleaned and placed on a pre-labeled glass microscope slide after dipping in a solution of 1:10 mucilage glue to water. A single scale from each of 10 fish is placed as two rows of 5 scales on each slide. Scales are viewed on a microfiche to ensure they are readable for age (not regenerated) and useable for measuring growth increments. If they are not useable to interpret age or measure growth increments, another scale is collected and examined. After all scales are checked they are covered with a second slide and taped together at the label end of the slide. All slides are stored in a labeled box or cabinet tray until examining for age.

Once a sample is complete, data are downloaded from electronic fish measuring board into an MS Excel spreadsheet. The scales are examined for age interpretation on a microfiche by 2 or 3 readers. Ages are interpreted independently and then the committee discusses any differences before agreeing on an age by consensus. The crew leader spot checks all samples to reduce the chance of reader drift in age interpretation.

C. Data Analysis and Statistical Methods

Aerial survey estimates of linear extent of Pacific herring milt, herring school biomass, sea lion counts, other marine mammal counts, and sea bird counts are saved directly in GIS shape files and an MS Excel spreadsheet is used to capture survey metadata. Once a survey is complete, shape files, the Excel metadata log file, GPS route files, GoPro video/image files, and DSLR photos are copied to the ADF&G Cordova file server. Survey metadata are entered into a yearly log file, and shape files, GPS route files,

photos and videos are saved into an aerial survey subdirectory by survey date. Shape file data are plotted in ArcMap and attribute tables are examined for errors and adjusted as necessary.

After all surveys are complete, copies of the GIS miles of milt files will be compared to GoPro video or still images and the location and classification of milt will be adjusted if necessary. This is the highest priority as these data are used to tune the ASA model. If possible, biomass, sea lion counts and bird estimates will be compared against available georeferenced images.

After adjustments are complete, the individual survey GIS data will be combined into shape files for the year and then added to the historical GIS shape files. These historical shape files will allow comparison across all years for milt observations (1973–2015), survey routes (1997–2015), sea lion location and abundance (currently 2008–2015), other marine mammals (currently 2008–2015), and birds (currently 2008–2015). These data could be compared to other areas if they have similar data sets.

The ability to detect a change in mile-days of milt among years depends on the frequency of surveys and the completeness of the survey coverage. Similar to most years since 1973, this project will begin surveys in mid to late March on the east side of PWS to examine fish and sea lion distribution and fly daily surveys once spawning begins in the areas with significant fish and sea lion counts. Surveys will be extended to the Kayak Island area next and then the Montague Island area. Additionally, pilot reports of herring or spawn from other areas will be considered in flight route planning.

Size and sex data are collected directly into an electronic fish measuring board. At the completion of a sampling event, data are downloaded from the fish measuring board to the ADF&G Cordova file server. Data are reformatted into an Excel spreadsheet using a VBA application. Age is interpreted from scales and keyed into the Excel spreadsheet. A VBA application is used to generate age, sex, and size composition summaries that include sample size and percentage by age class and sex, mean and standard deviation by age class and sex for weight and standard length. Currently, historical data (1973–present) are summarized in an Excel spreadsheet; however, data are in the process of being organized for inclusion in a database that could be used by other herring research efforts.

Detecting a change in the sex, age, or size composition among areas will depend on sample collection; however, collections have exceeded 1,000 fish per year since 1981 with a median of 5,300 fish (1982–2014). Age interpretations have been compared across areas in past, e.g., Brannian 1988).

D. Description of Study Area

The study will include all of Prince William Sound and Copper River/Bering River coastal areas between Cape Suckling to the east and Cape Puget to the west. The bounding coordinates are 61.300 N, -144.00 W and 59.750 N, -148.760 W.

IV. SCHEDULE

A. Project Milestones

Objective 1.

Complete all aerial surveys of spring herring assessment

To be met by June 2016

Summarize, edit, and combine all spring 2016 aerial survey shape files into yearly totals.

To be met by August 2016

Objective 2.

Finish processing all herring samples for age, sex, and size
To be met by July 2016

Distribute final age data and summaries.
To be met by July 2016

B. Measurable Project Tasks

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)

March:	*Start Aerial surveys*
April:	*Continue Aerial surveys*
April:	*Start herring ASL sample processing*

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)

May:	*Continue aerial surveys*
May:	*Continue herring ASL sample processing*
June:	*Finish herring ASL sample processing*
June:	*Quality control work on ASL data*
June:	*Finish ASL analysis and distribute ASL sample summaries*
July:	*Quality control and editing of aerial shape files.*

FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)

August:	*Finish analysis of aerial survey data.*
August:	*Combine aerial survey shape files into historical version.*

FY 16, 4th quarter (November 1, 2016- January 31, 2016)

January:	*Write summary reports.*

V. PROJECT PERSONNEL

Steven D. Moffitt

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Work: (907) 424-3212
FAX: (907) 424-3235
steve.moffitt@alaska.gov

Professional Background:

Prince William Sound/Copper River Research Project Leader, Alaska Department of Fish and Game, August 2000 to present. Duties: Develop, implement, and evaluate research projects on Pacific herring, Pacific salmon, and eulachon in Prince William Sound and the Copper River. Specific duties include setting spawning escapement goals, preseason forecasts, evaluation of harvest policies,

assessment of runs inseason, and local area network supervision. Supervises two 11-month seasonal Fishery Biologist I's. Current supervisor: Dr. Jack Erickson, Regional Research Biologist.

Prince William Sound/Copper River Assistant Research Project Leader, Fishery Biologist II, Alaska Department of Fish and Game, November 1991 to August 2000. Duties: Responsible for sampling, compilation, and analysis of age, sex, size, and stock composition data; and salmon catch and escapement reporting. Responsible for assisting with inseason assessment of Pacific salmon and Pacific herring abundance. Supervise five seasonal employees and responsible for five project budgets. Supervisors: Mr. John Wilcock and Mr. Mark Willette, Area Research Biologists

Assistant Project Leader, Fishery Biologist II, Alaska Department of Fish and Game, July 1991 to November 1991. Planned work and supervised five employees in collecting and compiling pink and chum salmon fry/egg abundance and mortality data. Assisted with data analysis and damage assessment report writing. Supervisor: Mr. Sam Sharr, Area Research Biologist

Education:

B.S. Wildlife Management, University of Alaska Fairbanks, 1989.

Selected Publications:

Bue, B.G., S. Sharr, S.D. Moffitt, and A. Craig. 1996. Effects of the *Exxon Valdez* oil spill on pink salmon embryos and preemergent fry. Pages 619-627 *in* S.D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright, editors. Proceedings of the *Exxon Valdez* oil spill symposium. American Fisheries Society Symposium 18.

Brenner, R.E., S.D. Moffitt, and W.S. Grant. 2012. Straying of hatchery salmon in Prince William Sound, Alaska. Environmental Biology of Fishes. Vol. 94:179–195.

Jasper J.R., Habicht C., Moffitt S., Brenner R., Marsh J., et al. 2013. Source-Sink Estimates of Genetic Introgression Show Influence of Hatchery Strays on Wild Chum Salmon Populations in Prince William Sound, Alaska. PLoS ONE 8(12): e81916. doi:10.1371/journal.pone.0081916

P-J.F. Hulson, S.E. Miller, T.J. Quinn II, G.D. Marty, S.D. Moffitt, and F. Funk. 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.

Marty, G.D., P-J.F. Hulson, S.E. Miller, T.J. Quinn II, S.D. Moffitt, and R.A. Merizon. 2010. Failure of population recovery in relation to disease in Pacific herring. Dis Aquat Org Vol. 90: 1–14.

Marty, G.D., T.R. Meyers, and S.D. Moffitt. 2002. Effects of disease on recovery of Pacific herring in Prince William Sound, Alaska, Fall 2000 and Spring 2001. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 01462), Alaska Department of Fish and Game, Habitat and Restoration Division, Anchorage, Alaska.

Moffitt, S., B. Marston, and M. Miller. 2002. Summary of eulachon research in the Copper River Delta, 1998-2002. Report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Commercial Fisheries Division. Regional Information Report No. 2A02-34, Anchorage.

Moffitt, S.D., R.E. Brenner, J.W. Erickson, M.J. Evenson, R.A. Clark, and T.R. McKinley. 2014. Escapement goal review of Copper and Bering rivers, and Prince William Sound Pacific salmon stocks, 2014. Alaska Department of Fish and Game, Fishery Manuscript No. 14–05, Anchorage.

Recent collaborators:

Paul Hershberger – U.S. Geological Survey, Marrowstone Marine Laboratory
Peter-John Hulson – University of Alaska Fairbanks
Dr. Gary Marty – University of California Davis
Melissa Muradian – University of Washington
Scott Pegau – Oil Spill Recovery Institute and Prince William Sound Science Center
Dr. Terry Quinn – University of Alaska Fairbanks

VI. BUDGET

A. Budget Spreadsheet (Detailed budget Attached)

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	$19,533.87	$19,533.87	
Travel	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	
Contractual	$0.0	$0.0	$0.0	$0.0	$35,512.00	$35,512.00	
Commodities	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	
SUBTOTAL	$0.0	$0.0	$0.0	$0.0	$55,045.87	$55,045.87	
General Administration (9% of	$0.0	$0.0	$0.0	$0.0	$4,954.13	$4,954.13	N/A
PROJECT TOTAL	$0.0	$0.0	$0.0	$0.0	$60,000.00	$60,000.00	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	

B. Sources of Additional Funding

A additional month of Fisheries Biologist I time ($7,587.48 from Fish and Game funds) will be spent on quality control and summarization of herring aerial survey data. This will include editing spawn lengths based on video or still images, checking attribute files for errors, and combining shape files into historical shape files.

R/V Solstice boat time (10 days at $4,125 per day or $41,250), State of Alaska General Funds) and permanent personnel (FB III for 10 days of Sea Duty, $4,400) will be used to collect samples processed by this project.

***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	$19,533.87	$19,533.87	
Travel	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	
Contractual	$0.0	$0.0	$0.0	$0.0	$35,512.00	$35,512.00	
Commodities	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	
SUBTOTAL	$0.0	$0.0	$0.0	$0.0	$55,045.87	$55,045.87	
General Administration (9% of subtotal)	$0.0	$0.0	$0.0	$0.0	$4,954.13	$4,954.13	N/A
PROJECT TOTAL	$0.0	$0.0	$0.0	$0.0	$60,000.00	$60,000.00	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	

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. For years where funding is not requested, please leave zeroes. The EVOSTC fiscal year is February 1 - January 31.

A additional month of Fisheries Biologist I time ($7,587.48 from Fish and Game funds) will be spent on quality control and summarization of herring aerial survey data. This will include editing spawn lengths based on video or still images, checking attribute files for errors, and combining shape files into historical shape files. R/V Solstice boat time (10 days at $4,125 per day or $41,250), State of Alaska General Funds) and permanent personnel (FB III for 10 days of Sea Duty, $4,400) will be used to collect samples processed by this project.

FY12-16

Project Title: Aerial surveys & age, sex, size processing.
Primary Investigator: Steve Moffitt
Agency: Alaska Department of Fish and Game

FORM 4A
TRUSTEE AGENCY
SUMMARY

Date Prepared: xx/xx/xxxx

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

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Jon Syder	Aerial surveys & age, sex, and size processing	1.0	7587.48	445.70	8,033.18
FWT III	Aerial surveys & age, sex, and size processing	1.0	6016.13		6,016.13
FWT II	Aerial surveys & age, sex, and size processing	1.0	5484.56		5,484.56
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	19088.2	445.7	
				Personnel Total	$19,533.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY16

Project Title: Aerial surveys & age, sex, size processing.
Primary Investigator: Steve Moffitt
Agency: Alaska Department of Fish and Game

FORM 4B
PERSONNEL & TRAVEL DETAIL

Date Prepared: xx/xx/xxxx

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

Contractual Costs: Description		Contract Sum
Air Charter for spawning surveys (non contract)		35,512.0
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$35,512.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY16

Project Title: Aerial surveys & age, sex, size processing.
Primary Investigator: Steve Moffitt
Agency: Alaska Department of Fish and Game

FORM 4B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: xx/xx/xxxx

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

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Panasonic Toughbook Tablet computers	1	ADF&G
GPS (blue tooth and handheld)	2	ADF&G
Canon DSLR camera	1	ADF&G
GoPro video camera	1	ADF&G

FY16

Project Title: Aerial surveys & age, sex, size processing.
Primary Investigator: Steve Moffitt
Agency: Alaska Department of Fish and Game

FORM 4B
EQUIPMENT DETAIL

Date Prepared: xx/xx/xxxx