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.