EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
FY18 CONTINUING PROJECT PROPOSAL SUMMARY PAGE

Proposals requesting FY18 funding are due to shiway.wang@alaska.gov and elise.hsieh@alaska.gov by August 23, 2017. 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 Number and Title

18120111-C Modeling and stock assessment of Prince William Sound herring

Primary Investigator(s) and Affiliation(s)

Trevor A. Branch, Associate Professor, School of Aquatic and Fishery Sciences, University of Washington

Date Proposal Submitted

September 11, 2017

Project Abstract

Prince William Sound (PWS) herring collapsed shortly after the Exxon Valdez oil spill, and has yet to recover. Here, we proposed a modeling component to the long-term herring monitoring project, which has as its chief goal an understanding of the current status of PWS herring, the factors affecting its lack of recovery, and an assessment of research and fishery needs into the future, with the following key products:

1. The core product of the modeling project is the maintenance and updating of the new Bayesian age-structured assessment (BASA) model based on the ASA model used by ADF&G, including annual assessment updates of PWS herring and the revision of BASA to fit to new data sources such as the age-0 aerial survey, condition data, and updated age at maturity.
2. Adapting the BASA model to better model the disease component of natural mortality. Specifically, this would be based on new methods for detecting antibodies of viral hemorrhagic septicemia virus (VHSV) in archival and planned future collections of herring serum.
3. Continued collection and expansion of catch, biomass, and recruitment time series from all herring populations around the world to place the lack of recovery of PWS herring into context given patterns of change in herring populations around the world.
4. An initial exploration of factors that may be used to predict herring recruitment, including oceanography, climate, competition, and predation.
5. A management strategy evaluation to test alternative harvest control rules for managing the fishery in the future, given realistic variability in productivity over time, and the possibility that the population has moved into a low productivity regime. Ecological, economic and social factors would be considered in the MSE.

Simulations to evaluate which data sources are the most useful in assessing future herring biomass, based on an MSE of the impact of each form of data on the accuracy of the BASA model.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
$124.3	$288.3	$297.0	$303.3	$148.9	$1161.9

Non-EVOSTC Funds to be used, please include source and amount per source:

FY17	FY18	FY19	FY20	FY21	TOTAL
0	0	0	0	0	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.*

1. EXECUTIVE SUMMARY

Please provide a summary of the project including key hypotheses and overall goals, as submitted in your original proposal. If there are highlights that you would like to include from your FY17 work, please include them here. Also, please list any publications that have been submitted and/or accepted since you submitted your last proposal.

The herring modeling project is intended to improve predictive models of Prince William Sound herring through synthesizing the data collected by the other components of the overall herring monitoring project and hence assessing the current status of the population.

Background, history and literature review

Muradian (2015, MS thesis) reviewed the available literature during the first five years of the long-term herring monitoring project; a brief summary is included here. PWS herring are the key forage fish species in Prince William Sound, and have been harvested commercially for at least a century, with catches over 40,000 t in the 1930s (Muradian 2015). After the Exxon Valdez oil spill in 1989, which occurred during a period of high herring abundance, the herring population remained high for three years until collapsing in 1992-3 (Quinn et al. 2001). Since then, the fishery has been closed, except for a brief period during 1996-98. The fishery is managed by ADF&G which keeps the fishery closed if the pre-fishery spawning biomass is less than 22,000 short tons (19,958 mt), has the discretion to set a catch limit of 0-20% if the spawning biomass is 22,000–42,500 short tons, and opens the fishery with a catch limit of 20% of the pre-fishery spawning biomass if this is over 42,500 short tons (Muradian 2015).

The fishery was initially managed using an index of male spawning biomass until 1988 when an age-structured assessment model (the "ASA Model") was developed that fitted to catch-at-age data and mile-days-of-milt, and used egg deposition data as an absolute estimate of biomass (Funk and Sandone 1990). Later developments included the incorporation of disease data to explain the rapid declines in the population in 1992 (Marty et al. 2003, Marty et al. 2010, Quinn et al. 2001). As hydroacoustic survey biomass estimates became seen as more reliable, they too were added to the model, helping to address the conflict between the trends in mile-days-of-milt and the egg deposition data (Hulson et al. 2008); and a Ricker stock-recruit relation was added to the model to stabilize estimates of recruitment (Hulson et al. 2008). The current version of the ASA model is based on this model, and is used by ADF&G to conduct annual stock assessments. The model is fit to the data by minimizing sums of squares using Solver in Excel.

In the first five years of the herring monitoring program, an updated version of the ASA model was developed at the University of Washington by Melissa Muradian, as outlined in Muradian (2015) and Muradian et al. (in review). The key new features included (1) a translation of the model into AD Model Builder (Fournier et al. 2012), (2) the use of likelihoods to allow a natural statistical weighting of data sets instead of sums of squares, (3) freely estimating recruitment in each year instead of using a Ricker stock-recruit relation, since the data did not support a Ricker model, (4) converting the model to a Bayesian model to allow statistically-based estimates of uncertainty in model parameter estimates and estimated biomass (e.g. Punt and Hilborn 1997). This Bayesian version of the ASA model (which we name "BASA") provides similar median estimates of pre-spawning biomass as the ADF&G ASA model, but also reports uncertainty in model estimates, as can be seen in model fits to the survey time series (Fig 1) and numbers-at-age data (Fig 2) from 2015 runs of the model by John Trochta (the current graduate student who took over the project after Melissa Muradian graduated). The new BASA model is the underlying basis for our proposal for the next five years of the long-term herring monitoring project.

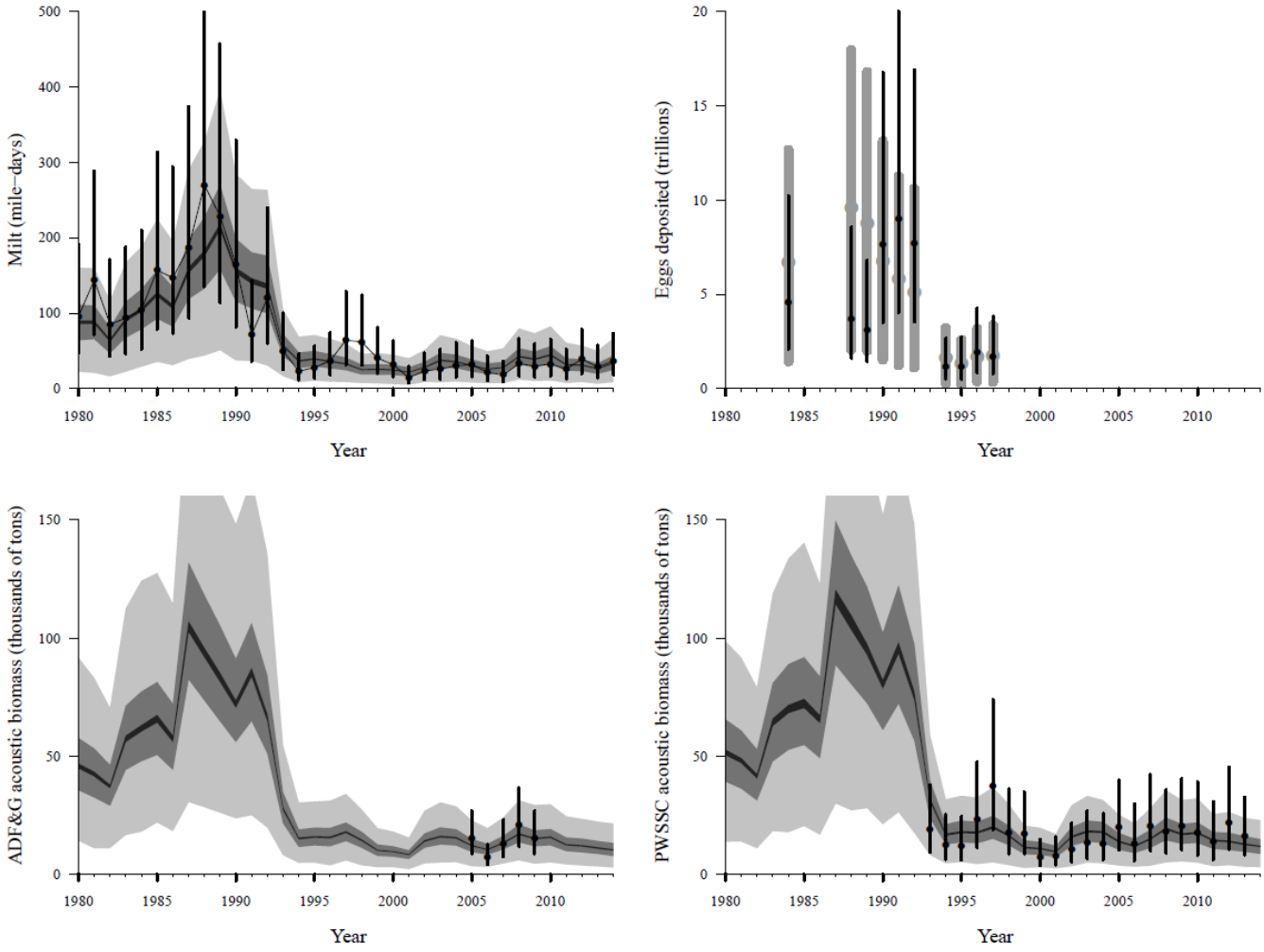

Figure 1 The 2015 Bayesian age-structured assessment (BASA) model estimates of Prince William Sound herring biomass fitted to the four main time series of biomass. Shaded polygons are the model-estimated posterior predictive intervals: 5th percentiles (black), 50th percentiles (dark gray) and 95% percentiles (light gray). Solid circles are the median of the data, and lines are the 95th percentiles including additional variance estimated by the model. Source: John Trochta, using the model described in Muradian (2015).

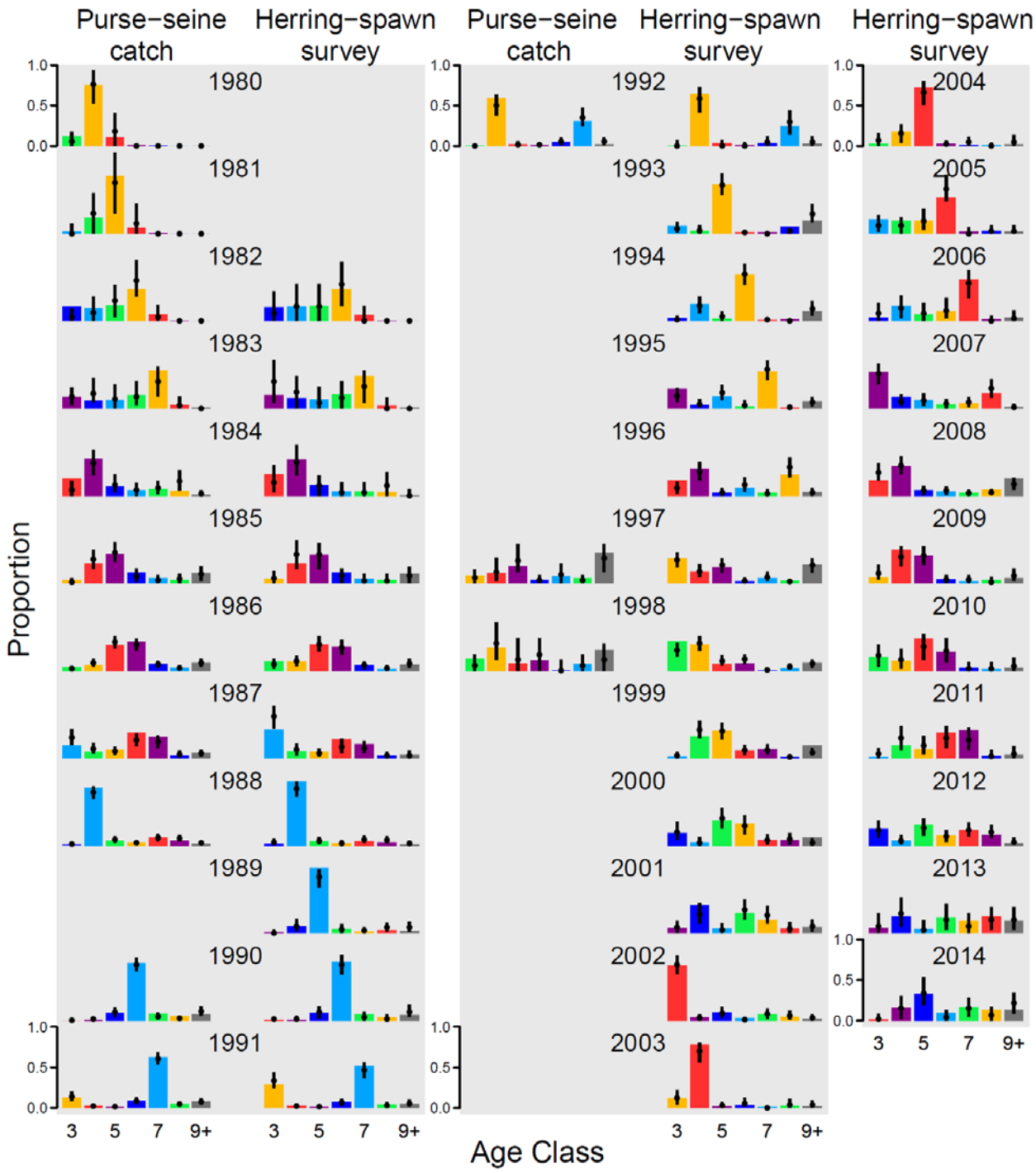

Figure 2. The 2015 Bayesian age-structured assessment (BASA) model fits to the age composition data from purse-seine catches and from the ADF&G herring-spawn survey. Colors track individual cohorts over time, while points and lines indicate the model posterior median and 95% posterior intervals. Source: John Trochta, using the model described in Muradian (2015).

Summary of project: Over the next five years, the BASA model will be revised and updated to provide an annual stock assessment of PWS herring to complement the ADF&G herring assessment. Updates will include model fits to new data sources and a more realistic disease component. We will continue the expansion of the database of herring abundance catch, and recruitment time series to place PWS in context of global trends in herring stocks. We will examine environmental factors that might predict herring recruitment. Finally, we will conduct

management strategy evaluations to test alternative harvest control rules for managing the fishery; and evaluate which future data sources will be the most cost-effective at improving the accuracy of the BASA model.

2. COORDINATION AND COLLABORATION

A. Within an EVOTC-Funded Program

Provide a list and clearly describe the functional and operational relationships with any EVOSTC-funded Program (Herring Research and Monitoring, Long-Term Research and Monitoring or Data Management Programs). 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.).

B. With Other EVOSTC-funded Projects

Indicate how your proposed project relates to, complements or includes collaborative efforts with other proposed or existing projects funded by the EVOSTC that are not part of a EVOSTC-funded program.

C. With Trustee or Management Agencies

Please discuss if there are any areas which may support EVOSTC trust or other agency work or which have received EVOSTC trust or other agency feedback or direction, including the contact name of the agency staff. Please include specific information as to how the subject area may assist EVOSTC trust or other agency work. If the proposed project requires or includes collaboration with other agencies, organizations or scientists to accomplish the work, such arrangements should be fully explained and the names of agency or organization representatives involved in the project should be provided. If your proposal is in conflict with another project, note this and explain why.

Detailed coordination is outlined in the overall project proposal. A few highlights are listed below.

Within the Program: coordination takes place through regular data transfer, emails, phone calls, and two in-person meetings per year. Each of the components of the herring plan has a close connection to the model, from the acoustic survey, to the disease work, to aerial surveys, and assessment of age at maturity.
With other EVOSTC-funded programs and projects: model inputs for oceanographic and predator data (humpback whales, etc.) will come through collaboration with the Gulf Watch program.
With Trustee or Management Agencies: input data for the assessment model (ADF&G survey, age composition, weight at age, etc.) comes from Steven Moffitt (ADF&G), which requires close coordination to understand how the data were collected and how they should be used in the model. Results are transmitted to lead ADF&G scientist such as Sherri Dressel.
With Native and Local Communities: no direct involvement is planned at this point.

3. PROJECT DESIGN – PLAN FOR FY18

A. Objectives for FY18

Identify the primary objectives for your project for FY18 as submitted in your original proposal.

B. Changes to Project Design

If the project design has changed from your original proposal, please identify any substantive changes and the reason for the changes. Include any information on problems encountered with the research or methods, if any. This may include logistic or weather challenges, budget problems, personnel issues, etc. Please also include information as to how any problem has been or will be resolved. This may also include new insights or hypotheses that develop and prompt adjustment to the project.

A. The two primary objectives are to conduct annual stock assessment for Prince William Sound herring, and to work on including the new antibody data from herring serum, which will tell us what percent of the herring at each age have been exposed to viral hemorrhagic septicemia virus (VHSV) disease in each year in the past. Work will

continue on the global herring meta-analysis to provide informative Bayesian priors for the assessment, and to explore factors used to predict herring recruitment.

B. Changes to project design: the identified graduate student, John Trochta, is planning to bypass from his MS to a PhD degree in 2017, and continue working on the project. However, he was awarded a prestigious Bondermann Travel Fellowship which provides selected students the opportunity to travel for 8 months, starting in October 2017. In his absence, a new MS student, Stephanie Thurner, will be conducting the stock assessment. This adds uncertainty to the timelines given both the shift in personnel and the steep learning curve in fisheries stock assessment and AD Model Builder.

We are requesting to add a postdoctoral researcher to integrate research by the HRM and GWA programs. There continues to be uncertainty as to which mechanisms are responsible for persistent weak recruitment and low herring population size over the past three decades. This research will examine linkages between physical and ecological processes to PWS herring recruitment at critical life stages to test the hypothesis that spawning and survival of herring during their first year of life is determined by bottom up processes that operate across the Gulf of Alaska (GOA) and broader Northeast Pacific, while survival of juvenile fish after their first winter is determined by local ecological processes within PWS. Using oceanographic, biological, and climate data series that represent environmental conditions across a range of spatial scales from within PWS to the Northeast Pacific, spatiotemporal models and time-series analysis techniques will be used to quantify the influence of environmental covariates on herring spawning, survival during juvenile stages, and recruitment. Key products from this project include:

1) **Identifying relationships among oceanographic, biological, and climate data series from within PWS, the GOA, and Northeast Pacific that can be used in subsequent analyses as potential predictors of PWS herring spawning, survival, and recruitment. This synthesis of environmental data series is expected to also support other EVOSTC-funded projects conducted by the Herring Research and Monitoring (HRM) and Gulf Watch Alaska programs,**
2) **A robust examination of physical and/or ecological processes linked to PWS herring spawning and survival during spawning and juvenile life stages prior to recruiting to the adult population,**
3) **A comparison of the relative influence of physical and/or ecological processes on recruitment to the PWS and Sitka Sound herring populations,**
4) **Providing environmental inputs to the HRM modeling and stock assessment project to facilitate expansion of the Bayesian age-structured assessment model to evaluate if incorporating environmental processes will improve the accuracy of recruitment predictions.**

The management teams from both HRM and GWA programs recommend the use of the cross-program publication group funds as partial support for the position. The teams feel the postdoctoral fellow provides the best means for achieving the desired result of programmatic synthesis publications.

4. SCHEDULE

A. Program Milestones for FY18

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.

B. Measurable Project Tasks for FY18

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.

FY18, 1st quarter, end April 30, 2018
Annual assessment update from BASA model

FY18, 2st quarter, end July 31, 2018
FY18, 3st quarter, end October 31, 2018
Obtain antibody data from herring serum 2012-2017 for inclusion in model.
FY18, 4st quarter, end January 31, 2019
Annual joint meeting with Gulf Watch
Annual Cordova meeting for PIs
Annual report.
Submit model results and code to Ocean Workspace.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

If there are any staffing changes to Primary Investigators or other senior personnel please provide CV's for any new personnel and describe their role on the project.

John Trochta (MS student soon to bypass to PhD) is taking an 8 month leave to travel on his prestigious Bondermann Travel Fellowship, starting in October 2017. In his absence, a new MS student, Stephanie Thurner, will be conducting the stock assessment.

This proposal adds David McGowan as a postdoctoral researcher. David's application and proposal was reviewed by a selection committee that included members of the HRM and GWA programs and they recommended that his position be funded because it integrates efforts from both programs. David will be examining the relationship between herring recruitment and condition and environmental parameters as monitored by the GWA program. Specifics about his work can be found in his proposal and in section 3 of this proposal.

DAVID W. MCGOWAN

University of Washington, School of Aquatic and Fishery Sciences, Box 355020, Seattle, WA 98195-5020
206-773-8754 (cell), 206-221-6864 (office), mcgowand@uw.edu

EDUCATION

Doctor of Philosophy, Aquatic & Fishery Sciences (expected October 2017)
University of Washington, School of Aquatic & Fishery Sciences, Seattle, WA
Supervisor: John K Horne
Capelin in the Gulf of Alaska: linkages between environmental variability and spatiotemporal changes in the distribution and abundance of a key small pelagic species over the continental shelf

Master of Science, Biology (2008)
Florida Atlantic University, Department of Biological Sciences, Boca Raton, FL
Supervisor: Stephen M Kajiura
Electroreception in the euryhaline stingray, Dasyatis sabina

Bachelor of Science with Honors, Marine Biology (2000)
Florida Institute of Technology, Melbourne, FL

RESEARCH INTERESTS

Acoustic description of fish and macrozooplankton horizontal and vertical distributions; spatiotemporal variability in fish distribution and abundance; scale-dependent relationships between fish distribution and abundance with physical and ecological processes; trophic interactions and energy transfer; survey design for fisheries-dependent and -independent monitoring; highly migratory species; recreational fisheries; public outreach.

PROFESSIONAL APPOINTMENTS

Ph.D. Graduate Research/Teaching Assistant (2011-2017), Seattle, WA
University of Washington, School of Aquatic and Fishery Sciences
- Research Assistant for Gulf of Alaska (GOA) Synthesis (2016-2017)
- Teaching Assistant (2014, 2017)
- Logistics coordinator for Bevan Series on Sustainable Fisheries (2014, 2017)
- Research Assistant for GOA Integrated Research Program (2011-2015)

Fish & Wildlife Biological Scientist 3 (2009-2011), Tequesta, FL
Florida Fish & Wildlife Conservation Commission, Fish & Wildlife Research Institute

Graduate Teaching Assistant (*2004-2007), Boca Raton, FL
Florida Atlantic University, Department of Biological Sciences

Observer: Commercial Shark Fishery Observer Program (*2003), Gainesville, FL
University of Florida, Florida Museum of Natural History

Fish & Wildlife Biological Scientist 2 (*2000-2009), Tequesta, FL
Florida Fish & Wildlife Conservation Commission, Fish & Wildlife Research Institute

Observer: North Pacific Groundfish Observer Program (2000), Anchorage, AK
Saltwater, Inc.

6. Budget
A. Budget Forms (Attached)

Provide completed budget forms.

B. Changes from Original Proposal

If your FY18 funding request differs from your original proposal, provide a detailed list of the changes and discuss the reason for each change.

C. Sources of Additional Funding

Identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

A. Budget Forms

See attached for detail.

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$48.7	$138.2	$144.3	$152.4	$64.8	$548.4	$ 19.9
Travel	$6.4	$13.7	$12.1	$9.3	$6.9	$48.4	$ 1.0
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$ 8.2
Commodities	$25.1	$25.7	$26.1	$25.0	$24.2	$126.1	$ -
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$ -
Indirect Costs (*will vary by proposer*)	$33.8	$86.9	$90.0	$91.6	$40.7	$343.0	$ 12.3
SUBTOTAL	$114.0	$264.5	$272.5	$278.3	$136.6	$1,065.9	$41.4
General Administration (9% of subtotal)	$10.3	$23.8	$24.5	$25.0	$12.3	$95.9	N/A
PROJECT TOTAL	$124.3	$288.3	$297.0	$303.3	$148.9	$1,161.9	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	

B. Changes from Original Proposal

We are seeking additional funds in FY18-20 to support a postdoctoral fellow. The cost of the position prior to the 9% GA is $150K in FY 18, $148.4K in FY 19, $150K in FY 20. The funding request includes 12 months of salary for the fellow each year, and 0.5 months for the PI. We are requesting funding to provide the position with a computer in FY 18, and publication funds in each of the three years. There is also travel funds requested to allow the person to attend the annual PI meetings and to spend time working with collaborators in the HRM and GWA programs. These costs are subject to the UW indirect rate of 0.55 in FY18 and 0.555 in FY19 and 20.

C. Sources of Additional Funding

No additional sources of funding.