Response to Reviewers: 17120111-C Modeling and Stock Assessment of PWS herring, P.I. Branch

EVOS Science Panel Comments

This is a well-written proposal that clearly shows the linkages with most of the other projects. The proposal lists six tasks, that are listed below (in Italics), with some short comments from the Science Panel on each.

(1) 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.

The Panel wondered what was meant by 'condition data'. Does this refer to the estimates of condition that can be derived from ASL data or does it refer to something else?

RESPONSE: the condition data are the data collected by Thomas Kline looking at over-winter survival of age-0 herring in Prince William Sound, including the condition of the fish during and after winter. The energy stores (condition) of these herring was a good predictor of over-winter survival.

Also, we assume that the updated maturity data would come from the Gorman proposal. The Panel also had some discussion on the benefits of new information on size-at-maturity and age-at-maturity or both for BASA. Regarding maturity data, we repeat that there is broad evidence of temporal and spatial structuring of herring on spawning grounds, and sometimes even in over-wintering areas. During spawning, larger, older fish tend to spawn earliest, and perhaps even at different locations than younger fish. Sampling during the spawning time can lead to bias in estimates of age composition, and may lead to errors in assumptions about age-at-maturity. Therefore, the Panel endorses the approach to provide empirical estimates of age-at-maturity with such temporal and spatial structuring in mind (also see Panel comments on Gorman proposal).

RESPONSE: the model is flexible and can handle changing estimates of age at maturity over time, from the Gorman proposal and any other source that might arise over the next five years. However, modeling spatial structure of herring among different spawning grounds is a much larger task beyond the scope of the current model.

(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.

The Panel endorses this task.

RESPONSE: this task is retained.

(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.

The Panel is puzzled and perhaps ambivalent about this. This seems like a worthy task but the implications for PWS seem remote. Providing that this task is not a big-ticket item, it does not present any issues, although it is not clear why this needs to be shown as a distinct task, when it could have been conducted sub-rosa.

RESPONSE: much of this work has already been completed in the first five years, but we believe this work is crucial in interpreting the decline and failure to recover of Prince William Sound herring. In addition to the value of this work towards obtaining a PhD for the graduate student involved, there are two main reasons to retain this part of the project: 1) The potential to develop informative priors for model parameters, based on data from other herring populations. 2) To understand whether the collapse is linked to factors peculiar to Prince William Sound or not. In other words, was the collapse particularly severe, or the period of lack of recovery exceptionally long compared to other herring populations. If not, Prince William Sound herring might just be undergoing natural long-term fluctuations experienced by all herring populations.

(4) An initial exploration of factors that may be used to predict herring recruitment, including oceanography, climate, competition, and predation.
The Panel strongly endorses this task.

RESPONSE: this is retained.

(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.
The Panel does not foresee the resumption of active herring fisheries in PWS anytime in the near future. Therefore while this task may have eventual worth, it belongs closer to the back-burner than the front.

RESPONSE: our evaluation of other herring stocks shows that nearly all recovered in less than 20 years. Thus there is a good possibility that Prince William Sound herring stock will recover in the next five years, and we should plan ahead for the resumption of the fishery. This MSE will provide a long-term strategic examination of current management rules for when the day of recovery is at hand, and be useful for ADF&G in managing other Alaskan stocks.

(6) 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.
We recommend caution. While it may be sensible to proceed with data evaluation, it also is essential to have a concurrent examination of the efficacy and integrity of some of the key databases used in the assessment model. In particular the factors that might affect the time series of acoustics data have not been well explained in any document to date. Similar comments might be made about some other types of data used in the assessment model (see comments made in response to the Moffitt and Gorman proposals).

RESPONSE: this section is now removed from the proposal.

The proposal would also benefit from a discussion of how this model could be transferred to ADFG for their future use.

RESPONSE: the model is available on the data portal, and is ready for use by ADF&G. The best course of action would probably be a workshop with herring assessment scientists to provide training on how to run this model, since it is implemented in AD Model Builder.

Appendix C

meEVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

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

August 12, 2016

Project Abstract

Prince William Sound (PWS) herring collapsed shortly after the Exxon Valdez oil spill, and has yet to recover. Here, we propose 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-1 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.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
$124.3	**$124.8**	**$135.3**	**$139.9**	**$148.9**	**$673.2**

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL

Please refer to the Invitation for the specific proposal requirements for each Focus Area. The information requested in this form is in addition to the information requested in each Focus Area and by the Invitation.

Appendix C

1. Executive Summary

Identify the hypotheses the project is designed to address. Describe the background and history of the problem. Include a scientific literature review that covers the most significant previous work history related to the project. Please provide a summary of the project including key hypotheses and overall goals.

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 may open 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.

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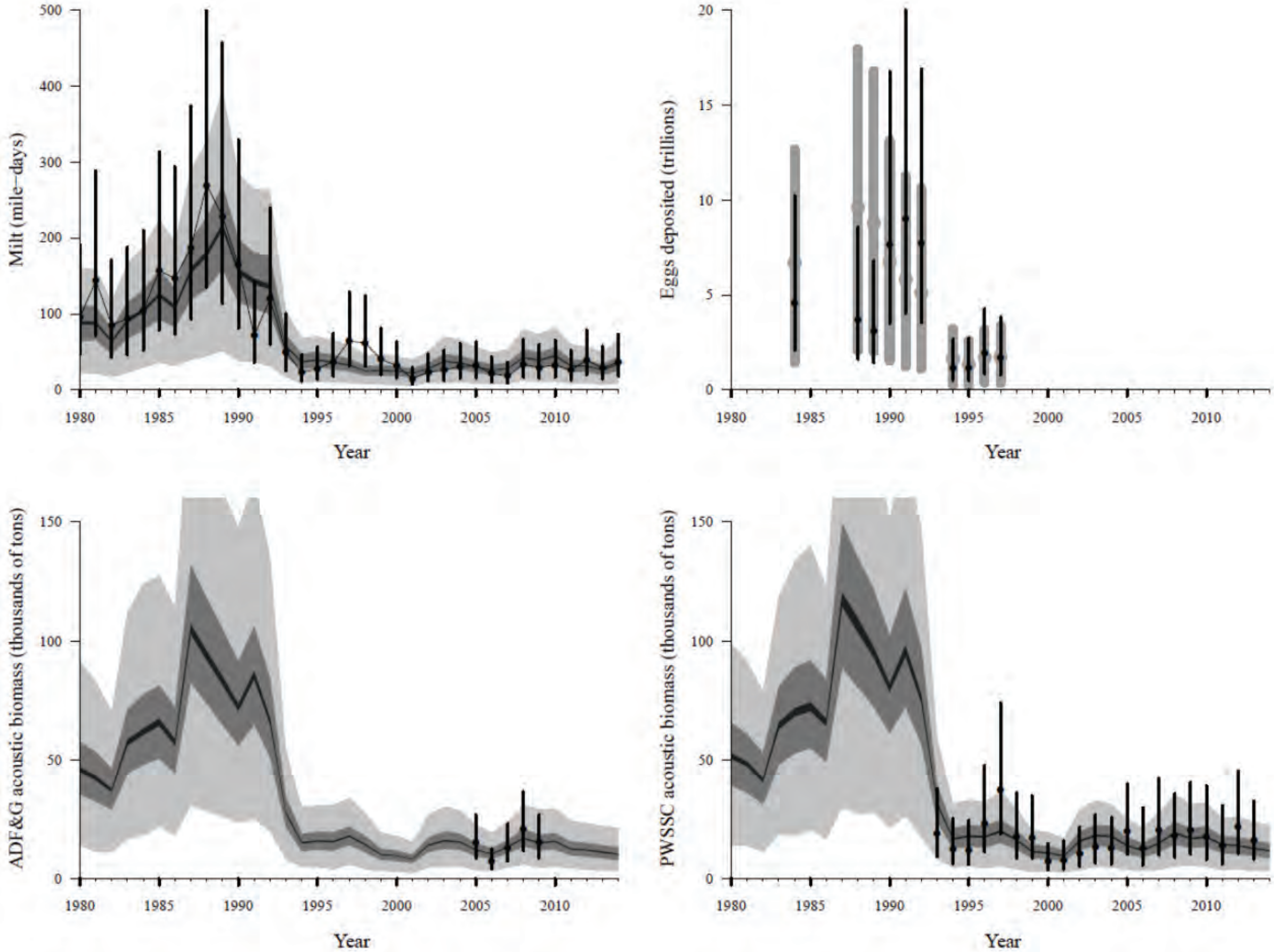

Figure 1 The 2015 Bayesian age-structured assessment (BASA) model estimates of Prince William Sound herring biomass fitted to the four main time series of biomass. Shaded polygons are the model-estimated posterior predictive intervals: 5th percentiles (black), 50th percentiles (dark gray) and 95% percentiles (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).

Appendix C

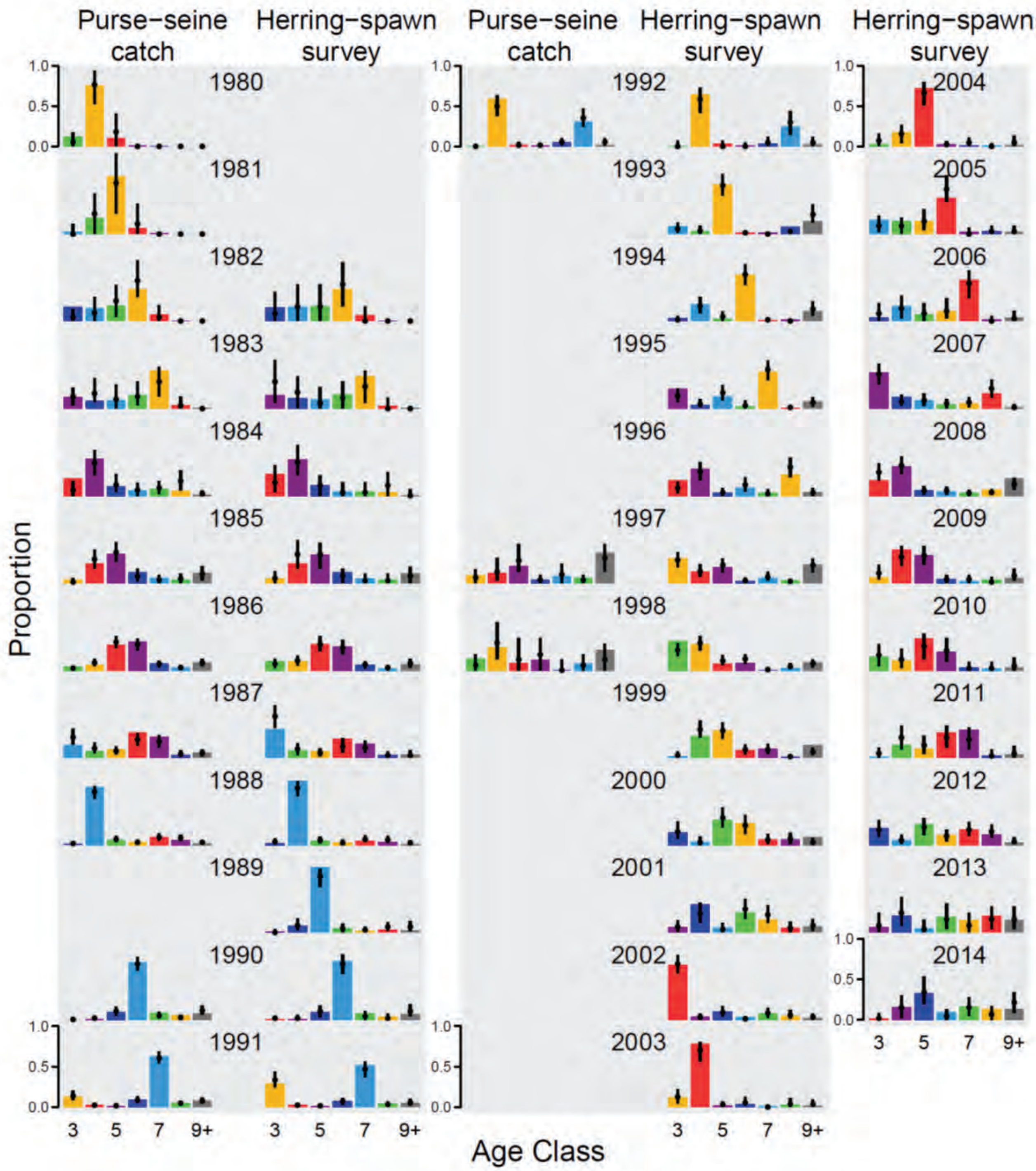

Figure 2. The 2015 Bayesian age-structured assessment (BASA) model fits to the age composition data from purse-seine catches and from the ADF&G herring-spawn survey. Colors track individual cohorts over time, while points and lines indicate the model posterior median and 95% posterior intervals. Source: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

Discuss how the project addresses the projects of interest listed in the Invitation and the overall Program goals and objectives. Describe the results you expect to achieve during the project, the benefits of success as they relate to the topic under which the proposal was submitted, and the potential recipients of these benefits.

This proposal addresses the following topics listed for the Herring Research and Monitoring Program:

1. Overall program goal: The continued development and testing of an updated age-structured assessment (ASA) model in collaboration with ADF&G.
2. Overall program goal: Simulations to evaluate which data sources, if collected under this Invitation, would be the most useful in assessing future herring biomass, trends, and recovery.
3. A comparative retrospective analysis of data from PWS and other herring populations to assist in determining the continued lack of recovery of PWS herring populations.
4. The study of the role of disease in herring recovery.
5. The relation of herring recruitment and abundance to physical and biological oceanographic factors and food web drivers.
6. The inclusion of new estimates of herring age-at-maturity within the ASA model estimates.
7. The development of the model, as in the first five years, can be used to assess the relative likelihood of different hypotheses affecting PWS herring, including those noted in the call for proposals: humpback whale trends, extractive fishing, and fish aquaculture.

3. Project Personnel

The CV's of all principal investigators and other senior personnel involved in the proposal must be provided. Each resume is limited to two consecutively numbered pages and must include the following information:

- A list of professional and academic credentials, mailing address, and other contact information (including e-mail address)
- A list of up your most recent publications most closely related to the proposed project and up to five other significant publications. Do not include additional lists of publications, lectures, etc.
- A list of all persons (including their organizational affiliations) in alphabetical order with whom you have collaborated on a project or publication within the last four years. If there have been no collaborators, this should be indicated.

Prof. Trevor A. Branch will be the lead PI on the herring assessment and modeling project. He will be responsible for coordination, writing proposals and reports, developing new models, and be the contact person for the proposal. He is requesting one month of salary per year of the proposal. Prof. Branch also served as the PI for the modeling portion of the first five years of the HRM program.

A PhD graduate student, likely John Trochta, will dedicate 12 months per year to the project. The student will implement and run the Bayesian stock assessment, conduct and organize datasets, and upload data to the data management system. John Trochta has been working on the project as his MS degree for the last 1.5 years and has a detailed knowledge of the system and the assessment model. The PI and student will jointly write scientific papers, attend meetings, and coordinate with the other HRM partners, Gulf Watch, and other affected parties.

Appendix C

Résumé: Trevor A. Branch, PI

School of Aquatic and Fishery Sciences, Box 355020, University of Washington, Seattle WA, 98195 email: tbranch@uw.edu, phone: 206-221-0776

Academic credentials

University of Washington	Aquatic and Fishery Sciences	PhD	2004
University of Cape Town	Conservation Biology	MSc	1998
University of Cape Town	Zoology	BSc(Hons)	1995
University of Cape Town	Zoology, Computer Science	BSc	1994

Recent appointments

2015–present	Associate Professor, School of Aquatic and Fishery Sciences, Univ. of Washington
2010–2015	Assistant Professor, School of Aquatic and Fishery Sciences, Univ. of Washington
2006–2010	Research Scientist, School of Aquatic and Fishery Sciences, Univ. of Washington
2005–2006	Research Scientist, Marine Resource Assessment and Management Group, Department of Mathematics and Applied Mathematics, Univ. of Cape Town

Five most relevant publications

Hillary RM, Preece AL, Davies CR, Kurota H, Sakai O, Itoh T, Parma AM, Butterworth DS, Ianelli J, Branch TA (2016) A scientific alternative to moratoria for rebuilding depleted international tuna stocks. Fish and Fisheries doi: 10.1111/faf.12121

Szuwalski CS, Vert-pre KA, Punt AE, Branch TA, Hilborn R (2015) Examining common assumptions about recruitment: a meta-analysis of recruitment dynamics for worldwide marine fisheries. Fish and Fisheries 16:633-648

Hilborn R, Hively DJ, Jensen OP, Branch TA (2014) The dynamics of fish populations at low abundance and prospects for rebuilding and recovery. ICES Journal of Marine Science 71:2141-2151

Stachura MM, Essington TE, Mantua NJ, Hollowed AB, Haltuch MA, Spencer PD, Branch TA, Doyle MJ (2014) Linking Northeast Pacific recruitment synchrony to environmental variability. Fisheries Oceanography 23:389-408

Branch TA, Jensen OP, Ricard D, Ye Y, Hilborn R (2011) Contrasting global trends in marine fishery status obtained from catches and from stock assessments. Conservation Biology 25:777-786

Five other significant publications (*n* = 68)

Branch TA, Watson R, Fulton EA, Jennings S, McGilliard CR, Pablico GT, Ricard D, Tracey SR (2010) The trophic fingerprint of marine fisheries. Nature 468:431-435

Branch TA, Lobo AS, Purcell SW (2013) Opportunistic exploitation: an overlooked pathway to extinction. Trends Ecol Evol 28:409-413

Branch TA, Hively DJ, Hilborn R (2013) Is the ocean food provision index biased? Nature 495:E5-E6

Sethi SA, Branch TA, Watson R (2010) Fishery development patterns are driven by profit but not trophic level. Proc Natl Acad Sci USA 107:12163-12167

Worm B et al. (2009) Rebuilding global fisheries. Science 325:578-585

Synergistic activities

1. Elected as Fellow of the American Institute of Fishery Research Biologists (2014).
2. Outstanding Researcher award for the College of the Environment, University of Washington (2013).
3. Ecological Society of America Sustainability Science Award (2011).
4. Aldo Leopold Fellow (2013) "to provide researchers with the skills, approaches, and theoretical frameworks for translating their knowledge to action and for catalyzing change to address the world's most pressing sustainability challenges."
5. Invited participant, Scientific Committee of the International Whaling Commission, 2000-08,15-16.

Appendix C

Collaborators and coauthors in the last 48 months (n = 177)

Acevedo-Whitehouse, K (UK), Agnew, D (UK), Ahrens, R (Univ Florida), Alagiyawadu, A (Sri Lanka), Allison, C (UK), Altweg, R (South Africa), Anderson, RC (Maldives), Anderson, SC (Simon Fraser Univ), Andrews-Goffs, V (Australia), Atkinson, S (Univ Alaska), Austin, J (Univ Florida), Baker, CS (Oregon State Univ), Baldwin, R (Oman), Balk, MA (Univ New Mexico), Barlow, J (NOAA), Baum, JK (Univ Victoria, Canada), Bell, RJ (Univ Rhode Island), Bellman, MA (NOAA), Benfield, MC (Louisiana State Univ), Berchok, CL (NOAA), Bianci, PL (UC Santa Barbara), Bonhommeau, S (France), Boveng, PL (NOAA), Brodziak, JKT (NOAA), Brownell, RL (NOAA), Butterworth, DS (South Africa), Cabral, B (UC Santa Barbara), Chassot, E (France), Chen, C (Duke Univ), Clavelle, T (UCSB), Collie, JS (Univ Rhode Island), Cooper, AB (Simon Fraser Univ), Cope, JM (NOAA), Cornejo-Donoso, J (Chile), Cosgrove, J (Canada), Costello, C (UC Santa Barbara), Cruz, E (NOAA), Cunningham, CJ (Univ Alaska), Davies, CR (Australia), DaVolls, L (UK), Defeo, O (Uruguay), deJoseph, B (UW), Double, MC (Australia), Dove, ADM (Georgia Aquarium), Doyle, MJ (UW), Dubroca, L (France), Dulvy, NK (Simon Fraser Univ), Dziak, RP (NOAA), Emmons, CK (NOAA), Essington, TE (UW), Evans, DM (UK), Fogarty, MJ (NOAA), Fromentin, JM (France), Gaines, S (UCSB), Gales, N (Australia), Garner, TWJ (UK), Gaskins, LC (Duke Univ), Gedamke, J (NOAA), Gendron, D (Mexico), Gerrodette, T (NOAA), Giles, DA (UC Davis), Gompper, ME (Univ Missouri), Gordon, IJ (UK), Guinet, C (France), Guttierrez, NL (UK), Haltuch, MA (NOAA), Harley, SJ (New Caledonia), Haynie, AC (NOAA), Hancock-Hanser, B (NOAA), Hanson, MB (NOAA), Helm, RR (Brown Univ), Heppell, SS (Oregon State Univ), Hilborn, R (UW), Hillary, R (Australia), Hively, DJ (UW), Hochberg, FGE (Santa Barbara Mus Nat Hist), Hogans, JT (Cascadia Research), Hoggarth, DD (UK), Hollowed, A (NOAA), Holt, MM (NOAA), Hospital, J (NOAA), Houghton, J (UW), Hulson, PJF (NOAA), Ianelli, J (NOAA), Itoh, T (Japan), Ivashchenko, YV (NOAA), Jenner, KCS (Australia), Jenner, M-N (Australia), Jensen, OP (Rutgers Univ), Johnson, JA (Univ N Texas), Kamikawa, KT (Univ Hawaii), Kaplan, D (France), Karachle, PK (Greece), Katzner, TE (W Virginia Univ), Kell, LT (Spain), Kendall, NW (UW), Kleiber, D (Univ British Columbia), Kuriyama, PT (UW), Kurota, H (Japan), Laidre, KL (UW), Larsen, A (UC Santa Barbara), Laverick, S (Australia), LeDuc, RL (NOAA), Lee FB (Duke Univ), Leland, A (Env Defense Fund), Le Paper, O (France), Link, JS (NOAA), Linnell, AE (Miami), Lobo, AS (India), Lotze, HK (Dalhousie Univ), MacIntyre, KQ (UW), Mantua, NJ (NOAA), Marsac, F (South Africa), Marshall, A (Mar Megafauna Foundn), Martell, SJD (Int Pac Halibut Comm), Mashburn, KL (Univ Alaska), Matsuoka, K (Japan), Maunder, MN (IATTC), McClain, CR (Natl Evol Synth Center), McMurray, SE (Univ North Carolina), Melnychuk, MC (UW), Minto, C (Ireland), Miyashita, T (Japan), Moffitt, SD (ADF&G), Monnahan, CC (UW), Muradian, M (UW), Nieblas, A-E (France), Ninnes, C (UK), Oleson, EM (NOAA), Ovando, D (UCSB), Palacios, DM (NOAA), Palomares, MLD (Univ British Columbia), Parma, AM (Argentina), Pettorelli, N (UK), Pons, M (UW), Pope, JG (UK), Preece, AL (Australia), Punt, AE (UW), Purcell, SW (Australia), Ranjan, R (India), Rantanen, E (UK), Rader, DN (Env Defense Fund), Ray, L (UW), Restrepo, VR (ISSF), Ricard, D (Czech Republic), Royer, J-Y (France), Rudd, MB (UW), Rutherford, K (Canada), Sainsbury, K (Australia), Sakai, O (Japan), Samaran, F (France), Saraux, C (France), Schanche, C (Duke Univ), Selden, RL (UC Santa Barbara), Sharma, R (Seychelles), Sistla, S (UC Santa Barbara), Smith, ADM (Australia), Spencer, PD (NOAA), Sremba, A (Oregon State Univ), Stachura, MM (UW), Stafford, KM (UW), Stawitz, CC (UW), Stern-Pirlot, A (UK), Stewart, IJ (NOAA), Stone, SN (Duke Univ), Strauss, CK (Env Defense Fund), Szuwalski, CS (UW), Teck, SJ (UC Santa Barbara), Thaler, AD (Blackbeard Biologic), Thorson, JT (UW), Valencia, SR (UC Santa Barbara), VanBlaricom, GR (UW), Vert-Pre, KA (UW), Wagner, C (UW), Watson, R (Australia), Williams, NE (Australia), Worm, B (Dalhousie Univ)

Graduate advisors: Douglas S. Butterworth and John G. Field, University of Cape Town (MSc); Ray Hilborn, University of Washington (PhD)

Thesis/postdoc advisor (last five years): Cole Monnahan (MS, PhD), Melissa Muradian (MS), Peter Kuriyama (PhD), Merrill Rudd (PhD), John Trochta (MS), Matthew Baker (postdoc), Sean Anderson (postdoc), Lewis Barnett (postdoc). Total graduate students: 5, postdocs: 3.

Appendix C

4. Project Design
A. Objectives
List the objectives of the proposed research and briefly state why the intended research is important. If your proposed project builds on recent work, provide detail on why the data set needs to be continued and whether any changes are proposed. If the proposed project is for new work, explain why the new data is needed. Describe the anticipated final product.

B. Procedural and Scientific Methods
For each objective listed in A. above, identify the specific methods that will be used to meet the objective. In describing the methodologies for collection and analysis, identify measurements to be made and the anticipated precision and accuracy of each measurement and describe the sampling equipment in a manner that permits an assessment of the anticipated raw-data quality.

If applicable, discuss alternative methodologies considered, and explain why the proposed methods were chosen. In addition, projects that will involve the lethal collection of birds or mammals must comply with the EVOSTC's policy on collections, available on our website www.evostc.state.ak.us

C. Data Analysis and Statistical Methods
Describe the process for analyzing data. Discuss the means by which the measurements to be taken could be compared with historical observations or with regions that are thought to have similar ecosystems. Describe the statistical power of the proposed sampling program for detecting a significant change in numbers. To the extent that the variation to be expected in the response variable(s) is known or can be approximated, proposals should demonstrate that the sample sizes and sampling times (for dynamic processes) are of sufficient power or robustness to adequately test the hypotheses. For environmental measurements, what is the measurement error associated with the devices and approaches to be used?

D. Description of Study Area
Where will the project be undertaken? Describe the study area, including, if applicable, decimally-coded latitude and longitude readings of sampling locations or the bounding coordinates of the sampling region (e.g., 60.8233, -147.1029, 60.4739, -147.7309 for the north, east, south and west bounding coordinates).

A. Objectives

1. Maintain and update the new Bayesian age-structured assessment (BASA) model based on the ASA model used by ADF&G.
2. Adapting the BASA model to better model viral hemorrhagic septicemia virus (VHSV) disease epidemics.
3. Expand database of global herring catch, biomass, and recruitment time series to place the lack of recovery of PWS herring into context.
4. Explore factors that might predict herring recruitment.
5. Develop a management strategy evaluation to test alternative harvest control rules for managing the fishery in the future

These objectives aim at continually improving our efforts at assessing the current status of PWS herring. The model development and database of global herring build on previous work and is central to understanding current status and putting this in context of global herring stocks. Expanding data collection improves the accuracy of this work.

The anticipated final product of this work is two-fold: (1) A PhD dissertation on these topics, or perhaps 2 MS theses depending on the level of the students applying to do this work. (2) 3-5 scientific papers describing the new results, with the number of scientific papers depending on the lines explored by the research.

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B. Procedural and Scientific Methods

For each objective listed in A. above, identify the specific methods that will be used to meet the objective. In describing the methodologies for collection and analysis, identify measurements to be made and the anticipated precision and accuracy of each measurement and describe the sampling equipment in a manner that permits an assessment of the anticipated raw-data quality.

If applicable, discuss alternative methodologies considered, and explain why the proposed methods were chosen.

1. Maintain and update the new Bayesian age-structured assessment (BASA) model.

Method: the current BASA model is implemented in AD Model Builder, with substantial R code for handling model inputs, model outputs, and the production of figures and tables expanding on the results. AD Model builder is a flexible and extremely fast package for fitting models to data, that enables a Bayesian analysis impossible in the Excel-based ASA model. Alternative Bayesian packages now available, such as WinBUGS, JAGS, and Stan could also be used to implement BASA, but this would require substantial reprogramming, debugging, and code validation, and model performance would be worse for WinBUGS and JAGS. Therefore we have decided to make modifications to the current BASA model structure in AD Model Builder. The model is available for use by ADF&G.

2. Adapting the BASA model to better model viral hemorrhagic septicemia virus (VHSV) disease epidemics.

Method: new research by Paul Hershberger's lab at USGS includes the ability to detect antibodies to VHSV in PWS herring. Antibodies indicate that those herring were exposed to VHSV at some point in their life, which solves one of the most problematic issues with disease inclusion in the BASA and ASA models: VHSV flares up suddenly and then rapidly kills affected fish. Thus measures of current disease detection do not directly measure mortality from VHSV since surviving fish test negative for the virus. However, surviving fish can now be tested for antibody production (P. Hershberger, pers. comm.). Furthermore, samples of herring serum stored since 2012, by age, can be tested for antibodies, and differences in antibody prevalence reveal information about the disease load experienced by each cohort during the lives. Preliminary models suggest that these age-year antibody data can be used to infer the severity of disease outbreaks in each year. We plan to build a complete simulated disease model with antibody production to test whether the antibody data can indeed measure the severity disease outbreaks. If this is successful, as we expect it will be, this model component will be included in the BASA model, with the disease outbreak percent becoming a direct component of natural mortality. However, if the simulations reveal insufficient accuracy about disease outbreaks, the proposed disease model will not be included in the BASA model.

3. Expand database of global herring catch, biomass, and recruitment time series to place the lack of recovery of PWS herring into context.

Method: during the current five-year program, John Trochta has compiled an extensive database of spawning biomass and recruitment time series from stock assessments (Fig. 3), together with time series of catches. These are currently being used to assess how likely it is for an individual herring stock to collapse and fail to recover, as seen in PWS herring. In the next five years, this database will be expanded to include more recent years and herring stocks currently missing from this dataset. The database will serve as a useful resource for herring biologists and be used to obtain informative priors for parameters in the BASA model.

Appendix C

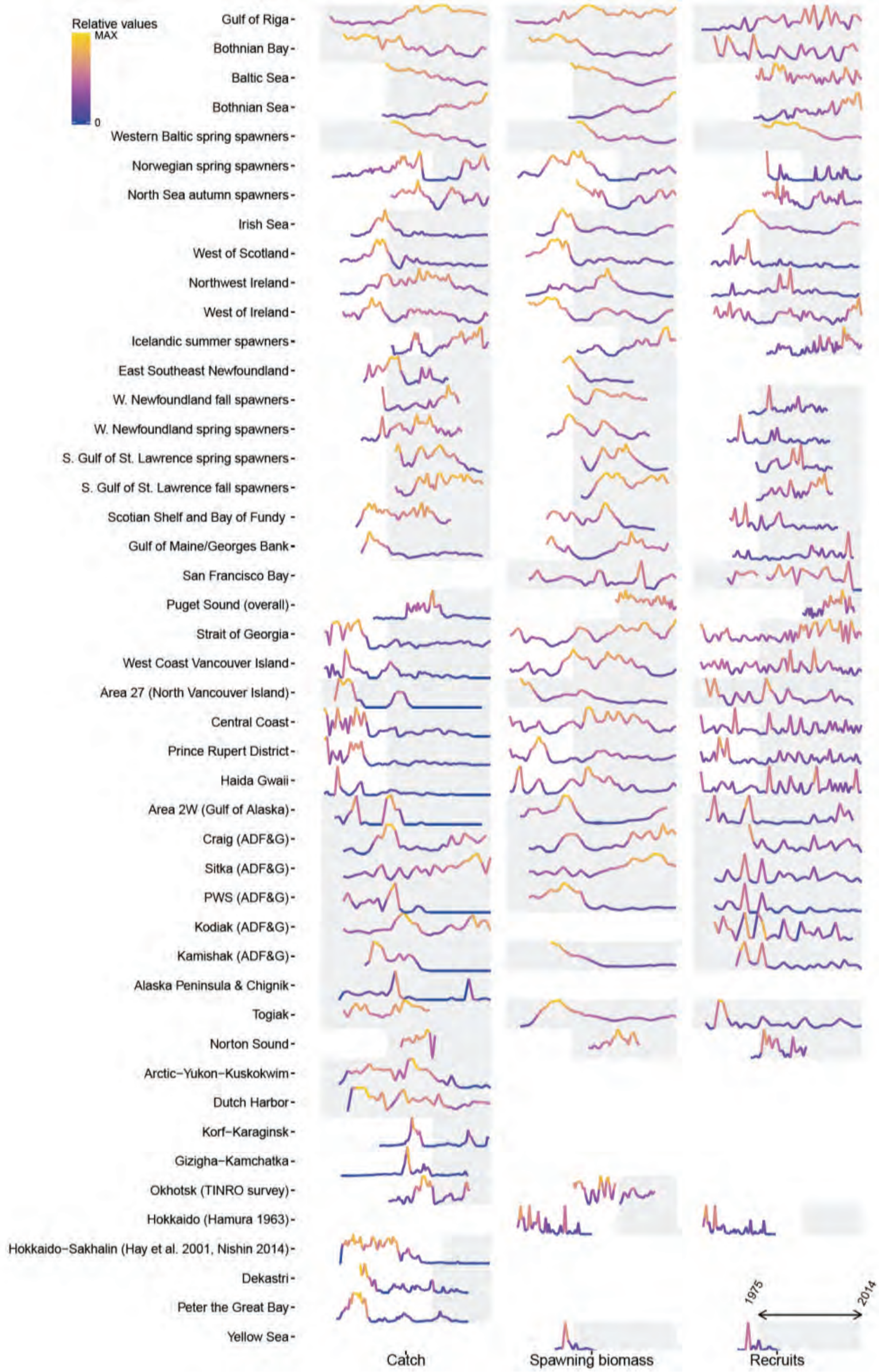

Figure 3. Time series of catch (left column), spawning biomass (middle) and recruitment (right) for 45 herring stocks, compiled by John Trochta.

4. Explore factors that might predict herring recruitment.

Method: this project could provide useful predictions of herring recruitment, but it should be noted that many previous projects attempting to predict recruitment from environmental factors have either found no correlations, or the correlations have disappeared later (Francis 2006, Walters & Collie 1988, Myers 1998). The one exception is species near the edge of the range (Myers 1998) such as PWS herring. However, PWS herring do provide a unique case study with long time series of oceanographic, biological, and climate variables that could be used as correlates. We therefore propose an initial scoping exercise using multiple regressions to see if any of the most obvious time series show strong correlations with recruitment estimated in the BASA model. Given the long time period associated with the herring monitoring program and Gulf Watch, this project has the unique opportunity to make predictions and test those predictions.

5. Develop a management strategy evaluation to test alternative harvest control rules for managing the fishery in the future

Methods: well-established methods exist for running management strategy evaluations (MSE) to test control rules for fisheries (e.g. Hillary et al. 2016, Punt et al. 2016), and efforts are underway for an MSE for Sitka Sound and Haida Gwaii by the Ocean Modeling Forum. Given the current state of the PWS herring fishery (closed for most of the last 26 years), it is possible that there exists a harvest control rule that would allow fishing at minimal risk to the stock. In addition, the herring stock appears to have entered a stable regime of low productivity and low recruitment. The current harvest control rule was tested on high and low recruitment regimes (Zheng et al. 1993). Given many years have passed since the current rule was developed, and our collection of data on global herring populations that allow for much more realistic simulations, we propose revisiting this using a new MSE. The implementation of an MSE would use the BASA model as an operating model to simulate "truth" under different scenarios; the operating model generates "data" that is fed into a control rule which sets the allowable catch the next year. Then the operating model is updated with the allowable catch and the process repeated for many years, and for many combinations of control rules. At the end, the control rules that best balance risk to the stock with catches, while being robust to uncertainty, could be put forward as possible control rules for consideration.

Note: The modeling project does not involve the lethal collection of birds and mammals.

C. Data Analysis and Statistical Methods

Sample size description is not directly relevant to the modeling objectives outlined above.

D. Description of Study Area

The project is focused on herring in the entirety of Prince William Sound.

5. Coordination and Collaboration

Within the Program

Provide a list and clearly describe the functional and operational relationships with the 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.).

With Other EVOSTC-funded Programs and Projects

Indicate how your proposed program relates to, complements or includes collaborative efforts with other proposed or existing programs or projects funded by the EVOSTC.

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.

Appendix C

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 or program, note this and explain why.

With Native and Local Communities
Provide a detailed plan for any local and native community involvement in the project.

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.

6. Schedule

Program Milestones
Specify when critical program tasks will be completed. Reviewers will use this information in conjunction with annual program reports to assess whether the program is meeting its objectives and is suitable for continued funding.

Measurable Program Tasks
Specify, by each quarter of each fiscal year (February 1 – January 31), when critical program tasks will be completed.

There is considerable uncertainty in the timeline here, depending on the duration of time it takes the current graduate student to complete his MS, register for a PhD, and finish the PhD. In addition, modeling projects can be finished quickly, or if they are tricky, may take 2-3 times longer than anticipated.

FY17, 1st quarter, February 1, 2017–April 30, 2017
Initiate project, identify graduate student
FY17, 2st quarter, end July 31, 2017
FY17, 3st quarter, end October 31, 2017
FY17, 4st quarter, end January 31, 2018
Simulation study completed on feasibility of estimating annual VHSV infection rate from antibodies in serum.
Annual joint meeting with Gulf Watch
Annual Cordova meeting for PIs
Annual report.
Submit model results and code to Ocean Workspace and ADF&G.

FY18, 1st quarter, end April 30, 2018
Annual assessment update from BASA model
FY18, 2st quarter, end July 31, 2018

Appendix C

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 and ADF&G.

FY19, 1st quarter, end April 30, 2019
Update BASA model with antibody disease component
Annual assessment update from BASA model
FY19, 2st quarter, end July 31, 2019
Preliminary examinations of environmental factors affecting recruitment
Submit paper on antibody disease component
FY19, 3st quarter, end October 31, 2019
FY19, 4st quarter, end January 31, 2020
Update on global herring meta-analysis and relevance to PWS herring
Annual joint meeting with Gulf Watch
Annual Cordova meeting for PIs
Annual report.
Submit model results and code to Ocean Workspace and ADF&G.

FY20, 1st quarter, end April 30, 2020
Annual assessment update from BASA model
FY20, 2st quarter, end July 31, 2020
Submit paper on factors predicting herring recruitment (if study is conclusive)
FY20, 3st quarter, end October 31, 2020
FY20, 4st quarter, end January 31, 2021
Annual joint meeting with Gulf Watch
Annual Cordova meeting for PIs
Annual report.
Submit model results and code to Ocean Workspace and ADF&G.

FY21, 1st quarter, end April 30, 2021
Annual assessment update from BASA model
FY21, 2st quarter, end July 31, 2021
Preliminary analysis of harvest control rules.
FY21, 3st quarter, end October 31, 2021
FY21, 4st quarter, end January 31, 2022
Submit paper on harvest control rules suitable for managing herring.
Annual joint meeting with Gulf Watch
Annual Cordova meeting for PIs
Final report for five-year project.
Submit model results and code to Ocean Workspace and ADF&G.

7. Budget
Budget Forms (Attached)

Appendix C

Please provide completed budget forms. Please note that the following items will not be considered for funding:

- Costs associated with international travel for meetings, symposia, or presentations.
- Costs associated with attendance at meetings, symposia, or presentations outside of those required to coordinate with project members.
- Costs associated with outreach or education efforts.

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.

Budget Forms: attached as an Excel file.

Sources of additional funding: None.

Salary

PI Trevor Branch is asking for 1 month of salary per year for five years. His salary is $10,101 in 2015-16. It is assumed to increase at 4% per year for each year of the proposal, with the first year of the proposal corresponding to 2016-17. Benefits are assumed to be 25.3% throughout the proposal.
Salary is requested for 12 months a year for a PhD-level graduate student throughout the 5 years. Graduate student salary in SAFS is 2,444 starting 1 July 2016 and is assumed to increase 6% every 1 July. After 1.5 yr it is assumed the student will be PhD II rates (currently $2630/yr). Benefits are assumed to be 17.0% for all years. Note: in the submitted sponsor budget forms, the mean monthly salary over the sponsor year (1 Feb-31 Jan) is listed for each Sponsor Year.

Tuition

Tuition is $5454 per quarter in the 2016-17 UW year. It is assumed to increase 5% per year. Summer tuition is assumed to be $2000 for 2 credits. Tuition is assumed to be paid in the last two-week period of each quarter (end March, June, September, December).

Travel

One PI meeting per year is planned in Cordova over two days in November for both the PI and the graduate student. In addition, both the PI and the graduate student are budgeted to attend the 5-day AMSS meeting in Anchorage in January each year. The Total cost in Year 1 is $6428. Annual cost increases of 2% are assumed for each year. In addition, in Year 3 an additional meeting in Anchorage is required for the Joint Science Workshop to present interim research to the funders (EVOSTC). This will cost $1181×1.02 for the PI to attend.
Total travel funds requested:
Year 1: $6,428
Year 2: $6,557
Year 3: $7,918
Year 4: $6,821
Year 5: $6,958

Publication costs

One publication will be produced per year, for publication costs (including those incurred for open access and color figures) of $1500 in each of the five years.

Computers

Appendix C

Provision is made for the purchase of one new laptop ($2000) in Year 1, and one number-crunching high-powered desktop computer ($3000) in Year 1, for a total of $5000 in Year 1. No computer purchases are anticipated in the remaining years of the proposal. These do not qualify as capital equipment.

Indirect costs

University of Washington indirect cost rate is 54.5% for 07/01/2016-06/30/2017 (first part of Year 1), 55.0% for 07/01/2017-06/30/2018 (second part of Year 1 and first part of Year 2) and 55.5% for 07/01/2018-06/30/2020 (second part of Year 2 and assumed to continue to the end of Year 5).

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***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$48.7	$53.1	$57.2	$60.3	$64.8	$284.1	
Travel	$6.4	$6.6	$7.9	$6.8	$7.0	$34.7	
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Commodities	$25.1	$21.1	$22.0	$23.1	$24.2	$115.5	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)	$33.8	$33.8	$37.0	$38.1	$40.7	$183.4	
SUBTOTAL	$114.0	$114.5	$124.2	$128.3	$136.6	$617.7	
General Administration (9% of	$10.3	$10.3	$11.2	$11.6	$12.3	$55.6	N/A
PROJECT TOTAL	$124.3	$124.8	$135.3	$139.9	$148.9	$673.2	
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 project funding and actual cumulative spending. The column titled 'Actual Cumulative' must be updated each fiscal year as part of the annual reporting requirements. 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.

FY17-21

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

NON-TRUSTEE AGENCY SUMMARY PAGE

Date Prepared: 08.24.2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor Branch	Associate Professor	1.0	13.164		13.164
John Trochta	Graduate student	12.0	2.959		35.508
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
		Subtotal	16.123	0.0	
				Personnel Total	48.672

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Joint AMSS and project meeting (PI)	0.400	1	5	0.201	1.405
Joint AMSS and project meeting (grad student)	0.400	1	5	0.201	1.405
PI meeting Cordova (PI)	0.500	1	2	0.172	0.844
PI meeting Cordova (grad student)	0.500	1	2	0.172	0.844
Airport shuttles and taxis (2 people x 2 meetings)	0.180	4			0.720
AMSS conference fee	0.605	2			1.210
					0.000
					0.000
					0.000
					0.000
					0.000
				Travel Total	6.428

FY17

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08.24.2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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 costs, page charges, color figure costs	1.500
Laptop (graduate student)	2.000
Number-crunching computer	3.000
Tuition	18.635
Commodities Total	25.135

FY17

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

Date Prepared: 08.24.2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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: Descriptior	Number of Units	Inventory Agency

FY17

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
EQUIPMENT DETAIL

Date Prepared: 08.24.2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor Branch	Associate Professor	1.0	13.690		13.690
John Trochta	Graduate student	12.0	3.280		39.360
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
		Subtotal	16.970	0.0	
				Personnel Total	53.050

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Joint AMSS and project meeting (PI)	0.408	1	5	0.205	1.433
Joint AMSS and project meeting (grad student)	0.408	1	5	0.205	1.433
PI meeting Cordova (PI)	0.510	1	2	0.175	0.861
PI meeting Cordova (grad student)	0.510	1	2	0.175	0.861
Airport shuttles and taxis (2 people x 2 meetings)	0.184	4			0.734
AMSS conference fee	0.617	2			1.234
					0.000
					0.000
					0.000
					0.000
					0.000
				Travel Total	6.557

FY18

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08.24.2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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 costs, page charges, color figure costs	1.500
Tuition	19.567
Commodities Total	21.067

FY18

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

Date Prepared: 08.24.2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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: Descriptior	Number of Units	Inventory Agency

FY18

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
EQUIPMENT DETAIL

Date Prepared: 08.24.2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Trevor Branch	Associate Professor	1.0	14.239		14.239
John Trochta	Graduate student	12.0	3.580		42.960
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
		Subtotal	17.8	0.0	
				Personnel Total	57.199

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Joint AMSS and project meeting (PI)	0.416	1	5	0.209	1.462
Joint AMSS and project meeting (grad student)	0.416	1	5	0.209	1.462
PI meeting Cordova (PI)	0.520	1	2	0.179	0.878
PI meeting Cordova (grad student)	0.520	1	2	0.179	0.878
Airport shuttles and taxis (5 people-meetings)	0.187	5			0.936
AMSS conference fee	0.629	2			1.259
Joint Science Workshop in Anchorage	0.416	1	3	0.209	1.044
					0.000
					0.000
					0.000
					0.000
				Travel Total	7.918

FY19

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08.24.2016

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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 costs, page charges, color figure costs	1.500
Tuition	20.545
Commodities Total	22.045

FY19

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: 08.24.2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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: Descriptior	Number of Units	Inventory Agency

FY19

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
EQUIPMENT DETAIL

Date Prepared: 08.24.2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor Branch	Associate Professor	1.0	14.808		14.808
John Trochta	Graduate student	12.0	3.795		45.540
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
		Subtotal	18.6	0.0	
				Personnel Total	60.348

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Joint AMSS and project meeting (PI)	0.424	1	5	0.213	1.491
Joint AMSS and project meeting (grad student)	0.424	1	5	0.213	1.491
PI meeting Cordova (PI)	0.531	1	2	0.183	0.896
PI meeting Cordova (grad student)	0.531	1	2	0.183	0.896
Airport shuttles and taxis (4 meetings)	0.191	4			0.764
AMSS conference fee	0.642	2			1.284
					0.000
					0.000
					0.000
					0.000
					0.000
				Travel Total	6.821

FY20

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08.24.2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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 costs, page charges, color figure costs	1.500
Tuition	21.573
Commodities Total	23.073

FY20

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: 08.24.2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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: Descriptior	Number of Units	Inventory Agency

FY20

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
EQUIPMENT DETAIL

Date Prepared: 08.24.2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Trevor Branch	Associate Professor	1.000	16.555		16.555
John Trochta	Graduate student	12.000	4.023		48.276
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
					0.000
		Subtotal	20.578	0.000	
				Personnel Total	64.831

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Joint AMSS and project meeting (PI)	0.433	1	5	0.218	1.521
Joint AMSS and project meeting (grad student)	0.433	1	5	0.218	1.521
PI meeting Cordova (PI)	0.541	1	2	0.186	0.914
PI meeting Cordova (grad student)	0.541	1	2	0.186	0.914
Airport shuttles and taxis (2 people x 2 meetings)	0.195	4			0.779
AMSS conference fee	0.655	2			1.310
					0.000
					0.000
					0.000
					0.000
					0.000
				Travel Total	6.958

FY21

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08.24.2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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 costs, page charges, color figure costs	1.500
Tuition	22.653
Commodities Total	24.153

FY21

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

Date Prepared: 08.24.2016

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

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: Descriptior	Number of Units	Inventory Agency

FY21

Project Title: Modeling and Stock Assessement of PWS Herring
Primary Investigator: Trevor Branch

FORM 3B
EQUIPMENT DETAIL

Date Prepared: 08.24.2016