ATTACHMENT B. Annual Project Report Form (Revised 11.21.19)

1. Project Number:

19120111-C

2. Project Title:

Modeling and stock assessment of Prince William Sound herring

3. Principal Investigator(s) Names:

PI: Trevor A. Branch, University of Washington

Researchers: John Trochta, David McGowan

4. Time Period Covered by the Report:

February 1, 2019-January 31, 2020

5. Date of Report:

March 2020

6. Project Website (if applicable):

https://pwssc.org/herring/

7. Summary of Work Performed:

This project has one overarching aim: to improve the performance of the assessment model for Prince William Sound herring. To achieve this aim, we continued to refine the assessment model and conducted a new assessment in 2019-20. In addition, we have undertaken a variety of additional projects to determine whether recruitment and natural mortality can be better predicted, to place Prince William Sound herring into a more global context, and to examine spawning changes in space and time to inform whether one model for the entire Prince William Sound region is appropriate.

Assessment model: In previous years, the age structured assessment (ASA) model run by the Alaska Department of Fish and Game (ADF&G) was expanded and updated to include a Bayesian formulation which naturally weights the input data sources, and better characterizes uncertainty through estimating Bayesian posteriors (Muradian et al. 2017). In addition, the assessment model was used to determine which historical data sets were the most informative given the trade-off between information gain and cost (Muradian et al. 2019).

The Bayesian age structured assessment (BASA) model continues to evolve since it was published. In the past year the model has been altered so that it now also fits to aerial surveys of age-1 school sizes. Furthermore, the run-time of the model has been greatly reduced from over 3.5 hours to just 15 minutes, by adopting a new and vastly more efficient Bayesian algorithm called the No-U-Turn-Sampler (NUTS), which was programmed into the modeling software packaged AD Model Builder by Cole Monnahan as part of additional efforts in the Branch lab to improve stock assessment methods (Monnahan et al. 2007, Monnahan & Kristensen 2018, Monnahan et al. 2019). This allows a much broader array of sensitivity tests to be run on the model in a Bayesian context, and facilitates rapid evaluation of additional models to assess factors that may influence natural mortality and recruitment.

The most recent BASA model was fit to data up to and including 2019. It provides a good fit to the age composition data (Fig. 1), with the exception of age-3s in 1987 and 1998. In 2019 the model estimates there to be a strong year class, with a high proportion of age 3s, of a size not seen since 2002 (Fig. 2). Consequently, an increase in biomass is estimated in 2019, with corresponding increases both in milt and acoustic data that are fit well by BASA (Fig. 3). However, the model does not fit well to the new age-1 aerial survey results. It is possible that the age-1 aerial survey results are not a reliable predictor of age-3 recruitment, but in addition, we should be cautious in interpreting the evidence from age composition data about the presence of the large age-3 year class. In recent years, model fits to age-1 school data have wide uncertainty since these observations have not been corroborated by data collected for age-3 and age-4 fish, and as a result BASA predicts recruitment to be close to the mean until age-composition information becomes available.

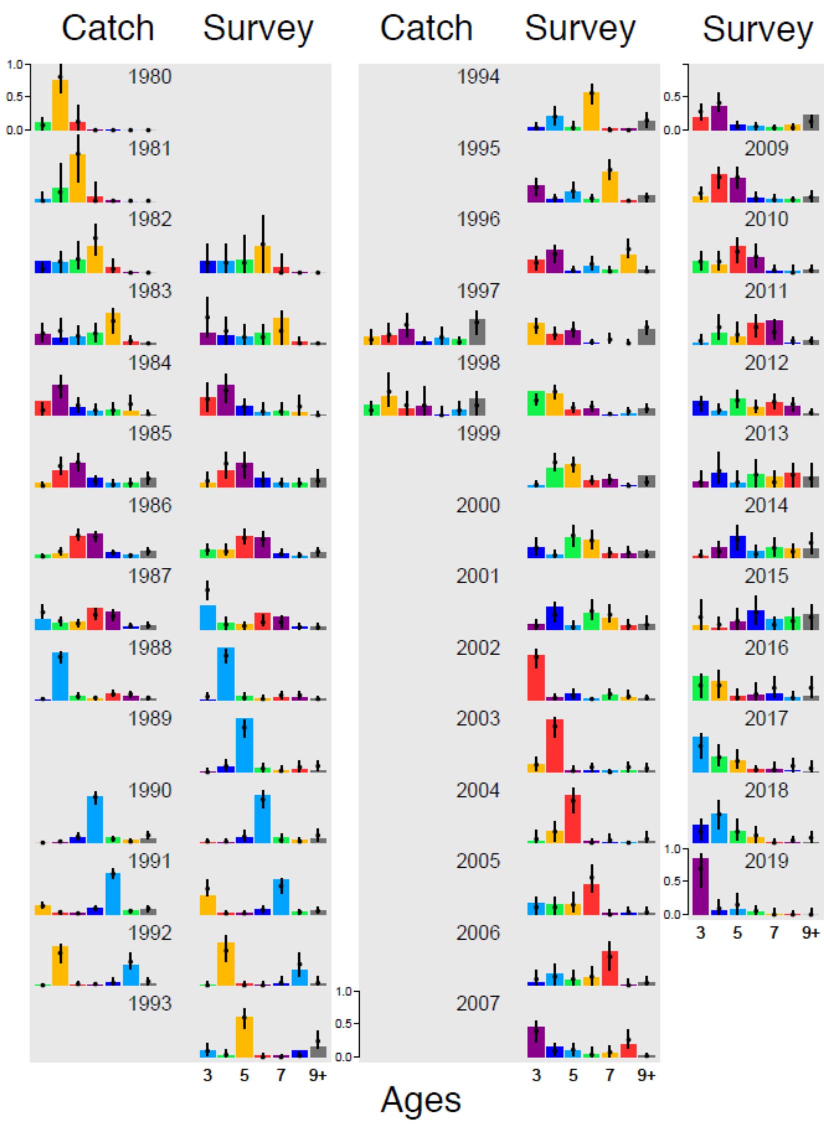

Figure 1. Fits of the Bayesian age structured assessment model (points = median, lines = 95% posterior predictive intervals) to the numbers at age data from catches and surveys (bars). Each color follows a single cohort as it ages through the fishery. Data are available only for ages 3 and above. Note the very large age-3 cohort in 2019.

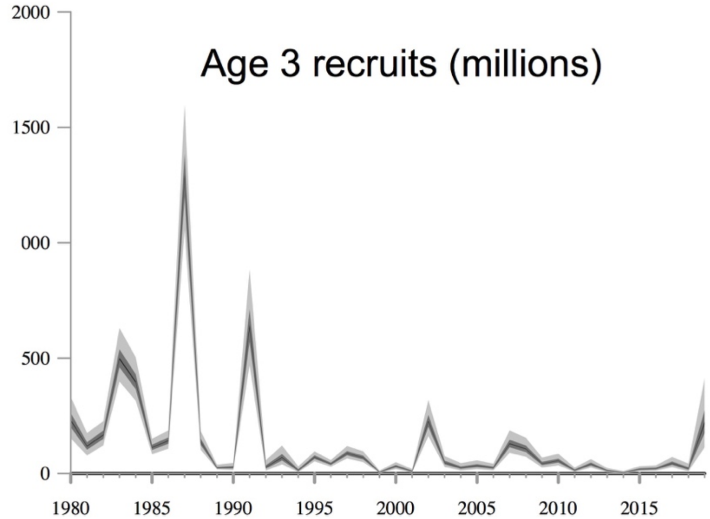

Figure 2. Bayesian age structured assessment estimates of numbers of age-3 recruitment in millions with 95% credibility intervals (light gray shading).

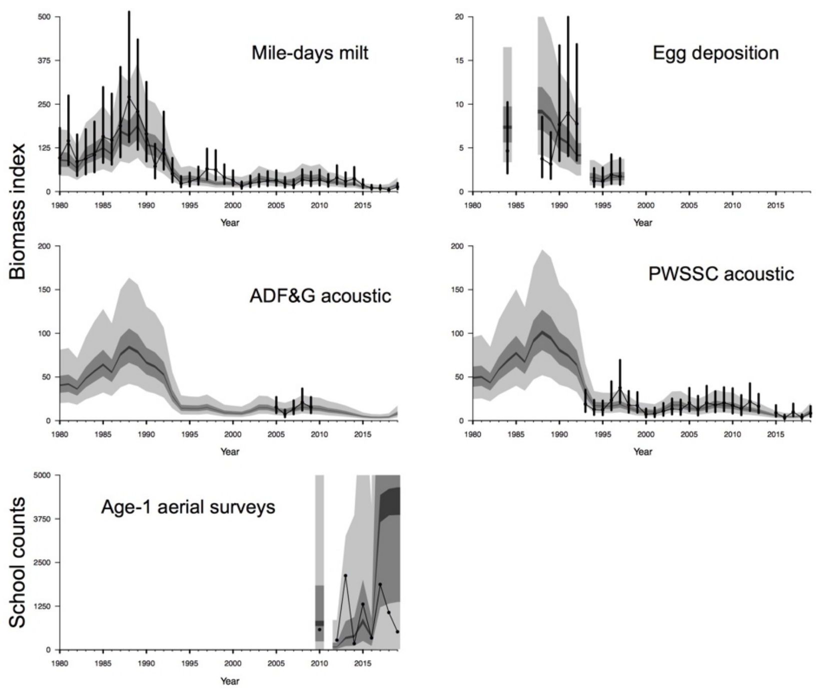

Figure 3. Estimated biomass from Bayesian age structured assessment (shading showing 50% and 95% posterior predictive intervals in dark and light gray, respectively) compared to indices of biomass within the population (points and lines showing observation CV). An increase in both acoustic and milt indices for 2019, resulted in increased biomass (13,670 t, 95% CI 8,860-21,660 t), which is still below the lower cut-off for fishing but a notable improvement from historical low biomass in the years since 2015.

Prior to 2019, BASA consistently overestimated biomass during years with historically low biomass (2014-2018). Checks on current BASA assumptions were explored including down-weighting age composition data, an alternative model of disease, and estimating a regime shift in mean recruitment.

Down-weighting the age-composition data resulted in much better fits to biomass indices and lower estimated biomass. Incorporating a shift in mean recruitment also lowered the biomass estimate, but to a lesser extent. These preliminary results may suggest a change in natural mortality is not adequately accounted for during these years. Analyses testing current model assumptions and structure are ongoing, in order to continue to improve fits and reduce estimation bias in the model.

Sensitivity analysis for maturity: Previous maturity assumptions within BASA imply a risk of model misspecification because of the mature vs. immature composition of the schools targeted by seine and cast net sampling and their representation of the pre- and post-spawning populations. Even though maturity data are available, it is not representative of the entire population and cannot offer an accurate estimation of the true biological maturity because sampling is largely from spawning schools. We explored different assumptions about maturity in BASA that bound the potential effects of mis-specifying maturity, including fixed fast vs. slow maturity schedules, one maturity schedule for all years vs. two different schedules split at 1997, estimating availability of immature fish (from the maturity data), assuming a fixed true biological maturity schedule of the total population (fast and slow), and estimating selectivity of seine and cast nets conditioned on the maturity data (making additional assumptions about certain samples showing high immature proportions representing the unsampled population). All of these different options had negligible impact on biomass and recruitment estimates on average but had some implications for model stability. Therefore, we have shifted the base BASA model to only estimate one period of maturity, with the value of maturity also including availability of herring to sampling. Future BASA assessments should continue to explore sensitivity to maturity assumptions using our suite of models as a starting point.

Global herring meta-analysis: The meta-analysis on global herring populations has recently been accepted for publication in *Fish and Fisheries* (Trochta et al. in press). Based on data from 64 herring populations, herring are more prone to collapses and recoveries than non-forage-fish taxa, and more frequently display strong year classes. Biomass recovery was most rapid in herring populations with high median recruitment, higher variability in sea surface height anomalies and higher variability in sea surface temperatures.

Simulating viral hemorrhagic septicemia virus (VHSV) outbreaks to examine the utility of antibody data within BASA: One currently poorly modeled component of the BASA model is the incorporation of disease data. There is the potential of novel antibody detection data (from principal investigator [PI] Paul Hershberger, project 19120111-E) to inform the severity of VHS outbreaks over time. In brief, herring retain antibodies to VHSV, and thus if a disease outbreak hits the population, all individuals will be exposed, and the population will harbor antibodies at a proportion related to the prevalence of the disease outbreak. New recruits will not have antibodies, and thus an age-specific antibody prevalence can be used to estimate the ages affected by VHSV, and the prevalence of VHSV in the population. Initial operating models for simulating antibody data took a fairly naïve approach to examining disease dynamics (e.g., ignoring susceptible and exposed groups of fish by age) and a more appropriate model is being developed. The new operating model will allow for a much more realistic representation of rapid VHS outbreaks, by projecting over smaller time steps (day to weeks), and then generating antibody data by simulating samples of fish from which prevalence is measured. A simple age-structured assessment estimation model will then fit these data with different simplifying assumptions on disease infection and mortality to determine whether antibody prevalence can be used to estimate the age-specific and year-specific components that disease adds to natural mortality. We anticipate this work will open a new avenue for improving estimates of natural mortality in fisheries stock assessments in general, as well as specifically improving the Prince William Sound herring assessment.

Factors affecting Prince William Sound herring: an in-depth analysis has been conducted (Trochta, Branch) of the potential effects of a wide variety of factors on Prince William Sound herring recruitment and mortality. Among the many factors considered were oceanographic variables, potential competitors and predators, and river discharge. Non-zero associations with adult herring mortality were detected for the North Pacific Gyre Oscillation (NPGO), Pacific Decadal Oscillation (PDO), humpback whales, and arrowtooth flounder, but these effects weakened (i.e., bounds zero) in the most recent time period of data. Only walleye pollock and Pacific cod spawning biomass consistently reduced herring mortality (i.e. more pollock, lower mortality, higher survival, more herring). Age-1 walleye pollock, juvenile hatchery pink salmon, and a regime shift in recruitment were associated with shifts in herring recruitment, but not over the most recent time frame. Bayesian model selection techniques were used to assess if these effects improve predictions from BASA, revealing that only NPGO and walleye pollock effects on mortality provide any notable improvement in predicted mortality and recruitment. These resulted were presented as a talk at the Alaska Marine Science Symposium in 2020 (Fig. 4) and are being written up for publication.

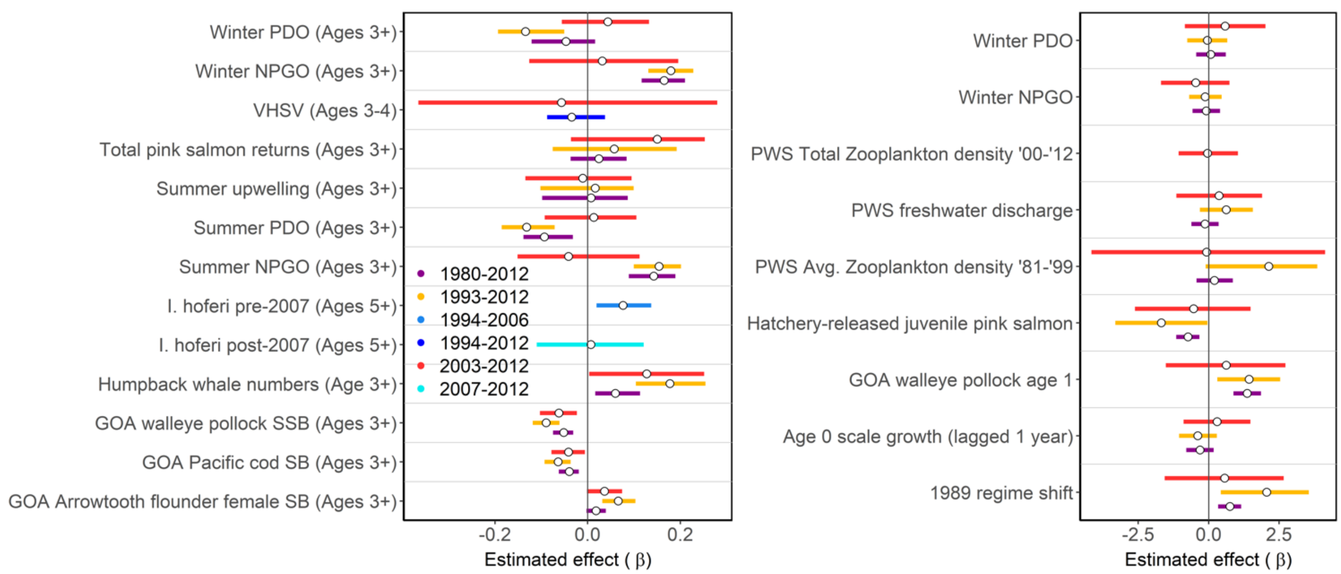

Figure 4. Estimated effects of covariates examined for adult mortality (left) and recruitment (right) in the Bayesian age structured assessment model. Medians (points) with 95% credibility intervals (lines) of the posterior distributions of the estimated effects are shown. Different colors represent different time frames of the covariates that we incorporate into the model to check for changing effects (e.g., effects that weaken towards a zero or effect, possibly strengthen, may suggest non-stationary relationships).

Semi-spatial recruitment models: There is an ongoing collaboration between Alec MacCall (retired National Oceanographic and Atmospheric Administration scientist), and the modeling group (Trochta, McGowan, Branch) on a study of the potential usefulness of semi-spatial stock-recruitment relationships for BASA. The key preliminary finding being investigated is whether interannual changes in where and when herring spawn, as measured by two-dimensional milt coverage, explain changes in the stock-recruitment relationship. For example, if spawning (milt) is evenly spread across sites, recruitment is likely to be higher than if recruitment is unevenly spread across fewer spawning sites. A primary benefit of this work is a potential improvement in forecasts from the herring age-structured model, particularly for management strategy evaluation. This work also has broader relevance to other fish populations with spawning information over space and time.

Postdoc progress: The postdoctoral fellow (David McGowan) completed the analysis of multi-decadal shifts in the distribution and timing of Prince William Sound herring spawning. This study shows there have been substantial changes in herring spawning distribution over the past 40 years, during which spawning has contracted towards southeastern areas of the Sound as the proportion of occupied spawning habitat declined from a peak of 65% in the mid-1980s to a recent low of less 9% in 2018 (Fig. 5). Herring no longer return to the primary spawning areas in Prince William Sound that were used in 1980s, and changes in spawning distributions may be contributing to, rather than resulting from, declines in population biomass. New analyses indicate that spatial shifts in spawning may have been influenced by both changes in population demographics and fishery-related effects on local spawning aggregations. Spawn timing also displayed large decadal changes that coincided with large-scale shifts in ocean temperature. Between 1980 to 2006, the median spawn date shifted earlier in the season by 25 to 30 days in eastern regions of Prince William Sound and by 15 days in western regions (Fig. 6). Spawn timing shifted back later in the season in all regions during a seven-year cold period (2007 to 2013) and returned to the long-term mean spawn time in 2019 following anomalously warm conditions across the Northeast Pacific.

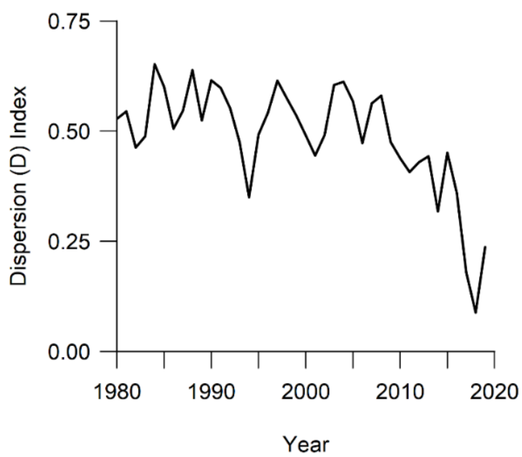

Figure 5. Spawning area dispersion index over time, representing the proportion of spawning habitat monitored by the Alaska Department of Fish and Game aerial survey that is used by herring each year. Index values range from 0 (highly aggregated) to 1 (evenly distributed).

Following the Herring Research and Monitoring (HRM) program's PI meeting in October 2019, we included two new analyses in this study to assess if shifts in spawning distributions correspond with spatial changes in population demographics and harvest by the commercial fishery. Age composition data used in the assessment model and ADF&G trip ticket records were summarized within each Prince William Sound region (Fig. 7) by year and compared to spawning spatial patterns.

There were minimal spatial differences in the age structure of herring in most years (Fig. 8). Strong cohorts (i.e., year classes that produced > 220 million age-3 fish, EVOSTC 2010) typically accounted for a similar proportion of the age composition within each region in a given year. However, a major shift in spawning distributions may be linked to spatial changes in population demographics. The rapid increase in population abundance during the 1980s primarily resulted from the combined production of the 1980, 1981, and 1984 cohorts. Spawning production declined as these cohorts aged out of the population, particularly in the northern regions of Prince William Sound. It appears that 1991 was a critical year for the population, during which the 1988 cohort recruited to the spawning population and first selected spawning areas. Age composition data for each region indicates that the 1988 cohort primarily spawned in the Montague Island region in 1991, but not in the northern regions where the 1984 cohort remained the dominant age class. The following year, no spawning was observed in the North Shore region (the first of five consecutive years with no activity), while spawning increased in both Montague Island and Northeast Shore where the 1988 cohort was the dominant age class. If the assumption that younger fish follow older fish to first select spawning habitat is valid (MacCall et al. 2018), then we hypothesize that productive spawning areas in the North Shore region were abandoned due to a failure of the 1988 cohort to use these grounds.

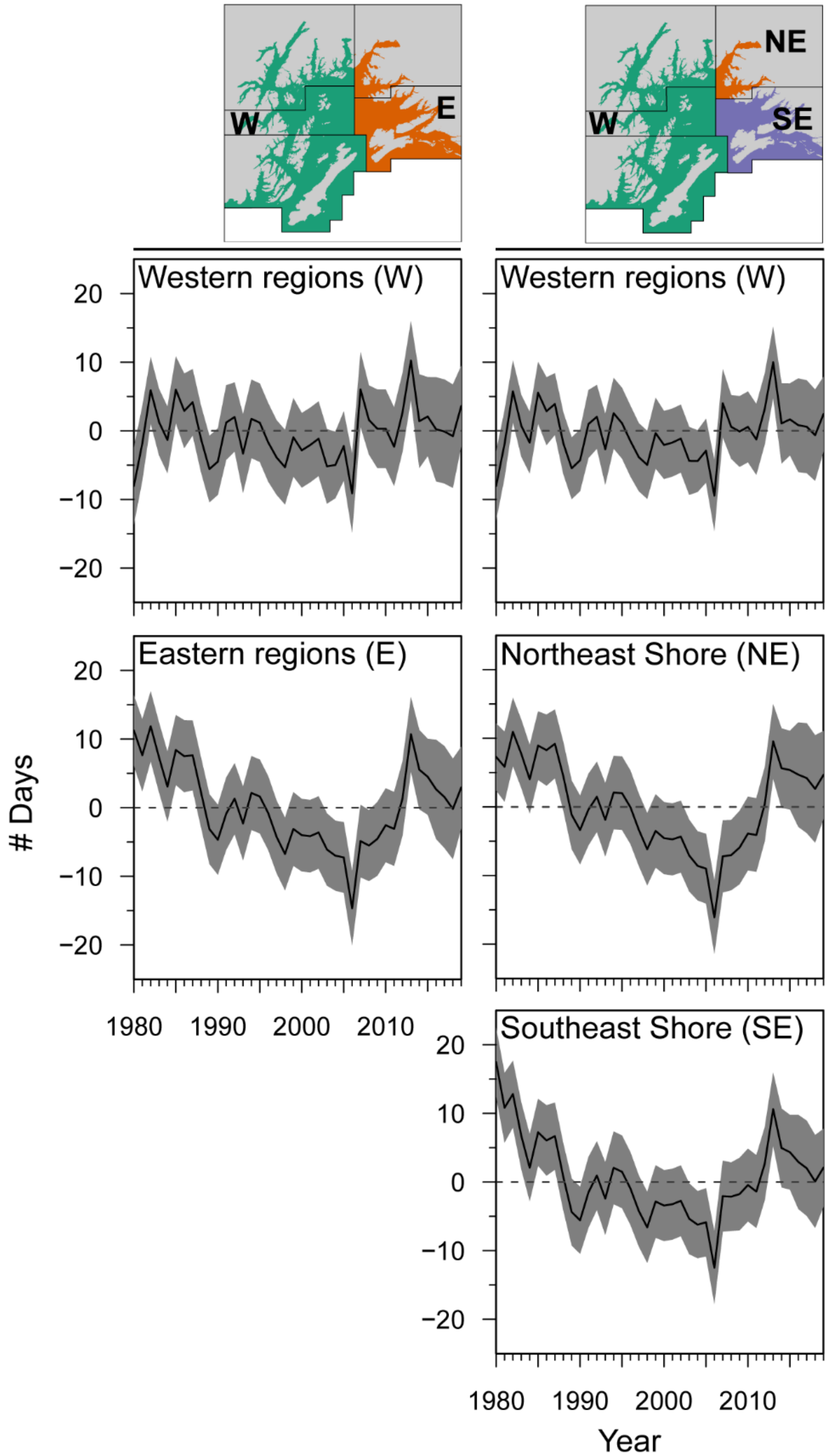

Figure 6. Estimated spawn timing trends (solid line) with 95% confidence intervals (shaded area) for the best supported multivariate autoregressive state-space (MARSS) models. Estimated spawn timing trends for each time series are centered by their mean for all years (dashed line) to indicate earlier (–) and later (+) median spawn date. The left column of plots shows the East vs. West scenario and the right column the three-area scenario for estimated spawn timing trend; these were the two best models.

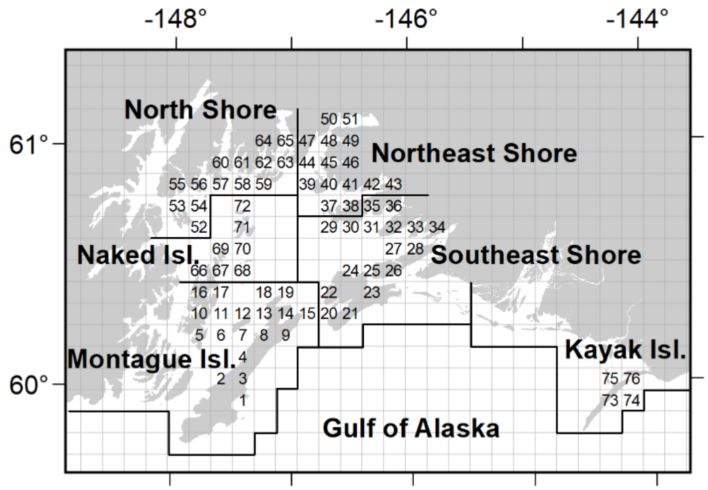

Figure 7. Boundaries for Prince William Sound regions and the Gulf of Alaska. Numbered 10×10 km grid cells indicate areas within each region where herring spawning was observed between 1973 to 2019.

Based on comments provided by the *Exxon Valdez* Oil Spill Trustee Council Science Panel on our FY20 proposal, we compared changes in spawning to the distribution of commercial landings in spring from 1980 to 1998 (Fig. 9). While Prince William Sound herring was spatially managed as a single population, in which the total allowable catch was allocated to multiple fisheries based on gear type (e.g., purse seine, gillnet) and product (e.g., sac-roe, spawn-on-kelp), most of the harvest occurred within one or two of the regions each year. As a result, the annual local exploitation rate often exceeded the management target rate of 0.2 within regions in which the purse seine fishery operated and harvested more than 500 mt, even though the overall exploitation rate for Prince William Sound remained below 0.2 in all years but one. The effect of high local exploitation by the fishery on spawning within a region is unclear. Spawning remained stable or increased in most years that immediately followed one year of high local exploitation. In contrast, spawning declined sharply in regions where high local exploitation had occurred in back-to-back years, including in the Northeast Shore (1991-92) and Montague Island (1980-81, 1997-98) regions, and remained relatively low for a decade or longer within these regions in the absence of recruitment from strong cohorts (Fig. 9). Extended periods of little to no spawning also followed a single year of high exploitation in the Southeast Shore region in 1981 and in the Naked Island region (spawning had already ceased in the North Shore region) in 1992.

The manuscript for this work is currently under internal review with the National Oceanic and Atmospheric Administration (NOAA) and ADF&G and will be submitted to the Canadian Journal of Fisheries and Aquatic Sciences.

Unanticipated departure: David McGowan accepted a permanent position with NOAA at the Alaska Fisheries Science Center in late 2019. His last day in the postdoc position was January 31, 2020. He is continuing his collaborations with Rob Campbell with the Gulf Watch Alaska program and ADF&G staff to identify environmental factors that influence herring spawn timing in Prince William Sound and other herring populations in the Gulf of Alaska. Preliminary results for these analyses were presented at the 2019 PI meeting in Homer. Additional modeling work is ongoing, and the expectation is that a manuscript for this work will be submitted by the end of 2020.

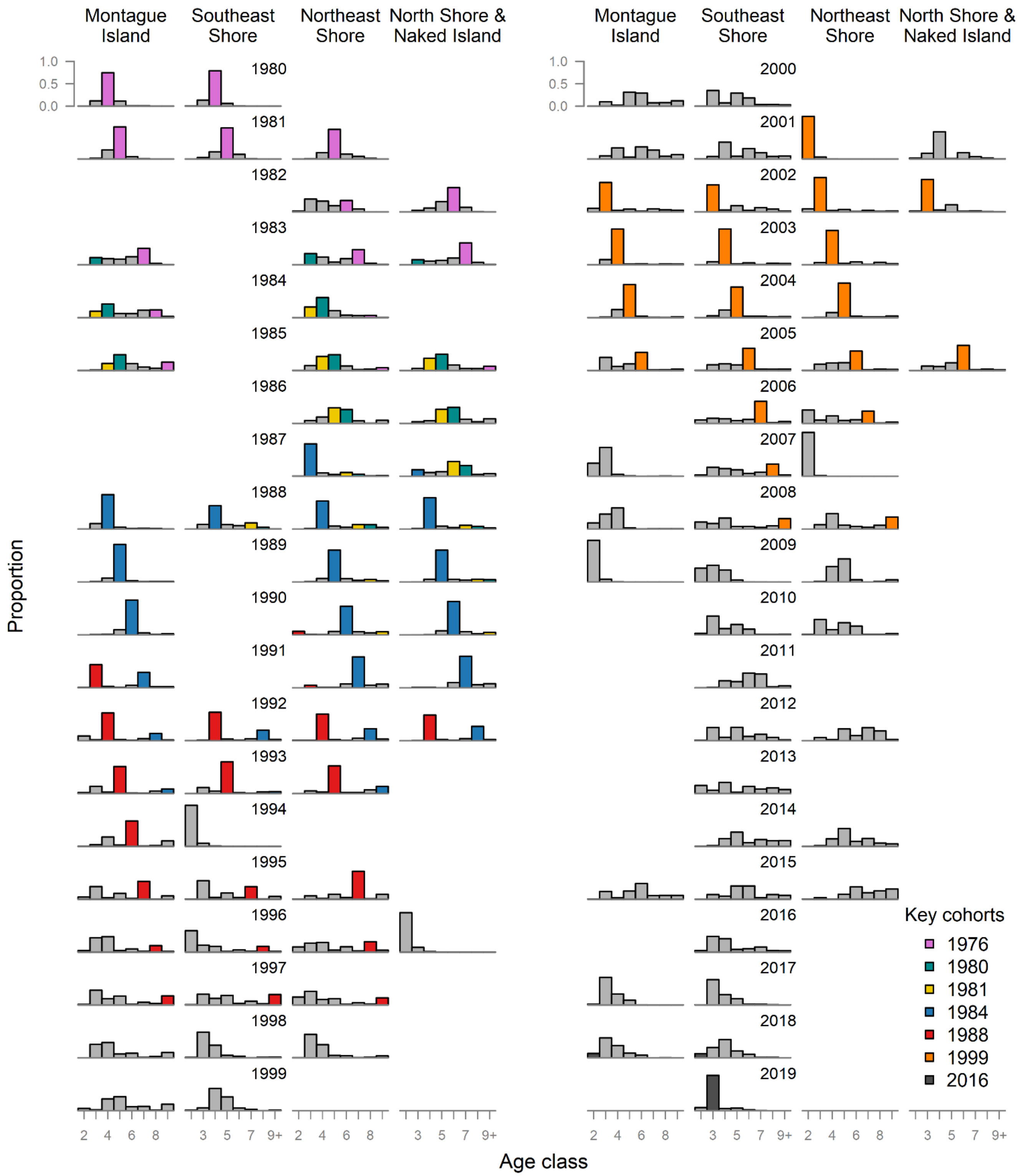

Figure 8. Herring age compositions by region and year from 1980 to 2019. Year classes that produced large cohorts (>200 million age-0 recruits) are highlighted in color.

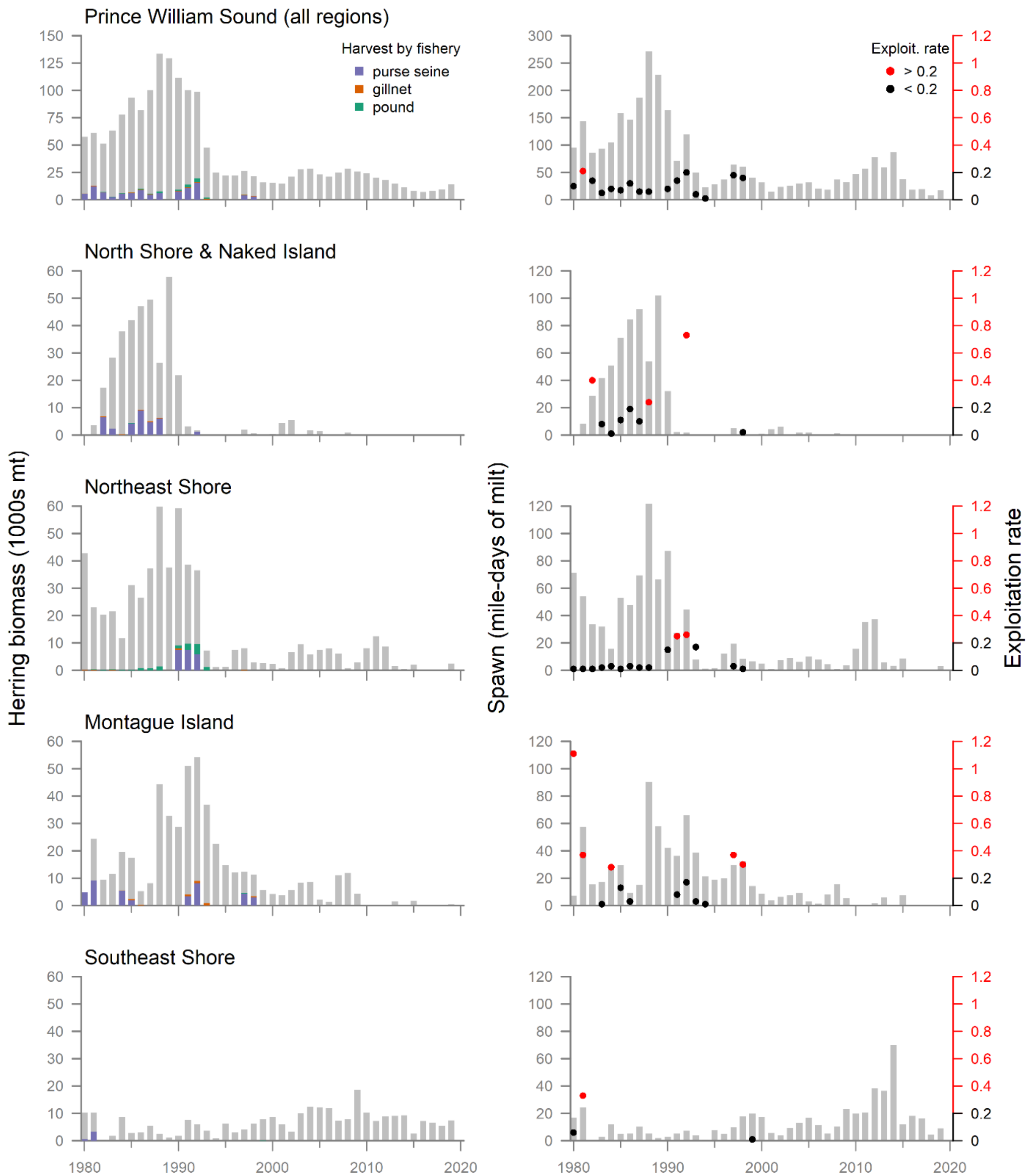

Figure 9. Estimated herring spawning stock biomass (mt) from 1980 to 2019 in Prince William Sound and within each region (left column, North Shore and Naked Island are combined) along with the reported commercial landings by fishery (purse seine and gillnet sac-roe fisheries and pound spawn-on-kelp fishery) from 1980 to 1999. The right column of figures shows total observed spawn on the left axis and the exploitation rate for all fisheries combined within each region on the right axis.

8. Coordination/Collaboration:

A. Long-term Monitoring and Research Program Projects

1. Within the Program

Close collaboration and coordination with the components of the HRM program are an integral part of the modeling project, including assumptions going into the model, data collection (milt survey, acoustic survey, numbers at age, age at maturity, and other data). In addition, the development of the antibody data involves working closely with the disease component of the program.

2. Across Programs

a. Gulf Watch Alaska

David McGowan has been collaborating with Rob Campbell (project 19120114-G) with the Gulf Watch Alaska program on modeling the effects of environmental drivers on shifts in herring spawn timing in Prince William Sound.

b. Data Management

Data and model outputs are being uploaded as they become available to the Gulf of Alaska Data Portal.

B. Individual Projects

A collaboration between John Trochta, David McGowan, and Alec MacCall (retired NOAA scientist) is ongoing to incorporate the spatio-temporal information of the aerial milt surveys into the age-structured assessment model. This project aims to simulation test the value of this spatial information to predict recruitment in the model. It uses Prince William Sound herring as an application since milt data here are mapped by day and year since the 1970s.

C. With Trustee or Management Agencies

Coordination with ADF&G scientists is ongoing and required for data inputs collected by ADF&G and used in the BASA stock assessment model. David McGowan has been actively collaborating with Kyle Hebert and Ted Otis with ADF&G to investigate if shifts in herring spawn timing in Prince William Sound is coherent with the Kamishak and Sitka Sound herring populations.

9. Information and Data Transfer:

A. Publications Produced During the Reporting Period

1. Peer-reviewed Publications (* = core publications)

Brown, C.J., A. Broadley, M.F. Adame, T.A. Branch, M.P. Turschwell, and R.M. Connolly. 2019. The assessment of fishery status depends on fish habitats. Fish and Fisheries 20:1-14.

Chong, L., T.K. Mildenberger, M.B. Rudd, M.H. Taylor, J.M. Cope, T.A. Branch, M. Wolff, and M. Stäbler. 2020. Performance evaluation of data-limited, length-based stock assessment methods. ICES Journal of Marine Science 77:97-108.

Gephart, J.A., H.E. Froehlich, and T.A. Branch. 2019. To create sustainable seafood industries, the United States needs a better accounting of imports and exports. Proceedings of the National Academy of Sciences U.S.A. 116:9142-9146.

Hilborn, R., R.O. Amoroso, C.M. Anderson, J.K. Baum, T.A. Branch, C. Costello, C.L. de Moor, A. Faraj, D. Hively, O.P. Jensen, H. Kurota, L.R. Little, P. Mace, T. McClanahan, M.C. Melnychuk, C. Minto, G.C. Osio, A.M. Parma, M. Pons, S. Segurado, C.S. Szuwalski, J.R. Wilson, and Y. Ye. 2020. Effective fisheries management instrumental in improving fish stock status. Proceedings of the National Academy of Sciences U.S.A. 117:2218-2224.

McGowan, D.W., T.A. Branch, S. Haught, and M. Scheuerell. in prep. Multi-decadal shifts in the distribution and timing of Pacific herring (*Clupea pallasii*) spawning in Prince William Sound, Alaska. Canadian Journal of Fisheries and Aquatic Sciences. (in internal review for NOAA & ADF&G)

*Monnahan, C.C., T.A. Branch, J.T. Thorson, I.J. Stewart, and C.S. Szuwalski. 2019. Overcoming long Bayesian run times in integrated fisheries stock assessments. ICES Journal of Marine Science 76:1477-1488.

*Muradian, M.L., T.A. Branch, and A.E. Punt. 2019. A framework for assessing which sampling programs provide the best trade-off between accuracy and cost of data in stock assessments. ICES Journal of Marine Science 76:2102-2113.

*Trochta, J.T., T.A. Branch, A.O. Shelton, and D.E. Hay. In press. The highs and lows of herring: A meta-analysis of patterns in herring collapse and recovery. Fish and Fisheries.

2. Reports

Branch, T., J. Trochta, and D.W. McGowan. 2019. Modeling and stock assessment of Prince William Sound herring. FY18 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 18120111-C. *Exxon Valdez* Oil Spill Trustee Council, Anchorage, AK.

McGowan, D.W., T.A. Branch, S. Haught, and M. Scheurell. 2019. Chapter 3 Multi-decadal shifts in the distribution and timing of Pacific herring spawning in Prince William Sound, Alaska. In W.S. Pegau, and D.R. Aderhold, editors. Herring Research and Monitoring Science Synthesis. Herring Research and Monitoring Synthesis Report, (*Exxon Valdez* Oil Spill Trustee Council Program 20120111). *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Pegau, W.S., J. Trochta, K. Gorman, and T. Branch. 2019. Chapter 2 Maturity. In W.S. Pegau, and D.R. Aderhold, editors. Herring Research and Monitoring Science Synthesis. Herring Research and Monitoring Synthesis Report, (*Exxon Valdez* Oil Spill Trustee Council Program 20120111). *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

3. Popular articles

McGowan, D.W. 2019. Spatial patterns of capelin in the Gulf of Alaska. Delta Sound Connections. Prince William Sound Science Center (https://pwssc.org/wp-content/uploads/2019/05/DSC-2019_WEB.pdf).

Trochta, J.T. 2019. Herring models: why and how they are used? Delta Sound Connections. Prince William Sound Science Center (https://pwssc.org/wp-content/uploads/2019/05/DSC-2019_WEB.pdf).

B. Dates and Locations of any Conference or Workshop Presentations where EVOSTC-funded Work was Presented

1. Conferences and Workshops

McGowan, D., and T. Branch. 2019. Large multi-decadal space and time shifts in Pacific herring spawning in the Gulf of Alaska. Oral presentation. PICES, Victoria, BC. 21-24 October

Trochta, J.T., 2020. A Bayesian analysis of the utility of ecosystem information in a stock assessment. Oral presentation. Alaska Marine Science Symposium, Anchorage, AK.

Pegau, W.S., T. Branch, D. McGowan, J. Trochta, A. Whitehead, P. Hershberger, M. Groner, P. Rand, K. Gorman, M.A. Bishop, and S. Haught. 2020. 2020. Prince William Sound Herring Research and Monitoring Program. Poster Presentation. Alaska Marine Science Symposium. Anchorage, AK, January.

2. Public presentations

None.

C. Data and/or Information Products Developed During the Reporting Period, if Applicable

Stock assessment of Prince William Sound herring for 2019.

D. Data Sets and Associated Metadata that have been Uploaded to the Program's Data Portal

Uploaded the most recent version of the BASA model and results using 2019 data (Feb. 2019). Metadata on the workspace summarizes the data sets and how to run the model, while detailed instructions and descriptions are contained within READ_ME files and line comments within the code. The upload includes: AD Model Builder files to run model, R code to pre-process data for model & post-process model output, figures and tables of key model output (fits to data, estimates of biomass and recruitment, parameter estimates), and raw model output (read in by R code to produce figures and tables).

10. Response to EVOSTC Review, Recommendations and Comments:

EVOSTC Science Panel Comment. The Science Panel requests for future reports and proposals to please clarify that ADF&G is now using the model from this project. Timeline products: What juvenile data (ages 0-2) are now being incorporated into the model?

PI Response. the ADF&G is not running their own stock assessment and is relying on the results from the BASA model to monitor the stock. Model running is still by Branch/Trochta and funded by this project. The BASA model now fits to the aerial surveys of age 1+ schools, although the variance is high around these model fits. In addition, we assess which factors influence recruitment and natural mortality and this requires the model to start at age-0 so that the covariates can influence recruitment and survival at the ages most likely to be affected.

EVOSTC Science Panel Comment. How are these data collected and have scaling issues of juvenile to adult data been adequately addressed?

PI Response. When the model fits to the age-1 aerial index, it estimates a scaling parameter ("catchability") that scales the magnitude of the juvenile data to the adult data.

EVOSTC Science Panel Comment. Can apparent increases in mortality of herring at ages 1-2 be distinguished from selectivity/catchability issues among aerial and acoustic surveys? The answers affect interpretation of the age(s) at which year class strength is determined.

PI Response. These are currently not incorporated into the BASA model, so the question cannot be addressed from the modeling perspective yet. It seems unlikely that changes in mortality could be estimated precisely enough from the aerial and acoustic surveys given inter-annual variance. However, our project to estimate factors that may affect mortality has uncovered some environmental covariates to address this work.

EVOSTC Science Panel Comment. Regarding the antibody paper, is the PI working closely with Hershberger to get this done?

PI Response. We have the initial results, but newer antibody data are being generated now that more precisely measure antibodies. Our initial simulations suggested that it should be possible to estimate disease prevalence by year and age, but the preliminary data are more ambiguous than anticipated. We are currently developing a more advanced age-structured simulation model to test how much information can be obtained.

EVOSTC Science Panel Comment. Different factors affect herring at different stages which is being incorporated into the ASA model. We find this valid and useful and are excited to see this published. In the FY18 work plan, the Science Panel suggested the PI to consider the development of a similar model for Sitka herring, which would be valuable as a contrast. We still believe this is an important exercise and it likely will be informative for PWS herring and valuable globally. As Sitka Sound is outside of the spill area, we encourage the PI to seek funding to accomplish this. Collaboration with ADF&G in Southeast Alaska would be ideal.

PI Response. A Bayesian model is being developed in ADMB for Sitka by Jane Sullivan (ADF&G), although this has substantial differences in the data used, model assumptions, and functional forms of the individual components. John Trochta travelled to Juneau in February 2020 to work with the ADF&G researchers on collaborative stock assessment proposals and management strategy evaluations, and we will continue coordinating with Sherri Dressel at ADF&G for joint stock assessment efforts.

11. Budget:

***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	$138.2	$144.3	$152.4	$64.8	$548.4	$ 314.8
Travel	$6.4	$13.7	$12.1	$9.3	$6.9	$48.4	$ 14.4
Contractual	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$ 50.6
Commodities	$25.1	$25.7	$26.1	$25.0	$24.2	$126.1	$ 7.4
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	$ 187.1
SUBTOTAL	$114.0	$264.5	$272.5	$278.3	$136.6	$1,065.9	$574.3
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	

LITERATURE CITED

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