



Exxon Valdez Oil Spill Trustee Council

Long-Term Research and Monitoring, Mariculture, Education and Outreach

Annual Project Reporting Form

Project Number: 25120111-C

Project Title: Modeling and stock assessment of PWS herring

Principal Investigator: Trevor A. Branch, University of Washington

Reporting Period: February 1, 2025 – January 31, 2026

Submission Date: March 16, 2026

Project Website: <https://gulfwatchalaska.org/>

Please check all the boxes that apply to the current reporting period.

Project progress is on schedule.

Project progress is delayed.

Budget reallocation request.

Personnel changes.

1. Summary of Work Performed:

Since last year's report, annual funding has been allocated in a more timely manner to this project, allowing for substantial progress to be made by two PhD students (C. L. Roberts and M. de Barros), including preparing a new assessment of Prince William Sound herring, and examining the robustness of the management process model mis-specification (in natural mortality and recruitment). It is now anticipated that funding will be available to complete the full ten-year duration of the originally envisaged project. Therefore, here I briefly review the original eight goals, outline progress (several have been completed), feasibility of completing these goals, and outline two new goals that have arisen from Alaska Department of Fish and Game (ADF&G) needs and basic research.

Review and status of project goals

Goal 1: conduct annual stock assessments of Prince William Sound herring using the Bayesian age-structured assessment model (BASA), described in Muradian et al. (2017). A draft version of the 2025 stock assessment was completed at the end of January 2026 (Roberts and Branch 2026), incorporating the catch data, catch at age, mile-days-of-milt survey, and aerial age-1 survey. The new stock assessment format has been revised so that it conforms more closely to the ADF&G format for stock assessments, expanded to include more extensive tables and figures, and now includes the complete model formulation in a new appendix. It also includes new material explaining how the pre-season forecasts are obtained for the following year, which is especially important given the potential fisheries in spring and fall on this stock. Fishing on herring was reopened in 2024 (399 [metric tons] mt) and 2025 (429 mt) for the first time since 1999.

In 2025, the mile-days-of-milt aerial survey was substantially impacted by poor weather resulting in far smaller survey days. Only 10.5 mile-days were observed but it was estimated that roughly 25 to 30 mile-days would have been observed (J. Morella pers. comm.), and therefore this data point was omitted from the model fitting process. However, sensitivity tests assuming 25 or 30 mile-days for 2025 resulted in very similar stock assessment predictions.

The estimated spawning biomass for the spring pre-fishery forecast is 25,662 mt, which is above the management threshold for opening the fishery (19,958 mt or 22,000 short tons), and there is a 78% probability of being above this threshold (Fig. 1). Spawning biomass has been remarkably stable (between 25,600 and 27,400 mt) since 2021. Four separate age classes are present: ages 3 to 6 all represent more than 10% of the stock, while the strong 2016 year class is now largely absent (Fig. 2). However, the stock remains far below the levels in the 1980s and early 1990s before the stock collapse.

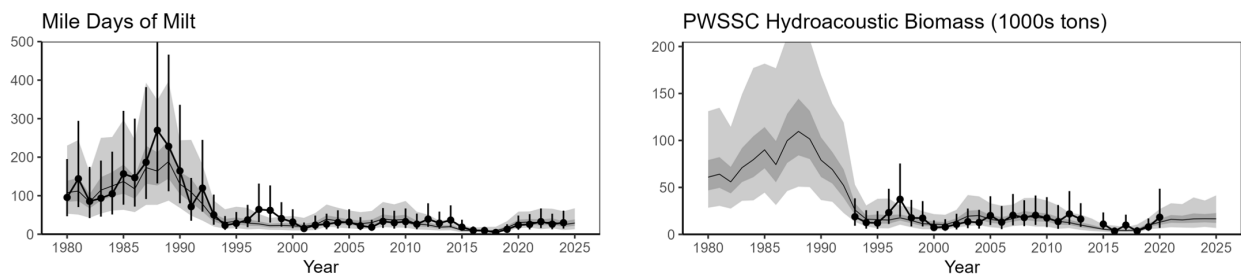


Figure 1. Estimated spawning biomass of Prince William Sound herring from the Bayesian age-structured assessment model fitted to the aerial mile-days-of-milt survey and the long-term hydroacoustic survey that ended in 2020.

Additional stock assessment work included fitting to the seroprevalence data: How many fish have antibodies to viral hemorrhagic septicemia virus (VHSV). In previous work on this project, we developed a model that can estimate the dates and magnitudes of disease outbreaks (Trochta

et al. 2022). However, fitting to the most recent actual data (Fig. 3) resulted in wide posterior predictive intervals often ranging from 0% to 100%, and suggest that the actual data are not informative enough for the model to estimate the additional parameters required. Therefore, for the 2025 assessment we did not include seroprevalence model fits.

Goal 2: Review best practices globally for managing highly variable fish populations. A global review of harvest control rules used to manage marine fisheries was completed as a chapter in J. Zahner's M.S. thesis (Zahner 2023), and found that the default harvest control rule used in managing Prince William Sound herring is aligned with global best practices.

Goal 3: Create a management strategy evaluation (MSE) framework for Prince William Sound herring. An MSE framework was developed as part of Zahner (2023), with additional MSE frameworks developed by C. L. Roberts and M. de Barros for their projects (described later). These are used to address the original Goals 4-6 for this project.

Goal 4: Evaluate alternative harvest control rules for setting herring catches. This task has been completed and published (Zahner and Branch 2024), finding that the default harvest control rule used to manage Prince William Sound herring performs well. Two alternate rules also performed well: one with a lower threshold for allowing fishing, and one that accounts for evenness in different age classes. Rules were assessed based on the balance between catch levels, probability of low biomass, and low inter-annual variability in catches.

Goal 5: Evaluate tradeoffs between cost and frequency of surveys and other types of data collected for use in the stock assessment. In our previous work we assessed the tradeoff between the cost and value of different data sources for assessing Prince William Sound herring (Muradian et al. 2019). However, this does not address the value of future data collection, nor was it embedded in an MSE to determine how availability and cost of data influence stock assessment precision, management advice, and the tradeoff between average catch and stock depletion. Work is underway on this goal as part of C.L. Roberts's PhD dissertation.

Goal 6: Test the robustness of the management process to misspecification in parameter values or relationships assumed in the stock assessment model. In addition to the model misspecification involved in the new goal 9 below (relation between Kayak Island and Prince William Sound spawning herring locations), work is also underway to examine how well the assessment and harvest control rule perform when the model is misspecified in terms of natural mortality and recruitment assumptions. M. de Barros has adapted the MSE framework to assess the impact on how the process performs when the true natural mortality is lower or higher than assumed in the model, and the impact of time-varying natural mortality in a variety of configurations (Fig. 4). Additional scenarios include alternative assumptions about recruitment form and fluctuations in recruitment. Generally, the model remains fairly robust to incorrect assumptions, but these can lead to incorrect management decisions (Fig. 5).

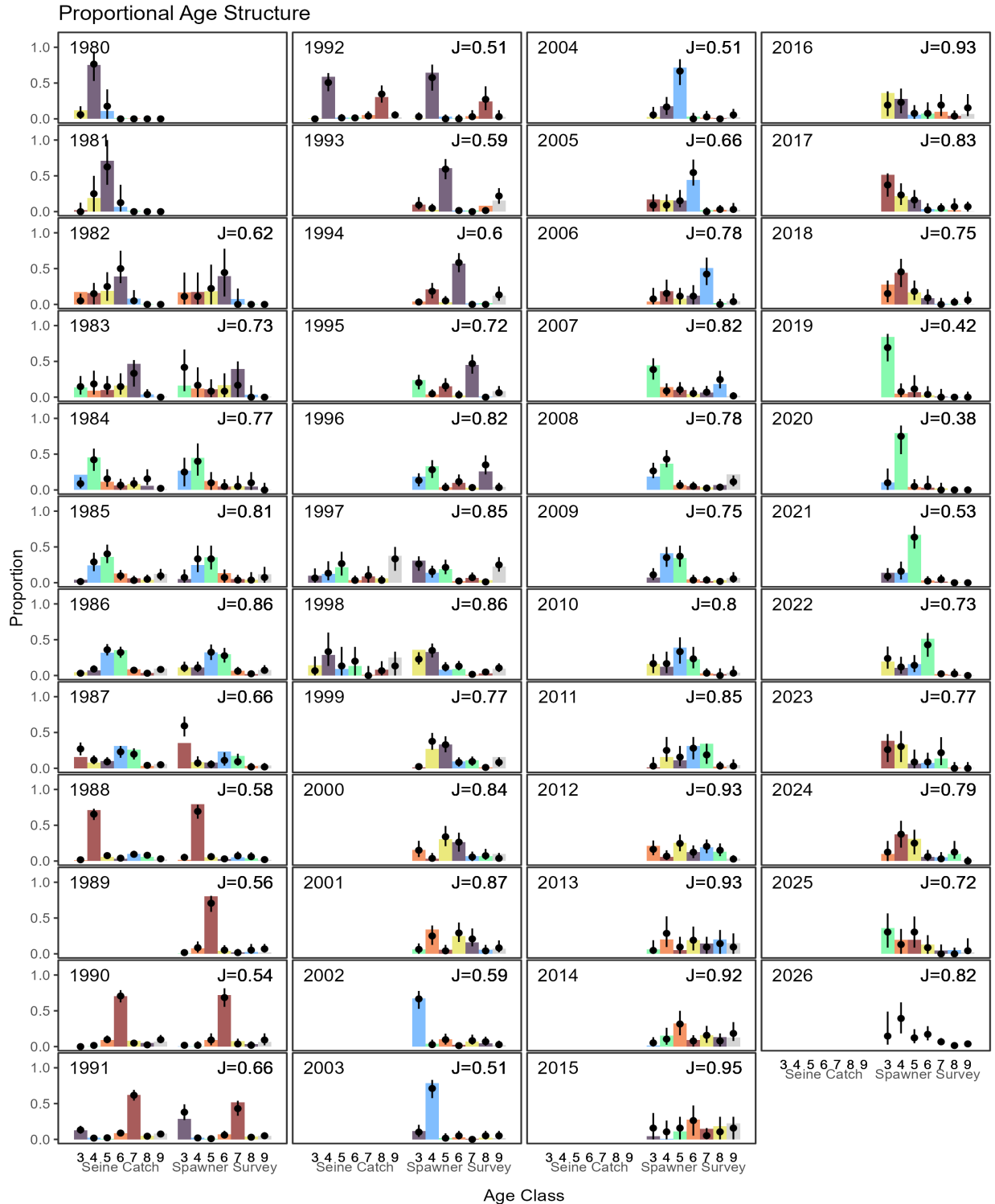


Figure 2. Model fits (circle and lines) to the fishery age composition data (left column) and survey age composition data (right column), 1980-2023. In each panel the “J” value is the evenness of the age composition, which is close to 1 when fish are evenly distributed among the age groups, and close to zero when a single age class dominates. The 2026 panel represents model forecasts; no data have been collected yet for 2026.

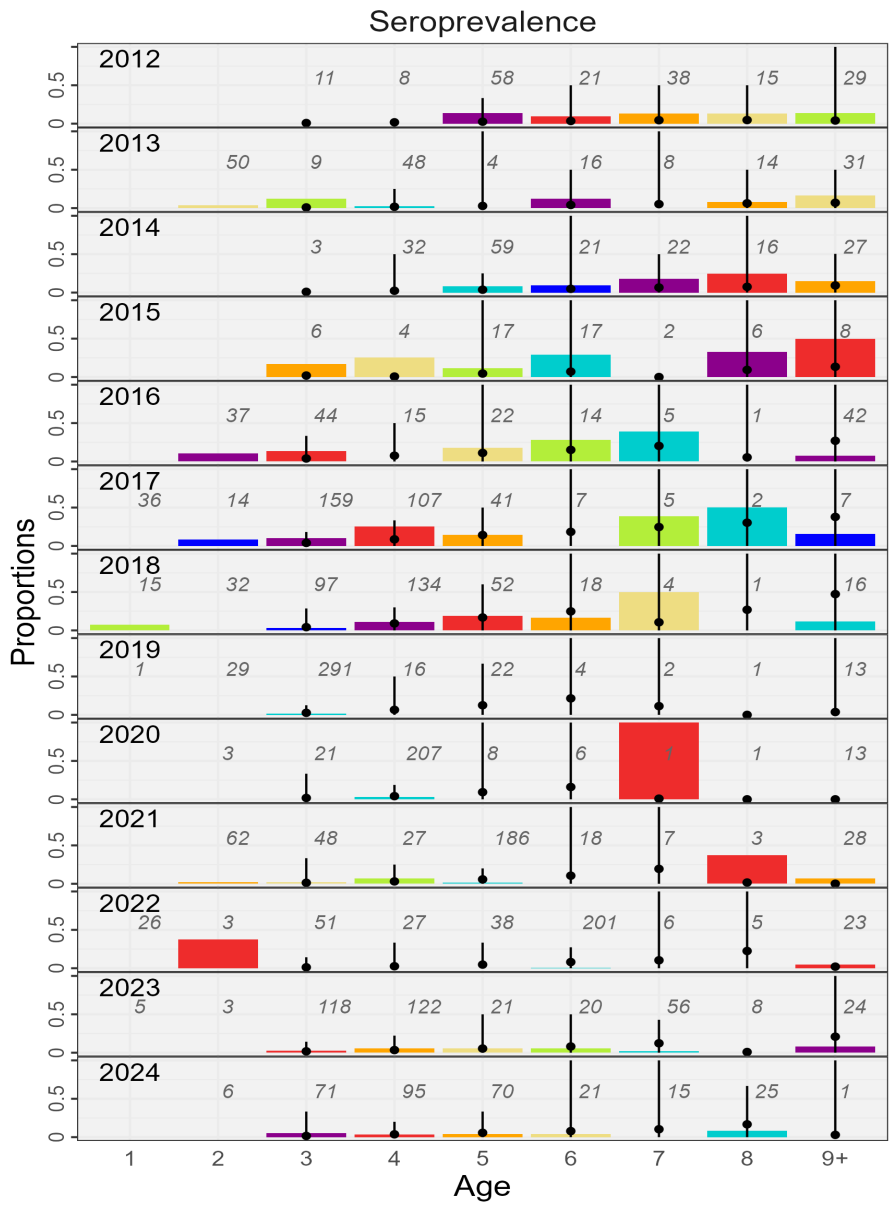


Figure 3. Alternative Bayesian age-structured assessment model formulation that also fits to age-varying Prince William Sound herring antibody prevalence for viral hemorrhagic septicemia virus. Colored bars show observed seroprevalence and model estimates are given as points (median posterior predictions) and lines (95% posterior prediction intervals). Colors track cohorts, while numbers are the sample sizes for each year and age class.

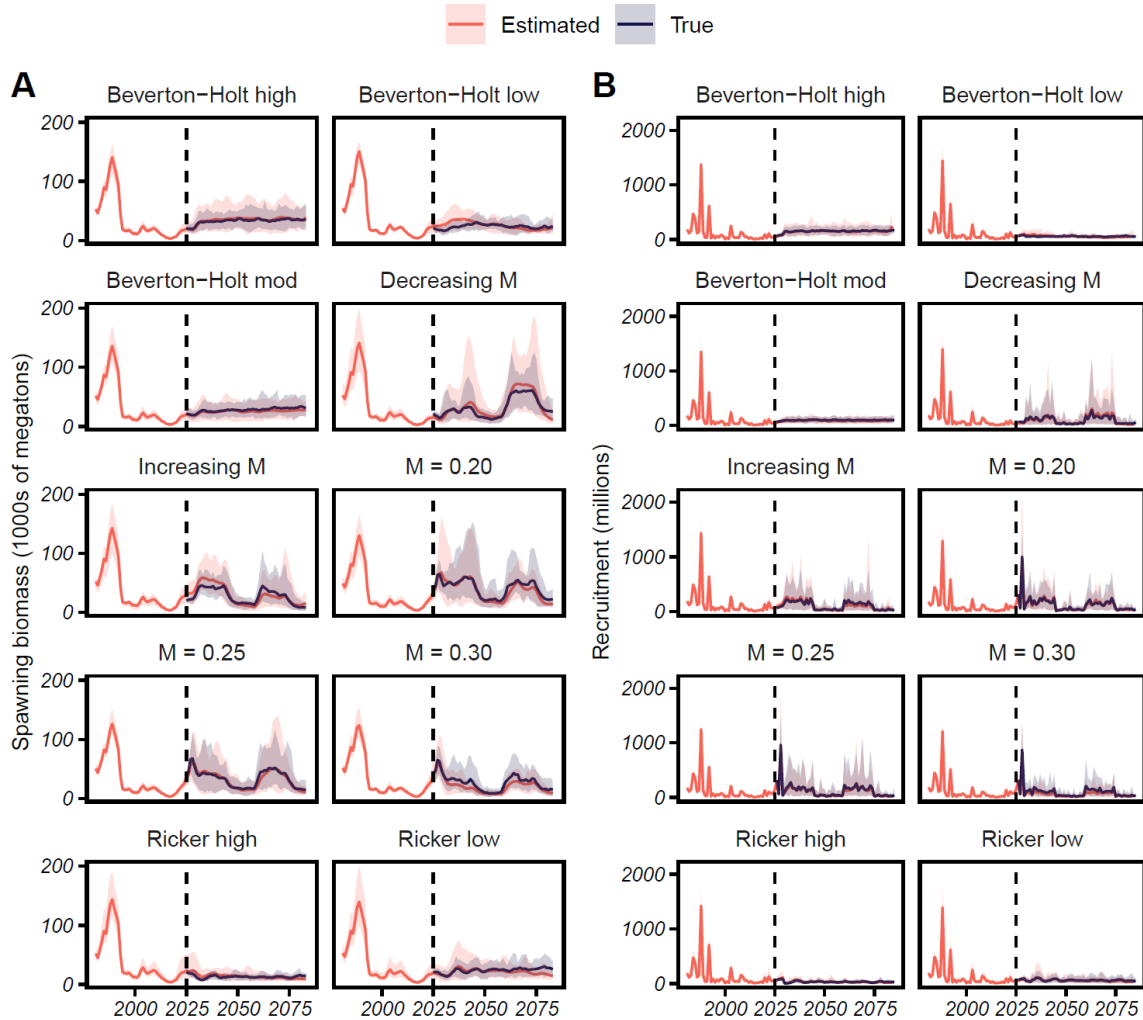


Figure 4. Comparison between estimated and true (a) biomass and (b) recruitment trajectories when the operating model (“truth”) differs from the assumptions made in the stock assessment. In each case the operating model assumption is listed (the “truth”), while the assessment model is kept the same as the one used in the stock assessment, i.e. with recruitment estimated independently each year and $M = 0.25$ (i.e., there is one case where the assessment and the operating model are the same, with $M = 0.25$).

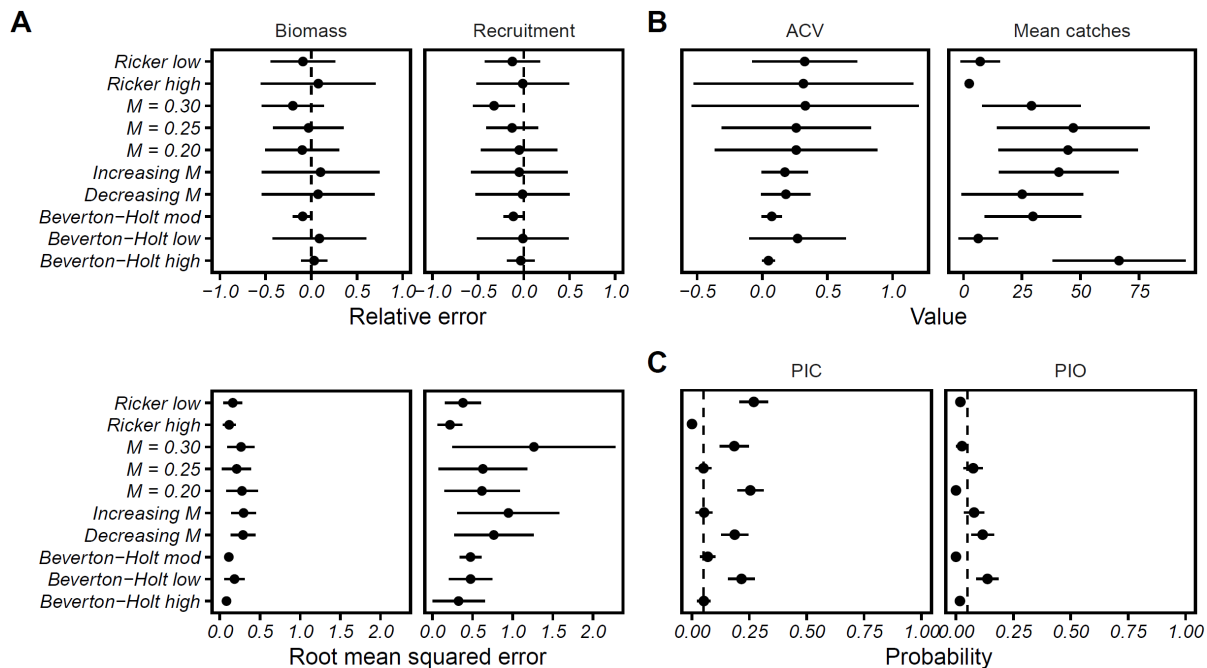


Figure 5. Performance metrics of the management strategy evaluations across the nine different alternative operating models and the reference scenario ($M = 0.25$): (a) estimation performance; (b) fishery performance including annual catch variation (ACV); and (c) Management performance, including the probability of incorrect closure (PIC) and probability of incorrect opening (PIO).

Goal 7: Create a spatial model of Prince William Sound herring. This goal, always the most ambitious of the original goals, may no longer be feasible to produce at a scientifically rigorous level. A spatial model requires work on genetic structure, distribution of biomass, movements of fish, and differences in age structure among regions. In our past projects we have shown major shifts in space and time in Prince William Sound spawning (McGowan et al. 2021, Bias et al. 2022). Unfortunately, sufficient data have not been collected to estimate model input needs. In particular, the tagging and movement project for herring is no longer funded. Instead, we have formulated a new spatial model goal in response to ADF&G needs: examining the impact of the now-large spawning output at Kayak Island (outside Prince William Sound) as outlined in goal 9.

Goal 8: Create a model of intermediate complexity (MICE) that captures key interactions between humpback whales, pink salmon, Alaskan pollock, and herring. Preliminary work is ongoing for this model by M. de Barros, but no results are yet available.

New goal 9: Implications of Kayak Island herring spawn aggregation on Prince William Sound herring. A major issue that has arisen and been highlighted by ADF&G is the large mile-days of milt observed at Kayak Island during the aerial surveys in recent years, often as large as the total recorded inside Prince William Sound. In this project, C.L. Roberts will assess the performance

of the stock assessment model under different scenarios of mixing between Kayak Island and Prince William Sound. Preliminary results show that the stock assessment produces biased estimates of biomass, with positive bias when movement rates are low and negative bias when movement rates are high. This work points towards the crucial value of conducting acoustic tagging and supporting the planned genetic studies to estimate the rate of movement between these two spawning regions.

New goal 10: Develop a framework for probabilistic harvest control rules. The primary advantage of using a Bayesian stock assessment is that it provides a statistically sound framework for estimating uncertainty in biomass. However, the default harvest control rule is still based only on median biomass, which differs little from a maximum likelihood or least-squares framework. We are investigating whether a probabilistic harvest control rule would be a better tool for directly including uncertainty in decision making, as a general framework for fisheries management (not aimed specifically at Prince William Sound herring). The idea is to create a harvest control rule that is based on a lower percentile of biomass, e.g., the 20th percentile of current biomass as estimated by a Bayesian stock assessment. Then, if more data are collected, the uncertainty would be narrower, and the 20th percentile would be higher *even if* the median biomass is unchanged. This would result in higher catches when there is less uncertainty in the model, and lower catches when uncertainty increases. This work is in a planning stage.

Literature cited

- Dias, B. S., D. W. McGowan, R. Campbell, and T. A. Branch. 2022 Influence of environmental and population factors on Prince William Sound herring spawning phenology. *Marine Ecology Progress Series* 696:103-117.
- McGowan, D. W., T. A. Branch, S. Haught, and M. D. Scheuerell. 2021. 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* 78:1611-1627.
- Muradian, M. L., T. A. Branch, S. D. Moffitt, and P.-J. F. Hulson. 2017. Bayesian stock assessment of Pacific herring in Prince William Sound, Alaska. *PLoS One* 12:e0172153.
- Roberts, C. L., and T. A. Branch. 2026. 2026 Bayesian age-structured stock assessment (BASA) results for Prince William Sound (PWS) herring.
- Trochta, J. T., M. L. Groner, P. K. Hershberger, and T. A. Branch. 2022. A novel approach for directly incorporating disease into fish stock assessment: a case study with seroprevalence data. *Canadian Journal of Fisheries and Aquatic Sciences* 79:611-630.
- Zahner, J. A. 2023. Operational harvest control rules and their application to a recovering forage fish stock. University of Washington, M.S. thesis.

Zahner, J. A., and T. A. Branch. 2024. Management strategy evaluation of harvest control rules for Pacific herring in Prince William Sound, Alaska. ICES Journal of Marine Science 81:317-333.

2. Products:

Peer-reviewed publications:

None to report.

Reports:

Roberts, C. L., and T. A. Branch. 2026. 2026 Bayesian age-structured stock assessment (BASA) results for Prince William Sound (PWS) herring. University of Washington report to Alaska Department of Fish and Game, Cordova, Alaska.

Popular articles:

None to report.

Conferences and workshops:

Roberts, C. L., T. A. Branch, and M. de Barros. 2026. Effects of model misspecification on a fished herring population in Prince William Sound, Alaska. Oral presentation, Alaska Marine Science Symposium, Anchorage, Alaska, January.

Public presentations:

None to report.

Data and/or information products developed during the reporting period:

None to report.

Data sets and associated metadata:

Branch, T. A. 2025. Bayesian age-structured-analysis (ASA) model and results for herring population dynamics in Prince William Sound, EVOS herring program. Gulf of Alaska data portal: https://gulf-of-alaska.portal.aos.org/#metadata/4aaecfe2-de4b-4b6b-ba8e-bb715d26c6f1/project/folder_metadata/41873621.

Additional Products not listed above:

None to report.

3. Coordination and Collaboration:

The Alaska SeaLife Center or Prince William Sound Science Center

The project team has extensive collaboration with personnel at the Prince William Sound Science Center, regarding historical hydroacoustic surveys of herring biomass, interpretation of stock assessment results, modeling ideas, and use of age-1 aerial survey for herring schools.

EVOSTC Long-Term Research and Monitoring Projects

This project coordinates with other Herring Research and Monitoring component projects, including extensive use of herring disease (25120111-E, principal investigators [PIs] Hershberger and Paez) data in the stock assessment model, estimation of hydroacoustic surveys for herring biomass (21120111-G Rand), aging projects (25170111-F Morella, herring maturity project (19170111-D Gorman), herring movement project (21160111-B Bishop), age-1 aerial surveys (25120114-C Arimitsu) and more. In essence, every herring project and other broader ecosystem projects that have gathered long-term data.

EVOSTC Mariculture Projects

None to report.

EVOSTC Education and Outreach Projects

In most years we provide articles for Sound Connections (although not this year). In addition, the PI actively disseminates science via social media, having shifted from X/Twitter to Bluesky after an 89% decline in audience participation from 2022 to 2023. On Bluesky, the PI has 11,400 followers and posts frequently (1500 total posts).

Individual EVOSTC Projects

As outlined above.

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. BASA model results and MSE simulations are shared and coordinated with Sherri Dressel of ADF&G. We are training an ADF&G scientist (C. L. Roberts) as a PhD student at the University of Washington, which should further enhance collaborations with NOAA and facilitate the transfer of the BASA model to ADF&G at the end of this project.

Native and Local Communities

No direct involvement.

4. Response to EVOSTC Review, Recommendations and Comments:

No review, recommendations, or comments were provided in 2025. This project responded to comments in the FY24 annual report.

5. Budget:

The University of Washington, mindful of widespread funding halts, cuts, and reductions in indirect costs, will no longer allow the project PI to spend on the EVOSTC-funded budget in advance of receiving the money, as was done from June 2024 to January 2025 during the delay in NOAA releasing EVOSTC grant funds to PWSSC.

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

Budget Category:		Proposed FY 22	Proposed FY 23	Proposed FY 24	Proposed FY 25	Proposed FY 26	5- YR TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel		\$62,295	\$65,827	\$67,599	\$69,421	\$71,293	\$336,435	\$211,951
Travel		\$4,509	\$4,734	\$8,719	\$7,809	\$8,199	\$33,970	\$8,113
Contractual/Tuition		\$18,672	\$19,606	\$20,586	\$21,616	\$22,697	\$103,177	\$63,689
Commodities		\$1,542	\$800	\$3,100	\$3,100	\$3,100	\$11,642	\$3,507
Equipment & F&A Exempt		\$5,066	\$0	\$0	\$0	\$0	\$5,066	\$5,046
Indirect Costs	Rate = 55.5%	\$37,932	\$39,606	\$44,077	\$44,583	\$45,839	\$212,036	\$124,082
SUBTOTAL		\$130,016	\$130,573	\$144,082	\$146,528	\$151,128	\$702,327	\$416,388
General Administration (9% of subtotal)		\$11,701	\$11,752	\$12,967	\$13,188	\$13,602	\$63,209	N/A
PROJECT TOTAL		\$141,717	\$142,324	\$157,049	\$159,716	\$164,729	\$765,536	
Other Resources (In-Kind Funds)							\$0	

COMMENTS:
 The Contractual row represents tuition, which is excluded from Indirect costs.

 The University of Washington (mindful of widespread federal funding halts, cuts, and reductions in indirect costs) will no longer allow us to spend on the EVOSTC budget in advance of receiving the money (as we did from June 2024 to January 2025).

FY22-26	Project Number: 25120111-C Project Title: Herring Modeling Primary Investigator: Branch (UW)	NON-TRUSTEE AGENCY SUMMARY PAGE
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