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

Project Number and Title

21160111-F

Surveys and age, sex, and size collection and processing

Primary Investigator(s) and Affiliation(s)

Stormy Haught, Alaska Department of Fish and Game

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14 August 2020

Project Abstract

This project conducts spring aerial surveys to document Pacific herring (*Clupea pallasii*) milt distribution and biomass as well as the distribution and abundance of sea lions, other marine mammals, and birds associated with herring schools or spawn. It also provides a research platform (R/V Solstice) for disease sample collection and processing. Finally, it collects and process age, sex, and size samples of herring collected by the acoustics survey, spawning surveys, and the PWS Herring Research and Monitoring Program disease sampling. Aerial survey and age, sex, and size data have been collected since the early 1970s and are an essential part of the age-structured model used by the Alaska Department of Fish and Game to estimate the historical and future biomass for fisheries management. Acoustics surveys have been conducted consistently since 1995 and the age-structured model is also tuned to acoustics biomass estimates. This project helps meet the overall program goal to improve predictive models of herring stocks through observations and research by providing necessary inputs to the age-structured assessment models of the Alaska Department of Fish and Game and the *PWS Herring Research and Monitoring Program* Bayesian model.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
$166,300	$166,300	$166,300	$166,300	$166,300	$831,500

Non-EVOSTC Funds to be used, please include source and amount per source: (see Section 6C for details)

FY17	FY18	FY19	FY20	FY21	TOTAL
$54,500	$54,500	$54,500	$54,500	$54,500	$272,500

1. PROJECT EXECUTIVE SUMMARY

This project helps meet the overall goal of improving predictive models of herring stocks through observations and research by providing necessary inputs to the age-structured assessment models of Alaska Department of Fish and Game (ADF&G) and the Prince William Sound (PWS) Herring Research and Monitoring Program – Population Modeling.

There are no proposed hypotheses to be tested directly from this project; however, this project will continue long-term monitoring programs to 1) conduct aerial surveys to collect data associated with spring Pacific herring (*Clupea pallasii*) spawning events, 2) collect and process age, sex, and size (ASL) samples from pre-spawn and spawning aggregations of Pacific herring, and 3) provide vessel support for spring acoustics surveys, disease sampling, and collection and processing of age, sex, and size samples for target strength assessment.

Spring aerial survey data have been collected since 1972 (Funk 1994), and spring acoustics surveys have been consistently conducted since 1995 (Willette et al. 1999). ASL data are available since 1973 (Sandone 1988); however, collections of both data sets have been more extensive since the early 1980s. Herring age data were collected in 1971 and 1972 also, but only published frequency plots (no individual fish data) are available (Pirtle et al. 1973).

Aerial surveys were used to document spring herring biomass and were the primary management tool prior to the development of the first statistical catch-at-age model or age structured assessment model (ASA) in 1988 (Brady 1987, Funk and Sandone 1990). Biomass is estimated as school surface area converted to biomass from a few paired observations of aerial observers and vessel harvests (Fried 1983, Brady 1987, Funk and Sandone 1990). Surface area and biomass conversion methods are as described in Brady (1987) and Lebida and Whitmore (1985). Prior to 1988, the aerial survey program's primary objectives were to collect biomass data for an annual index, document the distribution and linear extent of milt, document herring temporal movements, and document the distribution of commercial fishing boats, fishing tender boats, and processor boats (Brady 1987). Additionally, the locations of large aggregations of Stellar sea lions (*Eumetopias jubatus*) and other marine mammals were often noted on paper maps.

Brady (1987) described how herring arrive on the spawning grounds over time and may be available to document on multiple aerial surveys. Therefore, the biomass over several days of surveys cannot be summed to estimate the total or peak biomass. Consequently, peak biomass was calculated as the largest biomass observed in all areas on a single survey (Brady 1987). Additional biomass with a discrete time separation also would be added, but these conservative methods were required to estimate the peak biomass because the amount of time herring were available to observation by aerial surveys was unknown and likely variable (Funk and Sandone 1990).

Brady (1987) also detailed how the variable bathymetry of herring spawning areas in PWS has a large influence on the observer's ability to see herring schools. Herring may spawn in shallow bays (e.g., Rocky Bay, Montague Island), shallow beaches (e.g., Hells Hole beach), or deep bays (e.g., Fairmont Bay on the North Shore). The influence of bathymetry on observer efficiency suggests a biomass index will probably not be comparable across years. Although Funk and Sandone (1990) indicated that peak biomass values may be a useful measure of relative abundance, issues with biomass observations described by Brady (1987) and Funk and Sandone (1990) caused ADF&G to investigate the use of an index of spawn from observations of milt.

Two indices considered for spawn documented from aerial surveys were 1) discrete miles of milt over the season and 2) the sum of miles of milt for all survey days (mile-days of milt). The advantages of milt observations compared to school biomass observations are 1) herring schools likely spawn a single time (i.e., a single day) but a herring school may be observed for several days before or after spawning and 2) milt is relatively easy to observe from the air and observation efficiency is generally not influenced by ocean bathymetry (Brady 1987).

Discrete miles of milt do not account for multiple spawning events in the same area, so are unlikely to be a good index of total abundance in areas with multiple days of spawning on the same beach (Brady 1987). Mile-days of milt probably provide a better index to abundance because they account for multiple spawning days on the same beach, although they may be biased if the number of surveys varies significantly across years (Funk 1994). Additionally, although bathymetry probably will not influence observation of milt, it is likely one factor that will influence the biomass of spawning fish for each linear mile of milt observed. Willette et al. (1999) collected paired spawn deposition survey estimates from dive surveys and aerial survey estimates of miles of milt; the short tons (dive survey) per mile of milt (aerial survey) were much larger on Montague Island beaches when compared to short tons per mile of milt in northern or northeastern PWS beaches. Montague Island shoreline typically has large shallow, subtidal areas with complex kelp structure while the northern and northwestern beaches tend to have a steeper gradient to deep waters and less complex kelp structure.

Funk (1994) used the discrete miles of milt index in his ASA model rather than the mile-days of milt index because there were fewer surveys flown in the early years (1970s). However, subsequent runs of the ASA model have excluded the earlier years and use of the mile-days of milt index.

In 2008 ADF&G began using a tablet computer and a geographic information system (GIS) application to collect aerial survey data (Bochenek 2010). Because digital maps are scalable and allow much more data to be added to a small area (contrast with the 25 paper maps used prior to 2008), and because of interest in herring predator distribution and abundance, additional effort was employed in documenting numbers and locations of predators such as Stellar sea lions, humpback whales (*Megaptera novaeangliae*), killer whales (*Orcinus orca*), Dall's porpoises (*Phocoenoides dalli*), and bird aggregations (mostly gulls) associated with herring schools or spawn.

Age, sex, and size data from Pacific herring have been collected from commercial fisheries and fishery independent research projects since the early 1970s. ADF&G currently has an archive containing approximately 210,000 scales paired with size and sex data (most of the archive has been collected since 1979). Summaries of many of these data have been published (e.g., Sandone 1987, Funk and Sandone 1990, Willette et al. 1999). Processing methods are similar those described by Baker et al. (1991); however, electronic fish measuring boards have been used to enter sample summary data and individual fish data (standard length in mm, whole body weight in grams, and sex) at the time of processing since 1989. Gonad weights have been collected from pre-spawning fish (both sexes) in most years since 1994 (n = 8,500).

Scales are used to estimate age for PWS collections rather than otoliths because they are much easier to collect and prepare for examination. Additionally, Chilton and Stocker (1987) reported that Chi-square tests of age compositions from paired otoliths and scales collected off the British Columbia coast could not refute the null hypothesis that they were from the same population. Interpretation of age from otoliths indicated that there were older fish than interpreted from scales; however, few fish older than age 10 are found in PWS, so fish interpreted at age 9 and older are combined into an age category 9+. No age validation or tests of paired age structures have been completed for PWS herring.

Aerial survey, acoustics estimates, and ASL data sets are essential parts of the current ASA model that ADF&G uses to estimate the historical biomass and project pre-fishery run biomass a year ahead for management (e.g., Hulson et al. 2008). Additionally, the mile-days of milt and ASL data are part of the Bayesian formulation of the ASA model (Muridan 2015), and the scales collected from this archive were used in an *Exxon Valdez* Oil Spill

Trustee Council funded project titled "PWS Herring Program - Scales as growth history records" (project [insert number]).

This project will continue to conduct aerial surveys to collect data related to spring herring spawning events, provide vessel support for acoustics surveys and disease sample collections; and capture and process herring to generate age, sex, and size summaries and mean target strength. The overall goal of the aerial survey, acoustics survey, and ASL project components is to meet the overall program goal of improving predictive models of herring stocks through observations and research.

2020 Preliminary Results

In 2020 we conducted 20 aerial surveys (57 hours of flight time) from March 19 to May 10, and observed herring milt on 12 of 20 surveys (Fig. 1). The number of aerial surveys was above the recent 10-year average (2010-2019) of 17 survey flights per year and below the overall program average (1973-2019) of 20.5 survey flights per year (Fig. 2). As of this writing, we do not have a solid preliminary estimate of mile-days of active milt in 2020, due to COVID-19 related staffing shortages for analysis. A final estimate will be available in September 2020. A rough preliminary estimate at this time is greater than 25 mile-days of active milt in 2020, likely the most since 2014 and more than 4 times greater than 2018 observations. In 2020, milt was documented in multiple areas where spawn has not been observed in several years, most notably, Double Bay on Hinchinbrook Island, and Stockdale Harbor and Port Chalmers on Montague Island. Survey coverage of Kayak Island was poor in 2020, although pilot reports (and photos) as well as satellite imagery documented ~20 mile-days of milt there between April 2 and April 11. Sufficient documentation exists and these observations will likely be digitized, time and resources permitting. Observations from Kayak Island have not historically been included in the PWS mile-days of milt index.

2020 herring collections for ASL, and disease studies were made using cast nets only. Cast nets appear to be selective for males relative to purse seine so 2020 sex ratios (when available) should be viewed with caution. Due to COVID-19 concerns, all activities aboard the R/V Solstice were cancelled for spring 2020, including PWS purse seine herring collections. Cast net samples of actively spawning fish were collected from skiffs by ADF&G and community members at Red Head (April 3 and April 4), Hells Hole (April 4), and Canoe Pass (April 23 and April 25). ASL samples are in process and expected to be completed in September 2020 (all 2020 results reported here are preliminary). Age compositions from recent years show a large recruitment of age-3 fish into PWS in 2019 and subsequently a large proportion of age-4 fish in 2020 (Figs. 3, 4, and 5). Size data are not yet compiled for 2020, but ASL summaries from recent years show a decrease in size at age for most age classes (Fig. 6). Once complete, 2020 samples will be added to historical data to compare age composition and size.

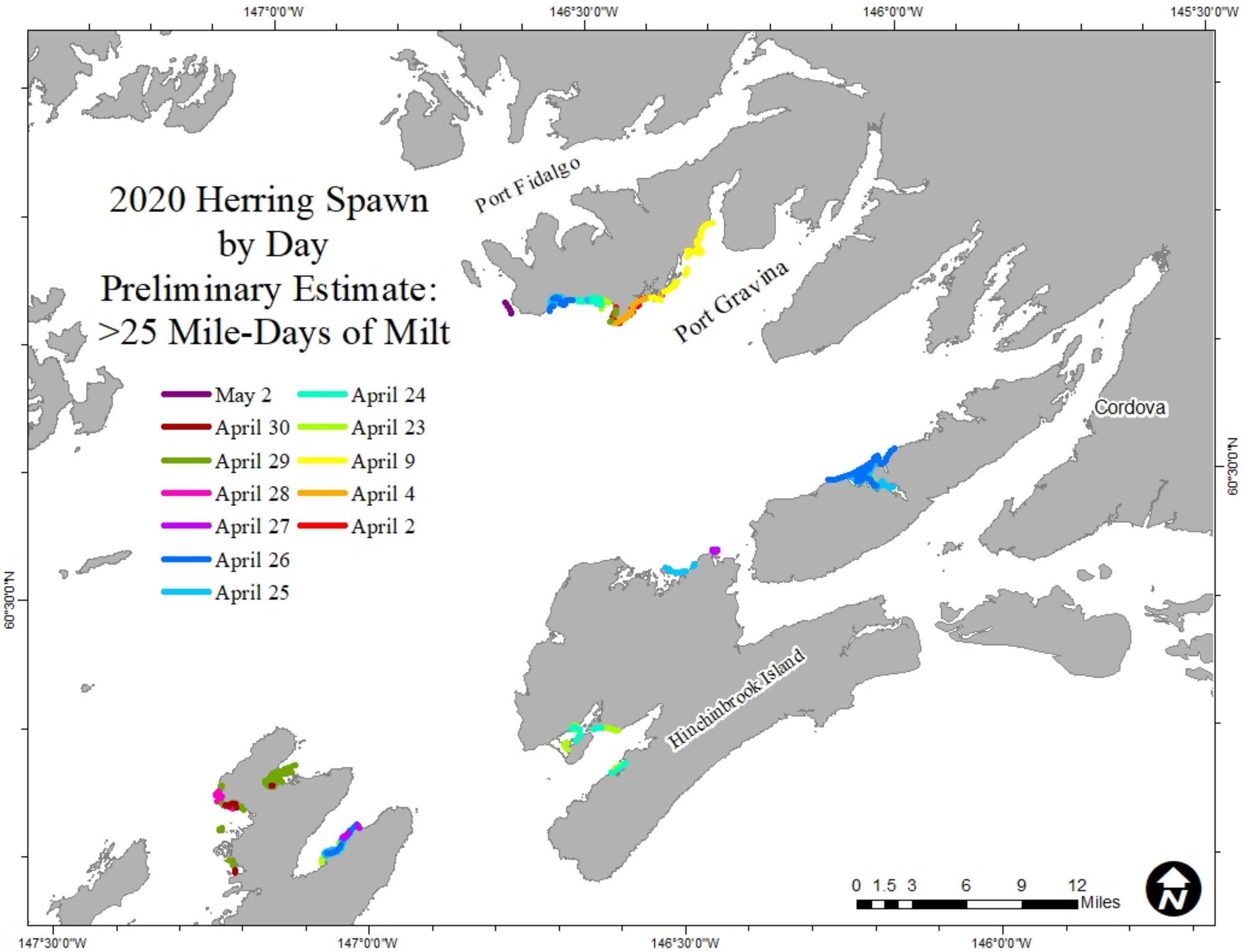

Figure 1. Observed spawning events in Prince William Sound during 2020 aerial surveys.

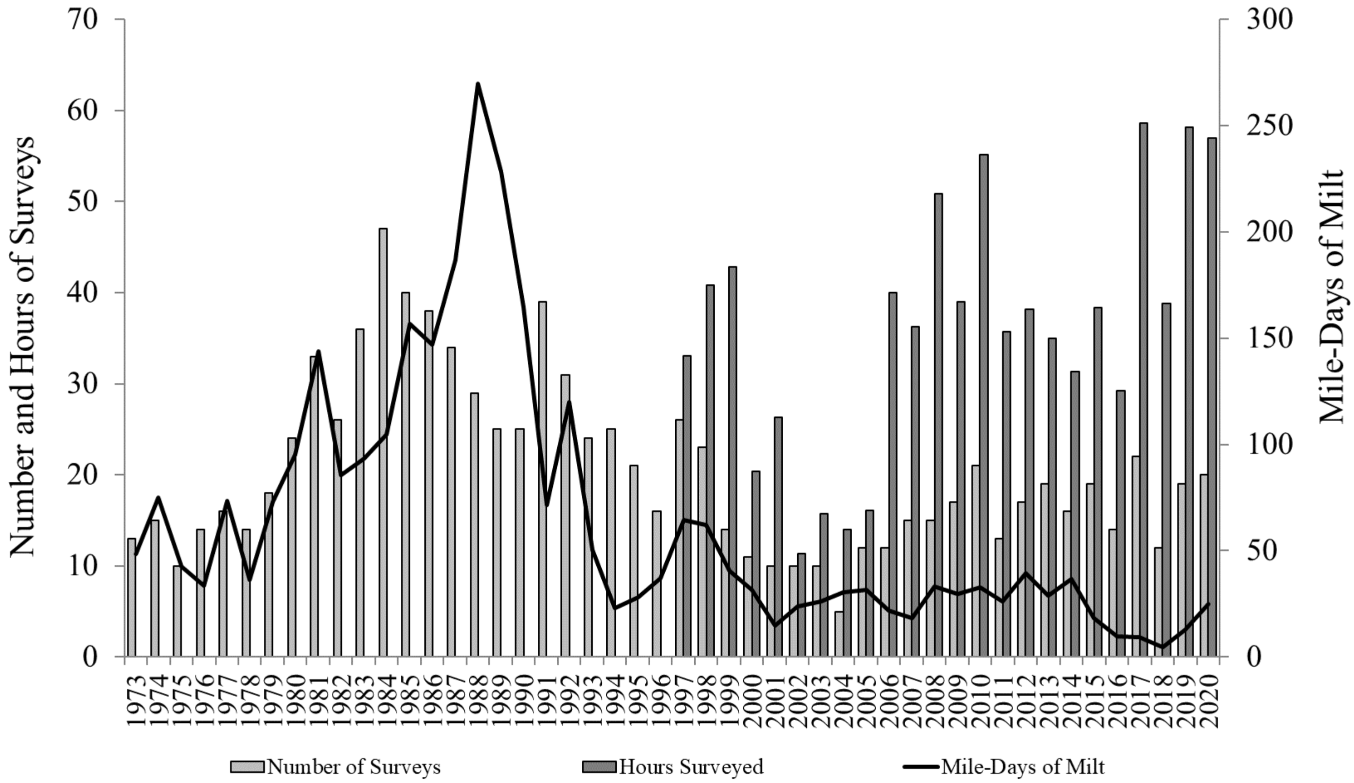

Figure 2. Spring Prince William Sound herring aerial surveys completed annually (2020 mile-days of milt is preliminary).

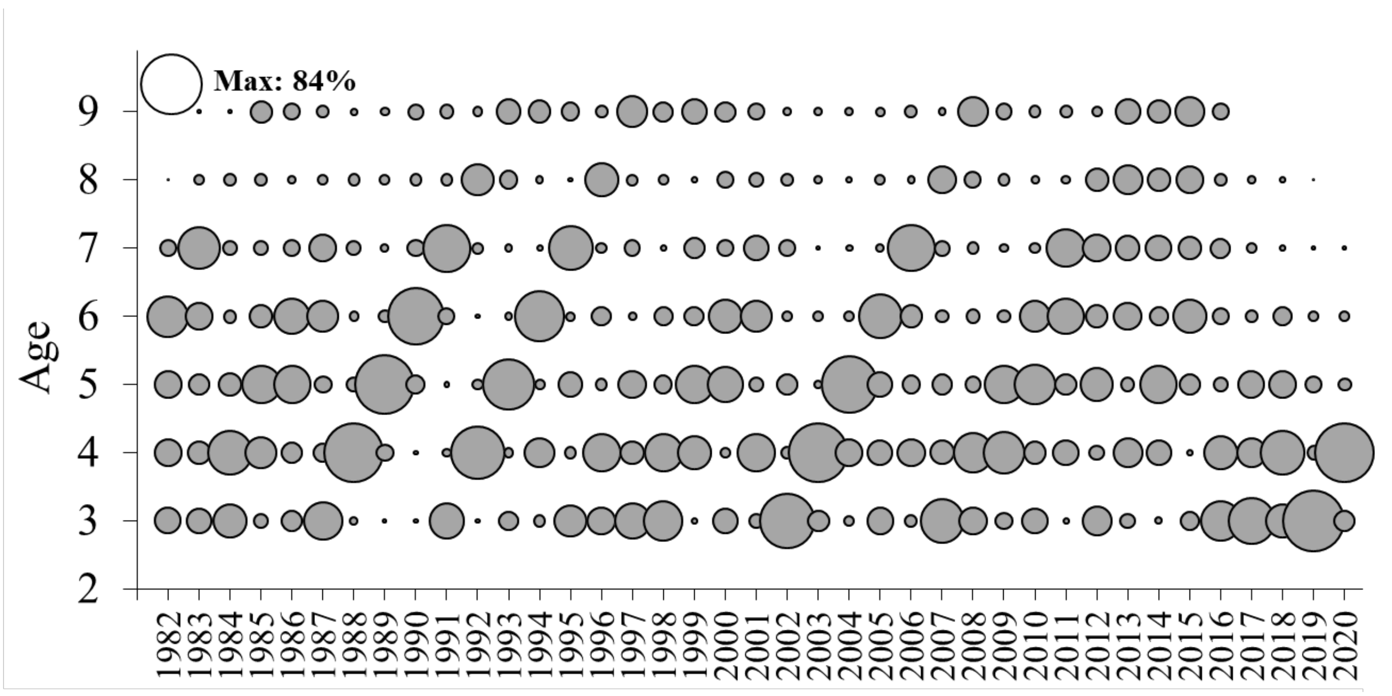

Figure 3. Spring Prince William Sound herring age composition by year, 1982-2020 (2020 data are preliminary).

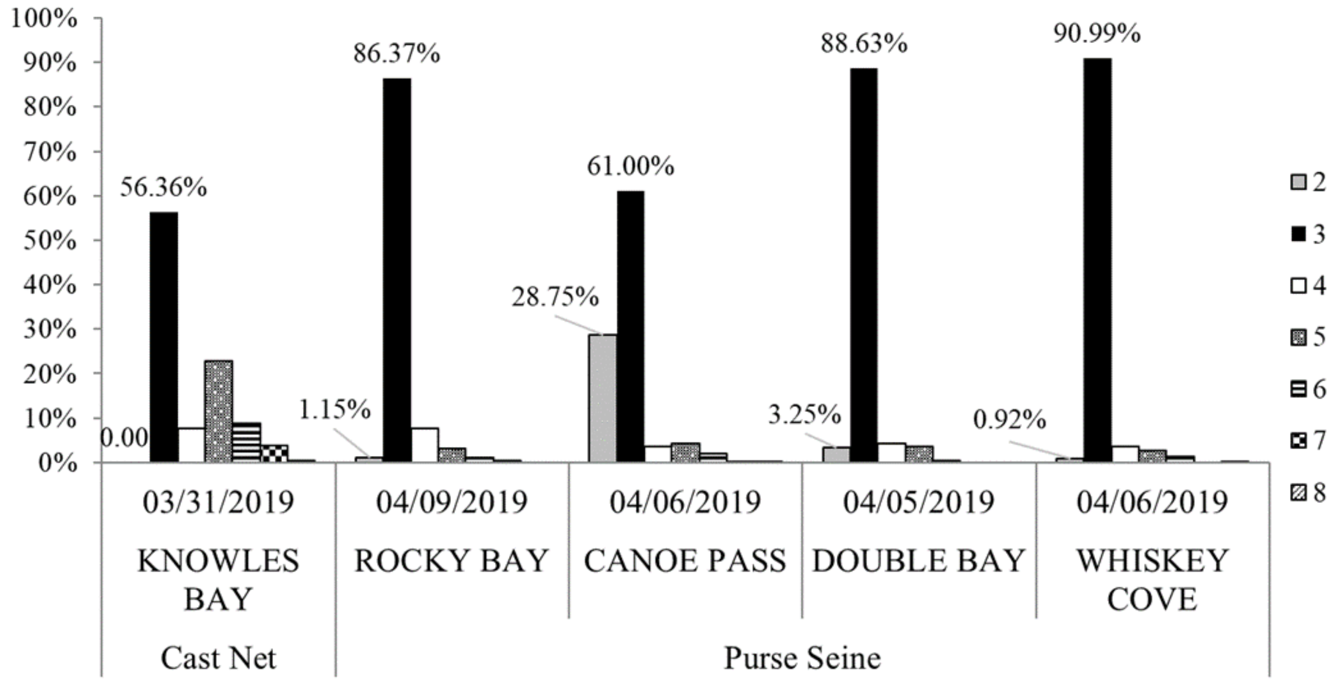

Figure 4. Prince William Sound herring age composition by sample, 2019.

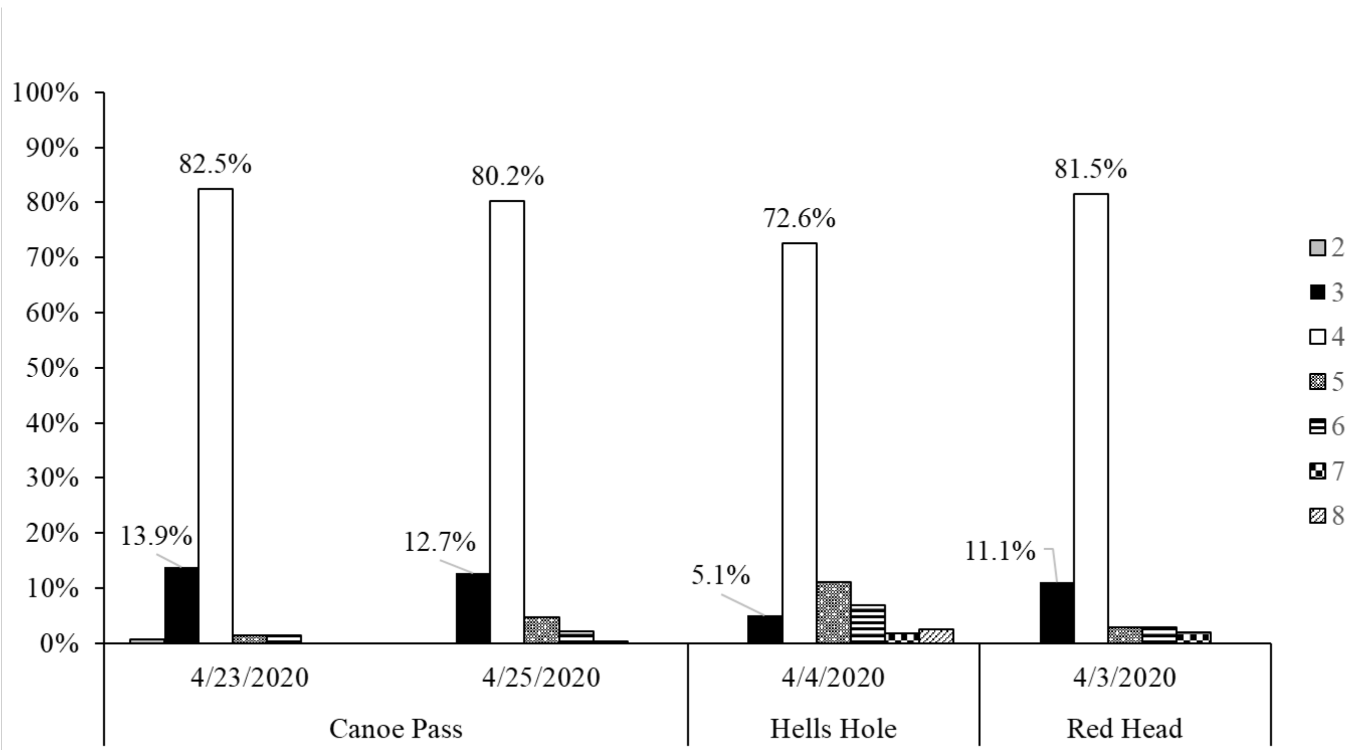

Figure 5. Prince William Sound herring age composition by sample, 2020 (preliminary data).

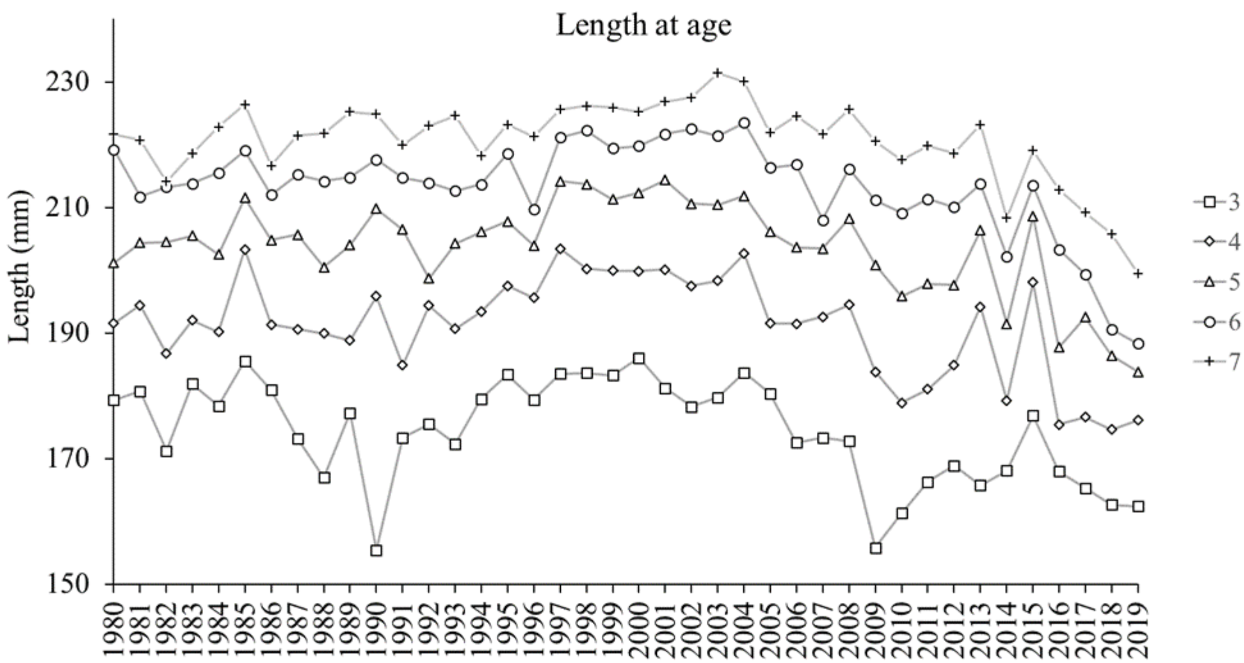

Figure 6. Spring Prince William Sound herring length at age, 1980-2019.

2. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

A. Project Milestones and Tasks

Table 1. Project milestones and task progress by fiscal year and quarter, beginning February 1, 2017. C = completed, X = planned or not completed. Fiscal year quarters: 1 = Feb 1 – April 30; 2 = May 1 – July 31; 3 = Aug. 1 – Oct. 31; 4 = Nov. 1 – Jan. 31.

	FY17				**FY18**				**FY19**				**FY20**				**FY21**			
Milestone/Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Fieldwork																				
Aerial surveys	C	C			C	C			C	C			C	C			X	X		
Acoustics and disease support survey	C				C				C				C				X			
Lab Analysis																				
Herring ASL sample processing	C	C	C		C	C	C		C	C	C		C	C	X			X	X	
Data																				
Quality control ASL data		C				C				C				C				X		
Quality control and editing of aerial shape files		C				C				C				X					X	
Analysis of aerial survey data			C				C				C				X				X	

Milestone/Task	**FY17**				**FY18**				**FY19**				**FY20**				**FY21**			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Combing aerial survey shape files into historical version															X				X	
Upload previous FY data/metadata to workspace														C			X			
Distribute ASL sample summary															X					
Reporting																				
Annual reports					C				C				C				X			
Summary Report								C				C				X			X	
FY work plan (DPD)			C				C				C				X			X		
FY17-21 Final Report																				X
Meetings & Conferences																				
Annual PI meeting				C				C				C				x				x

B. Explanation for not completing any planned milestones and tasks

Herring ASL sample processing is in progress and is expected to be completed as scheduled by October 2020. GIS work including quality control and editing of aerial shape files and combining 2020 aerial survey files with the historical files is expected to be completed by mid-September 2020. Timeline for 2020 survey data editing and analysis has been delayed slightly relative to previous years, but all work is expected to be completed by the end of September 2020.

C. Justification for new milestones/tasks

None.

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOSTC-funded Program

Gulf Watch Alaska

None

Herring Research and Monitoring

PWS Herring Research and Monitoring Program –Acoustics Survey (21120111-G)

ADF&G acoustics equipment are shared with the Acoustics Survey project if necessary. This project also captures and processes age, sex, and size samples to calculate mean target strength by time or area strata for use in acoustics echo integration. Aerial surveys conducted by this project provide additional location information on herring aggregation for acoustics surveys.

PWS Herring Research and Monitoring Program – Outreach and Education (21120111-A)

This project assists public outreach through public presentations of methods and results.

PWS Herring Research and Monitoring Program – Herring Disease Studies (21120111-E)

This project provides a research platform vessel support (R/V Solstice) for herring disease studies staff to capture and process adult herring for disease sampling. Additionally, this project helps collect scales for fish age and interpret the scales for age. This year we processed samples for the disease study project because they were unable to send personnel to Cordova.

PWS Herring Research and Monitoring Program – Age at Maturity (19170111-D)

This project assists with collection and processing of herring scales for the age at maturity project.

PWS Herring Research and Monitoring Program – Population modeling (21120111-C)

This project collects mile-days of milt, provides vessel support for the acoustics survey, and provides age, sex, and size data to update the time series of data required for the Bayesian population dynamics model.

Data Management

This project provides additional herring aerial survey and herring age, sex, and size data for use by other PWS Herring Program projects. Past funding and ADF&G funding has allowed us to provide aerial survey GIS data files for linear extent of spawn (1973–2020), survey routes (1997–2020), sea lion distribution and abundance (2008–2020), other marine mammals distribution and abundance (2008–2020), and bird aggregations (2008–2020). This project coordinates with the data management program by submitting data and preparing metadata for publication on the Gulf of Alaska Data Portal and DataONE within the timeframes required.

B. With Other EVOSTC-funded Projects

None

C. With Trustee or Management Agencies

ADF&G Fisheries Management

Aerial survey, acoustics estimates, and ASL data sets are essential parts of the current ASA model the ADF&G uses to estimate the historical biomass and project pre-fishery run biomass a year ahead for management (e.g., Hulson et al. 2008). Additionally, the mile-days of milt and ASL data are part of the Bayesian formulation of the ASA model (Muridan 2015), and the scales collected from the ADF&G – Cordova archive were used in an *Exxon Valdez* Oil Spill Trustee Council funded project titled "PWS Herring Program - Scales as growth history records" project number 12120111-N.

4. PROJECT DESIGN

A. Overall Project Objectives

Data are collected to meet the overall goal to improve predictive models of herring stocks through observations and research by providing necessary inputs to the age-structured assessment models of ADF&G and the *PWS Herring Research and Monitoring Program – Population Modeling.* These data add to data collected since 1972 (aerial surveys) and 1973 (age, sex, and size data).

Objectives of this proposed project are as follows:

1. Conduct spring aerial surveys to collect data on survey routes, location and linear extent of herring milt, classification of herring milt, herring school biomass; distribution and abundance of sea lions, other marine mammals and bird aggregations associated with herring or herring spawn; and other relevant environmental or anthropogenic observations.
2. Collect, process, summarize, and distribute age, sex, and size data from herring collected during acoustics surveys, spawning grounds surveys, *PWS Herring Research and Monitoring Program* disease surveys, or other relevant collections.
    a. Estimate age composition in each fishery and spawning escapements by gear type for time and area strata with sample sizes sufficient to simultaneously estimate all age proportions to within ± 5% at the 90% level of precision.
    b. Estimate mean standard length and whole body weight for each fishery and spawning escapements by gear type for time and area strata with sample sizes such that the relative error is ±5% at the 95% level of precision.
    c. Estimate the mean gonad weight of pre-spawning fish for time and area strata with sample sizes such that the relative error is ±5% at the 95% level of precision.
    d. Estimate sex composition of each fishery and spawning escapements by gear type for time and area strata with sample sizes sufficient to estimate proportions to within ±5% at the 95% level of precision.
3. Provide a vessel (R/V Solstice) as a research platform for an adult acoustics survey, disease sampling, and collection of pre-spawn and spawning Pacific herring samples. Mean length from pre-spawn samples will be used to estimate Pacific herring target strength for the acoustics work.

B. Changes to Project Design and Objectives

None.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

None

6. PROJECT BUDGET

A. Budget Forms (See GWA FY20 Budget Workbook)

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$54.5	$54.5	$54.5	$54.5	$54.5	$272.5	
Travel	$1.4	$1.4	$1.4	$1.4	$1.4	$6.8	
Contractual	$94.6	$94.6	$94.6	$94.6	$94.6	$473.0	
Commodities	$2.1	$2.1	$2.1	$2.1	$2.1	$10.5	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$152.6	$152.6	$152.6	$152.6	$152.6	$762.8	$0.0
General Administration (9% of subtotal)	$13.7	$13.7	$13.7	$13.7	$13.7	$68.7	N/A
PROJECT TOTAL	$166.3	$166.3	$166.3	$166.3	$166.3	$831.5	
Other Resources (Cost Share Funds)	$54.5	$54.5	$54.5	$54.5	$54.5	$272.5	

B. Changes from Original Project Proposal

None.

C. Sources of Additional Project Funding

ADF&G will provide an in-kind contribution of 2.4 months (0.17 FTE) of Fishery Biologist III time ($33.4 K) to provide overall supervision of the project, conduct boat and aerial surveys, analyze data, provide data to other program projects, and write reports. ADF&G will provide and in-kind contribution of 2.1 months (0.18 FTE) of Fishery Biologist II time ($20.7 K) to supervise FB I, FWT III, and FWT II, conduct boat and aerial survey, analyze data, provide data to other program projects, and write reports (*Objectives 1–3*).

7. FY17-20 PROJECT PUBLICATIONS AND PRODUCTS

Publications

Vega, S. L., C. W. Russell, J. Botz, and S. Haught. 2019. 2017 Prince William Sound area finfish management report. Alaska Department of Fish and Game, Fishery Management Report No. 19-07, Anchorage.

Russell, C. W., J. Botz, S. Haught, and S. Moffitt. 2017. 2016 Prince William Sound area finfish management report. Alaska Department of Fish and Game, Fishery Management Report No. 17-37, Anchorage.

Published and updated datasets

Gulf of Alaska Data Portal Datasets

Haught, S., Moffitt, S. 2020. Aerial survey observations of Pacific herring spawn in Prince William Sound, Alaska, 1973-2019. Research Workspace. 10.24431/rw1k440, version: 10.24431_rw1k440_202036203132.

Haught, S., Moffitt, S. 2020. Aerial survey observations of Pacific herring biomass, marine birds, and marine mammals in Prince William Sound, Alaska, 2008-2019. Research Workspace. 10.24431/rw1k43z, version: 10.24431_rw1k43z_202036203638.

Haught, S., Moffitt, S. 2020. Age-Sex-Length-Weight data for Pacific Herring in Prince William Sound, Alaska, 2014-2018. Research Workspace. 10.24431/rw1k441.

Presentations

Haught, S. 2018. ADF&G PWS Herring Surveys. Prince William Sound Science Center Tuesday Night Talk Series, December 18, Cordova.

Outreach

Haught, S. 2019. Mile-Days of Milt. *2019-2020 Delta Sound Connections*. Prince William Sound Science Center p. 15.

8. LITERATURE CITED

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