EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
FY20 CONTINUING PROJECT PROPOSAL SUMMARY PAGE

Project Number and Title

20170111-F

Surveys and age, sex, and size collection and processing

Primary Investigator(s) and Affiliation(s)

Stormy Haught, Alaska Department of Fish and Game

Date Proposal Submitted

August 16, 2019

Project Abstract

This project will continue to conduct spring aerial surveys to document Pacific herring (*Clupea pallasii*) milt distribution and linear extent of milt over time and estimate herring biomass based on the surface area of herring schools seen from the air, as well as document the distribution and abundance of sea lions, other marine mammals, and birds associated with herring schools or spawn. This project will also continue to provide a research platform (R/V Solstice) for an adult herring acoustics survey and disease sample collection and processing. Finally, this project will continue to collect and process age, sex, and size samples of herring collected by the acoustics survey, spawning surveys, and the Prince William Sound (PWS) Herring Research and Monitoring program disease sampling. Aerial surveys for documenting herring milt and herring biomass and herring sampling for age, sex, and size data have been conducted since the early 1970s and contribute essential data to the age-structured model (ASA) used by the Alaska Department of Fish and Game (ADF&G) and the Bayesian age-structured model (BASA) project supported by EVOSTC to estimate the historical and future biomass for fisheries management. This project will help to 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 ADF&G and the *PWS Herring Research and Monitoring Program* Bayesian model.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
Auth: $166,300	Auth: $166,300	Auth: $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 provides datasets that are necessary inputs to the age-structured assessment models of ADF&G and the *PWS Herring Research and Monitoring Program (HRM) – Population Modeling* (17120111-C) and are critical for meeting the overall HRM goal of improving predictive models of herring stocks through observations and research.

There are no proposed hypotheses to be tested directly from this project; however, this project will continue long-term monitoring programs essential to the overall goal of the HRM program to 1) conduct aerial surveys to collect milt distribution and linear extent of milt over time and estimate herring biomass based on the surface area of herring schools seen from the air, as well as document the distribution and abundance of sea lions, other marine mammals, and birds associated with spring Pacific herring *Clupea pallasii* spawning events, 2) collect and process age, sex, and size (ASL) samples from prespawn and spawning aggregations of Pacific herring to provide age composition and weight at age for the ASA and BASA models (Population Modeling, 19120111-C) and to estimate target strength for the acoustic survey estimates of biomass (Acoustics Survey, 17120111-G), and 3) provide vessel support for spring acoustics surveys, disease sampling (19120111-E), and collection and processing of age, sex, and size samples. In addition, this project provides timely aerial and vessel based survey observations to coordinate collection efforts for tagging (19160111-B) and maturity (19170111-D) studies.

Aerial survey, acoustics estimates, and ASL data sets are essential parts of the current ASA model 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 (EVOSTC) funded project titled "PWS Herring Program - Scales as growth history records" (13120111-N).

Spring aerial survey observations of herring milt and biomass have been collected since 1972 (Funk 1994), and spring acoustics surveys for assessing herring biomass have been consistently conducted since 1995 (Willette et al. 1999). ASL data are available since 1973 (Sandone 1988). Herring age data were collected in 1971 and 1972 also, but only published 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 (ASA) model 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 (Brady 1987, Fried 1983, Funk and Sandone 1990). 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).

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 probably is not comparable across years. Although Funk and Sandone (1990) indicated that peak biomass values may be a useful relative abundance, issues with biomass observations described by Brady (1987) and Funk and Sandone (1990) caused

the Alaska Department of Fish and Game (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 shoreline receiving milt over the season and 2) the sum of miles of milt spawned across all survey days (mile-days of milt), where the same mile of shoreline receiving spawn on two separate surveys is counted twice. The advantages of milt observations compared to school biomass observations are 1) herring schools likely spawn a single time (e.g., a single day), but a herring school may be observed for several days prior to or after spawning, leading to potential double-counting of the same school 2) milt is relatively easy to observe from the air and observation efficiency is generally not influenced by ocean bathymetry (Brady 1987) as are biomass observations. 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.

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 predators distribution and abundance, additional effort was employed in documenting numbers and locations of predators such as Steller 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. In 2001, ADF&G began extensive photo documentation of aerial survey observations, and more recently (2014) have collected video of most surveys. Photo and video documentation are now used to validate GIS collected milt extents post-season.

ADF&G provides cooperating researchers (NOAA, PWSSC, ADF&G, USGS) the results of individual aerial surveys on a daily basis. Typically, electronic copies of the surveys (Fig. 1) are provided to cooperators within 4 hours of the flight being completed. These surveys identify the extent of the aerial survey, locations of marine mammals, location and relative size of herring schools, and linear extent of observed herring spawn. Researchers use this information to monitor species associated with herring spawning activity and to anticipate the timing and extent of the spawning events

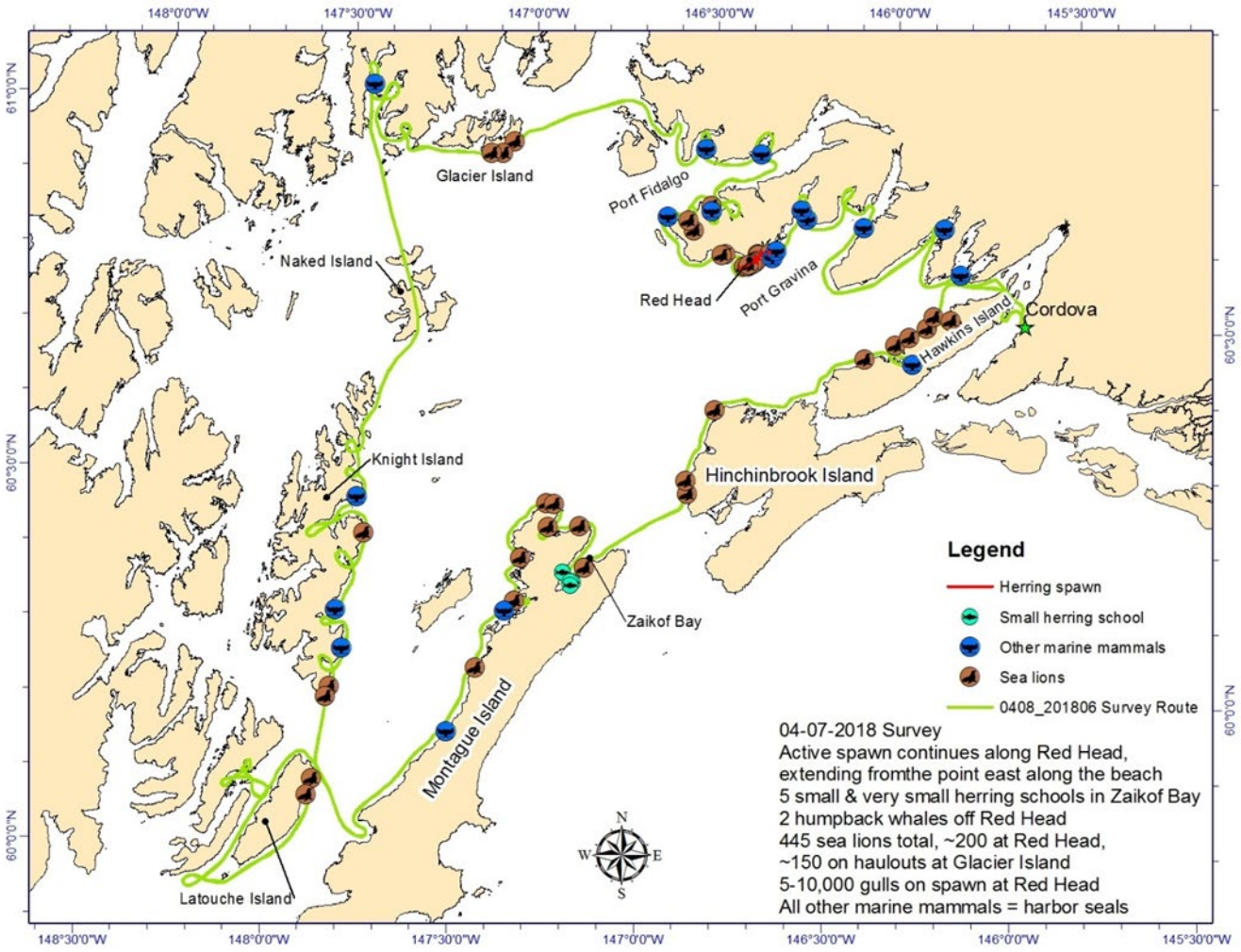

Figure 1. Example of a same-day aerial survey provided to collaborating researchers.

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 to those described by Baker et al. (1991) and include collecting standard length in mm, whole body weight in grams, sex, gonad weights, gonad maturity indices, and scales from spawning and prespawning fish (both sexes) in most years since 1994.

Scales are used to estimate age for PWS collections rather than otoliths because they are much easier to collect and prepare for examination and provide the same information for the range of ages used in the ASA and BASA. 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+.

2019 Preliminary Results

In 2019, we conducted 19 aerial surveys (58 hours of flight time) from March 19th – May 3rd (Fig. 2). The number of aerial surveys was above the recent 10-year average (2009-2018) of 17 survey flights per year and below the

overall program average (1973-2018) average of 20.5 survey flights per year (Fig. 3). Surveys documented 11.2 mile-days of active milt in 2019 (preliminary estimate pending video and photo review, consistent with previous years, the estimate does not include milt observations classified as “drift” or “dissipating” and does not include Kayak Island), the most since 2015 and more than double that observed in 2018. Spatial and temporal distribution of spawning events increased in 2019 relative to the previous three years, during which spawn events were increasingly limited in area, daily mileage, and duration (Figs. 2 and 4). In 2019, milt was documented in multiple areas where spawn has not been observed in several years, including multiple locations in Port Fidalgo, near Tatitlek, Rocky Bay on Montague Island, and Green Island. Spawn events in 2019 were relatively frequent, with active spawn observed on 12 different days (in 2018 there were only 4 days when active spawn was observed), and occurred over a relatively long time period from March 26 to May 3 (active spawn observed from April 7th to April 17th in 2018). As in recent years, additional observations of milt were made in the Kayak Island area (7.2 mile-days of milt in 2019, figure 2), but observations from this area have not historically been included in the PWS mile-days of milt index.

The 2019 herring collections for ASL and disease studies were made by using purse seine and the R/V Solstice, as well as cast netting in active spawn from a skiff. Collections involved two cruises on the R/V Solstice (April 3-April 7, April 9-April 10) for a total of 7 vessel days in 2019. Purse seine samples were collected near Double Bay on Hinchinbrook Island (April 5), near Canoe Pass (April 6) and Whiskey Cove (April 6), and in Rocky Bay on Montague Island (April 9). Cast net samples of actively spawning fish were collected at Knowles Bay (April 1) during the largest event observed in 2019. ASL samples are currently being processed and expected to be completed in October 2019. Age compositions from recent years have shown high proportions of 3- and 4-year old fish (Fig. 5) and declining size at age for most age classes (Fig. 6). Once complete, 2019 samples will be added to the historical dataset and age composition and size at age will be compared to previous years.

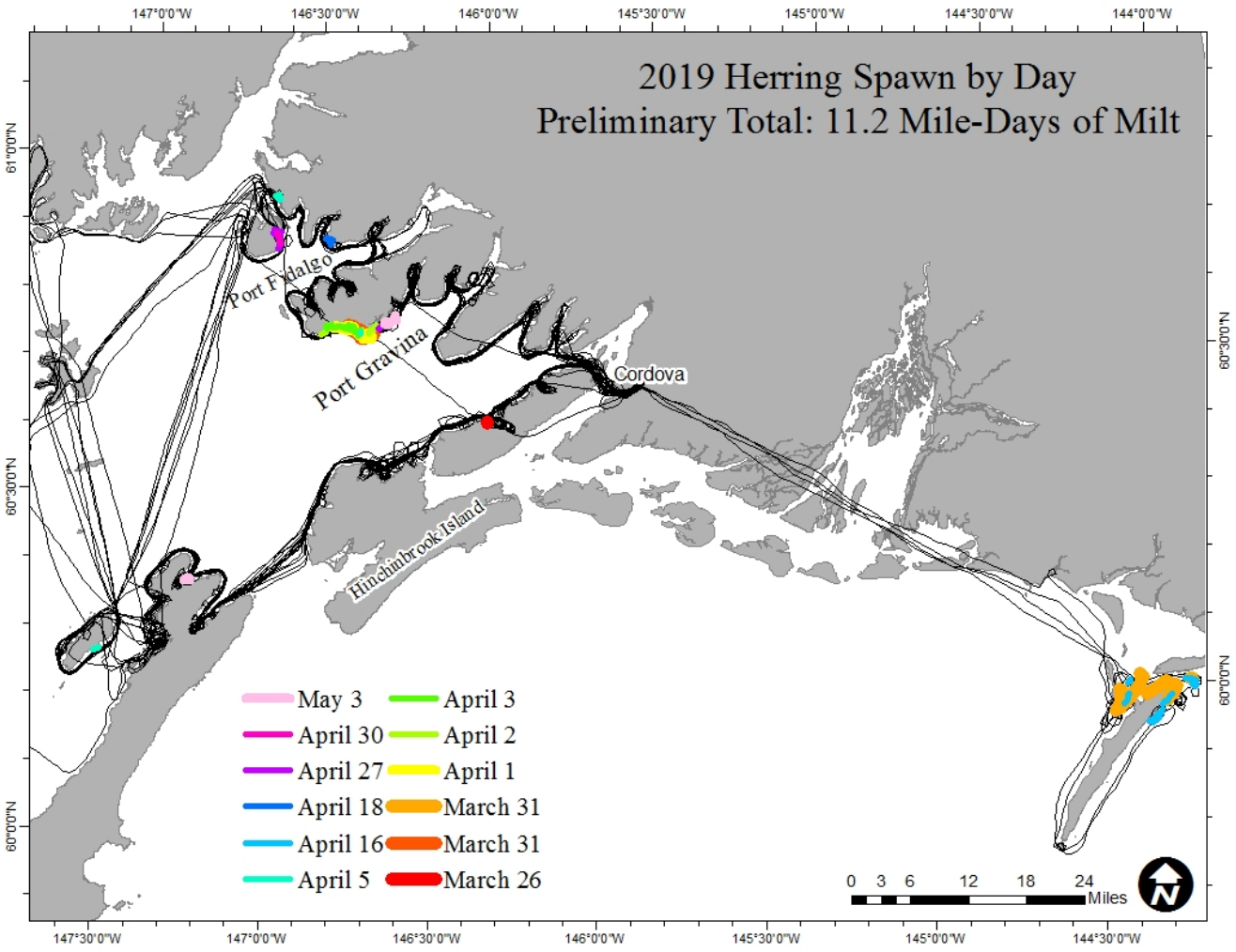

Figure 2. 2019 Aerial survey tracks (black lines) and observed spawning events (colored by date) in Prince William Sound and Kayak Island.

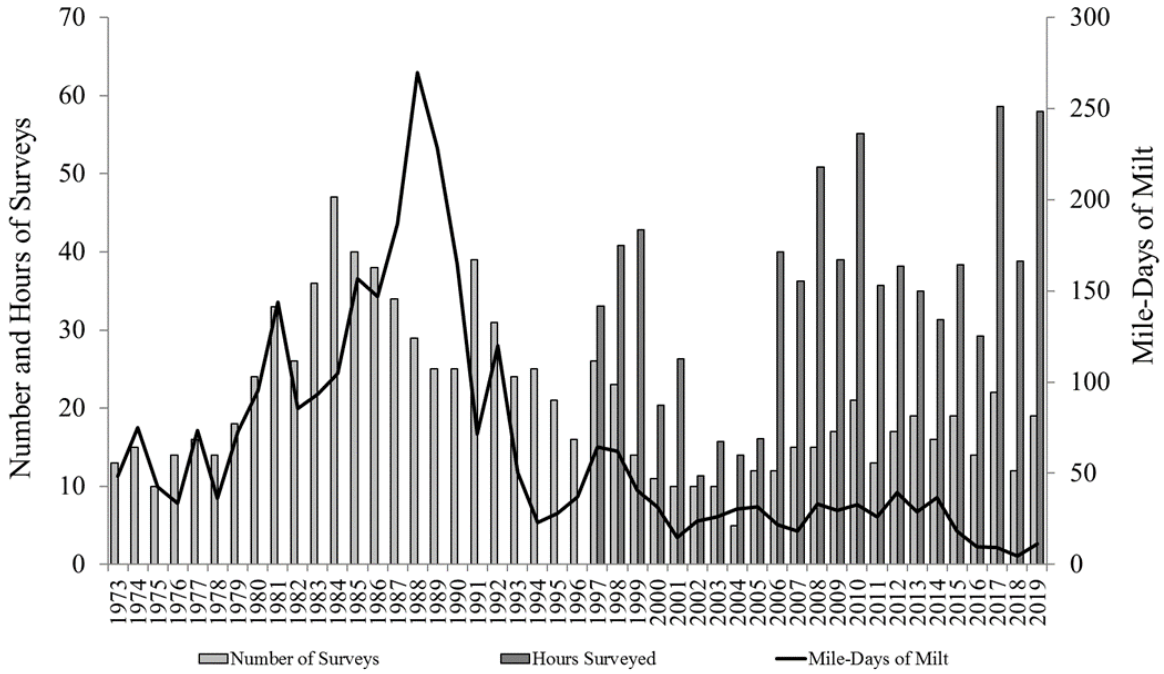

Figure 3. Number of spring Prince William Sound herring aerial surveys performed annually 1973-2019.

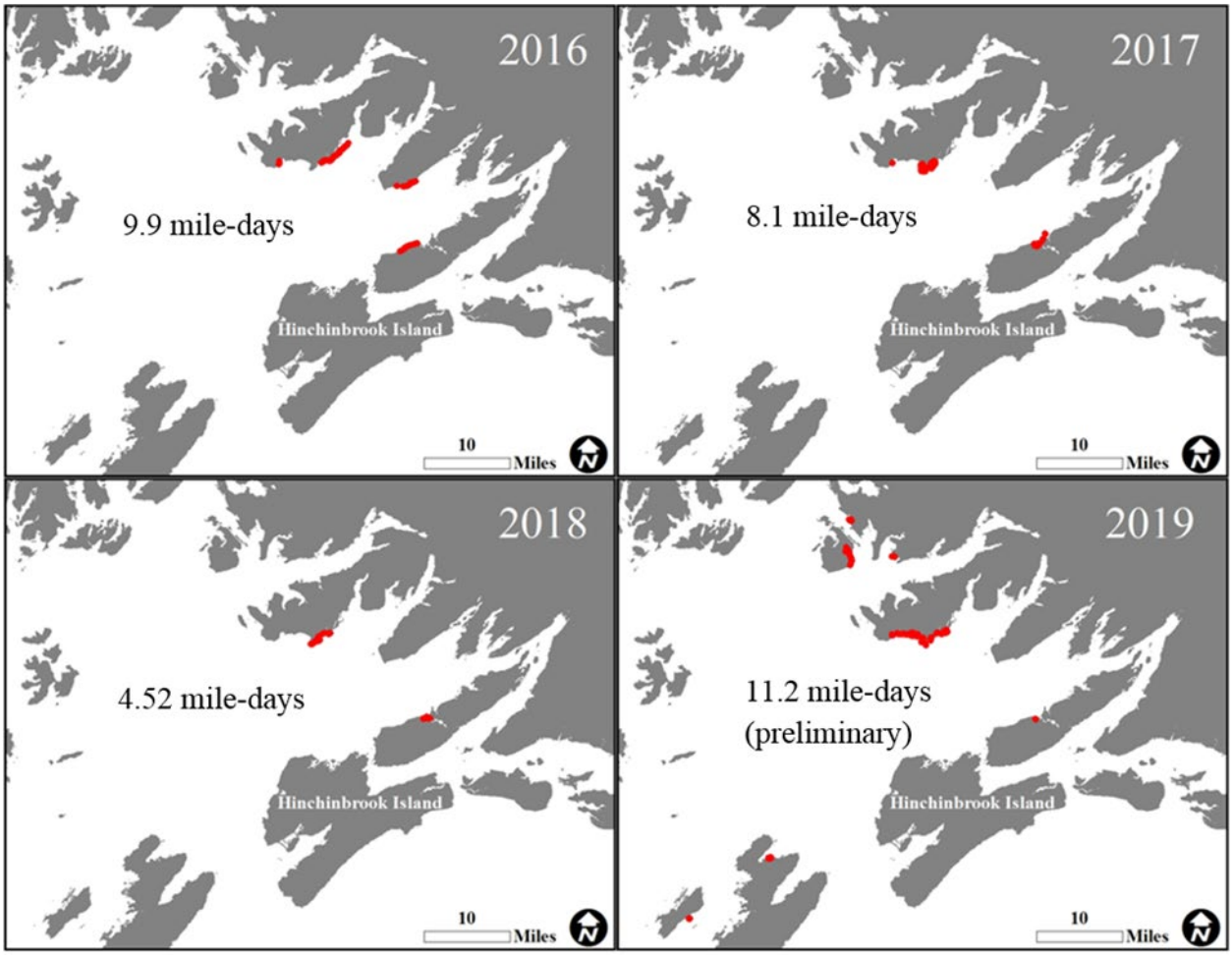

Figure 4. Location (red) and mile-days of active milt observed during aerial surveys of Prince William Sound, 2016-2019.

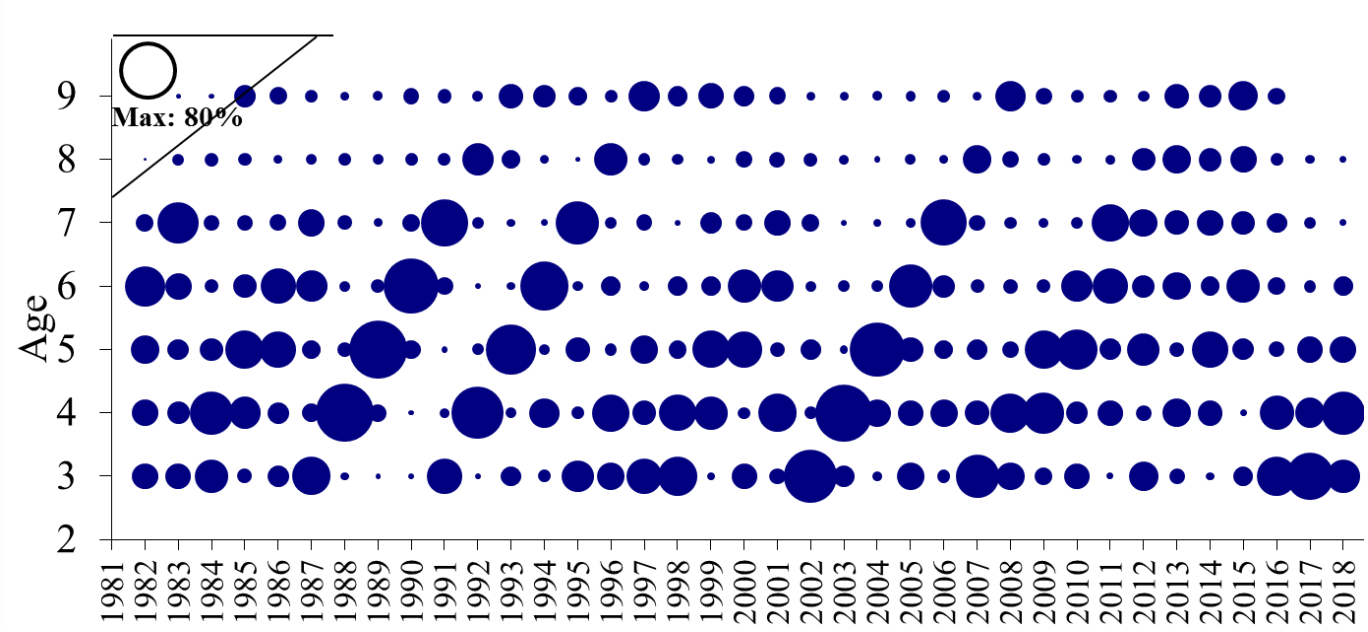

Figure 5. Spring Prince William Sound herring age composition by year, 1982-2018.

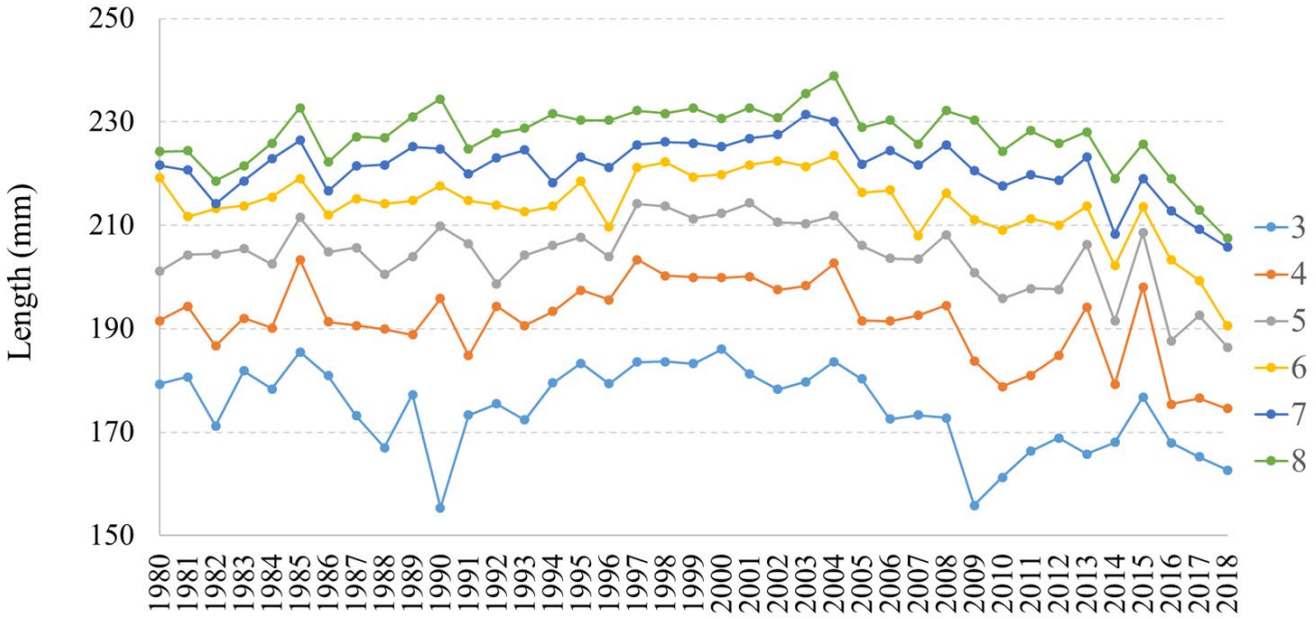

Figure 6. Spring Prince William Sound herring length at age 1980-2018.

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. Yellow highlight indicates proposed fiscal year workplan. Additional milestones and/or tasks have been added in red. C = completed, X = not completed or planned. Fiscal year quarters: 1 = Feb 1 – April 30; 2 = May 1 – July 31; 3 = Aug. 1 – Oct. 31; 4 = Nov. 1 – Jan. 31.

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
Fieldwork																				
Aerial surveys	C	C			C	C			C	C			X	X			X	X		
Acoustics and disease support survey	C				C				C				X							
Lab Analysis																				
Herring ASL sample processing	C	C	C		C	C	C		C	C	X		X	X	X		X	X	X	
Data																				
Quality control ASL data		C				C				C				X				X		
Quality control and editing of aerial shape files		C				C				C				X				X		
Analysis of aerial survey data			C				C				C				X				X	
Combining aerial survey shape files into historical version			C				C				C				X				X	
Upload previous FY data/metadata to workspace		C				C				C				X				X		
Distribute ASL sample summary		C					C				X				X				X	
Reporting																				
Annual reports					C				C				X				X			
Summary Report								C				X				X				X
FY work plan (DPD)			C				C				X				X				X	
FY17-21 Final Report																				X
Meetings & Conferences																				
Annual PI meeting				C				C				X				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 2019.

C. Justification for new milestones/tasks

None.

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOSTC-funded Program

Herring Research and Monitoring

PWS Herring Research and Monitoring Program – Coordination (19120111-A)

This project assists in coordinating sampling efforts by producing and distributing daily aerial survey maps and vessel-based observations to HRM participants. Additionally, This project assists with public outreach through public presentations of methods and results.

PWS Herring Research and Monitoring Program –Tagging (19120111-B)

This project provides daily updates of herring school and spawn event location in order to focus sampling efforts for tag deployment. Additionally, in cases where jig fishing is unproductive and ASL sampling with purse seine occurs in close proximity to the tagging/jigging vessel, purse seine captured fish are provided to the tagging researchers.

PWS Herring Research and Monitoring Program –Population Modeling (19120111-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.

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. Additionally, ADF&G scale images from the PWS Herring Program - Scales as growth history records (13120111-N) are utilized in this maturity study.

PWS Herring Research and Monitoring Program – Herring Disease Studies (17120111-E)

This project provides research platform vessel support (R/V Solstice) to Herring Disease Studies staff to capture and process adult herring for disease sampling. Additionally, this project collects and ages scales for fish sampled for disease.

PWS Herring Research and Monitoring Program –Acoustics Survey (17120111-G)

This project shares the R/V Solstice vessel research platform with a PWS Science Center (PWSSC) staff member to conduct the adult acoustics survey. ADF&G acoustics equipment are shared with the Acoustics Survey project if necessary. This proposed 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.

Gulf Watch Alaska

We provide data as requested for Gulf Watch Alaska synthesis efforts.

Data Management

This project provides new and updated herring aerial survey and herring age, sex, and size data, as well as associated survey data including aerial survey GIS data files for linear extent of spawn, survey routes, sea lion distribution and abundance, other marine mammals distribution and abundance, and bird aggregations. PI works frequently with the data management team to make data and metadata available in a timely fashion.

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 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 EVOSTC funded project titled "PWS Herring Program - Scales as growth history records" (13120111-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. Compile all survey data in ArcGIS files and distribute daily survey observation maps to all HRM participants.

2) Collect, process, summarize, and distribute age, sex, length, weight, gonad maturity, and gonad weight 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 (if they occur) and spawning escapements by gear type and area with sample sizes sufficient to simultaneously estimate all age proportions to within $\pm$ 5% at the 90% level of precision.

    b. Estimate mean standard length and whole body weight for each fishery (if they occur) and spawning escapements by gear type and area with sample sizes such that the relative error is $\pm$ 5% at the 95% level of precision.

    c. Estimate the mean gonad weight of prespawning fish by area with sample sizes such that the relative error is $\pm$5% at the 95% level of precision.

    d. Estimate sex composition of each fishery (if they occur) and spawning escapements by gear type and area strata with sample sizes sufficient to estimate proportions to within $\pm$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	$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. FY17-19 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

The following datasets are published on the research workspace: Aerial Herring Biomass (1973-2018), Aerial Herring Spawn Observations (1973-2018), Aerial Herring Survey Routes (1997-2018), Aerial Survey Marine Bird Observations (2008-2018), Aerial Survey Marine Mammal Observations (2008-2018), Aerial Survey Sea Lion Observations (2008-2018), Herring Age Sex Length (1973-2018).

Presentations

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

Outreach

Haught, Stormy. “Mile-Days of Milt.” *2019-2020 Delta Sound Connections*, 2019, p. 15.

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