

**EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
FY20 (YEAR 9) CONTINUING PROJECT PROPOSAL SUMMARY PAGE**

Project Number and Title

20120111-A

Herring Research Program – Program Coordination

Primary Investigator(s) and Affiliation(s)

W. Scott Pegau, Prince William Sound Science Center

Date Proposal Submitted

August 16, 2019

Project Abstract

This proposal is to provide coordination of the Herring Research and Monitoring (HRM) program. In addition to the coordination efforts, it includes a postdoctoral researcher examining the relationships between herring diseases and environmental conditions. Furthermore, it covers the community involvement and outreach activities of the program. The goal of the project is to provide coordination within the HRM program and with the Gulf Watch Alaska (GWA) and Data Management (DM) programs. The objectives of the project are:

- 1) *Coordinate efforts among the HRM projects to achieve the program objectives, maximize shared resources, ensure timely reporting, and coordinate logistics.*
- 2) *Oversee a postdoctoral researcher.*
- 3) *Provide outreach and community involvement for the program.*

Coordination is primarily through e-mail and teleconference. The management team of GWA and the lead of DM are included in the emails to HRM PIs to ensure they are aware of our activities. We also plan joint principal investigator (PI) meetings and community involvement activities.

The postdoctoral researcher, Dr. Maya Groner, was hired at the end of year one and is focusing her research on understanding the combined impacts of environmental conditions on disease in herring population dynamics using a field collected data, experiments, and population models.

Outreach efforts are focused on providing up-to-date information on the projects and their findings. Community involvement includes regular communications with stakeholders, such as the herring division of the Cordova District Fishermen United and Alaska Department of Fish and Game to stay aware of their findings and observations. We also are participating with GWA in listening sessions in villages within the spill affected area to seek additional local and traditional ecological knowledge.

EVOSTC Funding Requested* (must include 9% GA)

FY17	FY18	FY19	FY20	FY21	TOTAL
Auth: \$138,400	Auth: \$270,200	Auth: \$302,500	\$270,200	\$90,700	\$1,071,900

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

FY17	FY18	FY19	FY20	FY21	TOTAL
\$26,000	\$26,600	\$90,000	\$90,500	\$28,300	\$240,800

1. PROJECT EXECUTIVE SUMMARY

The **goal of this proposal is to provide the coordination necessary to continue integrating the research and monitoring projects** to achieve the program goals. The objectives of the project are:

- 1) *Coordinate efforts among the HRM projects to achieve the program objectives, maximize shared resources, ensure timely reporting, and coordinate logistics.*
- 2) *Oversee a postdoctoral researcher.*
- 3) *Provide outreach and community involvement for the program.*

Coordinate efforts among the HRM projects to achieve the program objectives, maximize shared resources, ensure timely reporting, and coordinate logistics

This project provides a program lead who works with the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) staff to ensure the EVOSTC's objectives and requirements are met. The coordinator facilitates the most cost-effective and scientifically supportive stream of funding; works with a program oversight panel to review proposals and reports, and feedback on the program and individual projects; and other duties as identified in the invitation for proposals.

Coordination since the annual report has focused on the spring and summer sampling activities. These include the aerial and acoustic surveys of herring biomass, age-sex-length sampling of the herring biomass, acoustic tagging of herring and age at maturity sampling in the summer. In support of the summer sampling for age at maturity, we conducted aerial surveys to identify locations of potentially mature herring and other forage fish as well as guide the sampling vessel to potential schools. We were funded by the Prince William Sound Regional Citizens' Advisory Council for aerial forage fish surveys that were used to support the age at maturity program and the Gulf Watch Alaska (GWA) program's forage fish project (project number 20120114-C).

We participated in the GWA teleconferences and with the Data Management (DM) program to make more data available through the Alaska Ocean Observing System (AOOS) Gulf of Alaska data portal. We worked with GWA to set the date of the fall principal investigator (PI) meeting. The Herring Research and Monitoring (HRM) meeting will be October 10th in Homer to allow PIs to collaborate with GWA investigators and DM team members. During this year we incorporated the lingering oil project (project 19170115) led by Dr. Whitehead into the HRM program.

This year an intern was supported in this project. The intern worked on updating the Alaska Department of Fish and Game (ADF&G) scale growth image library; the work ADF&G did for the EVOSTC (project 13120111-N) involved imaging and measuring herring scales through 2015. The intern completed imaging and measuring scales from 2016 to 2018. This will allow us to examine how herring growth may have been affected by the warm ocean temperatures in 2014-2016. We also participated in a discussion with ADF&G biologists regarding the aging of herring from scales. The conversation came about because many scales in recent years have had unusually close annuli. The discussion regarded whether they were true annuli or potentially false annuli that shouldn't be considered when aging. This led one fish being judged to be age-5, -6, and -7 by different readers. We contributed by trying to provide reasons why we might expect unusual growth or formation of false annuli.

With funding from the Prince William Sound Regional Citizens' Advisory Council we were able to continue aerial surveys of forage fish, including herring. During June 2019 the count of age-1 herring schools was relatively low

(Fig. 1). Validation efforts were conducted with vessels associated with the HRM Maturity project (project 19170111-D) and the GWA forage fish project (project 20120114-C). The aerial surveys correctly identified one age-0 herring, three age-1 herring, three age-2+ herring, and ten sand lance schools. There was one misidentification of age-0 herring as sand lance. The age-0 herring are not present during the June surveys and this misidentification arose because much of the validation effort occurred in July.

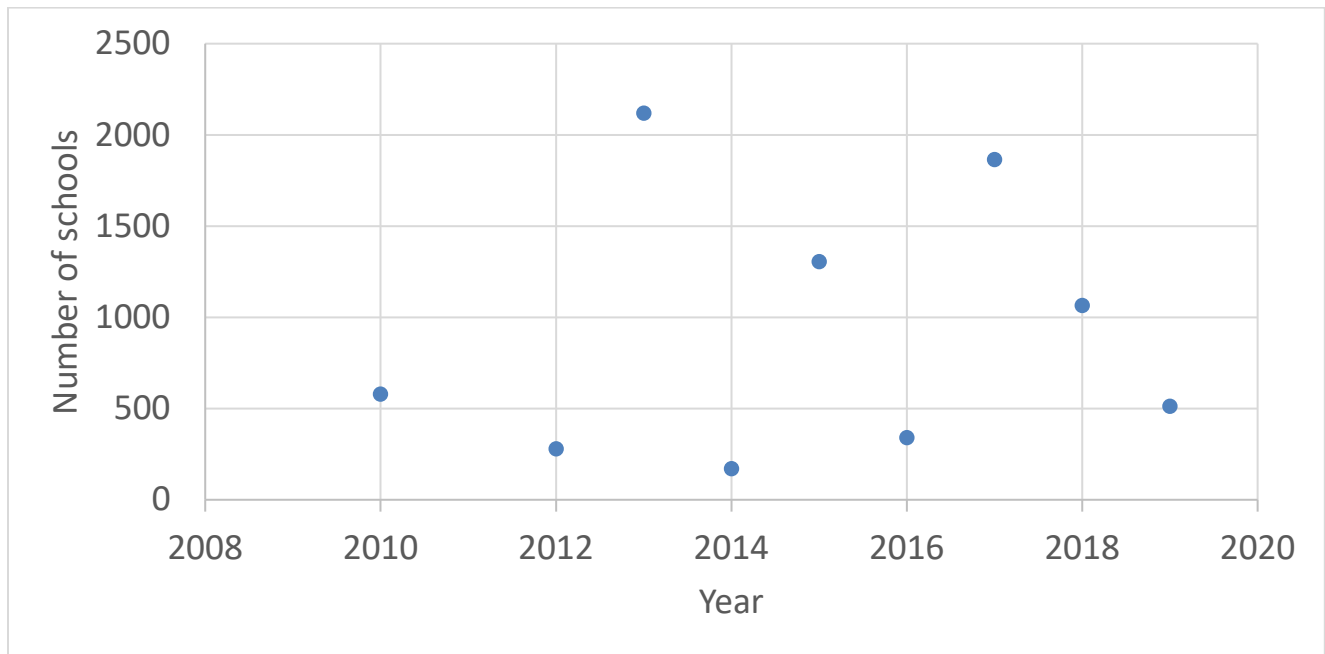


Figure 1. Number of schools of age-1 herring observed during aerial surveys of forage fish in Prince William Sound. 2011 was an incomplete survey and results are not provided. Data from projects 10100132-F (2010-2012) and 19120111-A.

Oversee a postdoctoral researcher

The project supported a post-doctoral researcher examining the relationship between herring diseases and environmental conditions. Dr. Maya Groner started at the beginning of the second year of funding and is primarily collaborating with Dr. Hershberger in Washington. Research conducted to date has been focused on three topics: examining and modeling patterns of *Ichthyophonus* in herring, modeling the impact of VHS on herring populations and experimentally examining patterns of viral erythrocytic necrosis (VEN) infection across herring age classes.

The first goal of the herring diseases/environmental conditions post-doctoral study is to experimentally quantify the relationship between *Ichthyophonus* sp. pathogen load and mortality using specific pathogen free herring at the U. S. Geological Survey (USGS) Marrowstone Laboratory. Replicate tanks (3) of age-1 herring were exposed to *Ichthyophonus* via consumption of offal from ground up infected conspecifics (Fig. 2). Mortality, infection status, size and cardiac tissue samples were collected from all tanks. Pathogen load will be quantified in dead, moribund, and subsamples of healthier fish by through quantitative image analysis of histologically sectioned cardiac tissue. A pilot experiment was completed with age-1 herring and a second experiment was successfully conducted with age-4 herring. These results are currently being used to parameterize demographic models

estimating mortality due to this disease in both Sitka Sound and Prince William Sound (PWS) between 2009 and 2019.

Models are being parameterized by quantifying infection loads from historical samples of herring hearts in Sitka Sound and PWS from 2009-2019 (180 hearts/ site/ year). Previously, data on pathogen presence was reported, by further examination of infection intensity (# parasites/ area) will allow us to determine if there is a shift in mortality associated with *Ichthyophonus*. This work is motivated by shifting patterns in disease prevalence across age (as a proxy for size) and an increase in observations of severely diseased herring particularly in Sitka Sound after 2013. We have finished processing, sectioning, and staining all hearts (>1000) and have begun imaging these samples for quantification of lesions. This work has been facilitated by a North Pacific Research Board (NPRB) grant awarded to Groner and Hershberger that allowed us to hire a technician (through USGS Western Fisheries Research Center) in summer 2018 and 2019. Our technician, Eliana Bravo-Mendoza, was instrumental in sectioning and staining all of these hearts and has begun work (under guidance from Groner and Hershberger) quantifying lesion densities in this large collection of images.

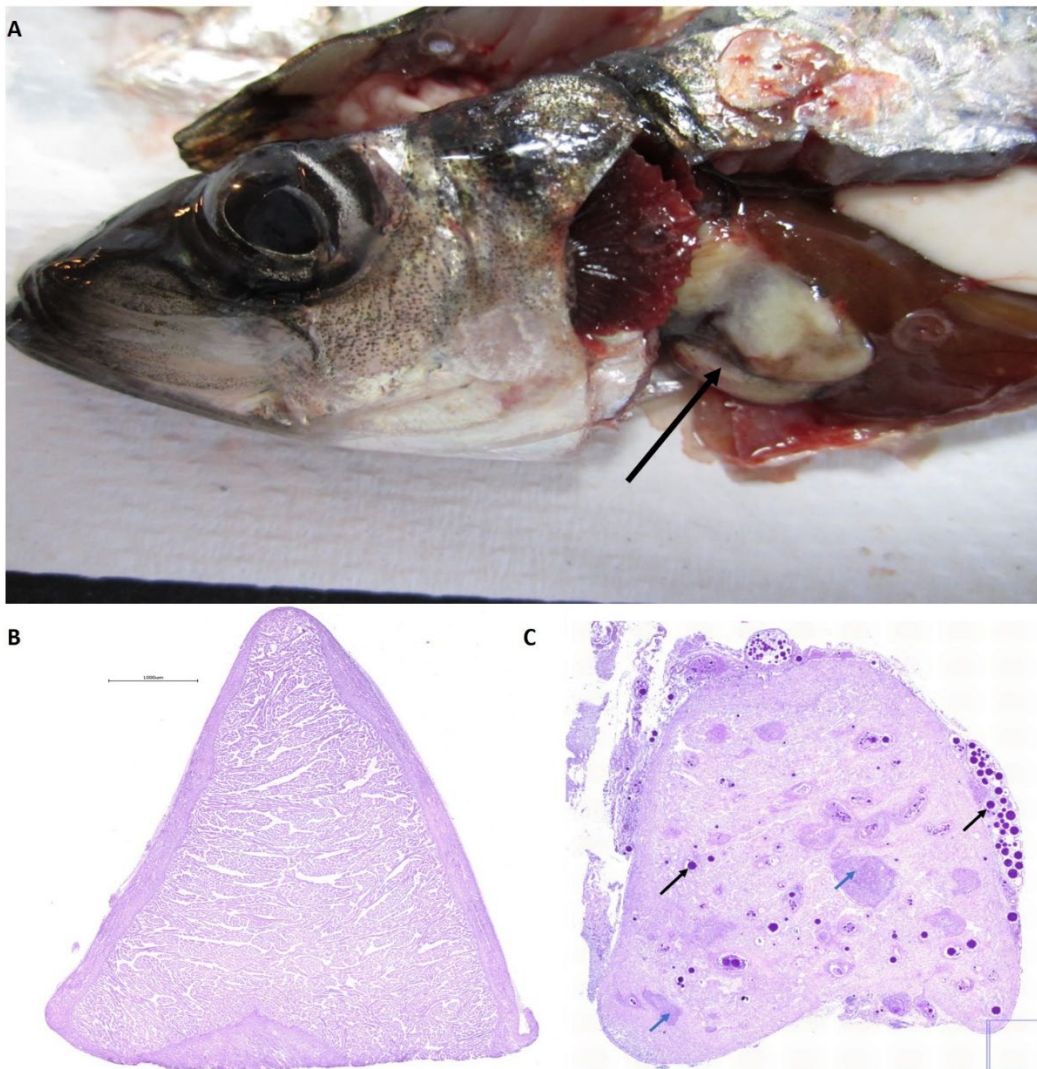


Figure 2. Hearts heavily infected with *Ichthyophonus* sp. can appear white instead of dark red (arrow) (A). Histological sections of a healthy herring ventricle (b) next to an infected ventricle (c). On the infected ventricle,

the dark purple circles (black arrows) indicate *Ichthyophonus* sp. schizonts. Granulomas of darker staining tissue surround some of the schizonts (blue arrows).

A second project being pursued by Dr. Groner is to use existing data from infection trials to parameterize mathematical models of VHS. Dr. Groner worked with her students to develop this model in a graduate level course she co-taught on the ecology infectious marine diseases at the University of Washington's Friday Harbor Lab (marine field station). The model is designed to examine the impact of temperature and fishing on dynamics of VHS across years. Herring immune function is suppressed at colder temperatures, which can result in increased mortality and more rapid spread of VHS. Fish that survive VHS infections have immunological memory; they produce antibodies to VHS infection that prevent them from getting infected again. Thus, fish that survive VHS outbreaks can dampen future disease dynamics by acting as dead ends in the transmission process. This is called herd immunity. This benefit can be compromised if fishing targets older fish (which are more likely to have immunity). Our model examines these interactions using a series of differential equations.

The framework is based on a classic SEIR model (Anderson and May 1991). This model is meant to imitate the dynamics of a directly transmitted parasitic pathogen in a population of herring, which is dependent on the prevalence of the VHS susceptible herring. The structure for our model is as follows,

$$dS/dt = (b - cN)N - (\mu + f + \lambda)S \tag{1}$$

$$dE/dt = \lambda S - (\mu + f + \gamma)E \tag{2}$$

$$dI/dt = \gamma E - (\mu + f + \alpha + \rho)I \tag{3}$$

$$dC/dt = \rho I - (\mu + f)C \tag{4}$$

where the state variables S , E , I , and C represent the numbers of susceptible, exposed (with latent infections), infected, and immune carriers, respectively. The size of the total host population (N) is given by $N = S + E + I + C$. Birth rate is marked by b and c is the strength of density dependence. Terms μ , f , γ , λ , and ρ denote natural mortality, fishing catch, transmission rate, force of infection, and recovery rate, respectively. Here, newborns are susceptible to infection and survivors of the infection are considered immune for life. We are in the process of parameterizing this model by using data from experiments conducted at a variety of temperatures by Dr. Hershberger. We anticipate publishing this work in the next year.

The third ongoing project involves a series of experiments examining interactions between age and susceptibility of herring to VEN. An experiment was conducted in which replicate tanks (3) of mixed aged herring (age 0, 1, 2, or 4) were been exposed to erythrocytic necrosis virus (ENV) or a control. Herring are tagged with elastomer tags to identify them to cohort. Mortality and water quality was monitored for two months and kidney samples were collected in fish after death and at the end of the experiment to determine infection status. The particular strain of ENV that was used was not as virulent as those that have been used experimentally in previous studies. As a result, so we did not observe substantial mortality or disease signs in this experiment. We are in the process

of evaluating our archived strains so that we can identify a more typical virulent strain to use in future experiments.

In addition to her focal projects, Dr. Groner has also participated in several other HRM projects including (1) participation in a research cruise to collect herring for size at maturity work with Kristen Gorman, (2) assisting Catrin Wendt collect samples for work on *Ichthyophonus* infection in juvenile herring, (3) discussing approaches for incorporating VHS antibody data in disease models with John Trochta, and (4) assisting Paul Hershberger in yearly disease sampling of herring in Sitka Sound. In the upcoming year, Dr. Groner will continue her work on the previously described projects and, over the next several months, she will also participate in synthesizing the disease work conducted on Pacific herring.

Dr. Groner has participated in several manuscripts that are tangentially related to this project including collaborations on (1) a book chapter on marine disease modeling, (2) a manuscript reviewing how management of marine resources (i.e., fisheries, marine protected areas, and rehabilitation) can indirectly alter host-pathogen interactions, and (3) a paper lead by Dr. Hershberger that evaluates patterns of *Ichthyophonus* infections in herring in Puget Sound, Washington. The book chapter will be published in a textbook on marine diseases and is currently in publication. Dr. Groner's contribution is focused on how to infer epidemiological processes by examining and modeling distributions of parasites within hosts. The theory in this chapter underlies her current work being applied to quantifying and interpreting *Ichthyophonus* intensities in herring hearts. The review paper uses several examples of Pacific herring diseases to illustrate how fishing practices may alter disease processes, including size-selective harvests that may inadvertently target herring infected with *Ichthyophonus* and the spawn-on-kelp fishery which has been associated with shedding of VHS. The book chapter and the manuscript led by Dr. Hershberger are both in production. The review paper is still in development.

Provide outreach and community involvement for the program

Work within the project also includes support for outreach activities. We focused on updating past projects to include more findings. We also drafted additional podcasts describing current HRM activities. We have been working to revise the podcasts to make them appropriate for broadcast on the public radio station. Two herring research programs presented on their work during the Prince William Sound Science Center (PWSSC) sponsored Tuesday Night Talks. Dr. Maya Groner's work on *Ichthyophonus* in herring was featured in a PWSSC blog (<http://pwssc.org/for-the-love-of-herring/>) and was also written up for the 2019-2020 edition of Delta Sound Connections. In addition, Dr. Groner, in collaboration with Dr. Paul Hershberger (project 19120111-D), used both *Ichthyophonus* and Viral Hemorrhagic Septicemia (VHS) in herring as case studies in a 5-week graduate-level course on infectious marine diseases that she co-taught at the University of Washington's marine field station, Friday Harbor Labs. In addition to receiving lectures by both Groner and Hershberger on both diseases, students learned how to dissect herring and set up plaque assays to evaluate VHS infections. In addition, students in the course worked with Dr. Groner to develop an epidemiological model examining the influence of fishing and temperature on VHS outbreaks and related mortality in herring populations. This work is being further developed for publication. These students will be co-authors on the final project.

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. 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
Postdoctoral Researcher																				
Request proposals for postdoctoral researchers	C																			
Select project to include in FY18 proposal submission		C																		
Hire postdocs				C																
HRM Website																				
Annual update				C				C				C				X				X
Management																				
Ensure previous FY project data submission to workspace/AOOS		C				C					X				X				X	
Ensure project annual reports submitted					C				C				X				X			
Reporting																				
NOAA semi-annual report			C		C		C		C		X		X		X		X		X	
Annual reports					C				C				X				X			
FY work plan (DPD)			C				C				C				X				X	
EVOSTC Joint Science Workshop Report												X								
Draft FY17-21 Final Report																				X
Meetings & Conferences																				
Annual PI meeting				C				C				X				X				X
EVOSTC Joint Science Workshop													X							
Post-doc effort																				
(1) Wild herring disease assessments in Sitka and PWS						C				C				X						
(2) Experimentally investigate effects of VEN on different age classes							X	X	X											
(3) Experimentally investigate effects of temperature on susceptibility to ENV and mortality associated with infection								X	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
(4) Publish manuscript on age-dependency and seawater temperature dependency of VEN in Pacific herring											X									
(5) Experimentally quantify <i>Ichthyophonus</i> mortality as a function of infection intensity						C	C	C												
(6) Quantify <i>Ichthyophonus</i> infection intensity in histological samples of cardiac tissue from PWS and Sitka 2009-2018							C	C	C	C										
(7) Publish manuscript on <i>Ichthyophonus</i> severity in PWS and Sitka from 2009-2018, comparing results to experimental infections											X	X								
(8) Model population-level effects of <i>Ichthyophonus</i>												X								

B. Explanation for not completing any planned milestones and tasks

An experiment was conducted to investigate the impact of age on VEN infection. We conducted this experiment using a new strain of ENV sourced from wild herring caught in Puget Sound. Unfortunately, while the strain caused some anemia in the wild fish, it was less virulent in our experimental fish. As a result, while we detected low levels of ENV in our experimental tanks, we did not see many signs of disease. We are in the process of evaluating our archived ENV strains to ensure we have an appropriate strain before we continue with this work.

C. Justification for new milestones/tasks

No new milestones or tasks were added.

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOSTC-funded Program

Herring Research and Monitoring

This project provides the overall coordination between all projects within the HRM program, therefore is directly linked to each project. Dr. Pegau is the program team leader responsible for ensuring a coordinated

and focused research program that leverages other assets whenever possible. Within program coordination is primarily through e-mail and phone communications. In-person meetings of participants occur in the fall of each year for exchange of information and to encourage collaboration between projects. Teleconference meetings are scheduled as needed. In July 2019 we had a teleconference meeting to ensure appropriate progress on the synthesis was being completed.

Coordination occurs each spring when the main sampling period is being conducted to ensure each group is providing information to others about where they expect to be and what types of sampling is being done. Further coordination occurred in ensuring aerial support for collection of herring and identification of schools for validation by the GWA forage fish project (project 20120114-C).

During this year we incorporated the lingering oil project (project 19170115) led by Dr. Whitehead into the HRM program.

We supported a graduate research project examining reasons that may explain the high *Ichthyophonus* prevalence in age-0 herring around Cordova. Support included collection of fish and sediment samples. While not an HRM sponsored study, this work is relevant to HRM and Dr. Hershberger is a member on the student's graduate committee.

Gulf Watch Alaska & Data Management

This project provides the primary link between the HRM, GWA, and Data Management programs. Dr. Pegau participates in the GWA quarterly PI meetings and program management meetings. Mandy Lindeberg, the GWA lead, and Dr. Carol Janzen, the DM lead, are included on the HRM email list so they are aware of what is going on in the HRM program. Administratively, the annual work plans and reports will continue to be developed together. We continue to plan joint PI meetings to encourage individuals to work with people in the other programs. We work together to design topics for analysis and development of joint scientific manuscripts. We work with the DM program to ensure timely submission of data and metadata.

B. With Other EVOSTC-funded Projects

We did not work with projects outside of the EVOSTC-funded programs.

C. With Trustee or Management Agencies

ADF&G is the primary trustee and management agency that the HRM program aims to serve. The success of the program is highly dependent on the information collected by ADF&G so it is imperative that we work with the agency. We will continue to have an ADF&G employee (Dr. Sherri Dressel) on our scientific oversight group. We worked with them to discuss potential aging issues that may arise from reading the scales when there is unusual growth.

Drs. Groner and Hershberger have partnered with ADF&G – Sitka to assess whether temporal changes in the severity of *Ichthyophonus* infections may be responsible for recent declines in the spawning herring biomass and age structure. Data and archived samples from the past 10 years of this EVOSTC-funded project were leveraged to obtain supplemental funding from the NPRB (# 1807: *Ichthyophonus* in Pacific Herring), for which ADF&G provided a letter of support.

4. PROJECT DESIGN

A. Overall Project Objectives

The original goals and objectives of the project are as follows. The **goal of this proposal is to provide the coordination necessary to continue integrating the research and monitoring projects** to achieve the program goals. The objectives of the project are:

- 1) *Coordinate efforts among the HRM projects to achieve the program objectives, maximize shared resources, ensure timely reporting, and coordinate logistics.*
- 2) *Oversee a postdoctoral researcher.*
- 3) *Provide outreach and community involvement for the program.*

The objectives have been modified to include the following that represent the work of the postdoctoral researcher that was selected.

- 1) *To quantify the role of VEN, VHS and Ichthyophonous in low recruitment of Pacific herring*
- 2) *To evaluate the contribution of environmental and biotic drivers of disease, particularly as they relate to decreased condition factor and disease susceptibility of juvenile herring*
- 3) *To provide estimates of the environmentally-dependent estimates of the effects of disease on Pacific herring recruitment to inform the Bayesian ASA model for Pacific herring assessment in (Muradian et al. 2017)*
- 4) *Parameterize an age-structured disease model for Ichthyophonus sp. in Pacific herring.*

B. Changes to Project Design and Objectives

The project design and objectives remain the same. We are evaluating whether the planned experiments associated with VEN can yield informative results and may need to change that objective in the future.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

There are no new personnel.

6. PROJECT BUDGET

A. Budget Forms

**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	\$57.0	\$153.3	\$177.4	\$171.9	\$51.7	\$611.2	
Travel	\$6.4	\$9.9	\$6.4	\$6.4	\$6.4	\$35.5	
Contractual	\$24.7	\$26.0	\$26.2	\$11.0	\$4.4	\$92.3	
Commodities	\$3.8	\$1.5	\$3.5	\$1.4	\$1.5	\$11.7	
Equipment	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	
Indirect Costs (<i>will vary by proposer</i>)	\$35.1	\$57.20	\$64.0	\$57.2	\$19.2	\$232.7	
SUBTOTAL	\$127.0	\$247.8	\$277.5	\$247.9	\$83.2	\$983.4	
General Administration (9% of subtotal)	\$11.4	\$22.3	\$25.0	\$22.3	\$7.5	\$88.5	N/A
PROJECT TOTAL	\$138.4	\$270.2	\$302.5	\$270.2	\$90.7	\$1,071.9	
Other Resources (Cost Share Funds)	\$26.0	\$26.6	\$69.7	\$90.5	\$28.0	\$240.8	

B. Changes from Original Project Proposal

We are requesting an additional \$10,000 in salaries in FY20 to hire Donna Aderhold to provide an additional level of review of documents that the HRM program is submitting to the EVOSTC. Donna will coordinate primarily with the HRM program lead, W. Scott Pegau, and with individual project PIs as needed to complete document editorial reviews. For FY20, editorial support will include FY19 annual reports and FY21 work plans.

C. Sources of Additional Project Funding

The Oil Spill Recovery Institute provides up to two months of salary for Dr. Pegau to complete his coordination activities (\$24,500). The Prince William Sound Regional Citizens' Advisory Council is supporting aerial surveys of forage fish that provides information on the number of age-1 herring schools (\$42,500).

The Herring Disease Program (project 19120111-E) was leveraged to obtain NPRB funding (Groner and Hershberger) to evaluate the possible involvement of *Ichthyophonus* in the recent herring population trends occurring in Sitka Sound (\$23,500). The funding claimed here is only for the portion associated with Groner's work. The portion associated with Hershberger's work is shown in his proposal (project 19120111-E).



To Whom it may Concern:

This letter is to confirm that the Oil Spill Recovery Institute (OSRI) has agreed to provide salary for up to two months in FY 20 and 21 for Dr. Pegau to support the Herring Research and Monitoring (HRM) program. Dr. Pegau's works for OSRI to identify efforts that help us understand recovery from oil spills and participation in the HRM program aligns with that mission. The value of Dr. Pegau's salary, benefits, and overhead is expected to be 18,500 per month in FY20 and 19,000 in FY 21.

Sincerely,

A handwritten signature in black ink, appearing to read "Katrina Hoffman", is positioned above the typed name.

Katrina Hoffman
Executive Director
Oil Spill Recovery Institute

Mail address: P.O. Box 706 – Cordova, AK 99574 – Phone: (907) 424-5800 x 222; fax 424-5820
Physical address: 300 Breakwater Avenue, Cordova, AK 99574
www.pws-osri.org or www.pwssc.org – wspgou@pwssc.org



Regional Citizens' Advisory Council / "Citizens promoting environmentally safe operation of the Alyeska terminal and associated tankers."

In Anchorage: 3709 Spenard Road / Suite 100 / Anchorage, Alaska 99503 / (907) 277-7222 / FAX (907) 277-4523
In Valdez: P.O. Box 3089 / 130 South Meals / Suite 202 / Valdez, Alaska 99686 / (907) 834-5000 / FAX (907) 835-5926

MEMBERS July 19, 2019

Alaska State
Chamber of Commerce

Chugach Alaska
Corporation

City of Cordova

City of Homer

City of Kodiak

City of Seldovia

City of Seward

City of Valdez

City of Whittier

Community of
Chenega

Community of
Tatitlek

Cordova District
Fishermen United

Kenai Peninsula
Borough

Kodiak Island
Borough

Kodiak Village Mayors
Association

Oil Spill Region
Environmental
Coalition

Port Graham
Corporation

Prince William Sound
Aquaculture
Corporation

To whom it may concern,

I am writing this letter in regards to forage fish survey work that the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) is currently funding. In early 2019, PWSRCAC contracted with the Prince William Sound Science Center, in an amount of \$42,500, to conduct aerial surveys of juvenile forage fish (e.g. herring, capelin, sand lance) in Prince William Sound. These surveys took place in June 2019, and we anticipate receiving a report with the findings this fall. PWSRCAC has budgeted an additional \$44,000 to conduct the same surveys in June 2020. This work uses the protocols as previous efforts funded by the Exxon Valdez Oil Spill Trustee Council, and the data will be combined with those prior year surveys. PWSRCAC is working with Dr. Scott Pegau at the Prince William Sound Science Center on this multi-year project.

The PWSRCAC Board of Directors believes that monitoring the long-term changes in forage fish distribution, and relative abundance in Prince William Sound, provides valuable information, especially since the Prince William Sound herring population has crashed to a new low level. Understanding where herring and other forage fish are, and where the important nursery grounds exist, is important for prioritizing their protection during an oil spill response or identifying suitable places of refuge for oil tankers, or other vessels in distress.

As you may be aware, the PWSRCAC is an independent non-profit corporation whose mission is to promote environmentally safe operation of the Valdez Marine Terminal and associated tankers. Our work is guided by the Oil Pollution Act of 1990, and our contract with Alyeska Pipeline Service Company. PWSRCAC's 18 member organizations are communities in the region affected by the 1989 Exxon Valdez oil spill, as well as commercial fishing, aquaculture, Native, recreation, tourism and environmental groups.

Please feel free to contact me if you have any questions or would like more information on PWSRCAC's work and interest in monitoring herring and other forage fish in Prince William Sound.

Sincerely,

Donna Schantz
Executive Director

900.105.190719.ForageFish

**NORTH PACIFIC RESEARCH BOARD
SUBAWARD AGREEMENT**

1. Scope of Work

(a) The North Pacific Research Board (NPRB) and the Recipient listed below, jointly and severally agree to the provisions herein and to perform the work described in Appendix 1, which contains a statement of work, schedule, and budget for the following project recommended for approval by NPRB on May 9, 2018, and approved by the Secretary of Commerce on May 14, 2018:

Project Number:	1807
Project Title:	Is shifting epidemiology of Ichthyophonus increasing mortality in Pacific Herring?
Recipient:	Prince William Sound Science Center PO Box 705 Cordova, Alaska 99574
Recipient DUNS:	85869551
Principal Investigator:	Maya Lowry Groner maya.groner@gmail.com
Period:	September 1, 2018 – August 31, 2020
Total Recipient Amount:	\$43,708 (Uniform Guidance 2.C.F.R Part 200 applies) 1807 \$94,928 (USGS)
Project TOTAL:	\$138,636

(b) This Agreement is a subaward of prime award number **NA17NMF4720289**, "North Pacific Research Board" (\$13,751,714) to NPRB from the U.S. Department of Commerce/National Oceanic and Atmospheric Administration, CFDA number 11.472 (Unallied Science Program).

(c) The Recipient shall provide to NPRB the time and expertise of the Principal Investigator to perform the services and produce the products and reports described in Appendix 1. Material change to the Scope of Work requires prior approval by NPRB.

(d) The Recipient shall provide full and timely financial and programmatic reporting in compliance with all federal laws, regulations, and OMB Circulars appertaining to funds received by NPRB for the Scope of Work described herein.

7. FY17-19 PROJECT PUBLICATIONS AND PRODUCTS

Publications

- Aderhold, D. G. R., M. R. Lindeberg, K. Holderied, and W. S. Pegau, 2019, Spatial and temporal ecological variability in the northern Gulf of Alaska: What have we learned since the *Exxon Valdez* oil spill? *Deep Sea Research II*. **147**, 3-8. DOI 10.1016/j.dsr2.2017.11.015
- Gorman, K. B., T. C. Kline, M. E. Roberts, F. F. Sewall, R. A. Heintz, and W. S. Pegau, 2019m Spatio-temporal variation in stable carbon and nitrogen isotope signatures and condition of juvenile herring (*Clupea pallasii*) in Prince William Sound, Alaska: teleconnections with the Gulf of Alaska. *Deep Sea Research II*. **147**, 116-126. DOI 10.1016/j.dsr2.2017.10.010
- Shore-Maggio, A., Groner, M. L., Burge, C. A., Carnegie, R., Hershberger, P. *in prep*. Disease transmission in managed marine systems.
- Ben-Horin, T., Groner, M. L., Bidegain, G., McCallum, H., Powell, E., Hofmann, E. *In press*. Modeling and forecasting disease dynamics in the sea. *Marine disease ecology*. Ed. Lafferty, K.
- Hershberger PK, MacKenzie AH, Gregg JL, Lindquist A, Sandell T, Groner ML, Lowry D. *In press*. A geographic hot spot of *Ichthyophonus* infection in the southern Salish Sea, USA. *Diseases of Aquatic Organisms*.

Published and updated datasets

The forage fish aerial survey data collected in 2019 were added to the forage fish data available from the AOOS Gulf of Alaska data portal.

Outreach

We completed updates to the website (<http://pwssc.org/research/>) for all of the ongoing projects within the HRM program and continue updating past projects to include more findings.

We drafted additional podcasts of current HRM projects and are working on modifying the length to make them appropriate for broadcast on the local public radio station. The podcasts can be found at <http://pwssc.org/education/field-notes/> and linked within the individual project posts.

Articles were provided for the Delta-Sound Connection paper that is produced and distributed by PWSSC that highlights active science in PWS.

Two herring research programs presented on their work during the Prince William Sound Science Center (PWSSC) sponsored Tuesday Night Talks.

Dr. Groner, in collaboration with Dr. Paul Hershberger (project 19120111-D), used both *Ichthyophonus* and Viral Hemorrhagic Septicemia (VHS) in herring as case studies in a 5-week graduate-level course on infectious marine diseases that she co-taught at the University of Washington's marine field station, Friday Harbor Labs. In addition to receiving lectures by both Groner and Hershberger on both diseases, students learned how to dissect herring and set up plaque assays to evaluation VHS infections. In addition, students in the course worked with Dr. Groner to develop an epidemiological model examining the influence of fishing and temperature on VHS outbreaks and related mortality in herring populations. This work is being further developed for publication. These students will be co-authors on the final project.

LITERATURE CITED

- Anderson, R. M., and R. May. 1991. *Infectious diseases of humans*. 1991. New York: Oxford Science Publication
Google Scholar.
- Muradian, M. L., T. A. Branch, S. D. Moffitt, and P. F. Hulson. 2017. Bayesian stock assessment of Pacific herring in Prince William Sound, Alaska. *PLoS One* 12:e0172153.