FY12 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Herring Condition Monitoring

Project Period: federal fiscal years of 2013 to 2016 (October 1, 2012 – September 30, 2016)

Primary Investigator(s): Thomas C. Kline, Jr., Ph. D., Prince William Sound Science Center
Ron Heintz, Ph. D., National Oceanic and Atmospheric Administration (NOAA) Alaska Fisheries Science Center (AFSC) Auke Bay Laboratories (ABL)

Study Location: Prince William Sound

Abstract:
Outlined here is a single herring monitoring project that is a part of an integrative program that will enhance the current herring monitoring efforts and examine aspects of particular life stages to allow better modeling of Prince William Sound herring populations. The long-term goal of the program is to improve predictive models of herring stocks through observations and research.

This project will be furthering the development of a herring overwintering mortality model that began with an ongoing monitoring project that began in 2007 and incorporates results from Prince William Sound herring research dating as far back as the 1990's. The model runs by applying herring condition observations made before and after winter. Accordingly, herring are sampled in November and the following March. Present sampling will end in March 2012. Proposed sampling will commence in November 2012 and end in March 2016. A future project is expected to continue the time series beginning in November 2016. The purpose of the time series is to relate overwinter mortality to herring recruitment.

This project will be furthering the development of a herring overwintering mortality model with additional data types as well energy levels per se. The goal is use physiological indicators to realistically modify the daily energy loss rate in the overwintering model. The results of model improvement will be tested using the March data model validation approach begun during the project that began in 2007.

Additionally, we will be assessing effects of competition of other juvenile fishes on condition of age-0 herring using stable isotope analysis on an opportunistic basis.

Estimated Budget:
EVOSTC Funding Requested:
To PWSSC: 141.7K (FY13), 147.1K (FY14), 156.7K (FY15), 162.3K (FY16)
To NOAA: 81K (FY13), 83.9K (FY14), 87.1K (FY15), 84K (FY16)
Non-EVOSTC Funds to be used:
(breakdown by fiscal year)

Date: 1 June 2011

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PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the Exxon Valdez Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here is a single project that is a part of an integrative program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. The long-term goal of the program is to improve predictive models of herring stocks through observations and research. While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

Studies conducted since the 1990's suggest that age-0 PWS herring begin winter deficient in energy, which leads to significant overwinter mortality. Starvation was confirmed by using RNA/DNA as a physiological indicator. It is hypothesized that when these constraints are relaxed, first winter survival is much greater and this leads to a good recruitment.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf) and in the FY 2012 invitation for proposals. In particular our program addresses the need to "Conduct research to find out why Pacific herring are not recovering" and "Monitor recovery", listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach. This particular project falls into the monitoring study category.

II. PROJECT DESIGN

A. Objectives

We have sought input for the design of the first five-year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.

2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.

3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.

4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

Objectives specific to this project:

Objective 1. Monitor juvenile herring condition by sampling in November
Objective 2. Monitor juvenile herring condition by sampling in March
Objective 3. Apply resultant observations from objectives 1 and 2 to continue refining an overwintering mortality model with the addition of physiological indicators
Objective 4. Assess competition interactions with fishes using stable isotope analysis

B. Procedural and Scientific Methods

Overwinter energy loss based mortality modeling

Each year the Herring Condition Monitoring (HCM) project will make a prediction using an HCM overwinter mortality model (**Objective 3**), which will use the energy density observed in November

(**Objective 1**) as model initial conditions. In addition to predicting mortality, the model predicts the frequency distribution of the population's March energy density assuming that there was no energy intake during winter. The difference between predicted and observed March distribution (**Objective 2**), which is currently very small, may lead to better forecasting if starvation is what is driving recruitment. The long-term goal is to develop a time series of these differences (each year being one difference, i.e. one data point, when considering the PWS as a whole) and correlate it to the resultant recruitment to test this hypothesis.

The initial overwinter mortality model and the methods used to obtain energy density are as described in Kline and Campbell (2010). Briefly, age-0 herring will be sampled in select Prince William Sound herring nursery bays in November and the following March (**Objectives 1 and 2**). By using energy density mortality criteria based on the experimental work of Paul and Paul (1998), the HCM overwinter mortality model is presently an improvement over the overwinter mortality model of Kline and Campbell (2010), which used a single "knife-edge" mortality criterion. This improved model predicted a March energy density frequency distribution that was much closer to that actually observed (Kline 2011). It remained skewed reflecting energy uptake by a small fraction of the population.

The next step is to incorporate physiological parameters (**Objective 3**). This is important because there are two ways in which starvation-related herring mortality might be reduced during winter, one is to begin winter with higher energy density (which can be observed directly) and second, by feeding during winter. A portion of the herring that have been sampled had non-empty stomachs. However, using that information is problematic because of sampling bias and possible sampling artifacts; physiological indicators are expected to more quantitatively reflect a herring population's foraging status.

The HCM overwinter mortality model assumes a winter fast. If fasting extends into starvation then mortality can be expected to occur. Use of proximate analysis and RNA/DNA can indicate the nutritional state and feeding status of fish (Sewall et al. 2011). By contrasting the relative contributions of lipid and protein to overwinter energy loss we can establish the proportion of fish found starving at the end of winter. Similarly, by comparing the RNA/DNA levels with levels known from starving and fed fish we can determine if fish in the field are actively feeding. Hence, combining proximate analysis, RNA/DNA and energy density analysis will enable the mortality model to provide better estimates of potential mortality.

Competition assessment

Other small fishes are routinely sampled alongside age-0 herring. These are assumed to be sympatric with herring and are important as potential competitors (Kline and Campbell 2010). Their presence and competition with herring may be driving the observed low herring energy density and consequent mortality. We may gain insight if for example we observed that herring were in better condition when there was reduced competition. Competitors may gain energy, or at least break even, at the expense of herring (Paul et al. 1998). Their interaction with age-0 herring has varied over time (Kline and Campbell 2010). We therefore need an index of competition that could be incorporated into the HCM overwinter mortality model. The mass spectrometric method used to obtain C/N ratio used to calculate energy density also provides natural stable isotope abundance, which is used to assess species interaction (**Objective 4**; e.g., Kline and Campbell 2010). We can thus add a sympatric species interaction component to the HCM model at the relatively low cost of the additional analyses of the sympatric species (N ~ 100 to 200 per year according to actual catch).

C. Data Analysis and Statistical Methods

Experimental Design

Sampling will continue to follow the present experimental design (Kline and Campbell 2010). Sampling occurs during November and March and is focused on four reference bays, known as the SEA bays since they were established as reference sites during the SEA project of the 1990's (Norcross et al. 2001). As well, approximately two other bays will be selected according to observations of herring distribution made by acoustics surveys and available cruise time, which is generally weather-dictated. The size distribution of age-0 herring can vary considerable by bay dictating that sampling additional bays is prudent. A goal of the synthesis will be to assess the effects of sampling in order to improve long-term monitoring.

Sample sizing is based on recent past history of herring sampling in PWS (Kline and Campbell 2010). Relatively large samples are needed to initialize the HCM overwinter mortality model. Because of the high mortality between November and March, the effective sample size after mortality is accounted for is only about 20% of the starting number (Kline and Campbell 2010). Because the model simulates overwinter mortality, those herring expected to die are subtracted from the simulated population like those from the actual population. For example, with a starting number of 100 herring in a given bay, there will be about 20 left in March to compare with observed March data. This is an absolute minimal amount for comparing frequency distributions in March. As part of the synthesis we will evaluate the effect of sample size on the model and make recommendations for future sampling. Sample size evaluation will involve simulating larger sample sizes, which will be done by data aggregation, such as pooling data across bays within one year or across years for one bay. This necessarily requires multiple years of data collected in the same way, which will be achieved by this project.

Time series approach

This project is, in part, a continuation of herring energy level monitoring in November and March that began in 2007. One goal is to observe one or more year classes that recruit well. For example, in the decade prior to the *Exxon Valdez* oil spill, there were several good recruitments; these numbered on the order of one billion herring at age three (Funk 2007). In recent years, herring recruitment has been on the order of tens of millions or only about one per cent of a good recruitment. Strong recruitments may occur again. If this should happen, a goal will be to assess what the condition of those herring were when they were at age-0. This will only be possible if the data are on hand. Furthermore, the poor recruitment years, such as we have been experiencing, will provide context (i.e., baseline values) for comparing with strongly recruiting cohorts. The time series will provide both before and after winter baseline values, making it possible to assess if strong year classes are determined prior to winter such as by having much higher November values (relative to the baseline) or if strong year classes are determined during winter such as my having much higher values in March without also having higher November values.

Table of time series of herring energy observations (by year and month of sampling) resulting from a past, ongoing, and future projects. Year classes recruiting in their third year from sampled age-0 cohorts as indicated. HFC = Herring Forage Contingency project, HERF = PWS Survey: Herring Energy Recruitment project, HCM = Herring Condition Monitoring project (this proposal).

Calendar Year	Sampling Period	Recruiting Year Class	Project doing the sampling
2007	March	2009	HFC
	November	2010	HFC
2008	March		HFC
	November	2011	HFC
2009	March		HFC
	November	2012	HERF
2010	March		HERF
	November	2013	HERF
2011	March		HERF
	November	2014	HERF
2012	March		HERF
	November	2015	HCM
2013	March		HCM
	November	2016	HCM
2014	March		HCM
	November	2017	HCM
2015	March		HCM
	November	2018	HCM
2016	March		HCM
	November	2019	future project
2017	March		future project
	November	2020	future project
2018	March		future project
	November	2021	future project
2019	March		future project
	November	2022	future project
2020	March		future project
	November	2023	future project
2021	March		future project

Data analysis

Herring will be measured for wet mass, dry mass, and length (fork and standard). Water content is calculated from these data. Samples will be ground to a fine power and analyzed for C/N ratio using an Elemental Analyzer mated to a Continuous Flow Isotope Ratio Mass Spectrometer. Energy density will be calculated from these data (Arrhenius and Hanson 1996, Paul et al. 2001, Kline and Campbell 2010). Energy density data are applied to the HCM overwinter mortality model as model initial conditions and for comparison with model predictions made for March (this ending time was selected to match our March observations; other ending times are also possible). Energy density will also be measured using bomb calorimetry on ten percent of the samples. This dual approach is used for quality control - quality assessment; it provides the means for assessing systematic error (Kline and Campbell 2010).

D. Description of Study Area

The study area includes all of Prince William Sound (N, E, S, and W boundaries of respectively, ~ 61, -145.5. 60, and -149°). However, most of the project will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment (SEA) and PWS Herring Survey programs (Figure 2). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question "What is the appropriate sampling distribution?" as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

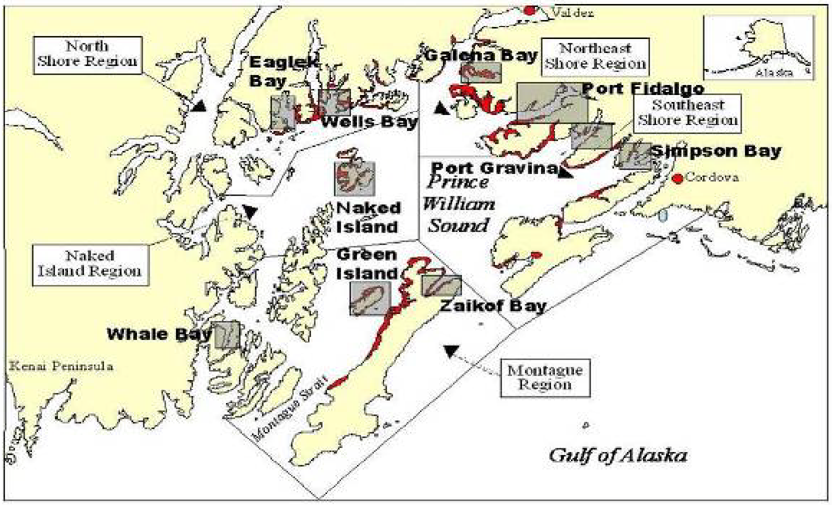

Figure 2. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring.

E. Coordination and Collaboration with Other Efforts

This proposal is structured to be part of a collaborative programmatic effort being led by the Prince William Sound Science Center. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Scott Pegau will act as the program team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program. He will also be responsible for outreach and public input efforts.

Dr. Pegau currently is the coordinator of the existing EVOSTC funding PWS Herring Survey program. This program consists of ten individual projects that provide a coordinated examination of juvenile herring in Prince William Sound. This proposal is heavily influenced by the early findings from that effort. Dr. Pegau also serves as the Research Program Manager for the Oil Spill Recovery Institute (OSRI). In that capacity he is responsible for developing annual work plans, ensuring proper reporting, making reports available, developing partnerships to leverage funding, and to ensure outreach of OSRI activities. All activities that provide experience delivering the team leader duties outline in the request for proposals.

One of his duties is to ensure proper scientific oversight of the research programs. To accomplish this we will be setting up a four-person scientific oversight panel that will help guide the program and ensure the research is relevant to the long-term goal. The team will consist of people representing Alaska Department of Fish and Game, the National Oceanic and Atmospheric Administration, academia, and the local fishing community. There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year's work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermen United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydro-acoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

Other important programs for coordinating with are the existing PWS herring survey program and existing ADF&G herring research. This program has been developed with input from both of these programs and the focus of this proposal is extending the interpretation of the data from those two programs. The Herring Survey program will still be operating in FY12 and FY13. There are field observations scheduled in FY12 and in FY13 funds are strictly for analysis and report writing. Included in the report writing is a synthesis of previous and current research. This report will be finished in FY13 and be the basis for the synthesis required under this request for proposals.

Lead Principal Investigator Dr. Thomas C. Kline, Jr. will be responsible for the execution of project's energy observations and energy modeling and oversight of the proposed project. Dr. Kline is a world-leader in applying natural stable isotope abundance to fish ecology problems. Dr. Kline has been a research scientist at the Prince William Sound Science Center (PWSSC) since 1995. During this time he has led numerous projects on the oceanography of Prince William Sound and adjacent Gulf of Alaska. He has published numerous research papers based on the resulting data.

Dr. Kline is currently the principal investigator of the *Exxon Valdez* Oil Spill Trustee Council project 'Prince William Sound Herring Survey: Pacific Herring Energetic Recruitment Factors**'** that is investigating the role of food sources and energy status of herring for recruitment. He was the principal investigator of several previous *Exxon Valdez* Oil Spill Trustee Council projects that had a herring focus. These included Herring Forage Contingency (2007-9), Productivity Dependencies: Stable Isotopes (1998-9), and Sound Ecosystem Assessment: Conforming Food Webs of Fishes with Stable Isotope Tracers (1995-8). Results of these projects have been incorporated into approximately two-dozen scientific publications. The data from the existing project and past projects will synergize with this proposed project.

Co-Principal Investigator Dr. Ron Heintz will be responsible for the execution of the RNA/DNA aspects of the proposed project. Heintz has been involved in Trustee herring studies aimed at contrasting energy loss rates of herring in different stocks (Project 100806) and examining the impacts of humpback whale predation on herring (Project 100804). In addition, Heintz is leading a study of RNA/DNA as a predictive tool for age-0 survival in PWS (10100132-D). In addition this study will contribute samples to the study proposed by Heintz and Sewall titled *"Fatty Acid Analysis as Evidence for Winter Migration of Age-0 Herring"*. A subset of the samples collected for RNA/DNA will be used for the fatty acid analysis.

Both investigators are also investigators of ongoing herring condition monitoring projects that are part of the herring program as well as a separate process study proposal assessing fine scale temporal and spatial variation at one site. This multiple project role will facilitate near real-time integration of project results. Both investigators will contribute to programmatic synthesis scheduled to take place in FY14.

The effectiveness of collaboration is often inversely proportional to the number of people gathered together. Therefore, as well as participating with the collective program, the investigators will be collaborating more closely together and with smaller groups of the other investigators within the program. This is necessary for focused work on model refinement and for writing reports and scientific publications. While much of this collaboration will be done using long-distance communication such as email, there is also a need a for face to face meetings, which will be done opportunistically during larger meetings (such as the January symposium) and on trips dedicated to this purpose.

As part of the integrated herring program, this project will be interacting with virtually all other aspects of the program. Personnel from multiple projects will be working in cooperation. This project will furnish one field technician for field sampling. This technician will be expected to cooperate with other projects during this sampling. For example, Dr. Kline's current technician has been simultaneously collecting, sorting, and preparing samples for multiple investigators such as Dr. Hershberger's disease samples as part of research cruise duties. Field sampling is being conducted on shared research vessels, with funding for vessel charter time outside the scope of this project.

The following table summarizes project tasks with responsible investigator indicated by initials:

1. (TK) Systematically assess energy levels of age-0 herring before and after winter (November and March).

2. (TK) Use stable isotope data that is a by-product of the energy analysis to assess changes in competition for food resources with sympatric species over time.

3. (TK) Model overwintering mortality using data from (1) and evaluate year-to-year mortality change in the context of (2) and (4) through collaborating with Heintz.

4. (RH) Systematically assess RNA/DNA and proximate composition of age-0 herring before and after winter.

5. (RH) Collaborate with Kline per (3).

6. Both P.I.'s will contribute to the synthesis effort in 2013 and workshop in 2014.

III. SCHEDULE

A. Project Milestones

Objective 1. **Monitor juvenile herring condition by sampling in November**
Sampling to be met by November 2015, analysis of samples collected through November 2014 by November 2015, incorporation of data generated through November 2015 into project synthesis by March 2016, and incorporated into herring program by August 2016

Objective 2. **Monitor juvenile herring condition by sampling in March**
Sampling to be met by March 2016, analysis of samples collected through March 2015 by March 2016, incorporation of data generated through March 2015 into project synthesis by April 2016, and incorporated into herring program by August 2016

Objective 3. **Apply resultant observations from 1 and 2 to and continue refining an overwintering mortality model using these observations**.
To be met by April 2016

Objective 4. **Assess competition interactions with fishes using stable isotope analysis**
To be met by April 2016 using data reflecting the same time frames as Objectives 1-3

B. Measurable Project Tasks

FY12 1st Quarter (October 1, 11 to December 31, 11)
October Continuation of existing monitoring project

FY12 2nd Quarter
January Continuation of existing monitoring project
January Annual Marine Science Symposium

FY12 3rd Quarter
April Continuation of existing monitoring project
May Annual PI meeting

FY12 4th Quarter
August Continuation of existing monitoring project

FY13 1st Quarter (October 1, 12 to December 31, 12)
October Project begins
November Conduct November juvenile collection

FY13 2nd Quarter
January Annual Marine Science Symposium
March Conduct March juvenile collection

FY13 3rd Quarter
May Annual PI meeting
June Submit FY14 work plan for review

FY13 4th Quarter
August Submit annual report

FY14 1st Quarter (October 1, 13 to December 31, 13)
October Collaborate to synthesis for EVOS science council
November Conduct November juvenile collection

FY14 2nd Quarter
January Annual Marine Science Symposium
March Conduct March juvenile collection
Winter ` EVOS sponsored workshop with Herring and Long-term monitoring programs

FY14 3rd Quarter
May Annual PI meeting
June Submit FY15 work plan for review

FY14 4th Quarter
August Submit annual report

FY15 1st Quarter (October 1, 14 to December 31, 14)
November Conduct November juvenile collection

FY15 2nd Quarter
January Annual Marine Science Symposium
March Conduct March juvenile collection

FY15 3rd Quarter
May Annual PI meeting
May Submit five-year plan for FY17-22 and work plan for FY16

FY15 4th Quarter
August Submit annual report

FY16 1st Quarter (October 1, 15 to December 31, 15)
November Conduct November juvenile collection (data processing to be completed in subsequent project)

FY16 2nd Quarter
January Annual Marine Science Symposium
March Conduct March juvenile collection (sample and data processing to be completed in subsequent project)

FY16 3rd Quarter
May Annual PI meeting
June Submit work plan for FY17

FY16 4th Quarter
August Submit final report

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Budget Justification

Project:

Herring Condition Monitoring

P.I.: T. Kline

Personnel

Dr. T. C. Kline, Lead Principal Investigator (P.I.). The Lead P.I.'s job and therefore responsibility is the administration of the project including report writing, supervision of personnel, and interpretation of the results. The purpose of these activities is dictated by the funding agency (e.g., report writing) and the needs of the research (e.g., data interpretation). The P.I. expects to dedicate 3 months of his time to this project in FY13; 3 months in FY14, 3 months in FY15, and 3 months in FY16.

Technician (to be named). One technician will be needed to accomplish the laboratory tasks and to lead in field sampling. Accordingly, The technician will be expected to dedicate 6 months of time in FY13, 6 months of time in FY14, 6 months of time in FY15, and 6 months of time in FY16.

Fringe benefit. It is the PWSSC's usual accounting practice that contributions to employee benefits (social security, retirement, etc.) are treated as direct costs. Workman's compensation for anticipated sea-days varies per year according to the anticipated number of cruise days. Included are anticipated modest benefit cost increases of 3% and 5% each year, respectively for the P.I. and technician, based on recent experience.

Travel

Travel is budgeted each year (FY13 to FY16) to attend the Alaska Marine Symposium in Anchorage. Travel is budgeted to enable workshops with individual or small groups of program investigators each year during FY14 to FY16 to facilitate integration and synthesis. The P.I. will attend and participate in workshops, special symposia, and town meetings at national and international conferences. The P.I. tentatively plans on attending a workshop and participate in symposia at the 2013 PICES Annual meeting, which is scheduled to be in Canada, likely cities are Victoria and Sidney. The P.I. tentatively plans on attending the 2014 and 2016 Ocean Sciences Meetings (location unknown), and 2015 Aquatic Sciences Meeting (location unknown). Symposia sponsored by PICES and AFS may be attended instead of these or in other years according to the details of the symposia content. Symposia registration fees run $300 to $500 and are incorporated as part of the ticket cost in the EVOS budget form. Emphasis will be symposia where methods used by the P.I. or herring are the focus. Air travel is based on the current cost of round-trip, economy airfare. Travel will be by US-flag carriers, if available.

Supplies

Field supplies: Ice, coolers, cast nets, gill nets, floats, lead lines, rope, sampling bags, foul-weather gear, and other items as determined by project needs (such as replacement items).

Laboratory supplies: LSC vials, vacuum pump oil, chemicals, grinder components, forceps, lab safety equipment and apparel, notebooks, bags, boxes, bulbs, and other items as determined by project needs (such as replacement items).

Experience dictates that about $3000 is spent per year for lab supplies and the same for field supplies. Bulk quantities of certain items such as case lots of vials will be purchased in FY12 where possible to save funds for this relatively long-term project. Accordingly the FY13 amount is higher at $3500 per category while FY14 is less at $2300 per category. It is expected that large lot purchases made early in the project will be depleted by FY15 and FY16 so these years are budgeted accordingly, $2400 per category in FY15 and $3000 per category in FY16.

Office supplies: Paper, folders, pens, pencils, and computer accessories as needed. Experience dictates that about $500 will be spent in FY13 and FY14, $600 in FY15 and $800 in FY16. A laptop computer ($3K) will be used to facilitate computer use and data transport to and from workshops. Experience dictates that after two-three years of daily use a laptop will cease to function or have significant problems and thus in need of replacement. Accordingly a laptop is budgeted for in FY15 to replace one to be purchased on another project in FY12.

Equipment

None

Contractual

It is the practice to charge a per use fee for photocopies, printing, and shipping to a project. The annualized total is estimated at $500. There is a base phone fee of $50 per person-month.

PWSSC Network charge (computer-months): The PWSSC presently must levy a $100 per person-month network charge to offset this cost.

Mass Spectrometry Elemental Analysis (EA): This is the actual mass spectrometric analysis of samples, which is outsourced to the UAF Stable Isotope Facility at $25 in FY13, $26 in FY14, $27 in FY15, and $30 in FY16 per sample. Budgeted cost increases, which can suddenly surge, are based on experience.

Lyophilizer usage (LU): This is a PWSSC-mandated cost for the operation of this equipment at $3 each.

EA and LU costs are based upon analyzing 800 samples per year with an additional 200 samples in the project’s final year to address data gaps.

Software: word processing, spreadsheet, email, operating system (OS), presentation, scientific graphing, statistical updates as needed (virtually annually) due to OS updates and fixes. Experience dictates that about $500 will be needed per year.

Indirect Costs:

The Prince William Sound Science Center has a federally approved indirect rate of 30% on modified total direct costs (excluding equipment, subawards in excess of $25,000, and tuition). Please contact the financial officer, Penelope Oswalt, for further information.

Below is the NOAA budget for the project. Funds are requested for only years 2-5, no costs will be incurred in year 1.

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0
Travel	$0.0	$0.0	$3.9	$7.1	$4.0
Contractual	$0.0	$75.0	$75.0	$75.0	$75.0
Commodities	$0.0	$6.0	$5.0	$5.0	$5.0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0

Budget Justification:

FY13

Personnnel:

No funds requested

Travel:

No travel funds are requested

Contractual :

Request contracts for:

RNA/DNA analysis:

Processing ($15/sample), nucleotide extraction, staining, digestion and fluorometry ($25/sample)

300 samples x $50/sample = $15,000

Proximate analysis:

Lipid extraction ($50/sample), ash and moisture content ($15/sample), protein analysis ($35/sample)

300 samples x $100/sample = $30,000

Stomach analysis:

Initial sample processing, stomach removal, content identification, weighing and archiving

300 samples x $100/sample = $30,000

Data consolidation contract $5,000

Commodities:

Sample collection and preparation : vials, lables, bags

$3.00 per sample x 450 samples = $1.3 K

Nucleic acid isolation : reagents, ethidium bromide, enzymes, multiplates

$6.75 per sample x 450 samples = $3.1K

Shipping: $0.6K

Equipment:

No funds requested

FY14:

Personnel:

No funds requested

Travel:

Funds are requested for Heintz and Vollenweider to travel to the 2014 AMSS meeting in Anchorage.

Funds are requested for Heintz and Vollenweider to travel to the annual herring meeting in Cordova

Contractual :

Request contracts for:

RNA/DNA analysis:
Processing ($15/sample), nucleotide extraction, staining, digestion and fluorometry ($25/sample)
300 samples x $50/sample = $15,000

Proximate analysis:
Lipid extraction ($50/sample), ash and moisture content ($15/sample), protein analysis ($35/sample)
300 samples x $100/sample = $30,000

Stomach analysis:
Initial sample processing, stomach removal, content identification, weighing and archiving
300 samples x $100/sample = $30,000

Data consolidation contract $5,000

Commodities:

Sample collection and preparation : vials, lables, bags
$3.00 per sample x 450 samples = $1.3 K
Nucleic acid isolation : reagents, ethidium bromide, enzymes, multiplates
$6.75 per sample x 450 samples = $3.1K
Shipping: $0.6K

Equipment:

No funds requested

FY15:

Personnel:

No funds requested

Travel:

Funds are requested for Heintz and Vollenweider to travel to the 2015 AMSS meeting in Anchorage.

Funds are requested for Heintz and Vollenweider to travel to the annual herring meeting in Cordova

Funds are requested for Heintz and Vollenweider to travel to the synthesis meeting.

Contractual :

Request contracts for:

RNA/DNA analysis:
Processing ($15/sample), nucleotide extraction, staining, digestion and fluorometry ($25/sample)

300 samples x $50/sample = $15,000

Proximate analysis:
Lipid extraction ($50/sample), ash and moisture content ($15/sample), protein analysis ($35/sample)
300 samples x $100/sample = $30,000

Stomach analysis:
Initial sample processing, stomach removal, content identification, weighing and archiving
300 samples x $100/sample = $30,000

Data consolidation contract $5,000

Commodities:
Sample collection and preparation : vials, lables, bags
$3.00 per sample x 450 samples = $1.3 K
Nucleic acid isolation : reagents, ethidium bromide, enzymes, multiplates
$6.75 per sample x 450 samples = $3.1K
Shipping: $0.6K

Equipment:
No funds requested

FY16:

Personnel:
No funds requested

Travel:
Funds are requested for Heintz and Vollenweider to travel to the 2016 AMSS meeting in Anchorage.

Funds are requested for Heintz and Vollenweider to travel to the annual herring meeting in Cordova

Funds are requested for Heintz and Vollenweider to travel to the synthesis meeting.

Contractual :
Request contracts for:
RNA/DNA analysis:
Processing ($15/sample), nucleotide extraction, staining, digestion and fluorometry ($25/sample)
300 samples x $50/sample = $15,000

Proximate analysis:
Lipid extraction ($50/sample), ash and moisture content ($15/sample), protein analysis ($35/sample)
300 samples x $100/sample = $30,000

Stomach analysis:
Initial sample processing, stomach removal, content identification, weighing and archiving
300 samples x $100/sample = $30,000

Data consolidation contract $5,000

Commodities:

Sample collection and preparation : vials, lables, bags

$3.00 per sample x 450 samples = $1.3 K

Nucleic acid isolation : reagents, ethidium bromide, enzymes, multiplates

$6.75 per sample x 450 samples = $3.1K

Shipping: $0.6K

Equipment:

No funds requested