PROPOSAL SIGNATURE FORM

THIS FORM MUST BE SIGNED BY THE PROPOSED PRINCIPAL INVESTIGATOR AND SUBMITTED ALONG WITH THE PROPOSAL. If the proposal has more than one investigator, this form must be signed by at least one of the investigators, and that investigator will ensure that Trustee Council requirements are followed. Proposals will not be reviewed until this signed form is received by the Trustee Council Office.

By submission of this proposal, I agree to abide by the Trustee Council's data policy (Trustee Council Data Policy*, adopted March 17, 2008) and reporting requirements (Procedures for the Preparation and Distribution of Reports**, adopted June 27, 2007).

PROJECT TITLE: ***PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring***

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* www.evostc.state.ak.us/Policies/data.cfm

** www.evostc.state.ak.us/Policies/reporting.cfm

FY10 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring

Project Period: October 1, 2009 to September 30, 2013

Primary Investigator(s):

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Dr. Sean Powers, University of South Alabama & Dauphin Island Sea Lab, spowers@disl.org

Study Location: Prince William Sound

Abstract:
Based on population trends, the Prince William Sound (PWS) Pacific herring population does not show signs of recovering. Predation pressure on juvenile herring has been cited as an important factor in preventing recovery. Juvenile herring are heavily predated by multiple species of fish, including rockfish, a species group injured by the *Exxon Valdez* Oil spill with unknown recovery status. This proposal is for a four-year study to investigate fish predation on the 0-age class herring over winter, a critical bottleneck for recruitment. We will examine the spatial and temporal abundance of fish predators in and around juvenile herring schools, as well as the physical and biological characteristics of the herring schools on which they feed. We will also conduct laboratory experiments to determine fish predators' daily rations and prey preferences. Our project is a component of the *PWS Herring Survey* program and relies on predator surveys being performed on integrated November and March cruises. Our models will provide estimates of juvenile herring consumption by the most important fish predators. Ultimately, this study will improve understanding of the role of fish predation on herring recruitment, will provide protocols and recommendations for long-term fish predator monitoring and management, and will help to identify candidate sites for herring supplementation efforts.

Estimated Budget:
EVOS Funding Requested *(must include 9% GA)*

FY10	FY11	FY12	FY13	Total
$185.5	$183.3	$193.4	$116.7	$678.9

Non-EVOS Funds to be used:

FY10	FY11	FY12	FY13	Total

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

The Prince William Sound Pacific herring (*Clupea pallasi*) has been identified as a resource injured by the 1989 Exxon Valdez Oil Spill (EVOS). Despite that 20 years have passed since the spill, this herring population does not show signs of recovering. In December 2008, the draft Integrated Herring Restoration Program was released by the EVOS Trustee Council. A major component of the restoration program is a core herring monitoring program that includes 1) herring stock assessment and 2) tracking herring survival and recruitment (EVOS Trustee Council 2008). Here we propose to investigate the magnitude of juvenile herring predation by fish, and their impact on juvenile herring survival and recruitment in Prince William Sound (PWS).

Herring populations tend to be dominated by the occasional strong year class. Most recently, the PWS 1999 herring year class showed a strong recruitment at age three (R. Thorne, PWSSC, pers. comm.), however, this recruitment event has been insufficient to restore herring populations to the levels of the 1980's. Brown (2003) proposed that herring 1-year age class abundance should be directly correlated with year class strength 2 or 3 years later, unless the local population is in a "predator pit". She suggested that predation pressure resulting from a stable or increasing predator population in PWS could maintain or reduce the herring recruitment when the juvenile herring population is composed of smaller school sizes and fewer aggregations over a reduced geographic range. Such a pattern has been observed with Atlantic herring (*Clupea harengus*). Predation mortality rates were relatively low during the 1960s, when Atlantic herring were abundant, but increased in the late 1970s and early 1980s, when Atlantic herring declined (Overholtz et al. 2008).

Juvenile herring (0, 1, and 2 year olds) over-winter in several bays and inlets primarily in east-northeast and west-southwest areas of PWS that are distinct from adult over-wintering areas (Stokesbury et al. 2000; Norcross et al. 2001). They occur at more shallow depths than adult herring (<30m). A critical bottleneck for herring recruitment is juvenile abundance and condition of young-of the-year (hereafter referred to as 0-age class) over the winter period (Cooney et al. 2001). During winter, feeding slows down and the 0-age class diet shifts from zooplankton to benthic amphipods and polychaetes (Foy and Norcross 1999, Norcross et al. 2001). For most juvenile herring, winter is a period when zero or negative growth rates occur (Paul and Paul 1999). Juvenile herring may be highly vulnerable to predators during this time period because their hunger suppresses their antipredatory behaviour (Robinson and Pitcher 1989; Robinson 1995).

In PWS, juvenile herring are heavily predated by multiple species of fish (Stokesbury et al. 2002; Brown 2003), seabirds (Irons 1992; Duffy 2000, Bishop and Kuletz unpub. data), and marine mammals (Matkin et al. 1999; J. Moran pers. comm.). Of this suite of predators, Brown (2003) suggested that piscivory by fish may be the primary source of PWS juvenile herring predation mortality. Nevertheless, no studies have investigated fish predation on juvenile herring in PWS. Stokesbury and others (2002) documented high natural mortality for PWS 0-age class herring over winter and hypothesized it was a result of predation and starvation, although they did not speculate who the most important predators were.

Based on a search of the herring literature, we have identified a suite of eight common fish species or fish groups (e.g. rockfish, *Sebastes spp.*) wintering in PWS that feed on herring (Table 1).

Table 1. Important fish predators on Pacific Herring wintering in Prince William Sound and their respective fisheries. Shark species are harvested primarily during summer months. Comm. = Commercial.

Species	PWS Winter fishery
Walleye Pollock	Comm.
Pacific Halibut*	Comm., Sport, Subsistence
Pacific Cod	Comm.
Spiny dogfish	Sport
Salmon Shark	Sport
Lingcod*	Sport & Comm.
Chinook Salmon	Sport
Rockfish (*Sebastes*)**	Sport, Comm. bycatch

* Halibut season closed Jan 1-31; Lingcod season closed Jan 1-Jun 30.
**EVOS injured species group with unknown recovery status.

Top-down predation pressure on juvenile herring depends on several factors, including predator abundance, density and patchiness of prey, and the availability of alternative prey (Mundy and Hollowed 2005). Based on Alaska Department of Fish and Game trawl surveys (Bechtol et al. 1999), walleye pollock (*Theragra chalcogramma*), Pacific halibut (*Hippoglossus stenolepis*), and Pacific cod (*Gadus macrocephalus*) in order represent the highest potential winter predator biomass. In PWS, large (> 50 cm) adult walleye pollock are predominantly piscivores (Kline 2008). During winter, much of the PWS adult pollock population is pelagic and is found in deeper (175-300 m) waters adjacent to the Gulf of Alaska (Thorne 2008). Adult pollock, however, have been observed on the bottom of shallow bays and inlets with 0-age class herring during November and March surveys (Thorne 2008), and jigged pollock are often full of juvenile herring (R. Thorne, pers. commun.). In the Bering Sea, walleye pollock and Pacific cod are the most important fish predators on 1-year age class juvenile herring during summer (May – September; Livingston 1993). Similarly, in the Barents Sea, the Pacific cod's congener the Arctic cod (*G. morhua*) is the major predator on the 0-age class Atlantic herring (Johansen 2002).

Both pollock and cod exhibit prey-switching behavior. Pollock migrate into surface waters during spring to feed on *Neocalanus spp.*. However, when large-bodied copepods are in low abundance, pollock move further into inshore waters to feed on small fishes, including pink salmon (*Onchorynchus gorbuscha*) fry and juvenile herring, (Willette et al. 2001; Thorne 2008). In the Barents Sea, predation on juvenile herring by the Arctic Cod is mediated by the abundance of capelin (*Mallotus villosus*;Johansen 2002). Less information is available on the winter feeding habits of the remaining potential predators.

Foraging behaviors of predators should reflect the need to optimize the intake of energy as prey items change in abundance over space and time (Stephens and Krebs, 1986). Predators may respond to changing prey abundance individually (functional response - the number of prey eaten per individual changes) and as a group (numerical or aggregative response - individual predators move to and concentrate in a certain areas within the study area). Most quantitative investigations of predator-prey interactions have focused on functional responses.

In this proposal, we will examine the suite of fish preying on juvenile herring using a combination of traditional field surveys, gut content analyses, and laboratory feeding experiments. We believe that the combination of approaches, coupled with the fact that all these species prey on juvenile herring will allow us to assess the potential for fish predators to regulate juvenile herring recruitment. Our study is designed to complement and expand on the studies that comprise the *PWS Herring Survey* program. From a fisheries management standpoint, this study will provide data on fish consumption of herring and alternative prey that can be used by managers to more realistically model herring recruitment. Stock assessment models can then determine the biomass of predatory fish needed to be removed so that predator and commercial fishery requirements do not create a "predator pit". By improving our understanding of the role of fish predation on herring recruitment, this study will help to identify candidate sites for future herring supplementation efforts.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

Pacific herring has been identified as a resource injured by the 1989 Exxon Valdez Oil Spill. Currently, the PWS herring population does not show signs of recovering. The Trustee Council recognized that conservation and improved management of injured resources and services will require substantial ongoing investment to improve understanding of the marine and coastal ecosystems that support the resources, as well as the people, of the spill region. In the case of herring, this knowledge can only be provided through a long-term monitoring and research program that will span decades. Specifically, the 1994 Restoration Plan addresses the need to "Conduct research to find out why Pacific herring are not recovering" and Monitor recovery (page 48). The plan cites the need to develop new tools to improve herring management by developing and or testing biological and physical models of herring growth and recruitment, rather than relying on empirical models.

In November 2006, the 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 December 2008. The main goal of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS from the effects of EVOS. 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 (EVOS Trustee Council 2008).

Predation is identified as one of the five potential factors limiting herring recovery in the 2008 IHRP. Predator surveys to determine the abundance and distribution of key herring predators are also one of the five components of the IHRP's proposed core data program (EVOS Trustee Council 2008). The core data program is considered the most basic information on both herring and the PWS ecosystem needed if restoration activities are to be assessed and modified.

Finally, in the 2008 IHRP, predator management ranks second among priorities for restoration alternatives. Under that alternative, identification of the fish predators, energetic models, and predator censuses are listed as components of the "Science Necessary" to explore this restoration option.

Based on the recommendations of the 2008 IHRP, and in recognition that more work will be necessary to develop a full implementation of the plan, the 2010 EVOS Trustee Council Invitation for Proposals, seeks projects that address several topics. The effort proposed here is relevant to at least 3 topics outlined in the 2010 Invitation: 1) feasibility studies for herring restoration; 2) herring surveys; and, 3) restoration of injured resources and services. Under feasibility studies, predator management is considered one of the recommended alternatives for herring restoration. Information from our study on areas with high fish predation will be important for planning, modeling, and mapping future predator management activities associated with restoration. The 2010 Invitation seeks collaborative "core data" studies to better understand 0-age class juvenile herring habitat utilization, including information on predator abundance. As mentioned above the core data program outlined in the IHRP includes predation studies (EVOS Trustee Council 2008). Our fish predator study is part of *PWS Herring Survey* program, an integrated and multi-agency collaboration. In addition to our study, this program is examining juvenile herring abundance, plankton availability, seabird predation on herring, oceanography, herring energetics, and disease. The *PWS Herring Survey* program is designed to inform future restoration efforts. A complete description of the integrated program is included in W.S. Pegau's proposal, *PWS Herring Survey: Community involvement, Outreach, Logistics, and Synthesis.*

Lastly, in addition to herring, our proposal concerns a second EVOS injured species group. Juvenile herring are an important food resource for rockfish, (*Sebastes* spp.) an injured species group with an unknown recovery status. Our study will shed light on the status of rockfish, and may be able to identify actions that will potentially benefit rockfish.

II. PROJECT DESIGN

A. Hypotheses & Objectives

Our overall hypothesis is that recruitment of juvenile Pacific herring during the overwinter period is controlled by top-down predation pressures, including the abundance and distribution of piscivorous fish. Specifically, we will test the following predictions as part of our overall hypothesis:

(1) Losses of juvenile herring to predation in winter are determined by:
a) the numbers and types of fish predators; and,
b) availability of alternative prey, particularly macrozooplankton.

(2) Vulnerability to predation is a function of:
a) predator and prey size; and,
b) juvenile herring density.

To evaluate our hypotheses, five objectives have been formulated.

1. Document the diet composition of fish predators in and around juvenile herring schools.
2. Determine the relationship between abundance of alternative prey and the occurrence of herring in fish stomachs.

3. Characterize juvenile herring schools where fish predators are abundant.
4. Model juvenile herring consumption by the most important fish predators including inter- and intra-annual consumption variability.
5. Provide protocols and recommendations for spatial and temporal coverage of fish predator monitoring for inclusion into future "core herring data collection" efforts.

In meeting these objectives, we will be able to assist in the assessment of the role of fish predation on herring recruitment by providing data to both herring and ecosystem modeling efforts. We will also be able to provide recommendations for future predator removal efforts aimed at restoring the herring population.

B. Procedural and Scientific Methods

The impact of fish predation on juvenile herring will be investigated by documenting the distribution, relative abundance and diet of fish foraging on juvenile herring. Our methods will include laboratory experiments at the Seward Marine Center as well as field surveys that are part of the *PWS Herring Survey* program cruises. The *PWS Herring Survey* program is developing the core data collection program for herring restoration. Our field research will take place in conjunction with combined, multi-project November and March cruises. This approach allows us to investigate aspects of overwinter juvenile herring mortality, which may be the critical factor in herring recruitment. Each cruise will include surveys of juvenile herring biomass, fish and seabird predators, plankton, oceanographic conditions in nursery bays, as well as to sample juvenile herring schools for species composition, energetics and disease.

As requested in the 2010 Invitation, the emphasis of the *PWS Herring Survey* program is on data collection from four nursery bays (Eaglek, Zaikof, Simpson, and Whale) that were previously monitored under the Sound Ecosystem Assessment and more recently as part of the juvenile herring assessment conducted by Thorne (EVOS 830). In addition, depending on the winter season we will collect fish predator data from 1-5 additional bays (Table 2).

Table 2. Schedule and location of PWS cruises for fish predators on juvenile herring. Fish predator surveys are performed in conjunction with other aspects of the *PWS Herring Survey* program including hydroacoustic surveys for juvenile herring, seabird predator surveys, herring energetics and disease collections; oceanographic measurements, and plankton tows.

Cruise Mo/Yr	Survey Areas	Additional Survey Bays
Nov 2009	Whale, Zaikof, Eaglek, Simpson	1
Mar 2010	Whale, Zaikof, Eaglek, Simpson	1
Nov 2010	Whale, Zaikof, Eaglek, Simpson	4-5
Mar 2011	Whale, Zaikof, Eaglek, Simpson	4-5
Nov 2011	Whale, Zaikof, Eaglek, Simpson	2
Mar 2011	Whale, Zaikof, Eaglek, Simpson	2

Field Collections and Laboratory Methods

We will use a combination of longline and otter-trawl surveys to identify and quantify the relative abundance of important fish predators on herring. Our vessel sampling platform will be ~20 m vessel with a back deck. In each survey bay, approximately 2 - 3 h before sunrise, two replicate 10 min otter trawls will be performed. The 7.6 m Marinovich otter trawl is a 2-panel, semi-ballooned designed net that measures 7.6-m wide (when fully opened) and 8.1 m length. It has two, 23 kg otter doors on each side. Mesh size is 9 cm on the wings and body of the net and 3 cm on the cod end. Trawls will be pulled at ~4 km h^{-1} for 10 min in areas where juvenile herring fish schools were previously observed on the hydroacoustic surveys (see R. Thorne's proposal for hydroacoustic methods). Replicate trawls will be spaced to avoid trawling over areas previously trawled. Starting and ending times and GPS locations, boat speed, bottom depth, tidal stage, and weather conditions will be recorded for each replicate trawl. Approximately 1 hour before morning twilight we will deploy a 530 m (1 skate) mainline with 200 gangions. Each gangion is ~60 cm long and consists of a longline snap and a #13/0 offset-shank circular hook that is baited with mackerel (*Scomber scomberus*) or other non-local species of bait fish. The mainline will be retrieved approximately 1 hour later.

For each trawl tow and longline set, all fish captured will be measured for standard length, total length, and weight. Up to 30 specimens of each species will be sexed and have their stomachs removed. Fish that show signs of regurgitation in the mouth or throat will not be used for gut contents. Each stomach will be placed in a whirl pack containing 10% formalin along with a tag containing total length, weight, and set number. After 24 h, samples will be transferred to 50% isopropanol for diet analyses. Stomachs will be weighed to the nearest 0.01 g, stomach contents removed, and the empty stomach reweighed and subtracted from the total to determine food mass. Contents will be rinsed over a 0.5-mm sieve, weighed, enumerated, and identified to the lowest taxonomic category possible. Potential bait items, based on tooth or hook marks and degree of digestion, will be removed and excluded from the analysis.

Juvenile herring sampling by a companion study (Kline *PWS Herring Survey: Pacific Herring Energetic Recruitment Factors*) will be used to characterize the age, weight, and length composition of herring schools as well as other fish species mixed in with the schools. Kline's study will collect fish samples in the deeper waters using a variable-mesh gill net. More shallow waters will be sampled using throw nets.

In year 3, we will conduct a series of feeding experiments in mesocosms at the Seward Marine Center (SMC) D.W. Hood Laboratory. Our experiments include: 1)assessing functional response of herring predators to increasing levels of juvenile herring; 2) determining predator food preferences; and, 3) estimating the gastric evacuation rates and daily ration for major fish predators. Gastric evacuation and daily ration experiments will be conducted only for those species without published estimates and where our field collections have determined the species is a major PWS juvenile herring predator during winter. We anticipate that the gastric evacuation and daily ration experiments will be conducted for Lingcod (*Ophiodon elongatus*), Chinook (*Onchorynchus tshawytscha),* and Pacific Halibut.

Seward Marine Center's facilities include 1,989 square feet of wet laboratory space with a running sea water system, a variety of sizes of tanks and aquaria, and lights controlled by timers for the ability to simulate natural photoperiods. The untreated sea water, taken from a pipe extending 137 meters out into Resurrection Bay and drawing from a depth of 75 meters, is monitored daily for temperature, salinity and dissolved oxygen. Two seawater pumps are each capable of pumping 150 gallons of water per minute. Water outflow is treated with a Chem-Free Ozone water treatment system before returning to Resurrection Bay in accordance with permitting agency regulations for holding non-resident species in the lab. There is an adjacent prep room for processing samples or preparing animal feed and two walk-in temperature controlled rooms.

Prior to the experiments, predators will be collected by hook and line in western PWS and transported in saltwater to the Seward Sea Life Center. Each species will be held in a separate aquarium, with a temperature of ~ 6^{o}C. Juvenile herring and macrozooplakton will be collected near the Seward Sea Life Center. All experiments will be conducted from Oct- March to facilitate prey size and environmental condition comparisons with our field data. Previous experiments have held juvenile herring in good condition at the Seward facility.

For each potential predator, we will determine their functional response to three increasing levels of juvenile herring biomass/m^3 (biomass levels will be chosen based on the field results of Thorne's component). Six replicates of each biomass level will be performed for a total of n = 18 for each predator. A second set of experiments will be conducted to determine predator preference for macrozooplankton versus juvenile herring. The experiment will be performed with 4 different treatment levels representing the possible combination of high versus low zooplankton and juvenile herring biomass (e.g., high zooplankton biomass/high juvenile herring, high – low, etc.). Consumption rate will be measured by determining the biomass (wet weight) placed in the mesocosms and filtering and measuring the biomass of the prey recaptured at the end of the experiment. Most experiments will be performed for 12 h. Prey biomass levels will represent 2% of predator biomass, 4%, and 8 %.

Finally, we will determine gut clearance rates in the lab to facilitate estimation of daily consumption rates of our field collected gut contents. All predatory fish will be held for 3 d without feeding to insure complete digestion of stomach contents. Each fish will be fed a measured quantity of juvenile herring. Following ingestion of prey items, fish will be sacrificed at 4 hour intervals and stomach contents collected.

C. Data Analysis and Statistical Methods

Stomach content indices will be calculated for each major predator species, and will be based on non-empty stomachs. In addition, unidentifiable prey items will be categorized as digested and removed from diet composition analyses. For each 10 cm size interval, we will calculate proportion of prey taxa by number (N), proportion of prey taxa by mass (M), and the frequency by occurrence among fish (FO). An index of relative importance (IRI) will be calculated as (N + M) * FO. Data will be analyzed by location and time period.

The probability of a predator feeding on juvenile herring, $P(h_i)$, will be calculated from a logistic regression analysis consisting of two separate processes, first identifying the probability that fish have any prey items in their stomachs, $P(f_i)$, and then identifying the probability of the nonempty fish having consumed juvenile herring, $P(r_i)$. This separates the overall patterns of feeding (e.g., changes in consumption rate across seasons or locations) from the patterns of juvenile herring predation observed in fish that had consumed prey. Variation in both of these probabilities will be explored via logistic regression on the potential predictor variables of predator length, time period (November or March), year, and location (Beaudreau and Essington 2007). Multiple regression analyses will be used to identify factors influencing the quantity of juvenile herring consumed per predator species. Variables to be considered include predator length, time period, year, location, juvenile herring density (as determined from hydroacoustic surveys), and the availability of alternative prey (as determined from plankton tows and nekton sampling; see Campbell *PWS Herring Survey: Plankton and oceanic observations in PWS* and Kline *PWS Herring Survey: Pacific Herring Energetic Recruitment Factors*). We will use Akaike's information criterion (AIC) to select the most parsimonious model (Burnham and Anderson 2002).

Predator density (kg/km^2) will be calculated from the otter trawl tows using the area-swept method. We will use regression analyses to identify fish school attributes that may be influencing predator abundance. Nocturnal hydroacoustic surveys will provide detailed information on the vertical and horizontal distribution of fish schools (including total depth of water, depth to each fish school, depth below each school) as well as density and biomass. A description of the methods for the hydroacoustic surveys can be found in R. Thorne's proposal, *PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization.*

An estimate of daily rations will be taken from the literature for walleye pollock (Dwyer et al. 1987), rockfish (Brodeur 1994) and spiny dogfish (Tanasichuk et al. 1991). For Pacific cod, we will use the daily ration for Atlantic cod whose diet and morphology are similar (Livingston 1989). If we determine that Pacific Halibut, Chinook, and Lingcod are significant predators, a daily ration will be ascertained from the laboratory feeding experiments. From these experiments, depletion of stomach contents with respect to time (evacuation rate) will be described by an exponential relationship developed by Elliott (1972) and Cochran and Adelman (1982). We will then use the Elliott and Persson (1978) model to estimate daily ration.

We will estimate seasonal juvenile herring consumption for each major fish predator. Our model is similar to that developed by Mehl and Westgard (1983) and used by Dwyer and others (1987) to calculate juvenile pollock consumption in the Bering Sea. We will use the following equation to calculate $C_{ijk,}$ the consumption by weight of juvenile herring by the population of a predator species belonging to size group *j* during season *i*, in area *k*.

$$C_{ijk} = DR_{ijk} * D_i * B_{ijk} * P_{ijk}$$

Where DR is the daily ration expressed as the percent body weight (% BWD), D_i is the number of days in the season *i*, B_{ijk} is the biomass of predator (kg/km^2 as estimated from otter trawl tows) and P_{ijk} is the proportion by weight of fish prey which were juvenile herring.

Univariate statistics will be used to analyze the results of our mesocosm functional response and food preference experiments. For the functional response experiments, a one-ANOVA testing the effect of prey density level (high, medium, and low) on consumption rate, biomass/hr, of juvenile herring. Separate ANOVAs will be performed for each predator. For the preference experiments, we will conduct a one way ANOVA to determine the effect of each treatment on the difference in biomass consumed (juv. Herring – macrozooplankton). Positive values will indicate preference for herring at the different biomass combinations. Transformation of dependent variables will be used as necessary for violations in normality of heterogeneity of variances.

Our final objective is to provide protocols and recommendations for spatial and temporal coverage of fish predator monitoring for potential inclusion into "Core Data Collection" of the Integrated Herring Restoration Program. For the fish predators on juvenile herring, our goal is to develop the necessary understanding to separate within and among site variability from annual patterns. Understanding these patterns will be important for: 1) developing fish predator management strategies (i.e., targeted fisheries) which are one of the recommended restoration options listed in the Integrated Herring Restoration Plan (EVOS 2008); and, 2) developing a long-term sampling strategy for the core data collection program. At the end of the 4 year study, we will evaluate the possibility of minimizing the spatial and temporal extent of sampling, thereby reducing cost, while maintaining our ability to detect inter-annual change in fish predator abundance.

D. Description of Study Area

The *PWS Herring Survey* program includes pre- (November) and post- winter (March) cruises, with an emphasis on monitoring four nursery bays Eaglek, Zaikof, Simpson, and Whale (Fig. 2). These four bays were originally selected in 1995 for intensive, three-year (1995-1998) study of juvenile herring ecology that was part of the EVOS Sound Ecosystem Assessment (SEA) program. More recently these same four nursery bays (hereafter referred to as the 4 SEA bays) were sampled during 5 winter cruises for herring biomass (Thorne EVOS 830), herring energetics (Kline EVOS 814) and seabird predators (Kuletz and Bishop EVOS 814). The *PWS Herring Survey* program will continue to sample the four SEA bays for three winter seasons, beginning with the 2009/2010 winter. The first 2009/2010 winter, one additional bay along Knight Island Passage will be sampled.

As part of our *PWS Herring Survey* program, in March 2010, there will be an intensive community-fisher sampling effort to identify bays with juvenile herring. Based on the results of the community effort, 4-5 additional bays will be sampled the second 2010/2011 winter season, and for the final winter season, 2 bays will be sampled in addition to the four SEA bays.

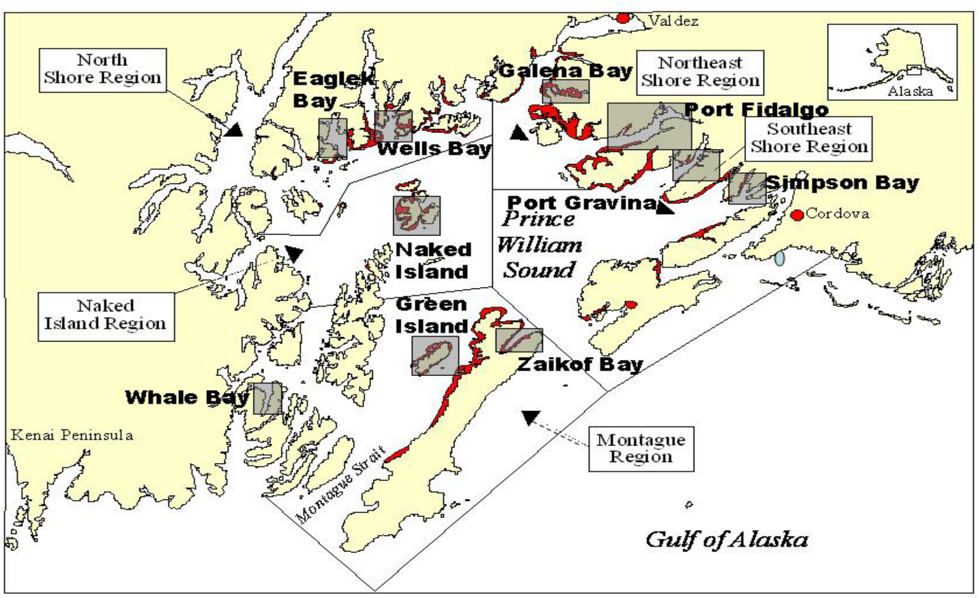

Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson) as well as other bays historically important for juvenile herring. Red = historic spawning areas.

E. Coordination and Collaboration with Other Efforts

This project is one of a set that makes up the *PWS Herring Survey* program. The set of projects include:

- *PWS Herring Survey: Community Involvement, Outreach, Logistics, And Synthesis*
- *PWS Herring Survey: Sound Wide Juvenile Herring, Predator, And Competitor Density Via Aerial Surveys*
- *PWS Herring Survey: Assessment Of Juvenile Herring Abundance And Habitat Utilization*
- *PWS Herring Survey: Plankton And Oceanic Observations In PWS*
- *PWS Herring Survey: Herring Disease Program*
- *PWS Herring Survey: Physical Oceanographic Characteristics Of Nursery Habitats Of Juvenile Pacific Herring*
- *PWS Herring Survey: Pacific Herring Energetic Recruitment Factors*
- *PWS Herring Survey: Growth And Energy Allocation In Overwintering Herring*
- *PWS Herring Survey: Seasonal And Interannual Trends In Seabird Predation On Juvenile Herring*
- *PWS Herring Survey: Top-Down Regulation By Predatory Fish On Juvenile Herring*

Coordination between these projects is provided in more detail in Pegau's *Community Involvement, Outreach, Logistics, and Synthesis* proposal. In addition to shared platforms and data sharing, our proposal includes substantial effort for interaction with other projects including workshops and annual meetings. Community involvement is also incorporated into the overall effort including: (1) community-based herring sampling program (to assist with identifying candidate sites for herring restoration; see Pegau's proposal); 2) use of local vessels for charters; and, (3) community presentations of on-going research.

III. SCHEDULE

A. Project Milestones

1. Document the diet composition of fish predators in and around juvenile herring schools. Completed September 2012.
2. Determine the relationship between abundance of alternative prey and the occurrence of herring in fish stomachs. Completed September 2012.
3. Characterize juvenile herring schools where fish predators are abundant. Completed September 2012.
4. Model the juvenile herring consumption by the most important fish predators including inter- and intra-annual consumption variability. Completed September 2012
5. Provide protocols and recommendations for spatial and temporal coverage of fish predator monitoring for inclusion into future "core herring data collection" effort. Completed April 2013.

B. Measurable Project Tasks

<u>FY 10, 1st quarter</u> (October 1, 2009-December 31, 2009)

Oct Secure Trustee Council funding approval.

Nov Field Cruise: *PWS Herring Survey* program: seabird predator/fish predator/plankton/disease/energetics/hydroacoustic surveys
Dates not yet known: EVOS meeting of Herring Principal Investigators

FY 10, 2nd quarter (January 1, 2010-March 31, 2010)
Mar Field Cruise: *PWS Herring Survey* program: seabird predator/fish predator/plankton/disease/energetics/hydroacoustic surveys

FY 10, 3rd quarter (April 1, 2010-June 30, 2010)
Apr-Jun Lab analyses – stomach contents
May *PWS Herring Survey* Principal Investigator update and outreach meeting

FY 10, 4th quarter (July 1, 2010-September 30, 2010)
Jul-Sep 30 Lab analyses – stomach contents
Sep 1 Submit Annual Report

FY 11, 1st quarter (October 1, 2010-December 31, 2010)
Nov Field Cruise: *PWS Herring Survey* program: seabird predator/fish predator/plankton/disease/energetics/hydroacoustic surveys
Dates not yet known: EVOS meeting of Herring Principal Investigators

FY 11, 2nd quarter (January 1, 2011-March 31, 2011)
Feb Deliver Community Lecture
Mar Field Cruise: *PWS Herring Survey* program: seabird predator/fish predator/plankton/disease/energetics/hydroacoustic surveys

FY 11, 3rd quarter (April 1, 2011-June 30, 2011)
Apr-Jun Lab analyses – stomach contents
May *PWS Herring Survey* Principal Investigator update and outreach meeting

FY 11, 4th quarter (July 1, 2011-September 30, 2011)
Jul - Sep 30 Lab analyses – stomach contents
Sep 1 Submit Annual Report

FY 12, 1st quarter (October 1, 2011-December 31, 2011)
Nov Field Cruise: *PWS Herring Survey* program: seabird predator/fish predator/plankton/disease/energetics/hydroacoustic surveys
Dates not yet known: EVOS meeting of Herring Principal Investigators

FY 12, 2nd quarter (January 1, 2012-March 31, 2012)
Mar Field Cruise: *PWS Herring Survey* program: seabird predator/fish predator/plankton/disease/energetics/hydroacoustic surveys

FY 12, 3rd quarter (April 1, 2012-June 30, 2012)
Apr-Jun Lab analyses – stomach contents
May *PWS Herring Survey* Principal Investigator update and outreach meeting

FY 12, 4th quarter (July 1, 2012-September 30, 2012)
Jul - Sep 30 Lab analyses – stomach contents
Sep 1 Submit Annual Report

FY 13, 1st quarter (October 1, 2012-December 31, 2012)
Finish data analyses

Oct First *PWS Herring Survey* Principal Investigators for synthesis preparation

FY 13, 2nd quarter (January 1, 2013-March 31, 2013)

Jan Alaska Marine Science Symposium & 2nd *PWS Herring Survey* meeting of Principal Investigators for synthesis preparation

Jan Submit manuscript *Marine Ecology Progress Series*

Mar 3rd *PWS Herring Survey* meeting of Principal Investigators for synthesis preparation

FY 13, 3rd quarter (April 1, 2013-June 30, 2013)

Apr 15 Submit final synthesis report of PWS Herring Survey to the EVOS Trustee office– this will consist of a draft manuscript

Jun Submit manuscript *Fish Bulletin*

Jun 30 Respond to peer review comments

FY 13, 4th quarter (July 1, 2012-September 30, 2012)

Jul 30 Secure final approval, acceptance of final synthesis report

Sep 30 Publication of final synthesis report complete, delivered to ARLIS

C. Publications

In addition to annual reports, we foresee at two peer-reviewed publications produced from this study. Their proposed titles, journals, and submission dates are:

Spatial and Temporal Patterns of Fish Predation on Juvenile Herring in Prince William Sound, Alaska. *Marine Ecology Progress Series.* Expected submission date January 2013.

Winter diet variability of demersal fish in shallow bays of Prince William Sound. *Fish Bulletin*. Expected submission date June 2013.

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Curriculum Vita

Sean P. Powers

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Education

1997 **Doctor of Philosophy**, Department of Biology, Texas A&M University, College Station
Areas of Specialization: Ecology &Evolution, Zoology, Biostatistics
1992 **Master of Science** in Biological Sciences, University of New Orleans
1990 **Bachelor of Science with Honors** in Biology and Chemistry, Loyola University

Professional Experience

2007- Associate Professor, Dept. of Marine Sciences, University of South Alabama
2007- Senior Marine Scientist II, Dauphin Island Sea Lab.
2003-2007 Assistant Professor, Dept. of Marine Sciences, University of South Alabama
2003-2007 Senior Marine Scientist I, Dauphin Island Sea Lab.
2002- Associate Research Scientist, Prince William Sound Science Center
1999-2002. Post-doctoral Associate, Institute of Marine Science, UNC-Chapel Hill.
1997-1998. Oceanographer, Division of Ocean Sciences, National Science Foundation.

Five most relevant publications (out of 41)

Fodrie, F. J., M. D. Kenworthy and **S. P. Powers**. 2008. Unintended facilitation between marine consumers generates enhanced mortality for their shared prey. *Ecology* 89 (12): 3268-3274.

Powers, S.P., M. A. Bishop, S. Moffit, and G. H. Reeves. 2007. Variability in freshwater, estuarine and marine residence of sockeye salmon (*Oncorhynchus nerka*) within the Copper and Bering River Deltas, Alaska. In: C. A. Woody, editor. Sockeye salmon ecology, evolution, and management. *American Fisheries Society Symposium* 54: 87-99.

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Five other publications (out of 41)

Gregalis, K. C., M. W. Johnson, and **S. P. Powers.** 2009. Interactions between location and reef design affect responses of resident and transient species on restored oyster reefs in Mobile Bay, AL. *Transactions American Fisheries Society,* In press.

Powers S. P., C. H. Peterson, R. R. Christian , E. Sullivan, M. J. Powers, M. Bishop and C. P. Buzzelli. 2005. Effects of eutrophication on bottom habitat and prey resources of demersal fishes. *Marine Ecology Progress Series*, 302: 233-243.

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Powers, S. P., J. Grabowski, C.H. Peterson, and W.J. Lindberg. 2003. Estimating enhancement of fish production by offshore artificial reefs: uncertainty exhibited by divergent scenarios. *Marine Ecology Progress Series*, **264**: 267-279.

Powers, S. P., M. A. Bishop, J.H. Grabowski and C.H. Peterson. 2002. Intertidal benthic resources of the Copper River Delta, Alaska. *Journal of Sea Research* 47: 13-23.

Advisors:
M.S.- M.A. Poirrier (UNO); Ph.D.– D.E. Harper (Texas A&M), Post-doctoral – C.H. Peterson (UNC).

Advisor to the following students:
M.S. students: K. Gregalis, N. Geraldi, S. Scyphers, B. Reynolds, M. Kenworthy
Ph.D. student: G. Miller (U. South Al.), M. Ajemeian, M. Drymon,
Post-doc: E. Clesceri (U.S. AID), F. Hernandez (DISL), M. Johnson (DISL) and F.J. Fodrie (DISL)

Other Collaborators:
M. Benfield (LSU), M.A. Bishop (PWSSC), M. Borsuk (Sweden), C. Buzzeli (NERRS), J. Cebrian (DISL), J. Grabowski (GMRI), K. Heck (DISL), T. Kline (PWSSC), W. Lindberg (UFL), R. Luettich (UNC), H. Paerl, J. Pinckney (TAMU), N. Rabalais (LUMCON), G. Reeves (OSU), R. Shipp (U. South Al.), Myers, R. A. (deceased), J. Buam (SIO), T. A. Sheperd (Dalhousie).

Synergistic Activities:
NSF LTER site review panel
NOAA Chesapeake Bay Oyster Research Program review
David and Lucille Packard Foundation
Marine Ecosystem-Based Management Tool Innovation Fund, Review Board Member;
Co-Chair Hurricane Impacts symposium, Esuarine Research Federation Meeting.
2006 NOAA Coastal Ocean Program, coastal hypoxia research panel.
National Marine Fisheries Service, MARFIN panel.
2008. Mobile Bay Symposium, Program Committee Member

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Education

Ph.D. Wildlife Ecology, Department of Wildlife and Range Sciences, University of Florida, Gainesville, 1988.
M.S. Wildlife and Fisheries Sciences, Department of Wildlife and Fisheries Sciences, Texas A & M University, College Station, 1984.
B.B.A. Real Estate and Urban Land Economics, School of Business, University of Wisconsin-Madison, 1974.

Recent Professional Experience

6/99- Research Ecologist, Prince William Sound Science Center, PO Box 705, Cordova, Alaska
11/88- Principal Investigator, Tibet Black-necked Crane Project, International Crane Foundation, Baraboo, Wisconsin (job location: Tibet, People's Republic of China).
3/97-5/99& Research Wildlife Biologist, Copper River Delta Institute, Pacific Northwest Research
4/90-4/94 Station, U.S. Forest Service, Cordova, Alaska.
4/94-3/97 Research Wildlife Biologist, Center for Streamside Studies and Dept. Fisheries, University of Washington, assigned to Copper River Delta Institute, U.S. Forest Service, Cordova, Alaska.

Five Most Relevant Publications (out of 42)

Powers, S.P., **M.A. Bishop**, S. Moffitt, and G.H. Reeves. 2007. Variability in Freshwater, Estuarine and Marine Residence of Sockeye Salmon (Oncorhynchus nerka) within the Copper and Bering River Deltas, Alaska. Pages 87-99 in C. A. Woody, editor. Sockeye salmon evolution, ecology and management. American Fisheries Society, Symposium 54, Bethesda, MD.

Kline, T.K., C.A. Woody, **M.A. Bishop**, S.P. Powers, E.E. Knudsen. 2007. Preliminary Assessment Of Marine-Derived Nutrients In The Copper River Delta, Alaska Using Stable Isotope Analysis . Pages 51-72 in C. A. Woody, editor. Sockeye salmon evolution, ecology and management. American Fisheries Society, Symposium 54, Bethesda, MD.

Powers, S.P., **M.A. Bishop**, J. Grabowski and C.H. Peterson. 2006. Distribution of the invasive bivalve *Mya arenaria* L. on intertidal flats of southcentral Alaska. Journal Sea Research 55:207-216.

Bishop, M.A. and S.P. Green. 2001. Predation on Pacific herring (*Clupea pallasi*) spawn by birds in Prince William Sound, Alaska. Fisheries Oceanography 10 (Suppl.1): 149-158.

Cooney, R.T., J.R. Allen, **M.A. Bishop**, D.L. Eslinger, T. Kline, B.L. Norcross, C.P. McRoy, J. Milton, J. Olsen, V. Patrick, A.J. Paul, D. Salmon, D. Scheel, G.L. Thomas, S.L. Vaughn, and T.M. Willette. 2001. Ecosystem control of pink salmon (*Oncorhynchus gorbuscha*) and Pacific herring (*Clupea pallasi*) populations in Prince William Sound. Fisheries Oceanography 10(1):1-13.

Five Other Publications (out of 42)

Bishop, M. A., N. Warnock, and J. Y. Takekawa. 2006. Spring Migration Patterns in Western Sandpipers *Calidris mauri*. Pages 545-550 in G.C. Boere, C.A. Galbraith, and D.A. Stroud (eds.) Waterbirds around the world. The Stationery Office, Edinburgh, U.K.

Bishop, M.A., N. Warnock, and J. Takekawa. 2004. Differential spring migration of male and female Western Sandpipers at interior and coastal stopover sites. Ardea 92:185-196.

Warnock, N., J.Y. Takekawa, and **M.A. Bishop**. 2004. Migration and stopover strategies of individual Dunlin along the Pacific Flyway. Canadian Journal Zoology 82:1687-1697.

Powers, S.P., **M.A. Bishop**, J.H. Grabowski, and C.H. Peterson. 2002. Intertidal benthic resources of the Copper River Delta, Alaska, USA. Journal Sea Research 47:13-23.

Bishop, M.A., P. Meyers, and P.F. McNeley. 2000. A method to estimate shorebird numbers on the Copper River Delta, Alaska. Journal Field Ornithology 71(4):627-637.

Professional Collaboration

J. Ackerman (USGS), E. Ammann (NOAA), W. Boyce & C. Cardona (UC Davis), E. Clesceri (UNC-Chapel Hill), R. Crawford (PWSSC), D. Crowley(Alaska Dept. Fish & Game), N. Dawson (PWSSC), J. Dudley (SAIC), S.M. Gay (PWSSC), K. George (Alaska DNR), J. Grabowski (U. Maine), H. Ip (USGS), S. Iverson (USGS-BRD), T. Kline (PWSSC), E. Knudsen (USGS-BRD Anchorage), K. Kuletz (USFWS), B. Lance (NOAA), A. Lang (Intl. Crane Foundation), F. Li (Intl. Crane Foundation), S. Moffitt (Alaska Dept. Fish & Game), S. Paraoulek (Wash. Fish Wild), C. “Pete” Peterson, (Inst. Marine Sci., UNC-Chapel Hill), S. Powers (U. S. Alabama) G. Reeves (USFS Pac. NW. Res. Station & OSU), B. Reynolds (Univ. S. Alabama), G. Schirato (WA. F&W) S. Schwarzbach (USGS), S. Senner (Audubon), J. Takekawa (USGS-BRD-San Francisco), A. Taylor (UAF), G. Thomas (U. Miami) R. Thorne (PWSSC), D. Tsamchu (Tibet Plateau Institute of Biology, PR China), N. Warnock (PRBO Conservation Sciences), T. Williams (Simon Fraser Univ.), C. Woody (USGS-BRD Anchorage)

Current Activities Relevant

Co-Principal Investigator for a study to evaluate seabird predation on juvenile herring in Prince William Sound during winter (FY07- FY09). Predation study is conducted in collaboration with PWSSC hydroacoustic surveys for juvenile herring and with in collaboration with NOAA humpback whale surveys. Project funded by EVOS.

Co-Principal Investigator lingcod (*Ophiodon elongatus*) movement study using acoustic tags in Port Gravina. In October 2008, deployed an acoustic receiver array across the mouth of Port Gravina. Project funded by Pacific Ocean Shelf Tracking (POST) project and the PWS Oil Spill Recovery Institute.

Co-Principal Investigator (final report submitted Nov 2008) to examine the residency and movements of copper rockfish (*Sebastes caurinus*) and lingcod (*Ophiodon elongatus*) in and around an artificial reef and two other locations in Passage Canal, near Whittier Alaska. Project funded by North Pacific Research Board.

Budget Narrative
FY10-13

PWS Herring Surveys: Top-down regulation by predatory fish on juvenile herring

PRINCE WILLIAM SOUND SCIENCE CENTER &
UNIVERSITY OF SOUTH ALABAMA DAUPHIN ISLAND SEA LAB

PWSSC Personnel Salaries & Fringe Benefits
Yr 1 = $77.2, Yr 2 = $79.6, Yr 3 = $81.6, Yr 4 = $44.0
Co-Principal (Lead) Investigator Bishop 4.0 mo/FY10 @ $10.0/mo; 4.0 mo/FY11 @ 10.3/mo; 4.0 mo/FY12 @ $10.5/mo; 4.0 mo/FY13 @ $11.0/mo..
For this project Bishop will oversee the project and coordinate with other studies that are part of the *PWS Herring Survey* program. She will have primary responsibility for contract management, field work (fish sampling) data integration, and completion of final products for *PWS Herring Survey* synthesis. She will supervise the research assistant including gut contents sorting and identification. Along with Powers she will be responsible for project design, statistical analyses and data interpretation and preparation of manuscripts and contributing to the *PWS Herring Survey* synthesis.
Research Assistant Reynolds: Yrs 1-3: 6.0 mo/yr, (includes ~1.25 mo/yr vessel time). FY10 @ $6.2/mo; FY11 @ 6.4/mo; FY12 @ $6.6/mo
Reynolds will conduct fish predator capture operations, and will assist with data collection for other projects while on cruises (e.g. plankton sampling). He will also process and analyze predator fish gut samples, and will conduct the lab experiments in year 3.

PWSSC Travel
Yr 1 = $3.4, Yr 2 = $3.4, Yr 3 = $6.7, Yr 4 = $3.4
Co-Principal Investigator Bishop, Cordova-Anchorage: Ticket price $0.4, one, 5d trip/yr to attend Alaska Marine Symposium. Yr 4 Marine Symposium includes a *PWS Herring Survey* meeting of Principal Investigators. Co-Principal Investigator Bishop, Cordova – Mobile Alabama. Ticket price $1.5, one, 7d trip/yr to meet with Co-Principal Investigator Powers at Univ. S. Alabama.
Research Assistant. Yr 3: Cordova – Seward Alaska. Ferry ticket price $0.5 plus perdiem $0.2/d@ 14d to conduct lab experiments at Seward Sea Life Center.

PWSSC Contractual/Consultants
University of South Alabama Yrs 1-3 $44.0/yr; Yr 4: $37.9.
This contract is to the Co-Principal Investigator, Dr. Sean Powers. Under this contract Dr. Powers will receive partial compensation for his summer salary (1 mo FY10-12 @ 10.4/mo and 2 mo FY 13 @ $11.0/mo).
Dr. Powers will be responsible for the design and execution of the experimental components of the project as well as assisting Dr. Bishop in the fish predator survey component of the project. He will also have primary responsibility for statistical analysis, data interpretation and preparation of manuscripts and contributing to the *PWS Herring Survey* synthesis. A portion of the fish gut processing and analyses will be performed by a technician under Dr. Powers supervision through the Dauphin Island Sea Lab.

Research Technician for Yrs1-3 (6 mo/yr @ $3.0/mo) to assist with field work (Nov & March cruises, ~1.25 mo) and process fish gut samples.
Also includes travel funds all 4 years. For Yrs 1-3: 2 rt/year for technician from Mobile – Cordova to assist on cruises ($1.5 airfare, $0.4 subsistence) and 1 rt in May for Powers to meet with Co-PI Bishop and other *PWS Herring Survey* Investigators (1 rt Mobile to Cordova w per diem 7d @ .18/d = $2.8/yr). Yr 4 = 3 rt for Powers to meet with Co-PI Bishop and other *PWS Herring Survey* (Oct, Jan & Mar) @ $2.8/trip.
Univ. S. Alabama Indirect Costs are 25%. Because all field work will be performed using the resources of the Prince William Sound Science Center the off campus F&A rate is applied (25% MTDC) to the University of South Alabama's subcontract.
Other PWSSC contractual costs:

Yr 3: Seward Sea Life Center bench fees: 2 weeks @ $1.5/week to conduct lab experiments

Yrs 1-4 Computer Network Costs, direct cost based on $0.05/mo x staff mo

Yrs 1-4 Phone/Fax/copy/mail/freight Charges; direct cost based on use only estimated at $0.1/mo x staff mo

PWSSC Commodities
Yr 1 = $11.0, Yr 2 = $7.0, Yr 3 = $6.0, Yr 4 = $0.6
Fishing gear & bait Yr 1: $7.0 yr; yr 2 $4.0; yr 3 $3.0: longline set up including hooks, lines as well as replacement hooks, lines, buoys, and 2 martinovich otter trawls & replacement lines & cods, bait.
Supplies (Field, office, & lab) Yr 1 $3.5, Yrs 2&3 = $2.5/yr, Yr 4 $0.5. Includes, scales, log books, plastic bags, plastic buckets, field notebooks, office supplies, personnel gear, recording equipment, coolers, dry ice, whirl paks, formalin, gas for truck)
Mail/Freight/Shipping samples Yrs 1-3 $0.5/yr, yr 4 =$0.1 to airfreight samples to Univ. S. Alabama

PWSSC Equipment No equipment purchases are anticipated
PWSSC will provide in-kind a Seabird CTD profiler**.**

PWSSC INDIRECT COSTS
Yrs 1-4 MTID is estimated at 28%, pending negotiations & and approval by NOAA.
Years 1-3 excludes $19.0 of University of South Alabama subcontract ($44.0 – 25.0) from IDC Formula as per MTDC rules; Year 4 excludes $12.9 of University of South Alabama subcontract ($37.9 – 25.0) from IDC Formula as per MTDC rules

Note: all vessel charter costs for years 1-3 are included under proposal by W.S. Pegau, *PWS Herring Survey: Community Involvement, Outreach, Logistics & Synthesis*

Data Management and Quality Control Statement for Project Entitled:

PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
PI's M.A. Bishop, PWS Science Center & S.P. Powers, Univ. South Alabama

Quality assurance control in the field:
In the field, exact locations, distances, and depths recorded during trawl and longline sets will be determined by navigational and sounding instruments on board the research vessel. Additional data recorded during sampling will include, time, weather (wind speed, cloud coverage, air temperature), tidal stage, wave height, and water temperature.

Trawl data will be used to calculate densities (fish/km^2) of predatory fish associated with juvenile herring at each sampling location. Longline catch per unit effort (CPUE) data will be used to compare relative abundances of fish predators between sampling locations.

Information collected for each specimen caught during trawl and longline surveys will include species identification, capture location and time, capture method, total and standard length (mm), and weight (g). All biological collections (stomach contents) in the field will be properly labeled with unique sample numbers to ensure correct identification in the laboratory. Labels will include information describing the date of collection, species ID, date and site of sample collection. Field data sheets will contain a reference to the collection label.

Prior to research cruises, the condition of trawl and longline equipment will be inspected to ensure all dimensions are correct and gear is in good working condition. During the research cruise, longline tackle will be checked for signs of wear between sets and damaged equipment will be replaced prior to resetting. Trawl nets will be inspected for holes after each tow and mending or replacing of gear will be performed prior to subsequent trawls. Additionally, a second trawl net and longline will be carried aboard the research vessel in the event that the primary equipment is destroyed or lost.

Both trawl and longline sampling will be conducted by a boat captain and a lead field technician with previous experience using each gear type. Following proper deployment of the trawl, tow speeds will be maintained within 25 percent of recommended towing speeds to ensure proper gear function. If a tow does not conform to proper towing guidelines during the tow or is halted due to obstruction or other impediment, the tow will be discontinued and repeated. After each tow is completed, tow acceptability will be evaluated by examining several factors that might indicate tow performance, including:

- Clogging- fishing efficiency could be compromised if the net is filled with macrophytes, invertebrates, or debris
- Hang ups- part of all of the catch could escape when the net is hung up on the obstruction
- Deployment- if the net is tangled, twisted, or flipped over when it is brought up to the surface, the net is unlikely to have functioned properly
- Tearing- badly torn nets, particularly those torn near the cod end, cannot retain specimens with normal efficiency

Quality assurance in the laboratory:
Laboratory staff handling biological collections (i.e., stomach contents) will properly confirm the identity of all samples prior to analysis. Information collected for each fish stomach will include: date, fish spp., trawl location, trawl replicate, standard length (cm), total length (cm), weight (g), stomach (g), stomach lining (g), all contents (g), unidentified contents (g), followed by a list of prey species (g). Additionally, all laboratory equipment used for analyses (e.g., scales) will be properly calibrated according to manufacturer's specifications. Both PWSSC and Dauphin Island Sea Lab laboratory buildings will be routinely locked after hours and safe standard laboratory practices will be observed by all laboratory staff.

We will use Seward Marine Center IACUC approved protocols for all lab experiments. Staff involved in the collecting and transferring of live animals for feeding experiments will attempt to reduce stress of specimens by minimizing handling time and air exposure after capture and maintaining proper water temperature and dissolved oxygen levels in both transit and laboratory aquariums. Prior to feeding experiments, any specimens displaying signs of stress will be excluded from the experiment. In the event of an error during the run time of an experiment, the experiment will be repeated. Additionally, if any experiments are inappropriately designed, conducted, or analyzed, the experiment will be redesigned and properly conducted and analyzed.

Data management quality assurance:
As the personnel collect data, Bishop and Powers will immediately review it. Following tabulation of the data, Bishop and Powers will review it again. Experiments and data will be recorded daily in bound laboratory notebooks. Information entered into notebooks from machine printouts will be verified twice and the originals will be filed. Data entered from notebooks into computer files will be verified and validated. This operation will be repeated until two consecutive verification checks yield no errors. Two copies (backup and original) will be kept of all computer files at all times.

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 10- FY 12

Budget Category:	Proposed FY 10	Proposed FY 11	Proposed FY 12	Proposed FY 13	TOTAL PROPOSED
Personnel	$77.2	$79.6	$81.6	$44.0	$282.4
Travel	$3.4	$3.4	$6.7	$3.4	$16.9
Contractual	$45.5	$45.5	$48.5	$38.5	$178.0
Commodities	$11.0	$7.0	$6.0	$0.6	$24.6
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect *(will vary by proposer)*	$33.1	$32.6	$34.7	$20.6	$121.0
SUBTOTAL	$170.2	$168.1	$177.5	$107.1	$622.9
General Administration (9% of subtotal)	$15.3	$15.1	$16.0	$9.6	$56.1
PROJECT TOTAL	$185.5	$183.3	$193.4	$116.7	$678.9
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: This project is a component of *PWS Herring Survey* program. Shared vessel costs are in proposal by W.S. Pegau, *PWS Herring Survey: Community Involvement, Outreach, Logistics & Synthesis*

FY10 - 13

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4A
NON-TRUSTEE
AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Personnel Costs: Name	Project Title	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Mary Anne Bishop	Principal Investigator		4.0	10.0		40.0
Brad Reynolds	Research Assistant		6.0	6.2		37.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	16.2	0.0	
					Personnel Total	$77.2

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Alaska Marine Symposium	0.4	1	5	0.2	1.2
Meet with co-PI at Univ. S. Alabama	1.5	1	7	0.1	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.4

FY10

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Contractual Costs: Description	Contract Sum
Univ. S. Alabama Dauphin Island Marine Lab, Co-Pi Powers	44.0
Network costs (based on $50/mo x staff mo)	0.5
Phone/fax/and copying charges	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$45.5

Commodities Costs: Description	Commodities Sum
Fishing sampling gear and bait	7.0
Office, field & lab supplies	3.5
Mail/freight/shipping	0.5
Commodities Total	$11.0

FY10

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Seabird 19-B CTD with fluorometer & turbidity sensor (PWSSC)	1	
Computers & software (PWSSC 2, Univ. S. Alabama 2)	4	
Laboratory - Prince William Sound Science Center	1	
Laboratory - Dauphin Island Sea Lab, Univ. S. Alabama	1	
Safety equipment - Prince William Sound Science Center & Univ. S. Alabama	2	

FY10

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B EQUIPMENT DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Personnel Costs: Name	Project Title	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Mary Anne Bishop	Principal Investigator		4.0	10.3		41.2
Brad Reynolds	Research Assistant		6.0	6.4		38.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	16.7	0.0	
					Personnel Total	$79.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Alaska Marine Symposium	0.4	1	5	0.2	1.2
Cordova to Dauphin Island, Alabama	1.5	1	7	0.1	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.4

FY11

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 10- FY 12

Contractual Costs:	Contract
Description	Sum
Univ. S. Alabama Dauphin Island Marine Lab, Co-Pi Powers	44.0
Phone/fax/and copying charges	1.0
Network costs (based on $50/mo x staff mo)	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$45.5

Commodities Costs:	Commodities
Description	Sum
Fishing sampling gear and bait	4.0
Office, field & lab supplies	2.5
Mail/freight/shipping	0.5
Commodities Total	$7.0

FY11

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Seabird 19-B CTD with fluorometer & turbidity sensor (PWSSC)	1	
Computers & software (PWSSC 2, Univ. S. Alabama 2)	4	
Laboratory - Prince William Sound Science Center	1	
Laboratory - Dauphin Island Sea Lab, Univ. S. Alabama	1	
Safety equipment - Prince William Sound Science Center & Univ. S. Alabama	2	

FY11

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Personnel Costs: Name	Project Title	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Mary Anne Bishop	Principal Investigator		4.0	10.5		42.0
Brad Reynolds	Research Assistant		6.0	6.6		39.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	17.1	0.0	
					Personnel Total	$81.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Alaska Marine Symposium	0.4	1	5	0.2	1.2
Meet with co-PI at Univ. S. Alabama	1.5	1	7	0.1	2.2
Cordova to Seward Sea Life Lab (run experiments)	0.5	1	14	0.2	3.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.7

FY12

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenilet herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Contractual Costs: Description	Contract Sum
Univ. S. Alabama Dauphin Island Marine Lab, Co-Pi Powers	44.0
Seward Sea Life Lab bench fees (1500/week @ 2 weeks)	3.0
Phone/fax/and copying charges	1.0
Network costs (based on $50/mo x staff mo)	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$48.5

Commodities Costs: Description	Commodities Sum
Fishing sampling gear & bait	3.0
Office, field & lab supplies	2.5
Mail/freight/shipping	0.5
Commodities Total	$6.0

FY12

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 10- FY 12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Seabird 19-B CTD with fluorometer & turbidity sensor (PWSSC)	1	
Computers & software (PWSSC 2, Univ. S. Alabama 2)	4	
Laboratory - Prince William Sound Science Center	1	
Laboratory - Dauphin Island Sea Lab, Univ. S. Alabama	1	
Safety equipment - Prince William Sound Science Center & Univ. S. Alabama	2	

FY12

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B
EQUIPMENT
DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Project Title	Step	Budgeted	Costs	Overtime	Sum
Mary Anne Bishop	Principal Investigator		4.0	11.0		44.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		4.0	11.0	0.0	
					Personnel Total	$44.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Alaska Marine Symposium	0.4	1	5	0.2	1.2
Meet with co-PI at Univ. S. Alabama	1.5	1	7	0.1	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.4

FY13

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Contractual Costs: Description	Contract Sum
Univ. S. Alabama Dauphin Island Marine Lab, Co-Pi Powers	37.9
network costs (based on $50/mo x staff mo)	0.2
phone/fax/and copying charges	0.4
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$38.5

Commodities Costs: Description	Commodities Sum
Office, field & lab supplies	0.5
mail/freight/shipping	0.1
Commodities Total	$0.6

FY13

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY13

Project Title: PWS Herring Survey: Top-down regulation by predatory fish on juvenile herring
Lead PI: Bishop (PWSSC)& Powers (U. S.Alabama)

FORM 4B
EQUIPMENT
DETAIL