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*: Pacific Herring Energetic Recruitment Factors, submitted under the BAA
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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*: Pacific Herring Energetic Recruitment Factors, submitted under the BAA

Project Period: FY10-FY13

Primary Investigator(s): Thomas C. Kline, Jr. Ph. D.

Study Location: Prince William Sound

Abstract: This project is one component of the greater integrated study titled PWS herring survey: Community Involvement, Outreach, Logistics, and Synthesis (Pegau, P.I.). This proposed effort seeks to improve understanding of habitat utilization by juvenile herring, especially age 0, and to help identify candidate sites that could be potentially used for supplementation efforts. This particular proposal builds on 15 years of experience in assessment of juvenile herring in PWS using isotope and energetic techniques. We propose to measure energy levels of juvenile herring and other fishes in 8 juvenile herring nursery areas. Four of these areas, Simpson Bay, Eaglek Bay, Whale Bay and Zaikof Bay, were the focus of earlier investigation by the Sound Ecosystem Assessment (SEA) program in 1995-96 as well as a current Council-funded "PWS Herring Forage Contingency" project. Four additional sites will be selected based on historical data and community input and the 'blitz' sampling program. We propose to conduct surveys three times per year, pre- and post-winter and summer, for three years (including a planning year). The pre- and post-winter series will complement other studies that propose to examine overwinter change in energetics. The pre- and post-winter periods have been examined for the past three years. The summer period will provide a link between a more dispersed age 0 herring distribution following larvae drift and the subsequent overwintering locations. The fourth year of the project will focus on data analysis, synthesis and reporting.

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

FY10	FY11	FY12	FY13	Total
258.7	256.6	265.0	218.3	998.6

Non-EVOS Funds to be used:

FY10	FY11	FY12	FY13	Total

PROJECT DESCRIPTION

I. NEED FOR THE PROJECT

A. Statement of Problem

The failure of Prince William Sound (PWS) populations of Pacific herring to recover from the 1989 Exxon Valdez oil spill reflects a period of poor recruitment. Herring fisheries in PWS remain closed. Recruitment into fishable populations is only possible if year class strength is strong. Historically, strong year classes in PWS happened when approximately 1 billion herring recruited at age three. For example, during the 1980s there were three cohorts at this level (Funk 2007). Since the 1989 oil spill not a single cohort has recruited to this level. Periods of a decade or longer with strong recruitments have also occurred in the more distant past (Funk 2007). Because no strong cohorts have recruited during the recent period of extensive herring research (since 1994), we do not know what factors lead to large recruitment.

Pacific herring use protected bays in Prince William Sound (PWS) as nursery bays for the first two to three years of their life. It is hypothesized that year class strength is determined during these early life stages. There is thus a need to make observations relevant to herring during their nursery residence for cohorts that result in strong age-3 recruitment. Empirical observation will lead to knowing which factors drive such recruitment which will be useful in determining what, if anything, can be done to improve it.

Over-wintering energy loss. An important ecological component is ecosystem energy flow. Energy flow is particularly important in high latitude ecosystems such as PWS because of strong seasonality. A long-standing hypothesis for high latitude herring populations is that they need to acquire sufficient energy during the feeding season to survive the long high-latitude winter (Blaxter and Holliday, 1963). This led to the Sound Ecosystem Assessment (SEA) program's herring overwintering hypothesis that 'over-winter survival of juvenile herring affects subsequent year-class strength' (Norcross et al., 2001). Data collected during SEA and subsequently during the Herring Forage Contingency (HFC) project verify that herring lose much of their accumulated energy between November and March of the following year (Fig 1). The relative loss of energy was greater more recently (Fig. 1). The whole-body energy density (WBED) units used in the right panel of Fig. 1 are like those reported by A.J. Paul during the SEA program (e.g., Paul and Paul 1998). Whereas whole-body energy content (WBEC; Fig. 1 left panel) is a conservative measurement (first law of thermodynamics applies), WBED is not. WBEC content, however, does not incorporate effects of changing water content, which is an important physiological parameter, whereas WBED does. Because the methods used in the HFC project and also this study to derive energy levels generate values of both WBEC and WBED for each analysis (Fig.1), we have the use of both options. WBED is also an important consideration for herring predators (A.J. Paul, pers. comm.). WBED appears to be far less dependent on herring length compared to WBEC and is thus a better parameter to use when aggregating data to a single mean or median value or when one needs to compare energy with metrics other than length on a two-dimensional plot such as for food source subsidy analysis using stable isotopes (below). WBED is thus a better parameter to synoptically characterize a given cohort of the PWS herring population. From WBED one can calculate the number of days the population is expected to live based on their stored energy reserves.

The life expectancy of a fasting individual herring can be estimated from its WBED (Fig. 1), the morbidity threshold, and the mean daily energy loss rate observed for Alaskan winter conditions in a laboratory study (Paul and Paul 1998). The average age-0 PWS herring in March 2007 had 40 days of energy reserves whereas the average age-0 PWS herring observed in April 2007 had 35 days to live. The upper quartile of the population had ≥ 64 days to live in March and ≥ 46 days to live in April. The upper quartile of the population observed at the start of spring were thus likely to survive until the spring bloom on their energy reserves. By this time many of those alive in November had likely succumbed. The average age-0 herring in November 2007 had only 88 days to live, which is considerably shorter than winter. The upper quartile had ≥ 108 days to live, not much better. In November, the upper 4%, 2%, and 1% of the population had energy reserves of, respectively, ≥ 148, 159, and 171 days. Thus only a small percentage of the population in November 2007 was likely to survive winter without supplementing energy reserves, such as by eating.

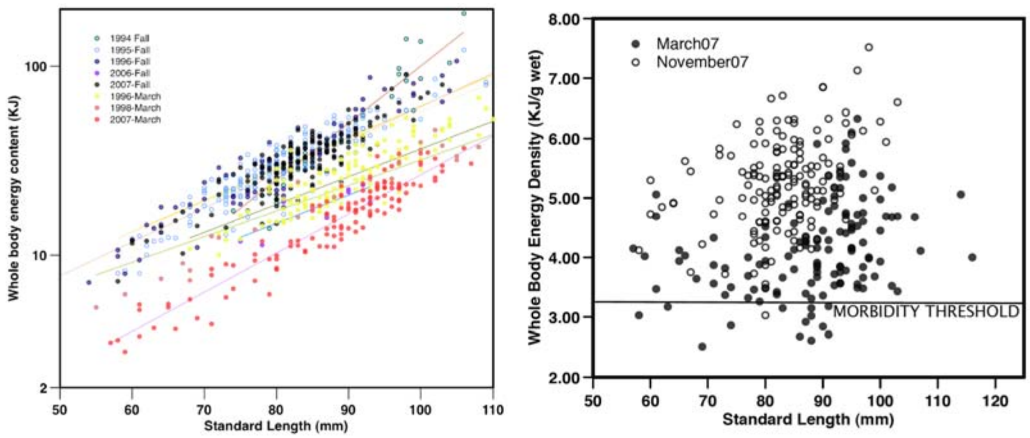

Figure 1. Ontogenetic (increase with size) and temporal (year to year and fall to late winter) variation in WBEC (left) and WBED (right) of age-0 PWS herring. The left panel compares fall (cooler colors) vs. late winter (warmer colors) energy as a function of length (length did not change during fasting; Paul and Paul 1998) for recent and previous PWS herring studies in terms of whole body content. The systematic decrease in energy that takes place over winter is evident across all size classes; $R^2 = 0.9$ and $P < 0.001$ for both March and November 2007. Energy levels in 2007 (red circles) were lower than that previously observed. Fall 2007 herring (black circles) were more similar to past data. WBEC is on a log scale. The correlations between length and WBED were significant ($P < 0.001$ for both regressions, which are not shown), however, the coefficients were much less than WBEC, $R^2 = 0.5$ for November and 0.1 for March. Nevertheless, the correlation suggests that herring size explains half of the variation in energy reserves in November with larger herring having more energy per unit mass. The mean morbidity threshold determined by Paul and Paul (1998) is shown in the right panel.

The expected WBED at the end of a fasting period can be estimated from the WBED at the start of the period, the morbidity threshold, and the mean daily energy loss rate observed for Alaskan winter conditions in a laboratory study (Paul and Paul 1998). Based on the observed WBED of age-0 herring in November 2007 (Fig. 1), the expected mean WBED of surviving herring in March 2008 is 3.6 kJ/g wet mass. This compares favorably with the mean WBED of herring observed in March 2007 of 4.1kJ/g (Fig. 1). A somewhat higher WBED is expected since herring are not strictly fasting during winter (Foy and Norcross 2001). A similar approach can be used for a one-month prognostication. Good samples of age-0 herring were obtained from Simpson Bay 31 days apart in March and April 2007. The expected mean WBED of April survivors based on March WBED observations was 3.6 kJ/g wet mass. The actual observed April WBED was 3.9 kJ/g wet mass. The 0.3 kJ/g wet mass difference was statistically significant (Mann-Whitney U test). The slightly higher observed value is consistent with some feeding. Given that the morbidity threshold varied by 0.8 kJ/g wet mass among individual herring (Paul and Paul 1998), the fasting energy predictions based on laboratory experiments were consistent with field observations with some, although not much, winter feeding. Furthermore, Paul and Paul (1998) observed that wild herring sampled in March from the same location as their laboratory subjects had statistically significant higher WBED levels of 0.3 kJ/g wet mass greater than the laboratory survivors. The above analyses validate the laboratory observations of energy loss and herring morbidity made by Paul and Paul (1998). We can thus estimate the WBED level needed to survive a specified fasting period from the morbidity threshold and the mean daily energy loss rate observed for Alaskan winter conditions in the laboratory study (Paul and Paul 1998). Assuming a winter fasting period of 120 days (mid-November to mid-March), herring would thus need a WBED of at least 6.0 kJ/g wet mass in order to have at least 3.2 kJ/g wet mass at the end of the fasting period. Only a minority of the herring observed in November 2007 had WBED values greater than 6.0 kJ/g wet mass, thus most PWS herring in November were not prepared to survive four months of fasting.

Does over-wintering energy loss factor into herring recruitment? This cannot presently be answered since all nursery cohorts observed thus far have led to poor recruitment. If, for example, much higher energy reserves were observed in March and these herring recruited in large numbers (~ 1 billion) at age 3, then this question would be answered affirmatively. Furthermore, if there had been a correspondingly higher energy level the previous November, e.g., >> 6.0 kJ/g wet mass, then there would be evidence that energy accumulated during the previous summer led to good recruitment. If instead the fall levels were similar to those already observed and the March reserves were high, it would suggest less net energy loss during winter. It is thus important to observing herring energy reserves both before and after winter.

Pelagic production. An emergent pattern arising from one and a half decades of observations is that pelagic food resources in the PWS region can be dichotomized into coastal and oceanic sources based on carbon stable isotope analysis (SIA; Kline 2009). Coastal production is defined as organic carbon generated in PWS and in the low salinity patches of ocean associated with mesoscale eddies, which is characterized by high stable isotope values ($\delta^{13}C' > -20$ in zooplankton; delta notation defined in methods section), whereas oceanic production, organic carbon generated in oceanic areas but not in low salinity patches, is characterized by low values ($\delta^{13}C' < -20$ in zooplankton). Trophic fractionation effects increase isotope values by 1 $\delta^{13}C'$ unit per trophic level thus herring $\delta^{13}C'$ values < -19 reflect oceanic carbon (Kline 1999). The more negative the $\delta^{13}C'$ value the greater the proportion of oceanic carbon. The observed isotopic dichotomy was verified during the HFC project (Fig. 2). The working hypothesis is that coastal food webs are primarily diatom based, which leads to high $\delta^{13}C'$ values whereas the low oceanic values reflect high nutrient low chlorophyll based food webs (Kline 2009). Any given zooplankton or fish species that is broadly distributed in the study area can potentially manifest a rage in dependency on these alternate production sources as evidenced by their observed $\delta^{13}C'$ range. This has been shown in the values observed for three species of *Neocalanus* copepods (Fig. 2) as well as herring and other fishes (e.g., Kline 2007). In other words, SIA reveals differences in feeding habit that are independent of the species composition of diet. SIA thus complements rather than replaces taxonomic analysis of diet.

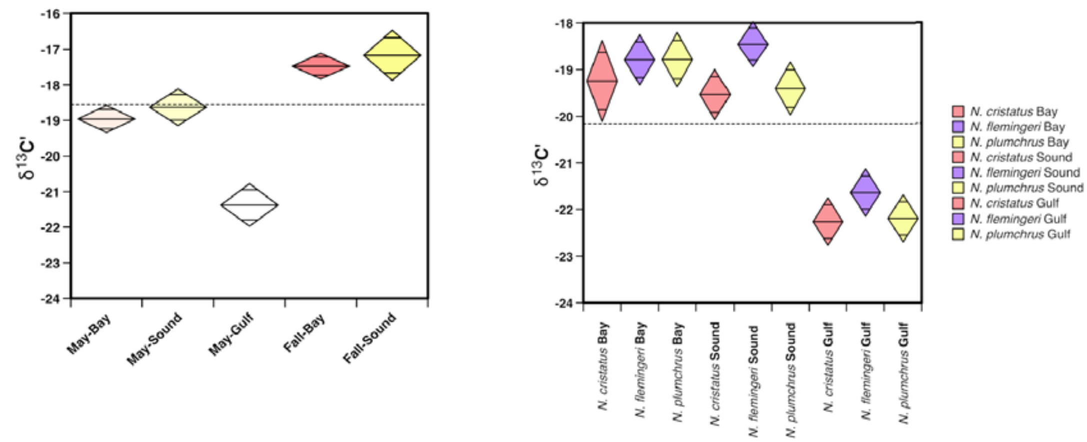

Figure 2. Dichotomous carbon SIA of bulk net plankton samples (left) and *Neocalanus* copepods (right). Carbon values in PWS whether within herring nursery bays (Bays above), or the remaining parts of PWS (Sound above), had values > -20, whereas those from outside PWS (Gulf) were < -20. These values are consistent with previous observations (Kline 1999, Kline 2009).

Energy subsidies. Complex dynamic processes drive material in and out of PWS (Vaughan et al. 2001). In particular is that pelagic fishes in PWS receive significant oceanic carbon energy subsidies from the adjacent Gulf of Alaska (Kline 1999, Kline 2007). Year-to-year differences in the relative contribution of energy subsidies from the Gulf is important because it explained 50% of PWS pink salmon recruitment variation and thus potentially other species as well (Kline et al. 2008). Among PWS resident pelagic fishes, juvenile herring have the greatest dependency oceanic subsides (Kline 2008). Typically more than half of herring energy is of oceanic origin. The 1994 and 1995 herring cohorts had the highest energy levels observed thus far and these cohorts were associated with high oceanic subsidies (Norcross et al. 2001). A spin-off of the elemental analysis approach used in the HFC project has been simultaneous SIA and energy analysis enabling data plots such as Fig. 3 that reveal associations of energy content with energy sources. The highest energy levels observed in the fall of 2007 were in St. Mathews Bay and because of their low δ^{13}C' values it can be inferred that these herring the greatest dependency on oceanic subsides (Fig. 3). Overwintering mortality results in significant losses of age-0 herring in PWS (Norcross et al. 2001). Herring sampled in March were winter survivors and these tended have dependency on oceanic subsidies (^{13}C' values mostly < -19, Fig. 3). Lowest WBED values near ~ 3.2 kJ/g wet mass were at the morbidity threshold (Paul and Paul 1998) and thus moribund (discussed above). We have yet to observe a cohort of age-0 PWS herring where WBED was sufficiently high in the fall that overwintering mortality could be projected to be low.

Competing species. Herring compete with other species for space and food resources in nursery habitats. Competitors are an important consideration for supplementation project since such efforts could backfire by aiding the competitors rather than herring. Competing species are generally sampled along with juvenile herring during sampling surveys and are counted to support acoustic assessments. SIA of sampled competing species provided a means for assessing herring interactions with other species (e.g., Kline 2008). Herring and herring competitors compete for the same food sources during summer feeding as evidenced by high degree of overlap in fall SIA values (Fig. 4 left). All species in the November of 2007 were centered near the threshold value between oceanic and PWS carbon (δ^{13}C' values ~ -19) suggesting a mixture of both carbon sources. However, there was minimal overlap in the stable isotope values pollock and herring in March 2007 samples suggesting that pollock had access to foods not available to herring although living in the same bays during winter (Fig. 4 right). Pollock δ^{13}C' values were generally > -19 suggesting their winter food had PWS origin whereas herring were mainly < -19 suggesting importance of oceanic carbon. PWS herring loose energy during winter whereas as pollock gain energy or at least break even (Paul et al. 1998). Herring may not be able to consume all locally available food resources because of physical limitations such as mouth structure that prevents them from eating the prey that pollock are able to use (Kline 2008). One thus needs to consider herring feeding ability limitations for any supplementation project. Monitoring using the SIA approach such as shown in the example above can be used to assess effects of supplementation.

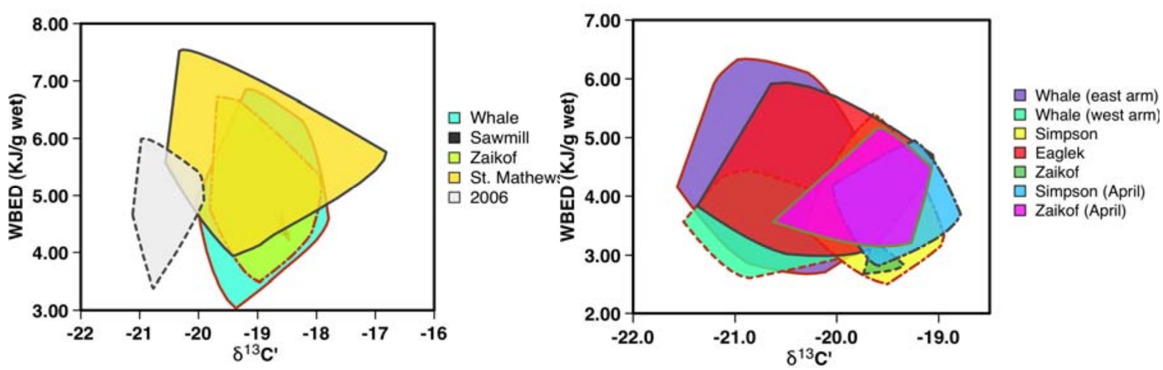

Figure 3. Convex hull plots showing distributions of whole body energy density in relation to carbon SIA in samples of age-0 herring collected in November 2007 as well as opportunistic samples from fall 2006 (left) and in age-0 herring from March 2007 (right). Herring data are split into individual herring nursery bays with the arms of Whale Bay in March shown separately. There was lesser dependency on GOA carbon in fall 2007 as evidenced by higher carbon isotope values compared to the fall 2006 as well as compared to late winter-early spring 2007.

Deriso et al. (2008) hypothesized that hatchery salmon are preventing herring from recovering either through competition or predation. Because they migrate out of PWS and into the Gulf of Alaska to complete most of their somatic growth, juvenile hatchery salmon co-occur with herring only during their early marine life stage following release from hatcheries (Sturdevant 1999). Opportunistic samples of early marine fry rearing in PWS identified as hatchery from otolith thermal marks provided to the P.I. by the Alaska Department of Fish and Game form a means for testing whether there is competition between juvenile herring and hatchery salmon using SIA similar to what was done with pollock (Fig. 5).

The δ^{13}C' values of PWS salmon vary significantly on inter-annual time scales according to their dependence on oceanic subsidies (Kline et al. 2008; Fig. 6). Strong concordance between salmon and herring in these inter-annual shifts (overlap in isotope values and the overlap shifting together from year to year) would provide evidence for competition. If concordance were weak (minimal isotope overlap or an inconsistent pattern of overlap with time), this would be evidence for a lack of consistent direct competition between herring and salmon. Due to trophic enrichment of ^{15}N (Minagawa and Wada 1984), the $\delta^{15}N$ values of salmon would be expected to be greater than herring if salmon were the predators but the same if competitors. We can thus test for predation on herring by salmon using SIA while simultaneously testing for competition. If there were predation, the relationships predicted above would be offset by trophic enrichment. For example, the overlap in isotope values shown in Figure 5 (left) is consistent with competition rather than predation. If predation was significant one would expect the $\delta^{15}N$ range of convex hulls of the predators to range from ~14 to 16, which is much higher than that observed. If there were competition, SIA of herring and salmon would parallel in time, similar to competition, but be offset by trophic enrichment. It would be of great significance if we did found evidence of competition or predation from SIA in poor recruitment years but little evidence for either competition or predation from SIA in a strong recruitment year. The proposed summer herring samples would be most appropriate for comparison with salmon for this particular analysis. Additionally we would include SIA data of herring larvae being proposed in another project with Kline as P.I. (project title: Pacific Herring Larval Recruitment into PWS Nursery Bays). We would do just the herring juveniles vs. salmon comparison if this other project is not also funded. Based on the assumption that there is competition for food, or predation on herring, it has been suggested that reducing or even shutting down hatchery salmon production could be used help PWS herring. The proposed SIA test for competition between salmon and herring should be done before such a Draconian step, which would affect the PWS salmon industry, is taken.

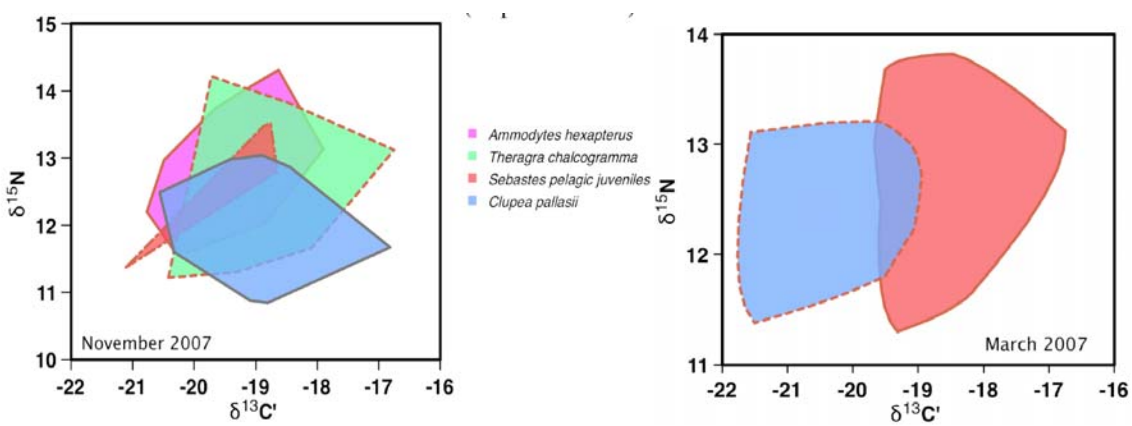

Figure 5. Stable carbon and nitrogen SIA of competing species shown as convex hulls similar to Fig. 3. Age-0 herring (blue) and pollock (green, left; red, right) value overlap in the fall 2007 and lack of overlap at the end of winter suggested a seasonal change in competiveness for available food.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities.

This project is responding directly to 'Herring Surveys', item #2 in the FY2010 Invitation. The project's principal objective is to measure the energy reserves of juvenile herring before and after winter; and to relate changes in energy reserves to cohort history, fish size, and feeding. The analysis objectives performed by the proposed study will lead to the goal of gaining a better understanding of habitat utilization by young herring and will assist in identifying options for supplementation efforts.

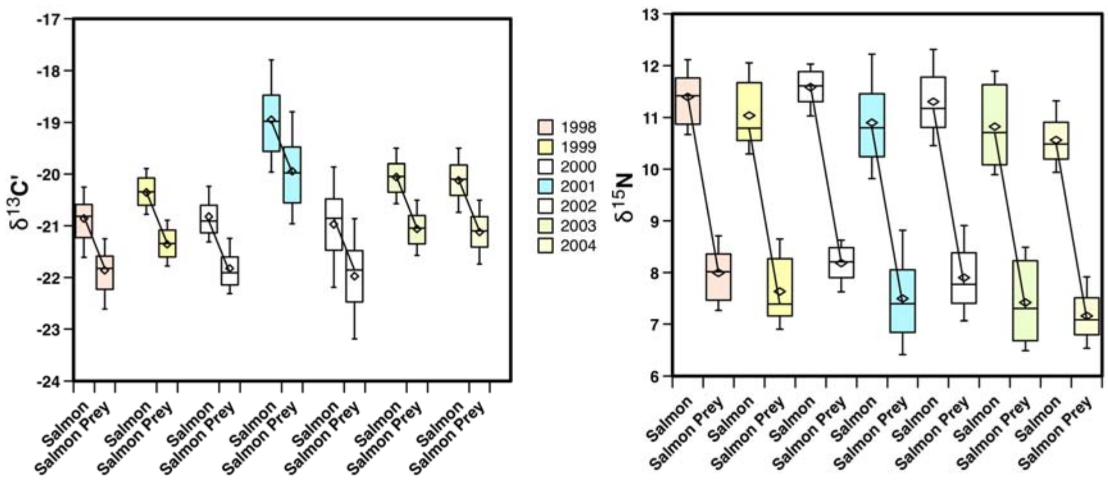

Figure 6. Measured $\delta^{13}C'$ and $\delta^{15}N$ values of PWS hatchery and predicted $\delta^{13}C'$ and $\delta^{15}N$ values of their prey during 1998 to 2004 (delta notion defined in section IIB). The lines connecting predator (salmon) and prey each year reflect expected trophic isotopic fractionation. If herring were salmon prey their values should approximate those predicted for salmon prey based on salmon values when sampled in the same time and spatial frame. If on the other hand salmon and herring were competing for the same food resources, the values would be the same for both species (not be offset as shown here). Data from Kline et al. (2008).

The ultimate goal is know what factors lead a herring cohort to recruit at the one billion individuals at age three, which is the historical level for achieving a PWS herring population sufficiently large to enable a fishery. We need to know what those factors are that lead to good recruitment if we are to emulate them as part of any supplementation effort. At this time we cannot rule out that overwintering mortality plays a role in the population dynamics. We need to determine whether we overcome this mortality by intervention.

The project is part of a collaborative effort being led by the Principal Investigators of the Prince William Sound Science Center, a community-based research and education center, and investigators from outside the Center, see Pegau proposal (project title: *PWS herring survey*: Community Involvement, Outreach, Logistics, and Synthesis). The project will collect the necessary supporting data needed to interpret juvenile herring such as herring competitors, and food as shown by example in section IA. These parameters are all important for establishing the context needed to fulfill the above goal.

The project incorporates three aspects of the FY2010 Invitation: A. monitoring-population modeling, B. integration, and C. data-management and synthesis. The project will be monitoring herring energy levels including generating modeling parameters for the PWS overwintering model (Patrick 2000). New data will be integrated with other projects as well as with data from past projects (e.g., Fig. 1). The project will also be integrated in terms of analyses since multiple analyses will be performed simultaneously on given samples (e.g., Fig. 3). The project has intrinsic data management and synthesis components as well. As illustrated by the figures in section IA, synthesis arises from integration new data with past data as well as by integrating multiple measurements of individual fish. This integration and synthesis place the data into a context for interpretation. This is important if we want to understand the nature of herring populations in PWS. Data will be shared with other investigators, the EVOS-TC, and will also appear in peer-reviewed published form. The P.I. has authored 18 scientific papers based on EVOS-TC funded research.

II. PROJECT DESIGN

A. Objectives

Objective 1. Systematically sample juvenile herring (and opportunistically, competitors) in nursery bays during their initial growth period in mid-summer, before winter, and after winter, respectively in August, November, and March each year.

Objective 2. Opportunistically sample plankton for energy baseline and verification of the carbon isotope dichotomy each year across seasons.

Objective 3. Prepare samples for elemental analysis and send out to lab (preparation includes wet and dry mass assessment)

Objective 4. Prepare samples for and perform bomb calorimetric and ash analyses.

Objective 5. Receive, integrate, and synthesize data into reports, presentations, and publications.

B. Procedural and Scientific Methods

Field sampling. Samples will be collected on collaborative cruises. Fish and zooplankton samples, respectively objective 1 and objective 2, necessarily utilize different sampling gear and therefore may be done on different vessels or cruises according to what is available. This project will furnish one technician to assist in field sampling on cruises as needed.

Objective 1 herring sampling. Samples collected for objective 1 will be done on collaborative fish sampling cruises in November and on 'blitz' cruises in March. The 'blitz' cruise design is given in Dr. Pegau's project description. It will provide a rapid and synoptic broad-scale sampling of PWS using small-sized 'bow-picker' vessels. Accordingly, 'blitz' cruise samples will be frozen in coolers supplied (by this project) with dry ice. Sampling in August and November will be based upon locating herring acoustically as determined by Dr. Thorne's project (project title: *PWS Herring Survey*: Assessment of Juvenile Herring Abundance and Habitat Utilization) in nursery bays and focusing sampling accordingly.

Herring will be sampled during and at the end of the summer growing season (November) to assess variation (variation has historically been at inter-annual time scales; seasonal and spatial variation will be tested as well) in energy acquisition processes leading to pre-winter condition. Herring energy will also be assessed post-winter in March. These planned observation periods (objective 1) match those done recently (see section IA) as well as during SEA (Norcross et al. 2001).

The sample design and focus is the four 'SEA bays', Zaikof bay, Whale Bay, Eaglek Bay, and Simpson Bay (see Dr. Pegau's project description, as above), as well as candidate bays for supplementation. We will sample only the four SEA bays the first fall (the EVOS-TC designated 'planning year'). However, the following two falls (field years 1 and 2), we will sample the 4

SEA bays and 4 supplementation candidate bays. Each March we will sample herring on the planned 'blitz' cruise (see above) The 'blitz' sampling will include the four SEA bays as well as candidate bays. We will collect at least juvenile 100 herring at each nursery bay per cruise for EA. This will include a representative range of sizes so as to be able to assess size dependency (e.g., Fig. 1). This will be facilitated by stratified sub-sampling by size. Size strata will be determined empirically from the size distribution observed on each cruise. A total of 600 herring will be analyzed per cruise (1800 per year). The analysis effort will be spread out to the extent possible so that bays can be compared as well as effects of fish size. Other species caught in conjunction with herring will be assumed to be competitors of herring and sampled as well. In the past herring have out-numbered competitors in samples so any competitors sampled were analyzed. 100 competitors will be selected from sample collections for EA per year.

Objective 2 plankton sampling. Samples collected for objective 2 will be done in collaboration with the two projects where plankton nets will be towed. This includes the project (project title: *PWS herring survey:* Plankton and oceanic observations in PWS) being led by Dr. Campbell and the P.I.'s separate herring larval recruitment project (project title: Pacific Herring Larval Recruitment into PWS Nursery Bays). Samples will be collected for EA from net tows that sample approximately 100 cubic meters of water (this amount is based on HFC project observations). Net samples from each nursery bay will be taken using methods established in the HFC project. They will be collected on the same transects established in the HFC project, which are being sampled in the aforementioned larval herring recruitment project. 100 plankton samples will be analyzed per year.

Other sampling. Other samples not collected specifically as a project objective will also be analyzed. These will be provided by the Alaska Department of Fish and Game. These may be samples caught incidentally as well as targeted samples. Incidental herring samples provided in the past have been useful to fill in gaps and will be similarly accommodated. Juvenile hatchery salmon are targeted as part of separate research projects. These samples will be used to assess potential competition with herring. 100 salmon per year will be analyzed – this will allow for 20 salmon from each of the four pink salmon hatcheries as well 20 unmarked salmon, which will assumed to be wild stocks. This is a minimal sample size needed to conduct the competition assessment (Kline et al. 2008).

Laboratory work. This project is focused on measureable energetic parameters of herring during their nursery residence. Energetic parameters include the whole-body energy density and whole-body energy content (respectively, WBED and WBEC), ash content, water content, carbon content, and nitrogen content. WBED and WBEC can be estimated from water content, carbon content, and nitrogen content. Furthermore, total lipid and protein can be estimated from carbon and nitrogen content. WBED, ash content, water content, carbon content, and nitrogen content parameters are constituents of the PWS herring overwintering model (Patrick 2000). Nitrogen and carbon mass units are the principal 'currencies' of the PWS NPZ (nutrients-phytoplankton-zooplankton) model (F. Chai, Univ. Maine, pers. comm.).
The following suite of laboratory observations (objective 3) will be performed on individual herring bodies: wet and dry mass, ash-free dry mass, and elemental analysis (EA). Standard length (fork length for salmon) to the nearest mm will be taken for each fish (used also for historical samples) prior to drying. Samples will then be oven dried to a constant mass then dry

milled (Retsch) to a uniform fine powder. Powdered samples are ready for EA and bomb calorimetric analysis (objective 3).

A calibrated top-loading electronic balance (Metler) accurate to 0.1 mg will be used for gravimetric analysis (wet and dry mass, and ash mass). Otoliths will be removed from herring as needed by collaborators (such as has been provided during the HFC project). Accordingly wet mass will be taken both before and after otolith removal. Bomb calorimetric analysis will be performed using a Parr Oxygen Bomb Calorimeter equipped with a digital thermometer following manufacturers instructions in Parr leaflet number 204M, "Operating Instructions for the 1341 Oxygen Bomb Calorimeter" that includes use of calibration standards before and during sample analyses. Ten percent of the herring undergoing EA samples will also have a bomb calorimetric analysis. These bombed herring are a QA/QC measure to verify the model used to calculated energy from EA (see below). Fish other than herring will undergo EA but not ash-free mass or the bomb calorimetric analysis.

Elemental Analysis (EA). Elemental analysis will be outsourced to the University of Alaska Stable Isotope Facility. This approach will expedite analysis while maintaining good quality. The P.I has a 15-year history of outsourcing to this lab. There, each sample will be weighed to the nearest microgram and loaded into tin capsules. Tin capsules are automatically loaded into an elemental analyzer interfaced with a light element stable isotope mass spectrometer (Finnegan Delta Plus). A single elemental analysis will generate the following data: $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios expressed in standard delta units, $\delta^{13}C$ and $\delta^{15}N$, respectively, and %C and %N. The delta notation used to express stable isotope ratios is reported as the per mil (‰) deviation relative to an international standard, air for nitrogen, and Vienna Peedee belemnite (VPDB) for carbon. By definition, the isotope standards have delta values of zero, i.e. $\delta^{15}N = 0$ ‰ for atmospheric N_2. Instrument replication is typically within 0.2 ‰. The %C and %N data will be used to calculate C/N atom ratios. The data will thus consist of $\delta^{13}C$, $\delta^{15}N$ and C/N. QA/QC protocols include running of laboratory standards before and after every 10 samples. The mean %N of the laboratory standard was within 0.05% of the expected value in a recent run. The mean %C of the laboratory standard was within 0.04% of the expected value in a recent run. The mean $\delta^{15}N$ of the laboratory standard was within 0.02 ‰ of the expected value in a recent run. The mean $\delta^{13}C$ of the laboratory standard was within 0.01 ‰ of the expected value in a recent run. Errors in the %C and %N due to weighing are further minimized by using the C/N ratio for computing energy (below).

Stable isotope analysis. Organisms acquire stable isotope ratios, respectively $\delta^{13}C$ and $\delta^{15}N$ for carbon and nitrogen stable isotope ratios, in response to the importance of a food source in bulk body tissues. SIA of tissues can thus provide insight into both habitat usage and assist in quantifying amounts derived from various areas. Nitrogen isotope ratios, in particular, provide excellent definition of relative trophic level. Nitrogen is $\delta^{15}N$ enriched by about 3.4 ‰ with each feeding step, or trophic level, and thus can accurately indicate the relative trophic status of species within an ecosystem such as PWS (Minagawa and Wada 1984, Kline and Pauly 1998, Kline 1999, 2001). Stable carbon isotope ratios will be normalized for lipid content following the methods of McConnaughey and McRoy (1979). Carbon isotopes undergo much smaller trophic enrichment relative to nitrogen and so instead reflect the isotopic variability originating at the food web base (Fry and Sherr 1984). For example, carbon isotope data suggested that the transport of zooplankton from offshore into PWS may provide significant subsidies of forage for food webs and may be a good method for detecting changes in biophysical coupling in the PWS region (Kline 1999). These oceanic subsidies appear to enhance marine survival rate of PWS pink salmon stocks (Kline et al. 2008). Whereas it is known that PWS herring receive significant oceanic subsides (Kline 1999, Kline 2008, Fig. 2), the herring data time series needed to show a causal relationship to recruitment such as with pink salmon (Kline et al. 2008) has not yet been generated.

C. Data Analysis and Statistical methods

Energy content from EA. From the analysis of a single herring we will simultaneously determine WBED and WBEC as well as the carbon and nitrogen stable isotope composition via EA. Using the carbon to nitrogen ratio data generated from the EA and the wet and dry mass previously recorded, WBED will be determined using the following empirical model on a per fish basis (1):

(1) WBED (kJg^{-1} (wet mass)) = 0.103 x C/N (carbon-nitrogen atom ratio) + 32.60 x D/W (dry-wet ratio) –2.904

Formula (1) was determined empirically from measurements of herring from PWS (Paul et al. 2001). WBEC of each herring is calculated from its WBED and its wet mass using (2):

(2) WBEC (kJ) = WBED (kJg^{-1}) x wet mass (g)

WBED data generated using (1) compared favorably with that measured directly with a bomb calorimeter (Fig. 7). The advantage here is that EA will reduce costs and will serve a dual purpose. Bomb calorimetric analysis is about twice as expensive as an EA due to the time needed to run a sample. Besides generating energy level in multiple formats (per whole fish, per unit wet mass, and per unit dry mass), each EA generates %C, %N along with $^{15}N/^{14}N$ and $^{13}C/^{12}C$ abundance. The delta notation used to express stable isotope ratios ($^{15}N/^{14}N$ and $^{13}C/^{12}C$ abundance) is reported as the per mil (‰) deviation relative to an international standard, air for nitrogen, and Vienna Peedee belemnite (VPDB) for carbon. By definition, the isotope standards have delta values of zero, i.e. $\delta^{15}N = 0$ ‰ for atmospheric N_2. Instrument replication is typically within 0.2 ‰. EA is very cost effective since not only is it less expensive to perform than bomb calorimetric analysis but because SIA as well as energetic data are generated for this cost. Furthermore, paired SIA and energetic data enable assessing the relationship between oceanic subsidies and energy in PWS fishes. The model used to calculate energy from EA will be validated by bombing 10% of the herring and regression analysis (Fig. 7).

Data integration and synthesis. Data will be sent to the P.I. following laboratory analysis (objective 5). This activity is expected to commence a few months from sending out samples. Samples will be sent out as batches throughout the project, from completion of laboratory preparation of those first sampled to those last sampled. New batches of data will thus be integrated nearly continuously throughout the project and will not be complete until the last data is sent to the PI during the synthesis year. Data from this project will be comparable with the historical data such as from the mid 1990’s, the HFC project, as well as among the sampling sites and years of the proposed project. This will enable data integration across time and space. Data are being generated so as to be able to use standardized statistical protocols such as ANOVA, T-tests, etc. as used in the references already cited.

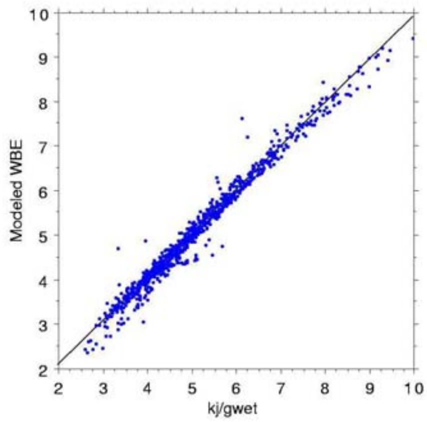

Figure 7. Modeled versus measured WBED (WBE in figure) of juvenile herring from PWS sampled during the SEA project. The WBED was measured using a bomb calorimeter which is being compared to modeled values based on C/N ratio and wet-dry ratio using formula 1 (R^2 = 0.98; P < 0.01); N = 833).

The sampling design is with ANOVA statistical procedures in mind. ANOVAs will be possible to test for year (e.g., year X vs. 1995), and site. Same seasons will be compared among years, e.g., one fall versus another fall as has been done (e.g., Kline 1999). Ontogenetic effects will be determined by plotting WBEC and WBEC an as dependent variables using standard length as the independent variable (Fig. 1). This will be done for data aggregates at various levels (by bay, season, etc.). Previously, there was little to no significant difference in SIA between synoptically sampled cohorts of age-0 herring and age-1 herring, and virtually no ontogenetic effect in SIA above 70 mm standard length, which is also about the smallest size of herring other than larvae (Kline 1999, Kline 2000). SIA data can be compared to WBED in convex hull plots, because of the relative lacking of size dependency.

An important synthesis product will be recommendations for further study and monitoring. As much as previous observations were important for developing this proposal, the observations to be generated will be important for future directions of the PWS recovery effort. Each observation type may have different implications as has been described. These will range from assessment of the efficacy of a feeding scenario by comparing to baseline WBED being generated here to assessment of the role of hatchery salmon on herring ecology (see above).

Data dissemination. The P.I. will disseminate project results (objective 5) among project collaborators, as well as other researchers through workshops and symposia. We are planning on having a project-wide P.I. meeting in the spring (most likely early May) following winter herring surveys as our principal annual meeting for integrating results across projects. The P.I. will also work closely with Dr. Heintz (NOAA, Juneau) throughout the project. Additional dissemination will come through presentations made at the annual Alaska Marine Science Symposium as well as national and regional level meetings such as PICES, Ocean Sciences and American Fisheries Society meetings. The P.I. will contribute data to annual reports as well as contribute to the main project-wide synthesis product, the final report. The P.I. plans on writing at least one journal article draft to be completed in the synthesis year. There will also be a project web page to which this project will contribute data.

The PWS Science Center maintains several outreach activities in the PWS community. The PWS Science Center is an educational as well as research organization. The PWS Science Center has a K-12 education program, with academic year and summer science camp components, and four dedicated education staff to translate research findings into education products. The P.I. has contributed, and will continue to contribute, research results to these efforts. Much of this communication, such as public programs and student visits to the center, is directed towards the PWS community, involving adults as well as K-12. The Cordova community comprises, in part, the Native Village of Eyak. Alaska Natives, and other minorities play and have played significant roles at the PWS Science Center. PWS Science Center Board members, employees, educators, and, scientists have likewise come from under-represented groups. We use local hires for our vessels whenever possible. This also enables us to involve directly members of the fishing community in our research. Oral presentations given in Anchorage at the Alaska Marine Science Symposium will be repeated in Cordova and elsewhere as appropriate. It is very cost effective to re-use a power point presentation that may take a week of P.I. time to make graphs for and assemble.

D. Description of Study Area

The study area will consist of PWS and adjacent Gulf of Alaska between latitude 58.0° and 61.0° N and longitude 146.0° and 150.0° W.

E. Coordination and Collaboration with Other Efforts.

Cruises will be done in collaboration and coordination with other projects as described above in section B. Sharing research platforms will facilitate part of this. No cruise charters are budgeted for within this project. All charter costs are imbedded in Dr. Pegau's project as described above. Dr. Pegau will be doing the over-all coordination among projects. This project will contribute to charters by providing a research technician on the fall cruises. We will provide the necessary materials (coolers, dry ice, sampling bags, data sheets) to enable sampling on the 'blitz' cruises. The blitz cruises will be short duration on small vessels without refrigeration.

Herring larval SIA will also be generated if the P.I.'s proposed project titled Pacific Herring Larval Recruitment into PWS Nursery Bays is funded. These data will combined with the salmon data being generated in this project assess predation on herring larvae by salmon. The salmon analysis will thus serve a dual purpose – both to assess competition with, as well as to assess role of predation on, herring

This project generates ancillary data that are often useful to other researchers. For example, since fish length is collected routinely, the resulting size-frequency data is of use to those studying predation. Thus length-frequency data has been sent out to the other researchers. Specifically length-frequency data will be provided for Dr. Bishop's project (project title: *PWS herring survey*: Seasonal and inter-annual trends in seabird predation on juvenile herring). Dr. Heintz's project (*PWS herring survey:* Growth and energy allocation in overwintering herring) compliments this one by assessing energy in specific fish components and rather than the whole fish. The nature of his analyses requires separate fish to be analyzed so fish will be randomly spit between our research projects in the field when there is temporal overlap in sampling. However, we will work toward integrating our results. Mr. Gay's project (project title: *PWS herring survey:* Physical Oceanographic Characteristics of Nursery Habitats Influencing Growth, Over-

Winter Energetics and Survival of Juvenile Pacific Herring) will assess oceanographic conditions and processes that may favor or prevent intrusion of water into nursery bays containing external sources of zooplankton, which would be necessary to explain oceanic subsidies observed using SIA. We will integrate our separate observational and analytical approaches throughout the study. Dr. Sonia Batten is proposing to continue deployment of the Hardy Continuous Plankton Recorder in the Gulf of Alaska. This project may reveal how zooplankton taxa are aggregated in oceanic structures such as mesoscale eddies, which may facilitate subsidizing PWS with oceanic zooplankton. We plan on integrating our finds through the synthesis process.

This project will collaborate with population dynamic modeling. The preliminary analysis of the HFC project described above demonstrates how WBED data can be used to forecast over-winter survival, which was validated by good concordance in the observed WBED values of survivors. WBED data are thus useful for population dynamics assessment and modeling. The overwintering survival forecasts based on WBED can be compared to measured populations size before and after winter (Dr. Thorne's project) as well as modeled population size before and after winter.

This project will collaborate with ecosystem process modeling. An NPZ marine ecosystem model is being developed to predict nutrient, plankton, and zooplankton distributions and levels, hence NPZ. The model is being developed by Dr. Fei Chai (University of Maine) and is incorporated into a circulation model as a part of the nowcast-forecast modeling effort within the Alaska Ocean Observing System. The circulation model is based upon the Regional Ocean Model System (ROMS), which has been configured for the Gulf of Alaska with the highest spatial resolution (1.5 km) for the PWS. NPZ processes are based on the Carbon, Si(OH)4, and Nitrogen Ecosystem (CoSiNE) Model, which consists of multiple nutrients and plankton dynamics (Chai et al. 2002, 2003). In collaboration with Dr. Yi Chao's group at the JPL/NASA, Dr. Chai used a version of the PWS circulation model to implement the CoSiNE model, and conducted simulations to test model structure and parameters. The ROMS-CoSiNE has been forced with atmospheric modeled wind and heat flux for the Gulf of Alaska and PWS region, using calendar year 2004 as a testing period. Dr. Chai has successfully coded the CoSiNE model into the PWS ROMS, and has been able to conduct several coupled model runs for 2004. This NPZ ecosystem model was able to reproduce seasonal cycle of phytoplankton growth dynamics, which depends on the light, nutrients, and temperature for the PWS (Fei Chai, pers. comm.). An extension of the NPZ model is to use it assess the carrying capacity issue and how oceanic subsidies may be affecting carrying capacity. The currencies of the NPZ model are N and C mass units. The Z part of the NPZ would be used to assess PWS carrying capacity for herring in terms of the C and N mass of herring being generated by the project.

III. SCHEDULE

A. Project Milestones

Objective 1. Sample juvenile herring in nursery bays. *To be met by September 2012.*

Objective 2. Sample plankton for energy baseline and verification of carbon isotope dichotomy. *To be met by September 2012.*

Objective 3. Prepare samples for elemental analysis and send out to lab. *To be met by September 2012.*

Objective 4. Prepare samples for and perform bomb calorimetric analysis. *To be met by September 2012.*

Objective 5. Receive, integrate, and synthesize data. *To be met by September 2012.*

B. Measurable Project Tasks (year categories per RFP)

Planning Year

FY10, 1st Quarter (October 1, 09 to December 31, 09)

November *Pre-winter juvenile herring survey*

FY10, 2nd Quarter (January 1, 10 to March 31, 10)

January *Annual Marine Science Symposium*

March *Post-winter juvenile herring survey*

FY10, 3rd Quarter (April 1, 10 to June 30, 10)

May *Workshop*

FY10, 4th Quarter (July 1, 10 to September 30, 10)

August *Summer juvenile herring survey*

August *Submit Annual Report*

Field year 1

FY11, 1st Quarter (October 1, 10 to December 31, 10)

November *Pre-winter juvenile herring survey*

FY11, 2nd Quarter (January 1, 11 to March 31, 11)

January *Annual Marine Science Symposium*

March *Post-winter juvenile herring survey*

FY11 3rd Quarter (April 1, 11 to June 30, 11)

May *Workshop*

FY11 4th Quarter (July 1, 11 to September 30, 11)

August *Summer juvenile herring survey*

August *Submit Annual Report*

Field year 2

FY12 1st Quarter (October 1, 11 to December 31, 11)

November *Pre-winter juvenile herring survey*

FY12 2nd Quarter (January 1, 12 to March 31, 12)

January *Annual Marine Science Symposium*

March *Post-winter juvenile herring survey*

FY12 3rd Quarter (April 1, 12 to June 30, 12)

May *Workshop*

FY12 4th Quarter (July 1, 12 to September 30, 12)

September *Complete lab work*

Report writing year

FY13 1st Quarter (October 1, 12 to December 31, 12)

October *Synthesis workshop*

December *Complete data analysis*

FY13 2nd Quarter (January 1, 13 to March 31, 13)

January *Annual Marine Science Symposium and Synthesis workshop*

March *Prepare data transfer, Synthesis workshop*

FY13 3rd Quarter (April 1, 13 to June 30, 13)

April *Draft Final report*

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Two-Page Curriculum Vitae

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Thesis: The significance of marine-derived biogenic nitrogen in anadromous Pacific salmon freshwater food webs

1983 **M.S. in Fisheries, University of Washington, Seattle**

Thesis: The effect of population density on the growth rate of the butter clam, *Saxidomus giganteus*

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Five Related Research Papers

Kline, T.C., Jr. 2009. Characterization of carbon and nitrogen stable isotope gradients in the sub-Arctic Pacific Ocean using terminal feed stage copepodite V *Neocalanus cristatus*. Deep-Sea Research II. In Press.

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Recent Collaborators

Carlisle, Aaron (Stanford Univ.), Coyle, K., Cooney, R., Haldorson, L., Hopcroft, Weingartner, T., Whitledge, T. (Univ. Alaska Fairbanks); Bishop, M., Campbell, R. Thorne, R. (P.W.S. Science Center); Moffitt, S. (Alaska Dept. Fish and Game); Knutsen, E., Woody, C. (U.S.G.S.); Boldt, J. (NOAA), Patrick, V. (Univ. Maryland), Kiefer, D. (Univ. So. California)

Budget Justification

Personnel

Dr. T. C. Kline, Principal Investigator (P.I.). A 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). Accordingly, The P.I. will be doing these things in addition to leading the field portions of the project (i.e., research cruises to collect samples). The P.I. expects to dedicate 100% of his time to PWS herring research during the next four years. Half of this time will be on this project and half of his time on a separate but complimentary project. Accordingly, this project is budgeted at 6 months per year for each year of the project

Technician (to be named): One full-time equivalent will be needed to accomplish the laboratory tasks and assist in filed sampling

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 2% each year based on recent experience.

Travel

Travel is budgeted each year to attend the Alaska Marine Symposium in Anchorage, one meeting with Juneau project collaborators in years 1 to 3, and one meeting/workshop outside of Alaska/year. Additionally travel is budgeted to attend project workshops in during the synthesis year. The P.I. will attend and participate in workshops, special symposia, and town meetings at a national conference. The P.I tentatively plans on attending the Ocean Sciences Meeting in Portland, Oregon in 2010 and the Aquatic Sciences Meeting in San Juan, Puerto Rico. Symposia sponsored by PICES and AFS may be attended instead of these or in other years according to the details of the symposia content. 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 air-fare. Travel will be by US-flag carriers, if available.

Supplies

Field supplies: Dry ice, coolers, bags, foul-weather gear

Laboratory supplies: LSC vials, vacuum pump oil, grinder blades, forceps, lab safety apparel, notebooks, zip-lock bags, boxes, bulbs, anything else as determined by project needs as they evolve. Experience dictates that about $3000 will be needed per year .

Office supplies: Paper, folders, pens, pencils. Experience dictates that about $500 will be needed per year .

Computer supplies and upgrades: Connectors and cables as needed, 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 $1000 will be needed per year.

Computer: A laptop computer ($3K) to facilitate computer use and data transport to and from workshops. Experience dictates that after two 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 years 1 and 3 of the project.

<u>Equipment</u>

None

<u>Contractural</u>

It is the practice to charge photocopies and telephone calls by entering a code corresponding to the project. There is also a base phone fee of about $40 per person-month.

PWSSC Network charge (computer-months): The PWSSC presently must levy a $50 per person-month network charge to offset this cost.

Elemental Analysis (EA): This is the actual mass spectrometric analysis of samples, which is outsourced to the UAF Stable Isotope Facility at $25 each.

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

EA and LU is based upon analyzing 1800 herring per year, 100 other species (other than salmon) per year, 100 salmon per year, and 100 plankton per year (for a total of 2100 samples per year)

<u>Indirect Costs:</u>

The Prince William Sound Science Center has a federally approved indirect rate of 28% on modified total direct costs (excluding equipment, subawards in excess of $25,000, and tuition).

Data Management and QA/QC statement

1. Study design is given in the Research Plan in section II, all sample types are biological, whole organisms that will be dried and ground into a powder; Locations will be the four SEA bays and other bays designated by the program (see lead proposal, P.I.: Pegau). Sample size is based upon results of previous research (Kline 1999) standard statistical methods such as ANOVA have been used.

2. Data characteristics are given in the Research Plan in section II.

Units of measure: mm, g and kJ; all SI units

Sample sizes: 100 per bay per cruise-bay (juvenile herring) – sub-sampled by size (age), bay and cruise for a total of 1800 per year.

50 non-salmon competitor species per cruise-bay: subsample by species and cruise – up to 100 total per year

100 juvenile salmon per year (from ADFG sampling) 20 for each hatchery (4 x 20) and 20 un-marked which will assume to be wild

Sampling techniques: nets

Specific equipment: fishing nets, drying oven, freeze dryer, Parr oxygen bomb calorimeter, Metler electronic balance, Retsch dry mill, EA-MS (at out-sourced lab)

Sample procedure: Catch and freeze in seawater, label sample bag

3. Data acceptability: Poor runs (evaluated by reproducibility of lab standards) will be re-done (highly unlikely based on experience, Bomb calormetery will not start until lab standards are consistent according to Parr protocols),

Hypotheses: A large majority of a given cohort will have sufficient WBED to survive the winter and as a result will recruit to ~ 1 billion at age 3

Instrument calibration: EA-MS and bomb calorimetric analysis through use of laboratory standards. The electronic balance has a calibration weight enabling weekly user calibration

4. Algorithms: EA-MS provide as part of the Finnegan instrument, bomb calorimetry see Parr leaflet 204M

5. Sample custody: samples will be stored frozen in PWS Science center freezers until dried. Stored at the PWS Science center lab until ground. Samples will be destroyed as part of the analytical process (combustion)

6. Data reduction and reporting: The PI will be responsible for all data reduction and reporting.

Software: Microsft Excel (currently version 12.1.5) and Gigawiz Aabel 20/20 Data Vision (currently version 2.4.2.R)

Computer model: Currently a MacBook Pro2,1 (2.33 GHz, 2 core, 3GB RAM – maximum specification at time of purchase – to be replaced in 2010)

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	$124.2	$128.4	$132.0	$88.8	$473.4
Travel	$4.5	$4.6	$4.6	$4.6	$18.3
Contractual	$60.9	$60.9	$60.9	$60.6	$243.3
Commodities	$7.7	$5.3	$5.3	$2.5	$20.8
Equipment	$3.0	$0.0	$3.0	$0.0	$6.0
Indirect *(will vary by proposer)*	$37.0	$36.2	$37.3	$43.8	$213.3
SUBTOTAL	$237.3	$235.4	$243.1	$200.3	$975.1
General Administration (9% of subtotal)	$21.4	$21.2	$21.9	$18.0	$82.5
PROJECT TOTAL	$258.7	$256.6	$265.0	$218.3	$998.6
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOS funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY10 - 13

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

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
Thomas Kline	Principal Investigator		6.0	11.1		66.6
TBD	Technician		12.0	4.8		57.6
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		18.0	15.9	0.0	
					Personnel Total	$124.2

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
Juneau workshop	0.4	1	3	0.2	1.0
Ocean Sciences	0.8	1	5	0.2	1.8
Registration and abstract fees	0.5	1			0.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.5

FY10

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

FORM 4B PERSONNEL & TRAVEL DETAIL

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

Contractual Costs: Description	Contract Sum
mass spectrometry	52.5
freeze dry	6.3
Network costs (based on $50/mo x staff mo)	0.9
Phone/fax/and copying charges	0.7
Shipping	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$60.9

Commodities Costs: Description	Commodities Sum
lab supplies	3.0
Office supplies	0.5
Grinding jar set (for Retsch dry mill)	2.0
computer supplies	1.0
Field supplies	1.2
Commodities Total	$7.7

FY10

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

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
laptop			3.0
			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	$3.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY10

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

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
Thomas Kline	Principal Investigator		6.0	11.4		68.4
TBD	Technician		12.0	5.0		60.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		18.0	16.4	0.0	
					Personnel Total	$128.4

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
Juneau workshop	0.4	1	3	0.2	1.0
Aquatic Sciences	0.9	1	5	0.2	1.9
Registration and abstract fees	0.5	1			0.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.6

FY11

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

FORM 4B PERSONNEL & TRAVEL DETAIL

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

Contractual Costs:	Contract Sum
Description	
mass spectrometry	52.5
freeze dry	6.3
Network costs (based on $50/mo x staff mo)	0.9
Phone/fax/and copying charges	0.7
Shipping	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$60.9

Commodities Costs:	Commodities Sum
Description	
lab supplies	3.0
Office supplies	0.5
computer supplies	1.0
Field supplies	0.8
Commodities Total	$5.3

FY11

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors,submitted under the BAA
Lead PI: Kline (PWSSC)

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

FY11

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

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
Thomas Kline	Principal Investigator		6.0	11.8		70.8
TBD	Technician		12.0	5.1		61.2
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		18.0	16.9	0.0	
					Personnel Total	$132.0

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
Juneau workshop	0.4	1	3	0.2	1.0
Ocean Sciences	0.9	1	5	0.2	1.9
Registration and abstract fees	0.5	1			0.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.6

FY12

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

FORM 4B
PERSONNEL &
TRAVEL DETAIL

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

Contractual Costs: Description	Contract Sum
mass spectrometry	52.5
freeze dry	6.3
Network costs (based on $50/mo x staff mo)	0.9
Phone/fax/and copying charges	0.7
Shipping	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$60.9

Commodities Costs: Description	Commodities Sum
lab supplies	3.0
Office supplies	0.5
Field supplies	0.8
computer supplies	1.0
Commodities Total	$5.3

FY12

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

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
laptop			3.0
			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	$3.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY12

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

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
Thomas Kline	Principal Investigator		6.0	12.1		72.6
TBD	Technician		3.0	5.4		16.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		9.0	17.5	0.0	
					Personnel Total	$88.8

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
Anchorage workshop	0.4	1	3	0.2	1.0
Aquatic Sciences	0.9	1	5	0.2	1.9
Registration and abstract fees	0.5	1			0.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.6

FY13

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

FORM 4B
PERSONNEL &
TRAVEL DETAIL

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

Contractual Costs: Description	Contract Sum
mass spectrometry	52.5
freeze dry	6.3
Network costs (based on $50/mo x staff mo)	0.9
Phone/fax/and copying charges	0.4
Shipping	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$60.6

Commodities Costs: Description	Commodities Sum
lab supplies	1.0
Office supplies	0.5
computer supplies	1.0
Commodities Total	$2.5

FY13

Project Title: PWS Herring Survey: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

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: Pacific herring energetic recruitment factors, submitted under the BAA
Lead PI: Kline (PWSSC)

FORM 4B EQUIPMENT DETAIL