PROPOSAL SIGNATURE FORM

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PROJECT TITLE: Prince William Sound Herring Forage Contingency, submitted under the BAA

Printed Name of P.I. Thomas C. Kline, Jr. Ph. D.

Signature of P.I. ______________________________ Date __________________

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PROPOSAL SUMMARY PAGE

Project Title - Prince William Sound Herring Forage Contingency, submitted under the BAA

Project Period:	FY 07-FY 09
Proposer(s):	Thomas C. Kline Jr., Ph. D. Prince William Sound Science Center
Study Location:	Prince William Sound and Adjacent Gulf of Alaska
Key Words:	Juvenile Herring, Zooplankton, Prince William Sound, Energy, Subsidies

Abstract

Prince William Sound (PWS) herring recruitment is hypothesized to be contingent on young of the year herring attaining from zooplankton sufficient whole body energy content (WBEC) to survive their first winter. PWS recruitment is presently variable, having changed since the Trustee Council funded Sound Ecosystem Assessment (SEA) project ended. Juvenile herring will be sampled and analyzed for WBEC and natural stable isotope abundance (SIA) for comparison with SEA data. The PI has direct familiarity with WBEC and SIA done during SEA enabling duplication. Oceanic subsidies (detected with SIA) are hypothesized to augment zooplankton energy density, which varies in time and locations. High zooplankton energy density is hypothesized to enable herring to acquire high WBEC in certain areas at certain times. To test these hypotheses, herring forage will be assessed in terms species composition and density, SIA, and energy density, which will be related to herring WBEC by location and time.

Funding:

EVOS Funding Requested:	FY 07	$ 262.0K – Approved 11/14/06	
	FY 08	$ 344.1K - Pending	
	FY 09	$ 167.3K - Pending	
			TOTAL: $773.4K
Non-EVOS Funds to be Used:	FY 07	$ 415.0K	
	FY 08	$ 250.0K	
	FY 09	$ 0	TOTAL: $665K

Date: 1 August, 2006

PROJECT PLAN

NEED FOR THE PROJECT

Statement of Problem

Pacifc herring (*Clupea pallasi*) populations in Prince William Sound, Alaska (PWS) have remained low since crashing in the early 1990's. The 1999-year class performed well, by having a strong recruitment at age three (R. Thorne, PWSSC, pers. comm.). However, this recruitment event was insufficient to restore herring populations to the levels of the 1980's. Overall, recruitment of herring in PWS remains low. The *Exxon Valdez* Oil Spill Trustee Council funded Sound Ecosystem Project (SEA), which made observations during the 1994 to 1998 period, postulated that herring recruitment in PWS is driven by early life history processes (Norcross et al. 2001). This project will address how have these processes may have changed since SEA ended. The project will describe manifestations of this change for PWS herring recruitment in terms of the energy content of herring and zooplankton, the role of oceanic zooplankton subsidies for herring and herring competitors, and the species of zooplankton available as forage.

The SEA project provides a foundation for this investigation. The Principal Investigator (PI) participated as a SEA project leader working closely with other SEA herring PIs. In particular, the PI collaborated closely with A.J. Paul, now retired. We paired our analyses using the same herring samples, exchanged results as well as specimens, and co-published results. An important issue is to determine if conditions in herring nursery habits in PWS have changed since SEA ended in 1998. To make this assessment without systematic error requires close duplication of the sampling design and methods used then so that the results will be comparable. The PI's direct familiarity with the methods used and results obtained during SEA will facilitate making this a successful project. Results of the SEA project, subsequent projects, and other proposed project results will be integrated in the proposed study as described below.

Role of herring whole body energy content (WBEC)

Herring recruitment in PWS is hypothesized to be contingent on forage during their first year. Good forage enables young-of-the-year (YOY) herring to acquire sufficient energy for surviving winter until good forage is available again in spring. Whole-body energy content (WBEC) of young-of-the-year (YOY) herring at the end of their first growing season in PWS may not be sufficient to last the whole winter (Paul and Paul 1998a). Those that actually survive to March may have less than a month's energy reserve left, which was estimated to be not sufficient to survive until good forage levels resume during the spring bloom (Paul and Paul 1998a). There can be significant spatial and inter-annual variability of WBEC measured during the fall in PWS (Paul and Paul 1998b, Paul et al. 1998). For example, the 6 kJ/g (wet) found in Simpson Bay (eastern PWS) was the highest observed mean WBEC value of YOY herring among the bays compared in October 1995 (Paul and Paul 1999). However, with a mean value of 4 klJ/g (wet), Simpson Bay had the lowest WBEC in October 1996, when the mean WBEC at Whale Bay (southwestern PWS) was about double that (Paul and Paul 1999). A WBEC value of 4 klJ/g (wet) was within the range of starting values in a laboratory study that led to herring mortality (Paul and Paul 1998a). It is likely that a herring with a WBEC of 4 klJ/g (wet) will die during the winter period, being more susceptible to predation, disease, and starvation (Paul and Paul 1998a). Winter survival can be the primary determinant of recruitment (Norcross and Brown 2001).

Since the SEA project ended, herring populations have slowly rebounded but only in certain areas in PWS. R. Thorne (PWSSC, pers. comm.) has observed high recovery rates for the herring that over-winter in northeastern PWS (includes Simpson Bay), where the population increased to over 12,000 metric tons in 2004 from 1,800 metric tons in 2000. Very little recovery has occurred in the Montague Island population. There is evidence that these populations are separate (Norcross et al. 2001, Brown 2003). To understand PWS herring recruitment, it is necessary to make observations on herring systematically at several locations in PWS since any one location is likely not to be representative of PWS as a whole. To facilitate comparison with SEA project data, a minimal sampling design should incorporate the same four bays sampled during that four-year project (see 'study area').

Herring form a critical component of the diet of many marine mammals and birds (Hardy 1924; Agler et al. 1999; Matkin et al. 1999; Irons et al. 2000; NAS 2002). Herring predators may be competing for a very limited resource. Herring predators including Steller sea lions, baleen whales (Mysticeti), orcas (*Orcinus orca*), harbor seals (*Phoca vitulina*), and several piscivorous marine birds have declined after the *Exxon Valdez* oil spill (Frost et al. 1999; Matkin et al. 1999). The effects of the *Exxon Valdez* oil spill on populations of several marine birds may have lasted longer than expected because of reduced forage fish abundance including herring (Irons et al 2000).

Recent results suggest that foraging intensity by Steller sea lions (*Eumetopias jubatus*) has had substantial impact on herring mortality (Thorne 2006). Using the dietary requirements from Winship and Trites (2002), in conjunction with forage intensity observations from herring surveys during 2000-2002, Thorne (2006) indicated that winter-period Steller sea lion foraging could remove as much as 12% of the herring biomass. Certain herring populations more susceptible to predation by sea lions and other predators may be more attractive because they are in weaker condition. This hypothesis will be answered from data to be collected on this project synergistically with results of a separate NOAA-funded study where the PI is measuring juvenile herring WBEC near sea lion fall foraging activity (Thorne et al. 'Steller Sea Lion Winter Food Limitation Research'). By comparing the WBEC of YOY herring from the NOAA project with that being proposed it will be possible to test the hypothesis that sea lions are preferentially feeding on populations of 'easy prey', i.e., those with lower WBEC.

During the growing season (spring and summer) the WBEC of juvenile herring increases as a function of body length. The slope of the increase, however, varies by location within PWS and from year to year (Paul and Paul 1998b), suggesting temporal and spatial variability in the ability of YOY herring to forage successfully in PWS. In PWS, herring growth rate, spatial distribution, and WBEC are highly variable (Stokesbury et al. 1999, 2000, Paul and Paul 1999). These SEA project observations were made on year classes of poor recruitment. WBEC observations were not made of 1999 year-class YOY herring. Observations need to be made for years covering a range of WBEC values, and must include years when it is relatively high in the fall, sufficient for over-winter survival, to test the hypothesis that PWS herring is contingent on fall WBEC levels. Analogous measurements to those made during SEA will enable assessing whether growing conditions have changed in the last decade. Therefore, herring WBEC observations will be made in October and March (cf. Paul et al. 1998, Paul and Paul 1999). If growing conditions inferred from WBEC have improved since SEA, in particular in the eastern areas where herring appears to be rebounding, resulting in higher WBEC than during SEA, the expectation is that the slope of WBEC with respect to herring length measured in October will have increased since the SEA project observations reported by Paul and Paul (1999). Presently, the March WBEC values should also be higher compared to those observed during SEA. This could reflect either better fall WBEC conditions or that winter period habitat conditions are such that less energy is lost (cf. Foy and Paul 1999). A herring over-wintering model was developed during SEA to address this issue. The WBEC proximate data required for the over-winter period (Vince Patrick, pers. comm.) will be provided by this project to herring modelers.

Role of zooplankton forage for determining herring WBEC

Relative foraging success on zooplankton can determine herring year class strength because herring need to acquire sufficient energy from their food to survive the long high latitude winter (Blaxter et al. 1963). Herring feed opportunistically on a wide range of zooplankton species (Foy and Paul 1999, Foy and Norcross 1999, 2001). Good herring recruitment may be contingent on the presence of zooplankton populations enabling herring to achieve high fall WBEC values. Zooplankton must be studied to understand this source of WBEC variability. Zooplankton may vary in quality (origin and composition – species and stages of species) and quantity (zooplankton population density) and these aspects may be related to each other.

Oceanic zooplankton subsidies play a key role in the PWS marine ecosystem (Cooney et al. 2001). Oceanic zooplankton is comprised of large calanoid copepods (especially *Neocalanus* spp.) and krill (especially *Euphausia pacifica* and *Thysanoessa* spp.). Subsidies of oceanic zooplankton can be detected in PWS by stable carbon isotope abundance (Kline 1999). For example, > 60% of the variability of marine survival rate of hatchery pink salmon with a history of recruitment co-variation was explained by the relative proportion of oceanic carbon, measured as stable carbon isotope ratio, consumed by early marine stages (Fig. 1, Kline et al. submitted). In late 1995, a strong pulse of oceanic carbon subsidies was detected concurrently using $^{13}C/^{12}C$ in several taxa including herring and pollock juveniles, other forage taxa (fishes and invertebrates), as well as *Neocalanus* copepods resting (diapause stage) in the deep area of PWS (Fig. 1, Kline 1999, 2006). Oceanic subsidies were driven by influx of Gulf of Alaska origin zooplankton, which is based on the diagnostic value of $^{13}C/^{12}C$ values via stable isotope analysis (SIA; Fig. 2, Kline 1999). Oceanic zooplankton subsidies, however, may only be part of story. For example, WBEC of herring in 1995 was generally low although subsidies were high. However, when PWS YOY herring had high WBEC (Paul and Paul 1999), there was an inverse correlation between WBEC and YOY herring $^{13}C/^{12}C$ content (Fig. 2). Herring with low $^{13}C/^{12}C$ values in 1994 were due to incorporation of oceanic carbon. Thus in 1994 oceanic subsidies played a role yielding YOY herring of higher WBEC, when WBEC was above average. We did not measure zooplankton energy densities during SEA. It is possible that oceanic subsidies enabled better WBEC in 1994, if background values were better to start with. If ambient (without subsidies) zooplankton populations were very low in 1995, the relative contribution by subsidies would have been high by default. It is thus important to estimate zooplankton energy as well as source.

Oceanic subsidies may affect herring recruitment in two ways, first by providing more zooplankton food for herring and second, by reducing predation pressure on herring. Certain herring predators such as walleye pollock (*Theragra chalcogramma*) and baleen whales are facultative zooplanktivores. When zooplankton densities are above threshold levels, predators may switch from fish prey to zooplankton sparing juvenile salmon and herring (Willette et al. 1999). The relative proportion of zooplankton size classes will be compared by sampling with three different mesh sizes since YOY herring prefer zooplankton such as that sampled with finer mesh sizes (Sturdevant 2001). Thorne (2006) has observed the importance of specific kinds of zooplankton for salmon survival (Fig. 3). It is thus important to account for taxonomic composition, i.e., species enumeration and density (SED). Density is based upon quantitative sampling. Larger oceanic zooplankton species, such as calanoid copepods are consumed by juvenile herring in the spring (Foy and Norcross 1999, 2001). Oceanic subsidies may be more important for the spring recovery of WBEC.

Zooplankton energy density may be driving herring WBEC. Accumulated energy stores in herring are a result of the balance between that gained through foraging and the losses incurred during the foraging processes as well as metabolic losses. Higher zooplankton energy density will be a better quality food source if herring are able to increase WBEC with lower expenses. Herring WBEC differences within PWS may be explained by differences in zooplankton energy density (ZED) during feeding. Accordingly, ZED will be determined at the same sites where herring will be sampled for WBEC. Herring WBEC will be measured at specific points in time to correspond to those done in the SEA program and to correspond to starting (October) and ending points (March) of the herring over-wintering model, when there is very little zooplankton forage. ZED needs to be determined at times that are more representative of zooplankton abundance and herring feeding on zooplankton. Accordingly, ZED will be determined twice, during the May spring-bloom zooplankton peak and August, which is a mid-point during the initial growth phase of YOY herring (Foy and Norcross 2001). This is an economically driven minimal sampling strategy. Sampling throughout their initial growth as well as their spring recovery would be cost-prohibitive.

Zooplankton sampling will take place on three spatial scales: the central area of PWS, the four SEA bays (Zaikof, Whale, Eaglek, and Simpson Bays), and on a fine scale in eastern PWS. The relatively deep central area is an important zooplankton corridor for, and is located between, the four study bays of SEA and this study (see 'study area'). Standard acoustic transects established in the central area (Thorne 2006) will continue (see 'study area'). The continuity of sampling the four bays used in SEA will enable inter-decadal comparison of WBEC. Fine scale analysis is focused on eastern PWS in a project being led by R. Crawford (PWSSC). This project will provide Crawford with zooplankton analyses (SIA, ZED, and SED) that are analogous to those done in the four bays and central area. Comparable methods for ZED, SIA, and SED will enable relating data across these three spatial scales.

The diagnostic value of SIA to infer oceanic subsidies is based on comparing $^{13}C/^{12}C$ values of zooplankton from the continental slope with those in PWS (Fig. 2). A cross-shelf $^{13}C/^{12}C$ gradient has now been observed for 10 years. This was confirmed by the PI systematically sampling on U.S. GLOBEC program long-term observational program (LTOP) cruises (Fig. 2). LTOP systematic sampling will continue on this project but on a more limited scope compared to that done during GLOBEC. Current LTOP zooplankton sampling, consisting of the 13 stations comprising the 'Seward Line', GAK1 to GAK13, and three in Knight Island Passage in western PWS, is being lead by R. Hopcroft (UAF) with cruises funded by NPRB. The PI (Kline) is presently participating as a guest investigator on LTOP cruises to ensure continuity of collections since GLOBEC, to furnish the Steller sea lion project with SIA 'end-members.' An 'end-member' is the stable isotope value expected of an organism exclusively dependent on a given source of a given element. The oceanic carbon end-member of, e.g., -23, was based on samples from the continental slope whereas the coastal carbon end-member of, e.g., -19.5, was based on samples from PWS (Fig. 2). End-members need to be derived for both May and August. Continued participation in LTOP cruises will enable collecting May end-members exactly as was done on GLOBEC (Kline submitted to Deep-Sea Res. II). Two days of the August cruise will be dedicated to sampling out to the continental slope south of PWS to furnish a summer oceanic end-member. The summer PWS end-member data will come from the four bays as well as the central area.

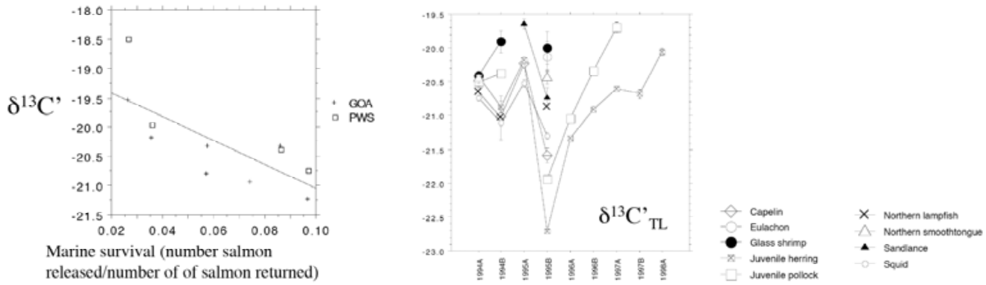

Figure 1. Left. Relationship between stable carbon isotope composition and marine survival rate for PWS hatchery pink salmon (line shows regression for combined sampling areas (R^2 =0.58, symbols by sampling area (R^2 = 0.63 (PWS), R^2 = 0.73 (GOA = Gulf of Alaska)). **Right.** Concomitant shifts in $^{13}C/^{12}C$ among PWS forage trophic level taxa during SEA suggested a large oceanic carbon pulse in late 1995. Years were split so that January through August was 'A' and September through December was 'B.' Figures from Kline et al. (submitted) and Kline 2006.

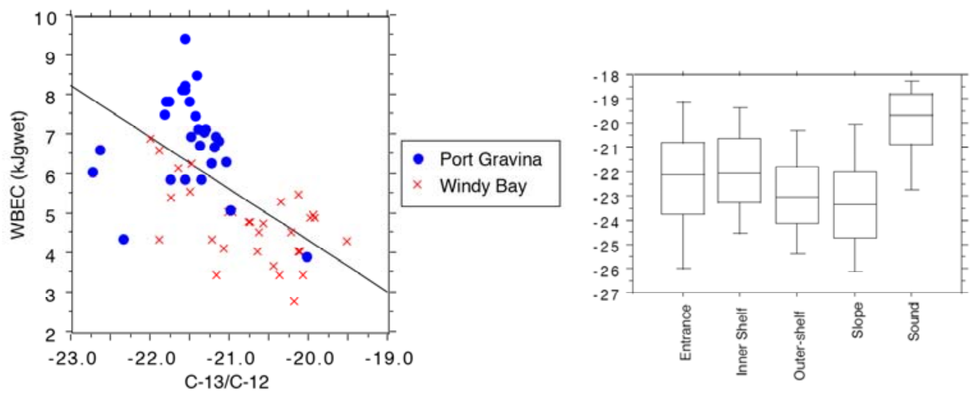

Figure 2. Left. Oceanic subsidies led to higher WBEC. Inverse relationship between $^{13}C/^{12}C$ and WBEC of YOY from fall of 1994 suggested oceanic carbon subsidies increased WBEC and the potential for over-winter survival for Port Gravina herring. In contrast, many if not most herring from Windy Bay were destined to die, R^2 = 0. 37. Paired analyses enabled this graph since both SIA and WBEC were made on the same individual fish. Similar sampling and analysis is proposed here. **Right.** Combined data from GLOBEC years 1998–2004 illustrates diagnostic value of $^{13}C/^{12}C$ data (left axis). Carbon measured in feeding stage *Neocalanus* from slope stations (Slope) was ^{13}C-depleted, had low $^{13}C/^{12}C$ values with a mean of –23, whereas feeding stage *Neocalanus* from PWS (Sound) was ^{13}C-enriched, had high $^{13}C/^{12}C$ with a mean of –19.5. Those from intermediate locations, Hinchinbrook Entrance, and the inner and outer shelf, had intermediate values reflecting mixing of these sources. Data for left panel from Paul and Paul () and Kline (1999); right panel from Kline (submitted).

A novel aspect of this study is determining ZED. Is ZED related to oceanic subsidies? A separate project funding by the Oil Spill Recovery Institute and a private foundation is sampling *Neocalanus* in deep areas of PWS during their resting phase (diapause). Based on their $^{13}C/^{12}C$, a large but variable fraction (can be >> 50%) of the *Neocalanus* diapausing in PWS come from the Gulf and not PWS (Kline 1999). About 90% of the *Neocalanus* from the 1995 year class diapausing in PWS came from the Gulf. This was the same year when herring and other forage taxa received strong Gulf subsidies. This concomitant relationship will be tested using the combined results of both projects. Multiple years of such a relationship would support the hypothesis that oceanic subsidies are a driving force for inter-annual variability in PWS.

Need for time series

By sampling early marine pink salmon over 7 years, encompassing poor to good marine survival rates, it was possible to show a relationship between oceanic food subsidies and marine survival rate (Kline et al. submitted). Accordingly, a long-term goal is to make concerted fisheries-oceanographic observations of herring over a sufficient period in order to find environmental linkages for good, as well as poor herring recruitment and answer the simple question: What does it take in terms of environment to make a good herring year class in PWS? Relationships between oceanic subsidies and zooplankton species composition with salmon survival rate was based on time-series observations. If the SEA program had run for six instead of four years and had ended in the spring of 2000 instead of the spring of 1998, it would have encompassed the first year of the stronger herring recruiting 1999 year class.

This project will address three over-wintering periods, 2006 to 2007, 2007 to 2008 and 2008 to 2009. Herring from the 2006 year will recruit as age 3 fish during 2009. WBEC data will provide an immediate performance parameter to partially overcome the inability to assess recruitment within the period of this project. Although sampling for this project will end in early 2009, the expectation is that it will continue in a second phase, albeit with sampling and analysis improvements, and will eventually lead to a time series analysis so that the question posed above can be answered.

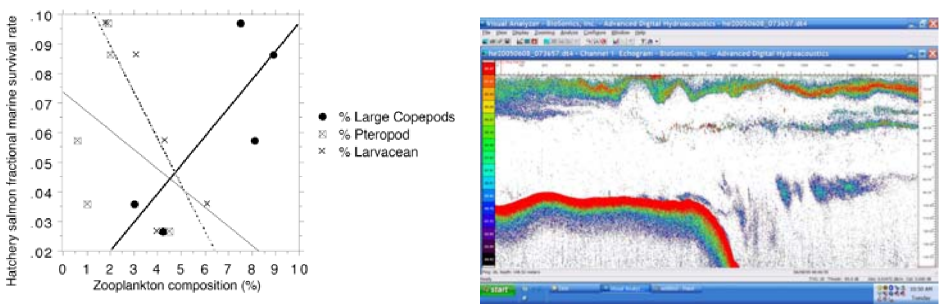

Figure 3. Left. Relationship between taxonomic composition of net plankton and salmon marine survival rate. Marine survival rate = number of adult salmon returning/number of salmon released. The percent of net samples comprised of large copepods, mainly *Neocalanus* spp, was directly correlated with survival $R^2 = 0.66$ (heavy line) whereas the percent composition of larvaceans (broken line) and pteropods (thin line) was inversely correlated with marine survival, $R^2 = 0.64$ and 0.10, respectively. These results illustrate how zooplankton composition may be as important as zooplankton abundance. **Right.** An example of an acoustic echogram collected by Thorne (2006) showing a strong zooplankton layer at ~ 10m depth, ranging from near the surface to ~ 20m. The lower layers are fish (Thorne pers. comm.). Acoustical data such as this will enable us to tow the Multinet horizontally through a layer with net openings and net closings conducted so as to sample particular features. Data and echogram figure from Thorne (2006).

Relevance to 1994 Restoration Plan Goals and Scientific Priorities

Herring remains in the non-recovered status. There is growing information on the culpability of EVOS in its decline, as well as indirect damage to the PWS ecosystem as a result of the herring collapse. PWSSC research shows that herring are an important winter-period food supply for at least three of the five other remaining non-recovered resources, including cormorants. The PWS herring crash is also implicated in the decline of the endangered western stock of Steller sea lions.

The effort proposed herein is relevant to most of the 8 categories for herring proposals outlined in the Invitation. It is most directly an oceanography effort, but the information is important for planning, modeling, predation and intervention. Oceanic subsidy assessment, WBEC and proximate data as part of the program would be useful to research in other areas such as modeling.

PROJECT DESIGN

Objectives

This is a three-year project that is designed to fill the information gaps on critical stage/seasonal data as outlined in Tables 1 and 2 in the QA-QC section. Listed within are objectives in terms 'cruise tasks' (Table 1) and sample particulars (Table 2).

Procedural and Scientific Methods

This project addresses the role of herring forage as a determinant of herring WBEC by leveraging existing studies and complementing other proposed studies. These other projects are focused on other ecosystem questions in the same time and space context. This project will provide support to these other projects through the zooplankton and herring analyses and by sharing vessel time. This project will enable a more complete picture by synergizing with an existing program that is specifically addressing herring as sea-lion forage. The same analyses are being performed by the PI.

This project deals with analysis of two trophic levels of the PWS ecosystem. One trophic level is the 'forage fish' trophic level of herring and similar trophic level fish competitors. They are often referred to as forage fish since many organisms, mammals and birds in particular, eat them. The other trophic level is that of zooplankton, which are the forage of zooplanktivores such as herring and other forage fish. This project will perform three types of analysis: natural stable isotope analysis (SIA), energy content, and species identification. SIA will be performed on individual fish and selected individual zooplankters to match what was done on previous studies (e.g., Kline 1999). SIA will also be done on bulk (the contents of a given net sample comprising a mixture a species and individuals) zooplankton samples collected quantitatively from layers in the water column in order to be matched to zooplankton energy density (ZED) measurements that will be performed on the same sample. Bulk sampling will ensure there is sufficient material to perform both analyses. Energy content will be determined on whole herring to be comparable with whole-body energy content (WBEC) determinations resulting from the SEA program. As was done during the SEA program, WBEC and SIA will be performed on the same individual fish.

Herring and other fish sampling

Herring and other fish sampling will be performed in a separate proposal titled "Trends in adult and juvenile herring distribution and abundance in PWS," PI Thorne. The PI and technician will participate, assist with sampling while collecting fish samples for WBEC and SIA on Thorne's herring cruises in March and October. Thorne will be locating herring schools acoustically which then be sampled with nets. Sub-samples of catches of herring and other forage fish taxa caught incidentally will be saved (frozen). Freezing was also the method used during SEA. Fish will be thawed in the laboratory and weighed. Herring otoliths will be extracted and sent to UAF (to Brenda Norcross and Nate Bickford). Their primary use of the otolith will be to determine the particular bay of origin of a given herring using geochemical techniques. Otoliths were also removed during SEA. The herring will be oven dried (60°C) to a constant weight (same technique as SEA). Dried sub-samples from each fish will be assessed for whole body energy content (WBEC) and stable isotope analysis (SIA) using mass spectrometry. Ten percent of the herring will also have WBEC determined using bomb calorimetry to validate the WBEC model described below. This will be more economical then doing bomb calorimetry on all samples, since relatively few, about 10 to 12 bomb calorimetric determinations, can be completed in an 8-hour day.

Zooplankton sampling

Zooplankton will be sampled in the four SEA bays (Zaikof, Whale, Eaglek, and Simpson Bays) and in the open area using two types of plankton nets, a Hydro-Bios Multinet Mini and ring nets. The Multinet is an electronically controlled multiple-net sampling device that can be towed vertically, horizontally, and obliquely. It has five nets that are deployed sequentially effecting vertically and horizontally stratified samples, according to how the net is towed. Nets are triggered by remote control via conducting cable or can be pre-programmed to specific depths (our Multinet can operate by both methods). Stratified horizontal tows will enable sampling horizontal features in the zooplankton distribution (Fig. 3). It has internal and external flow meters to determine the sample volumes. Nets are interchangeable. We have three mesh sizes, 150, 335 and 500 microns, respectively corresponding to the best size needed to collect herring forage (Sturdevant 2001), the standard mesh size used during SEA (Kline 1999), and the standard mesh size used during GLOBEC to sample meso-zooplankton (Coyle and Pinchuk 2005). Additionally we have ring nets of 0.5 and 1.0-meter diameter of 335 and 500 micron mesh nets equipped with flow meters that will be used to collect larger and rarer taxa needing greater sample volumes. The Multinet will be deployed horizontally at depths at which zooplankton layers are detected using hydro-acoustics. Ring nets will be towed vertically.

The Multinet unit is equipped with pressure (used to calculate depth), temperature, conductivity (used to calculate salinity), chlorophyll fluorescence, and dissolved oxygen sensors. It is effectively a plankton net combined with a CTD. The CTD capability will be used to assess relationships between zooplankton layers and other parameters, in particular where the phytoplankton is in relationship to the zooplankton. This will be useful for anticipated modeling activities to be done on other projects.

We will use acoustics to find zooplankton layers and then will deploy the Multinet in these layers. The acoustics will be run simultaneously so that the zooplankton abundance data can be used for calibration. Finite samples will be collected in the layers using the three mesh sizes. The fifth net of the Multinet must remain open and so will sample the water column from the layer to the surface. It will be used to sample live materials for sorting for SIA and for experiments. The other four nets of each Multinet deployment will yield four ‘closed’ (closed within zooplankton layers) samples, which will either be frozen (for combined SIA and ZED analysis) or preserved in formaldehyde (for identification and enumeration). The sample volume of the four closed samples will be known from the Multinet software, which uses the two flow meters. This sample volume will be the numerator for calculated ZED and zooplankton abundance per unit volume within zooplankton layers. This information will be provided to the acoustics PIs (collaborators Thorne and Crawford) so they can extrapolate the data to local area (fine scale project), bay, and Sound-wide according to acoustics data.

Bulk frozen zooplankton samples will be thawed, a wet weight determined, then oven dried (60°C) to a constant dry weight. Sub-samples of each dry zooplankton sample will be combusted in a Parr plain oxygen bomb calorimeter model 1341. Energy content will be reported as KJ/g wet and dry. The energy content of the sub-sample will be extrapolated to the whole sample and to in-situ ZED (KJm^{-3}) values using the sample volume. SIA will be performed on another sub-sample. SIA methods are described below.

Individual zooplankters will be sampled during cruises, sorted to species and stage (under microscopic examination) and preserved individually frozen in vials as described by Kline 1999.

The zooplankton samples preserved in formalin will be analyzed in the laboratory. Analyses will include enumeration after identification to species and stage based on microscopic examination. Sample volumes will be used to extrapolate to number, by species, per unit volume (m^3) in the zooplankton layers like the ZED data. These data will be furnished to acoustics PIs (collaborators Thorne and Crawford) so they can extrapolate the data to local area (fine scale project), bay, and Sound-wide according to their acoustics data.

SIA and WBEC

From the analysis of a single age-0 herring we will simultaneously determine whole-body energy content (WBEC) content and the carbon and nitrogen stable isotope composition via stable isotope analysis (SIA). WBEC predicted by a model using data from SIA (SIA protocols described in QA-QC section) compared favorably with that measured directly with a bomb calorimeter (Fig. 4). The advantage here is that one analysis will reduce costs and will serve a dual purpose. WBEC will be a by-product of SIA at no additional cost.

The energy content of bulk zooplankton samples will be determined using a Parr oxygen bomb calorimeter. Zooplankton energy density (ZED) will be calculated from the energy content of bulk zooplankton samples and the in situ zooplankton density. We will measure the wet and dry weight of bulk zooplankton samples from the Multinet for three mesh sizes, 150, 335, and 500 microns. Zooplankton density will be calculated by dividing these weights (dry and wet for each mesh size) with the volume sampled (from the Multinet's flowmeter). For each bulk sample, the ZED will be calculated by dividing the bulk energy content by the in situ zooplankton density. This will be done for each mesh size. The ZED values for each mesh size will be matched with acoustics data (projects of Crawford and Thorne) to extrapolate ZED values the zooplankton populations at each site (bay or transect according to survey type) to assess zooplankton forage energy.

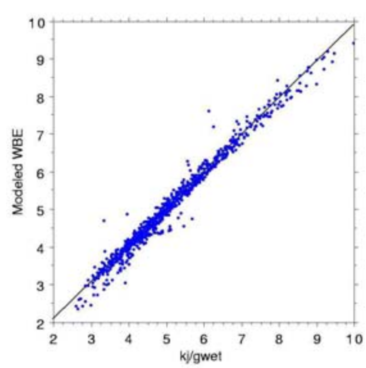

Figure 4. Modeled WBEC versus (vertical axis) measured WBEC (horizontal) content of juvenile herring from PWS sampled during the SEA project (units are kilo-Joules per gram wet mass). The close fit to the 45° line indicates that the model provides a good estimate of WBEC. The WBEC was measured using a bomb calorimeter which is being compared to modeled values based on C/N ratio and wet-dry ratio ($R^2 = 0.98$; $P < 0.01$); N = 833).

Cruises and Sampling

Cruises

Cruise are designated herring or zooplankton according to their primary sampling goal (Table 1 in QA-QC section). Herring cruises will be funded on a separate project (Thorne PI). There will be two juvenile herring sampling cruises per calendar year, one in March and one October. Two zooplankton cruises per calendar year will be funded by this project, one in May and one in August. There will also be two zooplankton cruises funded as part of the fine scale study (Crawford PI) in May and August. The PI's will be coordinating these two cruises each month as they will be participating in both. Which bays will be sampled first, second and so forth will be weather determined. This is an absolute requirement based on the PI's more than 25 years of aquatic research in Alaska. The weather is the limiting factor! Additionally, the PI will participate in the LTOP cruises funded by NPRB (Hopcroft PI). K. Coyle will be leading zooplankton sampling on these cruises. The PI has worked with Coyle for over a decade on MOCNESS sampling, which will be used to obtain zooplankton on this project as described by Kline (submitted). Table 1 also lists existing cruise funded by NOAA and the time course to early 2009.

The rationale for sample timing and geographic scope of cruises was given earlier. These rationales and tasks are listed in Table 1 (QA-QC section). The length of cruises is given in the lower block along with the funding source. Because this project will only be funding 22 days per year (see row labeled 'Kline – this project') this project will benefit substantially from cruises funded by other projects, from various sources, in collaboration with other PI's listed in this block.

Study area

The study encompasses PWS but with two foci, the 'four bays' studied during the SEA program and central Sound 'open areas' that have been monitored for zooplankton using acoustics since 2000 (Fig. 5), as well as the continental slope south of PWS. This sampling will provide continuity with previous research enabling systematic across-time comparisons with similar methodology.

The 'four bays'

During the SEA program four bays were selected and sampled for herring over the four-year course of the observational program (Norcross et al. 2001; Fig. 5). These are Whale Bay, in southwestern PWS; Eaglek bay in northwestern PWS, Zaikof Bay, west side of Hinchinbrook Entrance in southern PWS; and Simpson bay in eastern PWS. These bays should not be considered as replicates but instead as four rather different bays with many differences in geomorphology and oceanography (Gay and Vaughan 2001). It was necessary and will continue to be necessary to sample in four disparate bays such as these to encompass the range in habitat found in PWS, given that there were significant differences found in properties of herring from them (Norcross et al. 2001). Because of the proximity of eastern PWS to Cordova, it can, and will be sampled more intensively as part of a companion fine scale project (Crawford PI). Kline's project will be providing analytical support

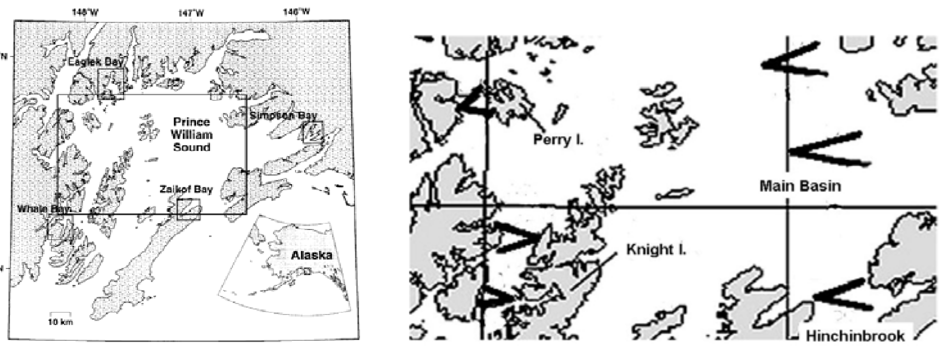

Figure 5 Left. The PWS study showing the four SEA bays and central area expounded in right panel. **Right.** Six standardized zooplankton acoustic transects from Thorne (2006).

The 'open areas'

The open areas in central PWS have been routinely sampled for zooplankton using six standardized acoustic transects shown in Figure 5. These areas are important for conveyance of plankton into the four bays from the Gulf and PWS. Sampling here will maintain continuity with a previous monitoring project, which is ending in 2006. Transects are located in deep water, which is important as zooplankton habit, especially for species that migrate vertically, either daily or as part of their life history (e.g., *Neocalanus*). The four bays are tributaries of this central area. The eastern end of PWS, Orca bay, and its tributary bays such as Simpson bay, is shallower than 200mm. Transects in the main basin are the nearest deepwater areas to Orca Bay.

Coordination and Collaboration with Other Efforts

This project will be coordinated and managed within the larger Prince William Sound Science Center program on juvenile herring research. There will be collaborators from outside the institution including, Alaska Department of Fish and Game, the University of Alaska (UAF), and the Prince William Sound Fisheries Research Applications Group. Samples and data from this project can be made be available for other uses including disease, marking and modeling. Prince William Sound Science Center program on juvenile herring research investigators leading separate projects include Dr. R. Thorne ("Trends in adult and juvenile herring distribution and abundance in PWS"), Dr. R. Crawford ("Characterization of Pacific herring nursery habitat in Prince William Sound"), Dr. M. Bishop ("Sea bird predation on juvenile herring"), and Doctoral candidate S. Gay ("Physical oceanographic factors affecting productivity in juvenile pacific herring nursery habitats"). This project will support these projects by providing data and results described in the proposal. Dr. Thorne's and Dr. Crawford's projects will provide vessel and sampling support for this project. Drs. Hopcroft and Coyle (UAF) and the PI were GLOBEC collaborators on LTOP cruises, which are being continued here. Vessel support for LTOP cruises comes from NPRB.

There will effectively be a quid pro quo arrangement with the projects being proposed by Thorne and Crawford to the same announcement. This project will be providing WBEC and SIA data on herring for Thorne's herring cruises. This project will be providing ZED, SED and SIA data on zooplankton Crawford's fine-scale process cruises. This project will be fund zooplankton cruises on which Crawford will provide acoustics support. The Crawford zooplankton cruises and those proposed here will be fully coordinated and likely will use the same vessel. The sampling order will be dictated by weather conditions. Combining cruise-days for both projects will optimize our ability to use weather windows for sampling more challenging sites (Gulf, central Sound, and Zaikof Bay – based on experience).

SCHEDULE

Project Milestones

The study will be conducted over a three-year period. The proposed starting date is October 1, 2006. The provisional cruise schedule is detailed in Table 1. It includes five juvenile herring surveys in PWS and four zooplankton surveys in PWS and the adjacent Gulf (see Table 1, QA-QC section). One juvenile survey will added during March of each year of the project, two in years one and two. All herring survey vessel charter time is funded on other projects (NOAA funded) or proposed projects (EVOS funded). Zooplankton surveys will be added in May and August of each year in years one and two. Zooplankton surveys will be of multiple legs comprised of cruises funded by separate projects. This project will be funding the vessel charter for one cruise each May and August each year for a total of four cruises over the duration of the project.

Measurable Project Tasks

FY07 1st Quarter (October 1, 06 to December 31, 06)

October	Project funding approved by Trustee Council

FY07 2nd Quarter (January 1, 07 to March 31, 07)

January	Annual Marine Science Symposium
March	Complete juvenile herring survey #1

FY07 3rd Quarter (April 1, 07 to June 30, 07)

May	Complete zooplankton survey #1

FY07 4th Quarter (July 1, 07 to September 30, 07)

August	Complete zooplankton survey #2
August	Submit Annual Report
September	PICES meeting Victoria, B.C.

FY08 1st Quarter (October 1, 06 to December 31, 06)

November	Complete juvenile herring survey #2
December	Complete analysis of juvenile herring survey #1
December	Complete analysis of zooplankton survey #1
December	Complete analysis of zooplankton survey #2

FY08 2nd Quarter (January 1, 08 to March 31, 08)

January	Annual Marine Science Symposium
February	AGU-ASLO-TOS Ocean Sciences Meeting, Orlando
March	Complete juvenile herring survey #3

FY08 3rd Quarter (April 1, 08 to June 30, 08)

May	Complete zooplankton survey #3
June	Complete analysis of juvenile herring survey #2

FY08 4th Quarter (July 1, 08 to September 30, 08)

August	Complete zooplankton survey #4

August Submit Annual Report

FY09 1st Quarter (October 1, 08 to December 31, 08)

November	Complete juvenile herring survey #4
December	Complete analysis of juvenile herring survey #3
December	Complete analysis of zooplankton survey #3
December	Complete analysis of zooplankton survey #4

FY09 2nd Quarter (January 1, 09 to March 31, 09)

January	Annual Marine Science Symposium
February	ASLO Aquatic Sciences Meeting, Nice
February	Complete analysis of juvenile herring survey #4
March	Complete juvenile herring survey #5

FY09 3rd Quarter (April 1, 09 to June 30, 09)

June	Complete analysis of juvenile survey #5

FY09 4th Quarter (July 1, 09 to September 30, 09

September	Submit Final Report. This will consist of a draft manuscript for publication to the Trustee Council Office

RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

Community Involvement and Traditional Ecological Knowledge (TEK)

This project is community based. It will be conducted out of the Prince William Sound Science Center (PWSSC) in Cordova, a community-based research and education center. The PWSSC is an existing community asset, since it consists of scientists and interested lay people and is in a community that depended on herring. We will employ local fishing vessels to do sampling. We will use their local knowledge of weather patterns.

The PI is a member of the Cordova-based PWS community research planning effort being led by Ross Mullins and Ken Adams (funded by the EVOS Trustee Council). The PI will continue to participate with this planning group and will exchange findings of the project as they develop.

Other community involvement consists of participation through the PWSSC education program. At the PWSSC, the PI has conducted well-received plankton exercises where students sample plankton with a small net in the Cordova harbor. They are then shown their own plankton collection and a variety of plankton from collections made on research cruises through microscopes. The PI also provides guest lectures and class exercises for the Cordova High School.

Resource Management Applications

Information from this project can incorporated into management models that are used to make decisions on herring fisheries management. The addition of juvenile herring information provides a potential forecast of recruitment. We may be able to advise best how and where to enhance populations through intervention from our assessment of the bays as good rearing habitat. The data will be made available to modelers of PWS herring (see modeling references in body of proposal).

PUBLICATIONS AND REPORTS

No costs for publications are specifically requested in this proposal beyond those for annual and final reports.

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Resume

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Education

1991	Ph.D. in Oceanography, University of Alaska, Fairbanks
1983	M.S. in Fisheries, University of Washington, Seattle
1979	B.S. in Fisheries, University of Washington, Seattle
1976	B.S. in Oceanography, University of Washington, Seattle
1972-74	Coursework at Sophia University, Tokyo

Research Accomplishments

- Dr. T. Kline developed natural stable isotope abundance techniques that provided the first direct evidence of the significant role of anadromous-salmon-marine-derived nutrients in freshwater ecosystems
- Dr. T. Kline developed natural stable isotope abundance techniques for detecting amphidromous fish migrations on the Alaska North Slope
- Dr. T. Kline developed natural stable isotope abundance techniques for providing evidence that production derived in the Gulf of Alaska plays a significant role subsidizing Prince William Sound food webs
- Dr. T. Kline discovered the existence of large inter-annual variations in natural stable isotope abundance in the Gulf of Alaska and their probable cause by meso-scale eddies
- Dr. T. Kline determined that oceanic subsidies enhance the marine survival rate of Prince William Sound pink salmon populations

Professional Appointments

1994-2006	Research Scientist, Prince William Sound Science Center
1995-2006	Director, Prince William Sound Science Center Scientific Diving Program
1995-2006	Diving Safety Officer, Prince William Sound Science Center Scientific Diving Program
1992-93	Instructor, University of Alaska Fairbanks
1991-94	Postdoctoral Fellow, University of Alaska Fairbanks
1985-91	Research Assistant, University of Alaska Fairbanks
1984-85	Teaching Assistant, University of Washington
1977-83	Research Assistant, University of Washington

Five Related Recent Research Papers (all based on EVOS Trustee Council funded projects)

2006 Kline, T.C. Jr. Trophic relationships among Prince William Sound, Alaska rockfishes. *In*: V. O'Connell (ed.) Biology, Assessment, and Management of Pacific Rockfishes. University of Alaska Sea Grant, Fairbanks. IN PRESS

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2001 Paul, A.J, J.M. Paul and **T.C. Kline, Jr.** Estimating whole body energy content for juvenile Pacific herring from condition factor, dry weight, and carbon/nitrogen ratio. *In:* F. Funk, J. Blackburn, D. Hay, A.J. Paul, R. Stephenson, R. Toresen, and D. Witherell (eds.), Herring: Expectations for a New Millennium. University of Alaska Sea Grant, AK-SG-01-04, Fairbanks. p. 121-133.

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Recent Collaborators

Coyle, K., Cooney, R., Haldorson, L., Hopcroft, Weingartner, T., Whitledge, T. (Univ. Alaska Fairbanks); Bishop, M., Schoch, C., Thorne, R. (P.W.S. Science Center); Moffitt, S. (Alaska Dept. Fish and Game); Knudsen, E., Woody, C. (U.S.G.S.); Cheng, L. (Univ. Calif. San Diego); Boldt, J., Hermann, A., Hinckley, S. (NOAA)

Resume

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EDUCATION
2002-present Graduate School of Oceanography, University of Rhode Island Kingston, RI
Ph.D. candidate in Oceanography (anticipated completion date: 09/06)
Graduate Adviser: D.J. Gifford

2001 Graduate School of Oceanography, University of Rhode Island Kingston, RI
M.S. in Oceanography
Graduate Adviser: D.J. Gifford

1999 The University of Tampa Tampa, FL
B.S. Majors: Marine Science and Biology, Minor: Chemistry

RESEARCH INTERESTS
Biological Oceanography. Ecology and physiology of marine zooplankton with an emphasis on feeding, growth and reproduction. The trophic role of gelatinous zooplankton, and importance of microzooplankton in their diets. Development of marine invertebrate larvae. The distribution and abundance of zooplankton.

PROFESSIONAL EXPERIENCE
2004-Present Dr. Dian Gifford, University of Rhode Island, Narragansett, RI
Research Assistant
Examined the trophic role of small hydromedusae, specifically the grazing on microplankton and the potential impact of hydromedusae on the spring bloom. Measured growth rates of small hydromedusae on microplankton diets.

2001-2003 Dr. Dian Gifford, University of Rhode Island, Narragansett, RI
Research Assistant
Examined the role of microplankton in the diet of larval ctenophores as it pertains to initiation and maintenance of ctenophore blooms in northern temperate coastal waters.

1999-2000 Dr. Dian Gifford, University of Rhode Island, Narragansett, RI
Research Assistant
Quantified growth rates of *Calanus finmarchicus* nauplii in relation to frontal structures on Georges Bank using image analysis. Research assistantships involved field work, laboratory experiments, sample processing and data analysis. Additional responsibilities included general lab maintenance, as well as care for and maintenance of numerous laboratory cultures. Through these research assistantships I had the opportunity to both supervise and mentor several high school students and undergraduate research projects. I also had the opportunity to be involved in

conception and preparation of the proposals that funded my two most recent research assistantships.

TEACHING EXPERIENCE

2004 Spring University of Rhode Island, Kingston, RI
Teaching Assistant
To Dr. Craig McNeil for the undergraduate course "General Oceanography," an upper level course for Marine Biology students.

2001 Fall University of Rhode Island, Kingston, RI
Teaching Assistant
To Dr. Paul E. Hargraves for the undergraduate course "General Oceanography," an upper level course for Marine Biology students.

2001 Spring University of Rhode Island, Kingston, RI
Teaching Assistant
To Dr. Bradley S. Moran for the undergraduate course "Introduction to Oceanographic Science" an upper level course for Ocean Engineering students. Teaching assistantships involved preparing and delivering numerous lectures, writing and grading homework assignments, reports, quizzes and tests, meeting students and addressing their questions and concerns, and administering grades.

PUBLICATIONS

Waggett, R.J., and **L.J. Sullivan**. *Accepted for publication*. Feeding efficiency of the larval ctenophore *Mnemiopsis leidyi* A. Agassiz (Ctenophora, Lobata). *Journal of Plankton Research*

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Sullivan, L.J. 2001. The diet of the larval ctenophore, *Mnemiopsis leidyi* A. Agassiz (Ctenophora, Lobata). M.S. Thesis, University of Rhode Island, Graduate School of Oceanography. 134p.

ACADEMIC HONORS AND AWARDS

2006 Ann Durbin Award in Biological Oceanography. Achievement based award for biological oceanography graduate students given in memory of Ann Durbin, Professor of Oceanography.

2005 Ada L. Sawyer Award. Achievement based award for female graduate students, established in memory of Ada L. Sawyer, the first female admitted to the Rhode Island bar.

2004 P.E.O. Scholar Award. Substantial achievement based award for women of the United States and Canada who are pursuing advanced degrees or are engaged in advanced study and research at an accredited institution.

2004 Ann Durbin Award in Biological Oceanography. Achievement based award for biological oceanography graduate students given in memory of Ann Durbin, Professor of Oceanography.

2003 Honorable Mention. Honorable mention for a student oral presentation at the 3rd International Zooplankton Production Symposium in Gijón, Spain.

2000 Henry S. Farmer Award in Biological Oceanography. Award for biological oceanography graduate students showing an interest in preserving and developing the oceans as a biological resource, a food source, or an economic activity.

RECENT COLLABORATORS

D. Gifford, P. Hargraves, C. McNeil, B. Moran, R. Waggett, B. Sullivan-Watts (Univ. Rhode Is.), J. Costello (Providence Coll.)

FY 07 was approved at the Trustee Council Meeting of 11/14/06; FY 08 & FY 09 are pending.

BUDGET JUSTIFICATION - $773.4K

This project is essentially like a combination of two separate sub-projects of the SEA project and a separate isotope project. These were project 320I and 311, which were led by PI Kline, and project 320U, which was led by PI Paul. The collective budget of these prior projects was about $2million. The proposed project has additional goals that were not part of either 311, 320I or 320U, that of zooplankton species enumeration and their density and that of zooplankton energy density. This is thus a very economical budget.

Personnel – Total $377.5

The employment period is annual, therefore salary is shown on budget forms under "calendar months." Salaries requested are consistent with the PWSSC's regular practices.

Three project personnel will be required to perform tasks during zooplankton sampling cruises – a winch operator, a deck unit operator and a primary net handler. Once the deck unit is shut off during a net recovery, the computer operator will assist the primary net handler in bringing the net onto the vessel. We will require that vessel personnel operate the vessel's boom. Personnel will consist of the PI (part time), one post-doc, and a technician. The post-doc will serve as co-PI, will lead zooplankton taxonomic analysis, assist in sampling and lead the laboratory processing of samples in preparation for SIA. The technician will assist in both the field and laboratory. The P.I. will lead field sampling, perform data interpretation, supervise other personnel, and perform administrative functions.

Fringe Benefits – Fringe benefits are incorporated into the average monthly cost. 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 day on cruises. The PI's average monthly rate is less in FY09 because of the reduced number of sea-days (only the March cruise in 2009).

Travel – Total $9.6K

Travel Funds are being requested for attendance at the annual January Alaska Marine Science Symposium, one round-trip to Seward for the PI and post-doc to participate on LTOP cruises, and conferences (one per year for the P.I. and post-doc), and other travel associated with the proposed work, including subsistence. It is also essential to keep up with developments in the isotope research field, particularly given the remoteness of living and working in Alaska. Attendance at meetings or conferences will enhance our ability to perform the work, plan extensions of it, or disseminate its results. Registration fee is based upon the announced fee registration fee for the ASLO 2007 Aquatic Sciences Meeting (Santa Fe, NM) of $0.4K.

Travel is planned to national or international (e.g., when US organizations such as ASLO meet in another country) level scientific conferences. Anticipated conferences include: the PICES Annual Meeting September 2007 Victoria, B.C., the ASLO-AGU-TOS Ocean Sciences Meeting February 2008, Orlando, and the ASLO Aquatic Sciences Meeting January 2009 Nice, France. Air travel is based on the current cost of round-trip, economy air fares (actual recent discounted fares, not full fares which are approximately twice a great). Travel will be by US-flag carriers, if available.

Contractual – Total $130.6K

A major cost in the contractural category is the actual mass spectrometric (isotopic) analysis of the samples which is outsourced (see QA-QC section). We will contract a local vessel (24 days per year), cost is based upon recent experience with the type of vessel needed. A vessel of at least 20m length will be needed to provide enough deck space for equipment. We also will need to be able to bunk four scientists. Shipping costs anticipate having to pay hazardous material (a.k.a. hazmat) delivery charges for oxygen, benzoic acid, and formalin. The PWSSC presently levies a $100 per person-month network charge.

Equipment & Commodities- Total $41.1 (all items under $5K)

Major laboratory supplies each year include expendables such as Omni and LSC vials, chemicals (e.g.,

formalin), sample bags, a spare parts kit, benzoic acid pellets, ignition wire and oxygen for the Parr bomb. Initial supplies include a Parr Plain Jacket Oxygen Bomb Calorimeter at $4.5K (in equipment in FY 07), which requires an ignition unit at $0.4K, high-end (large screen with lots of RAM ≥2GB and speed ≥2GHz) laptop computers ($3K ea., total $6K in equipment in FY 07) one each for PI and post-doc on cruises as well as on land. We will use the old deep-sea (~ 800m) winch bought on the SEA project. A new one will be purchased only if needed.
Each year we anticipate having to replace plankton nets (total of 3 at $1.05K), plankton net buckets (3 at 1.6K), the 'canvas part' (one at $1K), and one of the impellers of the Multinet, replacement rate, based on experience. Annual maintenance also requires buying a Multinet maintenance kit ($2.9K). Each year we anticipate having to replacement 1 ring-net ($0.5K), also based on experience.

Funds from non-EVOS sources, including in-kind contributions: Private foundation grant (M.J. Murdock) provides support for post-doc position during Year 1 only; this grant also bought the HydroBios Multinet ($80K) and provides some lab analysis and vessel charter support. Total Murdock funding is $260K (FY 07). NOAA is funding the Steller sea lion project (Thorne lead PI) that will provide comparison data as described in the proposal. This project is funded at $350K in FY 07 and $250K in FY 08. The Oil Spill Recovery Institute is contributing $40K in FY 07 to support sampling the diapausing *Neocalanus* project funded through Murdock, which will be compared to herring as described in the proposal. The PWS Ocean Observing System is contributing one month of PI time so that data from this project can be incorporated into the Observing System (FY 07 contribution about 15K). Additional support from the PWSOS in FY08 is probable but not yet appropriated. Non-EVOS funds thus far that most directly match this project's work amount to $415K in FY 07 and $250K in FY 08, for project total of $665K. Note that additional funds referenced above are in collaborative projects.

Our federal cognizant agency is NOAA. Future estimates of the negotiated rate were provided by the contracting officer, P. Oswalt, who should be contacted for more details.

DATA MANAGEMENT QA/QC

1. Study design, sample type(s) and location requirements, statistical analyses, types and numbers of physical samples.
<u>A Sample type.</u>

1. Fish (frozen – for stable isotope analysis (SIA) and whole body energy content (WBEC) analysis)
2. Zooplankton (frozen – for SIA and zooplankton energy density (ZED))
3. Zooplankton (preserved in formalin for identification to species and stage, enumeration and density (SED))

<u>B Locations.</u>
The area study encompasses Prince William Sound but with two foci, the 'four bays' studied during the SEA program and central Sound 'open areas' that have been monitored for zooplankton using acoustics since 2000 (Fig. 1 in main body of proposal), as well as the continental slope south of PWS. This sampling will provide continuity with previous research enabling systematic across-time comparisons with similar methodology.

Table 1. Outline of cruise schedule.

Timing	March	Early May	Mid-May	August	October
2006	existing	existing			existing
2007	proposed	proposed	proposed	proposed	existing
2008	proposed	proposed	proposed	proposed	proposed
2009	proposed				
Rationale	Herring 0-age post-winter	LTOP spring Bloom SEWARD LINE	Spring zooplk bloom PWS	Herring YOY growth	Herring YOY pre-winter
Designation	Herring	Zooplankton	Zooplankton	Zooplankton	Herring
GLOBEC time series		X		X	
SEA comparison time series	X	X	X		X
<u>Task</u>					
Adult Herring acoustics	Thorne				
Zooplankton acousitcs		Coyle	Crawford	Crawford	
Zooplankton species		Coyle	X	X	
Zooplankton SIA		X	X	X	
Zooplankton energy		X	X	X	
Juv. Herring acoustics	Thorne				Thorne
Juv. Herring SIA & WBEC (fish capture)	X				X
Herring competitors SIA (fish capture)	X		June-ADFG		X
Avian aggregation	Bishop				Bishop
<u>Geographic scope</u>					
Sound-wide survey	X (NOAA)		X (new)	X (new)	X (NOAA)
Four fjords	X (new)		X (new)	X (new)	X (new)
GOA shelf & slope		X (NPRB)		X (new)	
Fine-scale eastern PWS (Crawford)			X (new)	X (new)	
<u>Vessel-days</u>					
Vessel Charter (Thorne)	16				16
Vessel Charter (Crawford)			5	5	
Vessel Charter (Hopcroft)		5			
Vessel Charter (Kline - this project)			10	12	

<u>C Study design with sample numbers.</u>
Sampling design is categorized according to sample type (fish or zooplankton) and cruise type (Table 1). Zooplankton is further categorized into samples that will be combusted and bombed (for SIA and ZED) and those that will be enumerated (SED), which are outlined in Table 2.

Herring and other fishes. A sample size of 25 herring per bay will be adequate for statistics (Paul and Paul 1998a, Kline 1999). Four bays will be sampled on each herring cruise. We will sample up to 100 YOY herring per bay. We will select randomly from each bay 25 YOY herring for SIA. There will thus be a total of 100 herring for SIA per survey. Ten of these will be randomly selected for bomb calorimetry. On each herring cruise, forage trophic level fish (similar to herring, thus competitors, which area expected to shift concomitantly in SIA with herring, will be selected randomly from each bay for SIA. Fifteen forage fish will be selected per bay for a total of 60 per cruise. There will thus be 160 fish per cruise. One hundred additional herring competitors, mainly YOY salmon, will be collected by ADFG in PWS in June-July. The more than half billion salmon released into PWS each spring may be the most significant competitors of herring for zooplankton resources. Furthermore, the relative proportion of oceanic subsidies in YOY salmon in a given year was independent of month during the July - October period (Kline et al. submitted) suggesting they were not a short-lived phenomenon within a year. Therefore, concomitant oceanic subsidies are expected among all planktivorous fish taxa. Thus each 420 fish will undergo SIA. Twenty of the herring will also be bombed.

Table 2. Outline of project zooplankton samples.

Zooplankton SIA and ZED. Sample design for SIA and ZED varies by sample area-cruise as described below:

The four bays (Zaikof, Whale, Eaglek, and Simpson Bays; both May and August)

There will be two Multinet tows per bay. Each tow will consist of two each 150micron, one each 335 and 500 micron samples for a total of 4 samples per tow. There will thus be 8 SIA and ZED samples per bay, thus 32 samples per cruise.

Slope stations (due south of PWS where is Z > 300 m) in August

There will be four Multinet tows with four samples per tow like in the four bays for a total of 16 samples per cruise. There will be six ring net tows for a total of 6 samples per cruise. 50 individual *Neocalanus* will be picked for SIA only, consistent with Kline (1999) and Kline (submitted).

Central area in six transects (Thorne's existing transects; both May and August)

There will be one Multinet tow per transect with four samples per tow like in the four bays for a total of 24 samples per cruise. There will be one ring net per transect for a total of 6 samples per cruise.

Fine-scale analysis (sites to be determined by Crawford; both May and August)

There will be six Multinet tows with four samples per tow like in the four bays for a total of 24 samples per cruise.

LTOP cruise (existing stations; early May)

A sub-sample of the MOCNESS drogue (Kline submitted) will be saved from each LTOP station for combined SIA and ZED for a total of 16 samples per cruise. 100 individual *Neocalanus* will be picked for SIA only, consistent with Kline (1999) and Kline (submitted).

The number of zooplankton samples for combined SIA and ZED per May/August is 32 + 30 + 24 + 16 = 102. Total zooplankton combined SIA and ZED per year is 204. Total number of bomb samples per year is thus 204 + 20 (fish) = 224. The total number of individual zooplankter SIA per year is150.

Zooplankton samples to be identified and enumerated by species and stage for SED. Sample design for SED varies by sample area-cruise as described below:

The four bays (Zaikof, Whale, Eaglek, and Simpson Bays; both May and August)

There will be one Multinet tows per bay. Each tow will consist of two each 150micron, one each 335 and 500 micron samples for a total of 4 samples per tow. There will thus be 4 SED samples per bay, thus 16 samples per cruise.

Slope stations (due south of PWS where is Z > 300 m) in August

There will be two Multinet tows with four samples per tow like in the four bays for a total of 8 samples per cruise. There will be two ring net tows for a total of 2 samples per cruise. Total slope station SED samples will thus be 10.

Central area in six transects (Thorne's existing transects; both May and August)

There will be one Multinet tow per transect with four samples per tow like in the four bays for a total of 24 samples per cruise. There will be one ring net per transect for a total of 6 samples per cruise. Total slope station SED samples will thus be 30 per cruise.

Fine-scale analysis (sites to be determined by Crawford; both May and August)

There will be three Multinet tows with four samples per tow like in the four bays for a total of 12 samples per cruise.

There will be a total of 16 + 30 + 12 = 58 SED samples per May cruise: 16 + 30 + 12 = 58, and a total of 16 + 10 + 30 +12 = 68 SED samples per August cruise. The total number of SED samples per year will thus be 126.

D Statistical tests.

Data from this project will be comparable with the historical data from the mid 1990's as well as among the sampling sites and years of the proposed project. SIA and WBEC will be done with ANOVA statistical procedures in mind. ANOVAs will be possible to test for year (e.g., 2007 vs. 1995), and site (e.g., one of the bays) effects. Same seasons will be compared among years, e.g., one Fall versus another Fall as was done by Kline (1999). Ontogenetic effects will be determined by plotting WBEC and SIA as dependent variables using standard length as the independent variable (linear regression). This will be done for data aggregates well as by sampling cruise. Previously, there was 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 size of herring when recruited into bays as very few smaller than this were sampled during 1994 - 1998 (Kline 1999, Kline 2001).

E Essential metadata.

Name of bay (location), Month, Year (to be recorded) – factors to be use in ANOVA

Fish standard length, wet weight, dry weight – to be measured and used as independent variables in regressions for WBEC and

stable isotope values
WBEC and stable isotope values will also be regressed against each (e.g., see Fig. 2 in main body of proposal).

2. Criteria for determining acceptable data quality in terms of the activities to be performed or hypotheses to be tested.

Criteria = significance values for standard statistical tests: Alpha = 0.05 and P = 0.05

3. Metadata 'lite' information.

Title: Prince William Sound Herring Forage Contingency
Date: 1 August 2006
Contacts: Dr. Thomas C. Kline, Jr.
Access: via web and e-mail
Use and Security Policies: open via web
Contacts and Credits: Dr. Thomas C. Kline, Jr.
Geographical Boundaries: Northern Boundary: 60.8° N Latitude, Southern Boundary: 55.0° N Latitude, Eastern Boundary: 145.5 W Longitude, Western Boundary: 148.5 W Longitude
b. species-specific measurements- stable C and N isotope value and WBEC
taxonomic sampling—identification to species and stage (e.g. copepodite 5 for copepods, e.g., juvenile for fishes)

4. Algorithms.

Isotopic analysis is outsourced to labs using continuous flow isotope ratio mass spectrometers (CFIRMS). All algorithms are internal to the machine. Isotope abundance data are reported to the PI in conventional delta units.

5. Handling and custody of samples.

Samples are frozen, held frozen until freeze dried then stored dry. Identification to species and stage takes place in the field. Samples remain in the custody of the P.I. at all times except for when being shipped in which case Express Mail is used for tracking. Isotopic analyses will be outsourced to either the University of Alaska Stable Isotope facility or the Colorado Plateau Stable Isotope Laboratory at Northern Arizona University according to backlog status and price at each lab. This approach will expedite analysis while maintaining good quality. Both labs use similar equipment, Finnegan Delta Plus continuous flow isotope ratio mass spectrometers (CFIRMS), and employ similar quality assurance and quality control protocols. Dr. Kline has a history of outsourcing to these labs. Preserved samples will be preserved in the field and disposed of after counting in accordance to direction given by the sewage treatment authority (1 gallon per day allowed).

6. Calibration and evaluation of instrumentation.

Quality assurance and quality control protocols include analyses of laboratory standards before and after every five samples as well as periodic (1 in every 5 samples) sample duplication.

7. Procedures for data reduction and reporting.

A single isotopic 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 consist of $\delta^{13}C$, $\delta^{15}N$ and C/N.

Stable carbon isotope ratios will be normalized for lipid content following the methods of McConnaughey and McRoy (1979) and trophic level following the method of Kline et al. (1998) and expressed as $\delta^{13}C_{TL}$' following Kline (1999). The $\delta^{13}C_{TL}$' will reflect source, either GOA or PWS, which have end-member values of –23.0 and –19.5, respectively (Kline 1997, 1999, 2001).

Trophic level will be determined by comparing $\delta^{15}N$ values to a reference value (Vander Zanden et al. 1997). The $\delta^{15}N$ of higher trophic levels will be calculated by adding the trophic enrichment factor, 3.4 (Minagawa and Wada 1984, Checkley and Miller 1989, Kline 1997), to the reference value. The herbivorous, i.e., trophic level = 2, copepod *Neocalanus cristatus*, will be used as the reference (Kline and Pauly 1998, Kline 1999). ***N. cristatus*** was chosen as the reference herbivore based upon observations that their carbon isotope values corresponded with those of PWS fishes (Kline 1999). Furthermore, ***N. cristatus*** will be sampled and SIA will be performed on them in the companion zooplankton project being submitted simultaneously to NPRB. The following formula will be used to calculate trophic level: $TL_i = (\delta^{15}N_i - \delta^{15}N_H/ 3.4) + 2$, where TL_i is the trophic level of organism i, $\delta^{15}N_i$ is the mean $\delta^{15}N$ value of organism i, and $\delta^{15}N_H$ is the mean reference herbivore $\delta^{15}N$ value.
The following applies to herring:

From the analysis of a single age-0 herring we will simultaneously determine whole-body energy content (WBEC) and the carbon and nitrogen stable isotope composition via stable isotope analysis (SIA). Wet and dry weight will be measured using an electronic balance and with carbon to nitrogen ratio data that are a product of SIA. WBEC will be determined using the following empirical model: WBEC (kJg^{-1} (wet mass)) = 0.103 x C/N (carbon-nitrogen atom ratio) + 32.60 x D/W (dry-wet ratio) –2.904. This model was determined empirically from measurements of herring from PWS (Kline unpublished; Paul et al. 2001). WBEC predicted by the above model compared favorably with that measured directly with a bomb calorimeter (Fig. 4 in main body of proposal). SED and ZED will computed by dividing direct measures with sample volumes obtained using the Multinet flowmeters.

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 07 - FY 09

Budget Category:	Approved FY 07	Pending FY 08	Pending FY 09		TOTAL PROPOSED
Personnel	$103.4	$167.8	$106.3		$377.5
Travel	$3.2	$3.2	$3.2		$9.6
Contractual	$58.5	$64.4	$7.7		$130.6
Commodities	$13.7	$13.2	$3.7		$30.6
Equipment	$10.5	$0.0	$0.0		$10.5
Subtotal	$189.3	$248.6	$120.9		$558.8
Indirect (rate will vary by proposer)	$51.1	$67.1	$32.6		$150.8
Project Total	$240.4	$315.7	$153.5		$709.6
Trustee Agency GA (9% of Project Total)	$21.6	$28.4	$13.8		$63.8
Total Cost	$262.0	$344.1	$167.3		$773.4
Other Resources:					

Comments:

FY 07 was approved at the Trustee Council meeting of 11/14/06; FY 08 & FY 09 are pending

Funds from non-EVOS sources, including in-kind contributions: Private foundation grant (M.J. Murdock) provides support for post-doc position during Year 1 only; this grant also bought the HydroBios Multinet ($80K) and provides some lab analysis and vessel charter support. Total Murdock funding is $260K (FY 07). NOAA is funding the Steller sea lion project (Thorne lead PI) that will provide comparison data as described in the proposal. This project is funded at $350K in FY 07 and $250K in FY 08. The Oil Spill Recovery Institute is contributing $40K in FY 07 to support sampling the diapausing Neocalanus project funded through Murdock, which will be compared to herring as described in the proposal. The PWS Ocean Observing System is contributing one month of PI time so that data from this project can be incorporated into the Observing System

FY 07-09

Project Number: 070811
Project Title: Prince William Sound Herring Forage Contingency - Submitted under the BAA
Proposer: T.Kline, PWSSC

Date Prepared: 1 August 2006

***EXXON VALDEZ* OILSPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 07 - FY 09

Personnel Costs:			Months	Monthly		Personnel
Name	Description		Budgeted	Costs	Overtime	Sum
T. Kline	PI		5.0	11.5		57.5
R. Campbell	Post-doc		0.0	0.0		0.0
TBN	Tech		9.0	5.1		45.9
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	14.0	16.6	0.0	
					Personnel Total	$103.4

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Annual meeting	0.3	2	8	0.2	2.2
Cruise travel	0.3	2	4	0.1	1.0
(Inter)natioanl meeting	0.0	0	0	0.0	0.0
Abstract fee	0.0	0			0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.2

FY 07

Project Number: 070811
Project Title: Prince William Sound Herring Forage Contingency - Submitted under the BAA
Proposer: T.Kline, PWSSC

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 07 - FY 09

Contractual Costs:	Contract
Description	Sum
Vessel Charter (purse seiner)	33.6
Photocopying	0.3
PWSSC Network charge (computer-months)	1.4
Stable isotope analytical (freeze-dry)	13.7
Stable isotope lyophilizer useage	1.7
Stable isotope analytical (oven-dry)	4.9
Shipping include hazmat	1.0
Communications(fax&phone)	0.3
2 R/T (one per Juv Herring cruise) aircharter CDV-western PWS	1.6
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$58.5

Commodities Costs:	Commodity
Description	Sum
calorimeter spare parts kit	0.3
ignition unit	0.4
Multinet maintenance kit	2.9
Replacement Multinet nets (3)	1.0
Replacment Multinet buckets (3)	1.5
Replacement Multinet canvas part (1)	1.0
Replacement impeller	0.2
Replacement ring net	0.5
Lab supplies- chemicals, gases, vials, bags	3.5
Office supplies	0.4
Computer supplies - software, upgrades	2.0
Commodities Total	$13.7

FY 07

Project Number: 070811
Project Title: Prince William Sound Herring Forage Contingency - Submitted under the BAA
Name: T.Kline, PWSSC

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 07 - FY 09

New Equipment Purchases:	Number	Unit	Equipment
Description	of Units	Price	Sum
Oxygen bomb calorimeter plain	1	4.5	4.5
Laptop computer (high end)	2	3.0	6.0
			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	$10.5

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency
Winch	1	PWSSC
Balance	1	PWSSC

FY 07

Project Number: 070811
Project Title: Prince William Sound Herring Forage Contingency - Submitted under the BAA
Proposer: T.Kline, PWSSC

EXXON VALDEZ **OILSPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 07 - FY 09

Personnel Costs:			Months	Monthly		Personnel
Name	Description		Budgeted	Costs	Overtime	Sum
T. Kline	PI		5	11.8		59.0
R. Campbell	Post-doc		9	6.2		55.8
TBN	Tech		10	5.3		53.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	24.0	23.3	0.0	
					Personnel Total	$167.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Annual meeting	0.3	2	8	0.2	2.2
Cruise travel	0.3	2	4	0.1	1.0
(Inter)natioanl meeting	0.0	0	0	0.0	0.0
Abstract fee	0.0	0			0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.2

FY 08

Project Number: 070811
Project Title: Prince William Sound Herring Forage Contingency - Submitted under the BAA
Proposer: T.Kline, PWSSC

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 07 - FY 09

Contractual Costs:	Contract
Description	Sum
Vessel Charter (purse seiner)	38.4
Photocopying	0.3
PWSSC Network charge (computer-months)	2.4
Stable isotope analytical (freeze-dry)	13.7
Stable isotope lyophilizer useage	1.7
Stable isotope analytical (oven-dry)	4.9
Shipping include hazmat	1.0
Communications(fax&phone)	0.3
2 R/T (one per Juv Herring cruise) aircharter CDV-western PWS	1.7
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$64.4

Commodities Costs:	Commodity
Description	Sum
calorimeter spare parts kit	0.3
ignition unit	0.4
Multinet maintenance kit	2.9
Replacement Multinet nets (3)	1.0
Replacement Multinet buckets (3)	1.5
Replacement Multinet canvas part (1)	1.0
Replacement impeller	0.2
Replacement ring net	0.5
Lab supplies- chemicals, gases, vials, bags	3.5
Office supplies	0.4
Computer supplies - software, upgrades	1.5
Commodities Total	$13.2

FY 08

Project Number: 070811
Project Title: Prince William Sound Herring Forage Contingency - Submitted under the BAA
Proposer: T.Kline, PWSSC

***EXXON VALDEZ* OILSPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 07 - FY 09

New Equipment Purchases:	Number	Unit	Equipment
Description	of Units	Price	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:	Number	Inventory
Description	of Units	Agency
Winch	1	PWSSC
Balance	1	PWSSC

FY 08

Project Number: 070811
Project Title:Prince William Sound Herring Forage Contingency - Submitted under the BAA
Proposer: T.Kline, PWSSC

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 07 - FY 09

Personnel Costs:			Months	Monthly		Personnel
Name	Description		Budgeted	Costs	Overtime	Sum
T. Kline	PI		5.0	11.5		57.5
R. Campbell	Post-doc		5.0	6.4		32.0
TBN	Tech		3.0	5.6		16.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	13.0	23.5	0.0	
					Personnel Total	$106.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Annual meeting	0.3	2	8	0.2	2.2
Cruise travel	0.3	2	4	0.1	1.0
(Inter)natioanl meeting	0.0	0	0	0.0	0.0
Abstract fee	0.0	0			0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.2

FY 09

Project Number: 070811
Project Title: Prince William Sound Herring Forage Contingency - Submitted under the BAA
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EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 07 - FY 09

Contractual Costs:	Contract
Description	Sum
Vessel Charter (purse seiner)	0.0
Photocopying	0.5
PWSSC Network charge (computer-months)	1.3
Stable isotope analytical (freeze-dry)	3.8
Stable isotope lyophilizer useage	0.5
Stable isotope analytical (oven-dry)	0.0
Shipping include hazmat	0.4
Communications(fax&phone)	0.3
1 R/T (one per Juv Herring cruise) aircharter CDV-western PWS	0.9
Contractual Total	$7.7

Commodities Costs:	Commodity
Description	Sum
calorimeter spare parts kit	0.3
ignition unit	0.4
Multinet maintenance kit	0.0
Replacement Multinet nets (3)	0.0
Replacement Multinet buckets (3) s	0.0
Replacement Multinet canvas part (1)	0.0
Replacement impeller	0.0
Replacement ring net	0.0
Lab supplies- chemicals, gases, vials, bags	1.5
Office supplies	0.5
Computer supplies - software, upgrades	1.0
Commodities Total	$3.7

FY 09

Project Number: 070811
Project Title: Prince William Sound Herring Forage Contingency - Submitted under the BAA
Proposer: T.Kline, PWSSC

EXXON VALDEZ OILSPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 07 - FY 09

New Equipment Purchases:	Number	Unit	Equipment
Description	of Units	Price	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:	Number	Inventory
Description	of Units	Agency
Balance	1	PWSSC

FY 09

Project Number: 070811
Project Title: Prince William Sound Herring Forage Contingency - Submitted under the BAA
Proposer: T.Kline, PWSSC