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: Assessment of Juvenile Herring Abundance and Habitat Utilization, submitted under the BAA (AB133F-09-RP-0059)

Printed Name of PI **Richard E. Thorne**

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Signature of PI: _____ Date: _____

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City, State, Zip _____

Phone: _____

Signature of PI: _____ Date: _____

Printed Name of PI _____

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Mailing Address _____

City, State, Zip _____

Phone: _____

Signature of PI: _____ Date: _____

* 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: Assessment of Juvenile Herring Abundance and Habitat Utilization, submitted under the BAA (AB133F-09-RP-0059)

Project Period: October 1, 2009 – September 30, 2013 (FY 10-FY 13)

Primary Investigator(s): Richard E. Thorne, Prince William Sound Science Center (rthorne@pwssc.org))

Study Location: Prince William Sound (PWS)

Abstract: The objectives of the proposed effort are 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. The proposal builds on three years of experience in assessment of juvenile herring in PWS using hydroacoustic techniques. We proposed to measure juvenile herring and other fish abundance in several potential 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 SEA program in 1995-96 as well as a current Council-funded project, "Trends in adult and juvenile herring distribution and abundance in Prince William Sound". Additional sites will be selected based on historical data and community input. We propose to conduct surveys three times per year: pre- and post-winter and summer. The pre- and post-winter series will complement other studies that propose to examine overwinter mortality, including 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. In addition, a 4-day survey of adult herring will be conducted in conjunction with the post-winter juvenile survey. This project will provide essential data on the distribution and abundance of juvenile herring and their competitors and predators. It will also assist development of a "Core Data Collection" program. The project is one part of a collaborative program for PWS herring surveys coordinated through the Prince William Sound Science Center.

Key words: hydroacoustics, herring, habitat, nursery areas

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

FY10	FY11	FY12	FY13	Total
$ 170,214	$ 196,723	$ 173,563	$ 56,227	$596,727

Non-EVOS Funds to be used:

FY10	FY11	FY12	FY13	Total
0	0	0	0	0

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

The Prince William Sound herring population size has been depressed for nearly two decades. An aerial survey index of the extent of herring spawn (milt) along beaches began to decline shortly after the Exxon Valdez Oil Spill and continued a multi-year decline until 1994 (Thomas and Thorne 2003; Thorne and Thomas 2008). The herring population increased slightly from 1994 to 1997, then declined precipitously following a reopened commercial fishery on relatively young herring in 1997. The adult herring biomass has generally remained below 20,000 mt since 1998. The reasons for the decline are controversial. However, a comparison between the aerial index of herring spawn and the estimates from the age structured assessment (ASA) model used in herring management (Hulson et al 2008) shows the two estimators disagree only during four years over the past three decades: 1989, 1990, 1991 and 1992. Such a divergence in the two estimators could only occur if there was an undetected increase in adult herring mortality that caused the ASA model to overestimate the herring population size. There is considerable evidence that the oil spill overlapped the herring pre-spawning aggregations (Peterson et al. 2003), and it is well documented that herring need to surface routinely to replenish gas for their swim bladders (Thorne and Thomas 1990, 2008; Nottestad 1998; Wahlberg and Westerberg 2003; Wilson et al. 2004; Thomas et al. 2007). Consequently, there is no doubt that direct interaction between adult herring and surface oil took place. Such interaction would have certainly resulted in an increased mortality, as suggested by the one-time divergence between the aerial spawn and ASA estimates of the herring population size.

The Trustee Council has classified the Pacific herring population in PWS as a resource that has not recovered from the effects of the 1989 oil spill. While the reasons for the collapse may be controversial, they are well documented. In contrast, reasons for the failure to recover remain largely unknown. Over the past 3 years, the Trustee Council has worked to develop a restoration program for herring and has completed a draft Integrated Herring Restoration Program (IHRP). Based on the recommendations of the draft IHRP and in recognition that more work will be necessary to develop a full implementation of the plan, the Trustee Council seeks projects that address several topics. One of these topics is Herring Surveys. Specifically, the Trustee Council seeks proposals to conduct surveys of bays in PWS for a better understanding of habitat utilization by juvenile herring and to identify candidate sites that could potentially be used for supplementation efforts.

<u>Rationale for the Approach</u>

It is well recognized that hydroacoustic techniques provide a powerful tool for assessment of both fish populations and habitat (Thorne 1983a,b, McLennon and Simmonds 1992; Gunderson 1993; Brandt 1996; Medwin and Clay 1998). The nature of transmitted sound to propagate through water and reflect off objects and boundaries is the basis for decades of undersea warfare and naval operations and has been incorporated into navigation and commercial fisheries (Cushing 1973; Mitson 1983; Medwin and Clay 1998). Highly quantitative hydroacoustic instruments have been applied to fisheries and habitat assessment for many decades (Thorne 1971; Thorne 1983a; MacLennan and Simmonds 1992; Brandt 1996). In addition to pelagic fish assessment, hydroacoustic applications have included evaluations of coastal power plant impacts

on fish, studies of fish passage through dams, evaluation of fish utilization of natural and artificial reefs and habitat characteristics including depth and bottom type (Thorne et al. 1989, 1990; Chivers et al. 1990; Thorne and Johnson, 1993; Ross et al. 1993; Thorne 1994, 1998**)**. Hydroacoustic assessment techniques have been applied to adult herring assessment for nearly four decades (Thorne 1977a,b; Thorne et al. 1983; Trumble et al. 1983).

During spring 1993, commercial fishers in Prince William Sound could not locate fishable concentrations of herring despite a preseason forecast of substantial herring abundance from the ASA model. Concerned over the status of the stock, the Cordova District Fisherman United organization contracted with the Prince William Sound Science Center (PWSSC) to conduct an independent herring survey in fall 1993 using hydroacoustic assessment techniques. This effort began a program that has now completed 17 consecutive annual surveys of the herring population in Prince William Sound. During the last several years these surveys have been conducted in cooperation with ADF&G, Cordova. The efficiency of the surveys is greatly enhanced under this arrangement since a two-ship operation allows for much greater synoptic coverage of the herring groups, an important consideration as herring distributions can be dynamic.

From 2005 to 2008, PWSSC conducted a major study of interactions between adult herring and marine mammals, especially the endangered western stock of Steller sea lions (Thomas and Thorne 2001; Thorne and Thomas 2008). The study was funded and supervised by the Alaska Regional Office of the National Marine Fisheries Service through a Congressional earmark. Beginning in fall 2006, the study was broadened to include juvenile herring. The EVOS Trustee Council funded a complementary program that supported juvenile herring surveys during spring 2007-2009 and fall 2008 (Thorne 2007, 2008). The result is a three-year series of surveys of juvenile herring at the beginning and end of each winter. Our experience over these past three years is the foundation for this current proposal.

This proposal is part of a collaborative program coordinated through the Prince William Sound Science Center (See PWS herring survey: Community Involvement, Outreach, Logistics, and Synthesis, P.I. W. Scott Pegau). This project is directed specifically to the hydroacoustic surveys. A direct capture effort is included, but limited to that needed to support species and size identification. A more extensive direct capture effort to obtain biological samples is part of the PWSSC administrative proposal. The separation of hydroacoustics and the major direct capture effort is made because biological samples are critically important to many potential studies, while that needed to support the hydroacoustic observations is comparatively minor. This issue will be discussed in more detail in the description of the procedural and scientific methods.

Similarly, ship-time is contained in the PWSSC administration budget. This approach allows for vessel efficiency: multiple projects using the same vessel. Hydroacoustic surveys are conducted primarily at night with transit between locations during day. There is sufficient time for other activities. During the past 3 years the major additional activity was census of marine mammals and seabirds in conjunction with daytime replicate hydroacoustic surveys.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The Pacific herring population in PWS is classified as a resource that has not recovered from the effects of the 1989 oil spill. In April 2006, prompted by public comments about the continuing impacts to communities and the commercial fishermen from herring losses, the Trustee Council convened a herring workshop in Anchorage. The meeting was comprised of representatives from the science community, commercial and subsistence fishers and natural resource managers. The goal of this initial workshop was to open a dialogue and exchange current information among stakeholders. One of the most important outcomes of the meeting was the consensus that a long-term, integrated, Herring Restoration Program was needed if viable herring recovery activities were to be implemented.

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

Based on the recommendations of the draft IHRP and in recognition that more work will be necessary to develop a full implementation of the plan, the Trustee Council seeks projects that address several topics. One of these topics is Herring Surveys. Specifically, the Trustee Council seeks proposals to conduct surveys of bays in PWS for a better understanding of habitat utilization by juvenile herring and to identify candidate sites that could potentially be used for supplementation efforts. This proposal is in response to the solicitation for Herring Surveys.

II. PROJECT DESIGN

A. Objectives

The objectives of the proposed effort are 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. Several important characteristics need to be investigated for these objectives: (1) the abundance and distribution of juvenile herring in various locations, (2) how that abundance changes with seasons, (3) conditions of fish at the end of the critical winter period, (4) abundance and distribution of predators, (5) abundance and distribution of competitors and (6) physical characteristics of the habitat that may impact juvenile herring survival. An ideal candidate site might be one that currently lacks juvenile herring (no larval drift to site), but otherwise has appropriate characteristics (food supply, low predator abundance, etc). This project, in collaboration with others, will provide key information to help evaluate these issues. It will also assist development of the "Core Data Collection" program discussed in the draft IHRP.

B. Procedural and Scientific Methods

Hydroacoustics

Our proposed survey approach is based on our previous experience. Hydroacoustic observations of juvenile herring in PWS were conducted during the SEA program in October 1995 and March and July 1996 (Stokesbury et al. 2000). More recently, PWSSC has conducted juvenile herring surveys in October/November and March over the past three years. Currently, the primary acoustic system is a BioSonics DT scientific echosounder at 70 kHz (Fig 1). PWSSC has three scientific echosounders in its inventory, including one that is sufficiently portable for small vessel operations.

Fig. 1. Deploying a hydroacoustic system from the M.V. Auklet, November 2008.

The juvenile surveys over the past three years have consisted of a series of transects within bays and inlets that are suspected nursery areas for herring (Fig. 2). The transects are designed to characterize the spatial distribution of the juvenile herring and are focused on heads of bays (Fig. 3). Transects are primarily run at night. There are two reasons for this timing: (1) herring are often very near or on bottom during day and not fully accessible to hydroacoustic methods, (2) species and sizes typically segregate into distinct distributions at night that can be separated and individually quantified.

The distinctive nature of these distributions minimizes the need for direct capture. Adult herring form large, virtually monospecific schools during winter and have relatively high site fidelity as spawning approaches (Fig. 4). They remain schooled at night. Consequently, adult herring are relatively easy to survey and quantify (Thomas and Thorne 2003; Thorne and Thomas 2008). Age 2 herring are also found in substantial school groups during late winter, and are occasionally confused with adult aggregations (Thorne 2002). Both groups can be sampled with either herring purse seines or gill nets. Age 0 herring are typically located in relatively shallow water near heads of bays and inlets. Their night-time distribution typically consists of a relatively dense near-surface layer (Fig. 5). We found similar distributions (near surface at heads of bays)

both pre- and post-winter, which contrasts slightly from the observations of Stokebury et al. (2000). Direct sampling for juvenile herring during the SEA program was primarily by pair

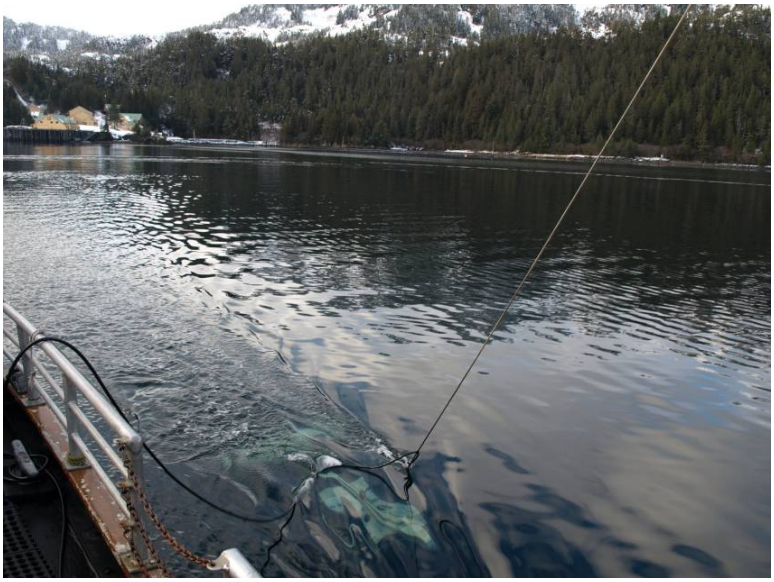

Fig. 2. Towing a hydroacoustic system in Sawmill Bay, November 2008

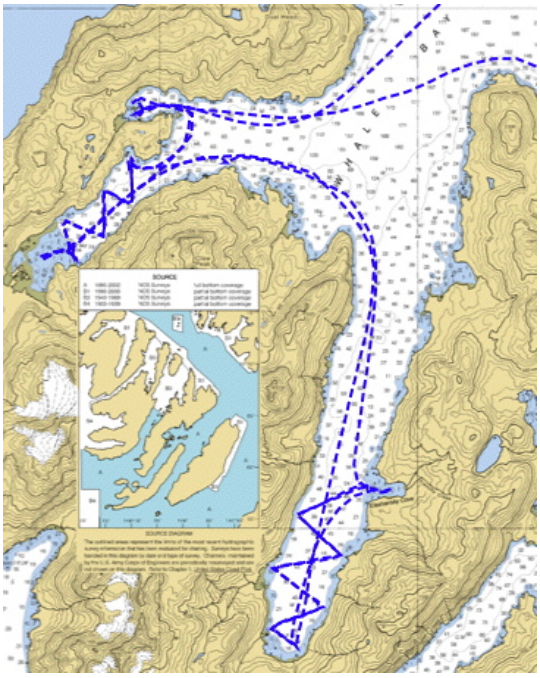

Fig. 3. Cruise track with transects in east and west arms of Whale Bay, November 2008. Note emphasis on heads of each arm. Most age 0 herring were actually observed during the innermost two-three transects.

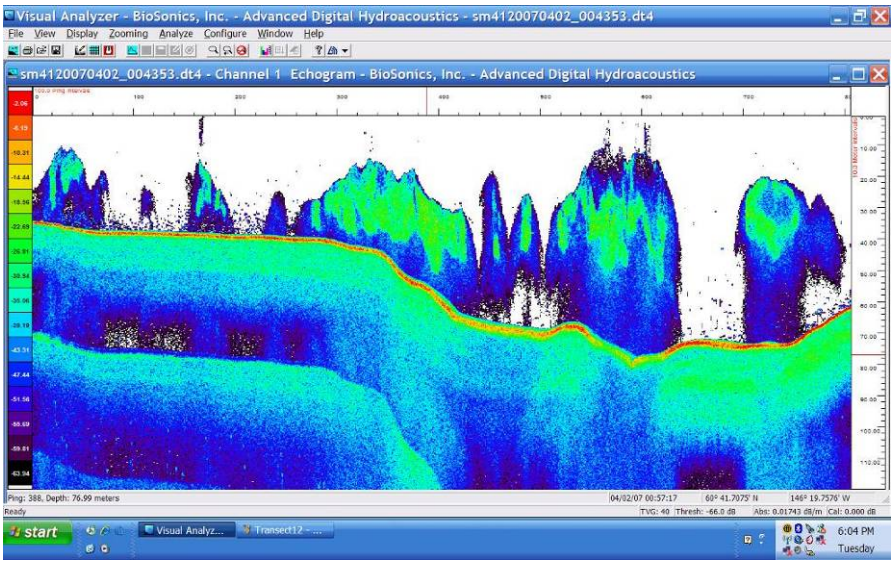

Fig. 4. Night-time echogram of typical adult herring pre-spawning school group, from Port Gravina, spring 2007.

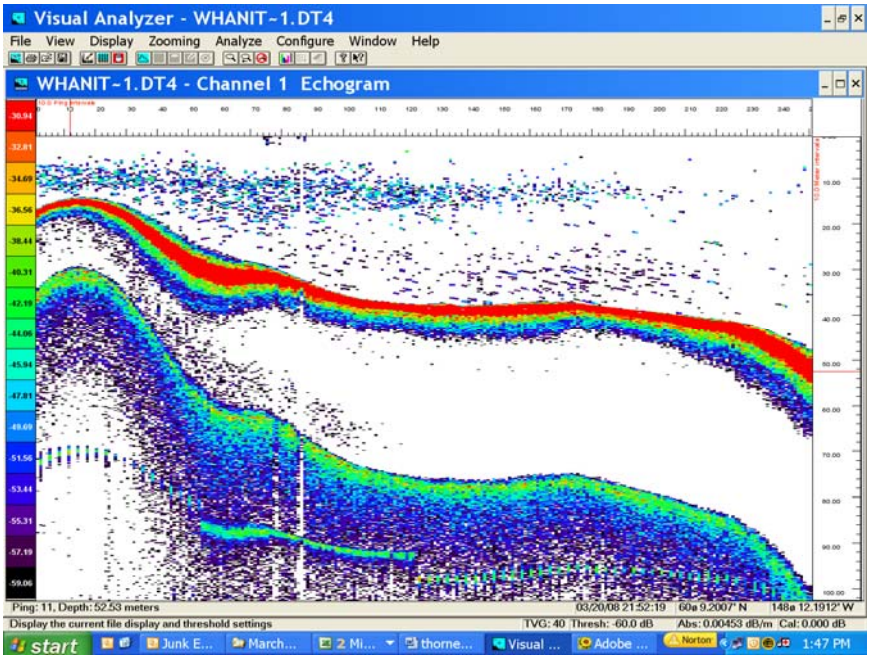

Fig 5. Echogram from east arm of Whale Bay during March 2008 showing extensive layer of age 0 herring. The direct capture effort from this location resulted in a catch of 1,123 age 0 herring. A similar set in March 2009 resulted in a similar capture.

trawling. This approach is relatively effective, but can be expensive. We have experimented with other approaches over the past three years. We developed a small midwater trawl that could be deployed from a purse-seine vessel. While it was reasonably effective, we more recently

replaced this approach with a multi-mesh gill net. The mesh sizes were optimized for age 0 herring capture since samples for this age group were most required by collaborators. The gill net operation is less costly as the vessel can remain at anchor. On two occasions, age-0 captures exceeded 1000 fish (Fig. 6). For this proposal we will explore several alternatives including cast nets and jigging. However, the direct capture effort in this proposal will focus on identification of specific assemblages that we detect with the hydroacoustics and will use the same vessel. At the same time, we will coordinate closely with the overall direct capture effort of the PWS Herring Survey program to enhance our understanding of species/size assemblages. The hydroacoustics can also detail aspects of the fish distribution available for sampling, thus enhancing the efficiency of the overall direct capture effort.

Fig. 6. Picture of gill net retrieval at the Whale Bay sampling site (Fig. 3), spring 2008 (photo courtesy of T. Kline).

Locations and Seasons

The proposal invitation states that "four bays (Zaikof, Whale, Eaglek, and Simpson) were extensively studied under the Sound Ecosystem Assessment study (SEA) and should be included as part of any proposed project". The PWSSC juvenile herring surveys over the past three years have focused on these four historic SEA sites. Additional sites have included St. Mathews Bay (Port Gravina), Two Moon Bay (Port Fidalgo) and Sawmill Bay (Table 1; Fig. 7). We propose to again focus on the four SEA bays, as discussed in greater detail in the next section.

We propose three distinct cruise periods: pre- and post-winter and summer. Surveys during the past three years have been conducted pre- and post-winter. This approach allows us to investigate aspects of overwinter mortality, which may be the critical factor in eventual recruitment. In addition, this approach facilitates the collection of biological samples of age 0 herring during these two periods to investigate overwinter mortality. The synoptic hydroacoustic surveys and biological sampling result in a more efficient allocation of the sampling effort since the acoustic surveys detect the locations of the highest age 0 herring concentrations (McClatchie et al. 2000). The third proposed time period is during summer. Our rationale in this case is that

Table 1. Acoustic Sampling Areas for Juvenile Herring Fall 2006 to Spring 2009

Location	Fall 06	Spring 07	Fall 07	Spring 08	Fall 08	Spring 09
Simpson Bay	X	X	X	X	X	X
Eaglek Bay	X	X	X	X	X	X
Whale Bay		X	X	X	X	X
Zaikof Bay	X	X	X	X	X	X
Sawmill Bay	X	X	X	X	X	X
St. Mathews Bay	X	X	X	X	X	X
Port Fidalgo (off Two Moon)	X		X		X	X
Windy Bay	X					

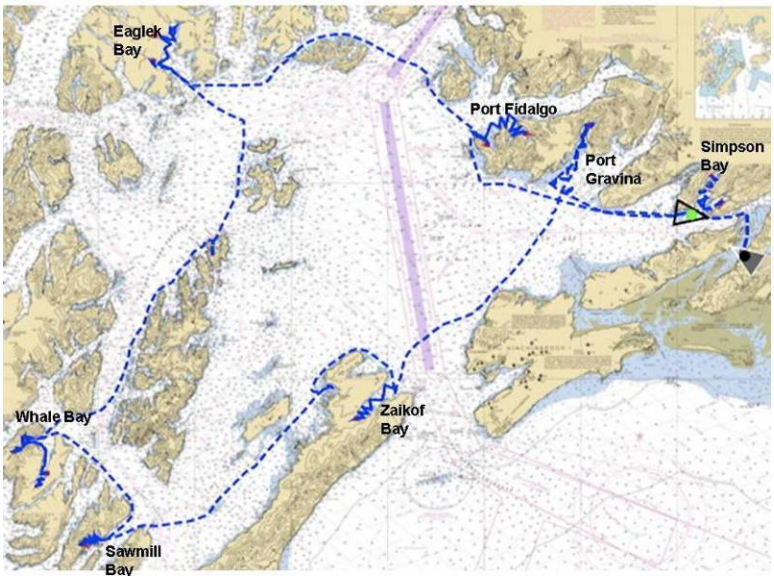

Fig. 7. Overall cruise track for November 2008 juvenile herring survey showing location of seven survey sites.

the initial distribution of age 0 herring is more cosmopolitan as a result of the larvae drift dispersion (Stokesbury et al. 2000; Norcross et al. 2001). We believe it is important to link this early distribution with the subsequent establishment of a smaller number of overwintering locations. This effort also supplements aerial surveys proposed for the summer period. The information on summer period juvenile herring abundance and distribution, along with predator and food supply characteristics of the various sites, will aid our understanding of which habitats are most suitable for age 0 survival. The much more favorable summer weather conditions should allow us to use smaller vessels for the hydroacoustic surveys. This approach would increase the number of surveyed sites during the summer period at relatively low costs.

Finally, we propose to add an additional 4 days of ship time during the March (post-winter) survey to assess adult populations. Adults during this time period are often distributed near the same bays occupied by juveniles, or are located along transit lines. Consequently, it is efficient

to assess the adult numbers at this time. If Alaska Department of Fish and Game continues to assess the adult population, our contribution will aid that effort since two-vessel synoptic observations allow for higher precision and minimize potential error caused by the dynamic nature of herring distributions and movements. In the unfortunate case that ADF&G is not funded for adult assessment, this proposed effort would provide a minimal tracking of the adult population. Such tracking is critical to evaluate the results of juvenile surveys, since recruitment success is the ultimate goal.

Annual Survey Efforts

This is proposed as a four-year effort, FY10 to FY13. The primary field effort is proposed for the second year (FY11). A limited field effort is proposed for the first and third years. The latter half of the third year and all of the fourth year are focused on data analysis, synthesis and reporting. This approach will maintain a limited set of long-term observations for context with a single year of more extensive surveys.

The pre- and post winter survey effort proposed for FY10 consists of five sites: the 4 historic "SEA" program bays: Simpson, Eaglek, Whale and Zaikof plus a site in Knight Island Pass. Over the past two years, age 0 herring abundance has been consistently highest in Whale Bay. This conforms to expectations based on the primary spawning in Port Gravina and circulation patterns. A location in Knight Island Passage would provide a site between Whale Island and Eaglek Bay, which has had only minor concentrations of age 0 herring. Normally, administrative procedures require 3-4 months to set up contracts and budgets, but the current EVOS TC budget for juvenile studies will allow conduct of the limited pre-winter series in November 2009. In addition to the pre- and post-winter surveys, the FY10 proposed effort includes a 4-day adult survey in late winter/early spring and an exploratory summer juvenile series in July/August 2010. The summer series will use a smaller, faster and less expensive vessel and a portable acoustic system.

A more extensive survey effort is proposed for FY11. In addition to the four SEA bays, four to five other sites will be selected based on community input, historical significance, geographic suitability for enhancement activities and any real-time information on juvenile herring presence. The FY11 effort will also include a 4-day adult herring survey in late March and a more extensive summer juvenile series in July/August 2011. For FY12 we propose pre- and post winter surveys of 6 bays total including the 4 SEA bays, plus a small adult survey in late March. No summer effort is proposed for FY12 in order to concentrate on the final reporting. The proposed approach will result in 5-6 consecutive annual pre- and post winter surveys of the four SEA bays, a 20th annual adult herring survey and extensive coverage of additional areas of potential juvenile herring habitat. The experience gained in this project will substantially assist the development of a core data collection program as discussed in the draft IHRP.

C. Data Analysis and Statistical Methods

There are well-developed protocols for hydroacoustic data analysis. Basic analysis is done using echo integration techniques (Thorne 1983a,b; McLennon and Simmonds 1992). We use BioSonics Visual Analyzer version 4.0. Parameters of the analysis depend on the objectives. For standard comparisons the format typically consists of one-minute outputs by 5-meter depth intervals. Specific analysis of schools or layers requires a bounding process to limit analysis to a

specific school or layer (Fig 8). Target strength characteristics of herring as well as several other common fishes are well documented (Thorne 1983b; Traynor 1998; Thomas et al. 2002). The acoustic analysis determines the biomass density of the fish. The biomass estimates use scaling factors that are size and species specific, but are relatively insensitive to these variables (Thorne 1983b). These densities are extrapolated to the appropriate area based on the GPS information that is automatically written to the acoustic data files. Conversion of biomass to numerical values is more sensitive to species/size information. For adults and age 0 herring this information is typically available. Some assumptions are required for other species and these assumptions are dependent on the direct capture information.

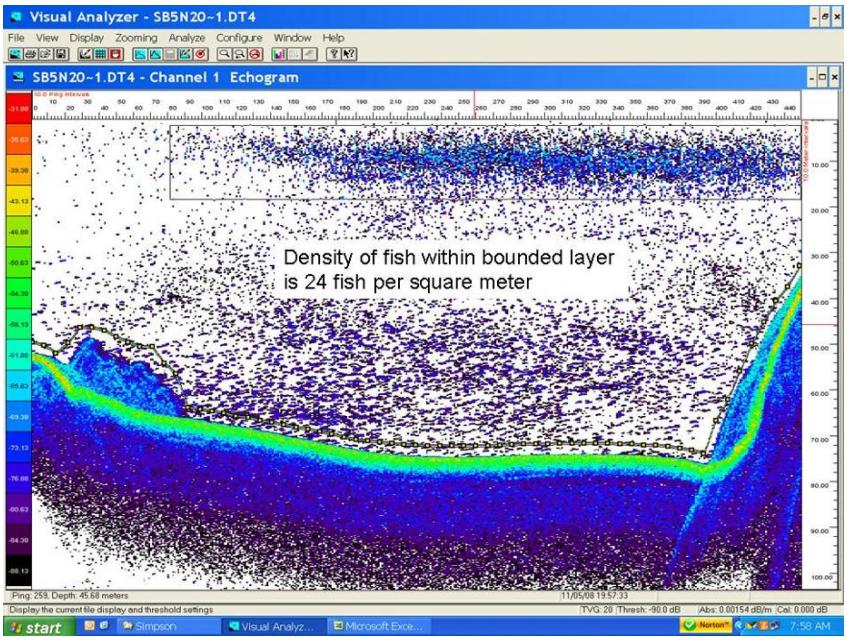

Fig. 8. Illustration of the analysis of a bounded age-0 herring layer from a night-time transect in the inner portion of Simpson Bay, November 2008. There were an estimated 20 million age 0 herring in the area represented by this particular transect.

The statistical analyzes depend on objectives. Many comparisons can be achieved by simple linear regression and pair wise testing. Log transforms are used as needed depending on distributional characteristics and presence of any zero values. We anticipate that a broader analysis approach, probably ANOVA, will be needed as the data set increases in size. Other approaches and tests will depend on interactions with data sets from associated projects.

D. Description of Study Area

A detailed description of the study area is provided above, especially the section on "Locations and Seasons", including the map in Figure 7.

E. Coordination and Collaboration with Other Efforts

This project is designed as a collaborative effort with several other studies. Details of the collaboration are given in the PWSSC administration proposal (PWS herring survey: Community

Involvement, Outreach, Logistics, and Synthesis, P.I. W. Scott Pegau), which includes the ship time needed for this project. This specific project obtains information on the distribution and abundance of fishes, especially juvenile herring, which is foundational data for understanding herring survival mechanisms. The project will obtain some samples, but will also rely on a broader direct capture effort. It also shares a vessel platform with other proposed studies, especially PWS Herring survey: Seasonal and Interannual Trends in Seabird Predation on Juvenile Herring, P.I.s Bishop and Kuletz. This proposal includes substantial effort for interaction with other projects including workshops and annual meetings. Community involvement is detailed in the overall PWSSC effort. The hydroacoustic project specifically involves the local community in several ways including: (1) use of local vessels for charters, (2) community input to site selection, and (3) community presentations of on-going research.

III. SCHEDULE

A. Project Milestones

As detailed above, the project milestones include summer and pre- and post winter surveys of juvenile herring and a late winter/early spring survey of adult herring. Subsequent milestones include the completion of analysis for each of these surveys, and various reporting requirements. The first cruise is scheduled for November 2009. The final cruise is scheduled for March 2012. Subsequent time is focused on data analysis, synthesis and reporting as detailed below.

B. Measurable Project Tasks

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

November	Pre-winter juvenile herring survey of 5 bays including 4 SEA bays

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

January	Annual Marine Science Symposium
March	Post-winter juvenile herring survey of 5 bays including 4 SEA bays
	Adult herring survey in cooperation with ADF&G

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

April	Complete analysis of Pre-winter juvenile herring survey
June	Complete analysis of Post-winter juvenile herring survey

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

July/August	Exploratory summer juvenile herring survey
August	Submit Annual Report

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

October	Complete analysis of adult herring survey
November	Pre-winter juvenile herring survey of 8 to 9 bays
December	Complete analysis of summer juvenile herring survey

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

January	Annual Marine Science Symposium
March	Post-winter juvenile herring survey of 8 to 9 bays
	Adult herring survey in cooperation with ADF&G

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

April	Complete analysis of Pre-winter juvenile herring survey
June	Complete analysis of Post-winter juvenile herring survey

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

JulyAugust	Summer juvenile herring survey
August	Submit Annual Report
September	Complete analysis of adult herring survey

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

November	Limited survey of 6 bays including 4 SEA bays
December	Complete analysis of summer juvenile herring survey

FY012 2nd Quarter (January 1, 12 to March 31, 12)

January	Annual Marine Science Symposium
March	Limited Survey of 6 bays including 4 SEA bays
March	Cooperative adult survey

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

May	Complete analysis of juvenile herring surveys
June	Complete analysis of adult survey

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

July	Complete integration of juvenile surveys
August	Submit Project Annual Report.

FY13 1st Quarter (October 1, 11 to December 31, 11)

December	Complete integration with cooperative programs

FY013 2nd Quarter (January 1, 12 to March 31, 12)

January	Alaska Marine Science Symposium

FY13 3rd Quarter (April 1, 12 to June 30, 12)

April	Submit Draft Final Report
June	Respond to peer review comments

FY13 4th Quarter (July 1 to September 30, 12)

July	Secure final approval, acceptance of final report
September	Publication of final report complete, delivered to ARLIS

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CURRICULUM VITAE

Richard E. Thorne, Ph.D.
P.O. Box 705, Cordova, Alaska 99574
(907) 424 -5800 email: rthorne@pwssc.org

A. Employment History

Prince William Sound Science Center	Senior Scientist 2000-present
BioSonics, Inc. 4027 Leary Way NW Seattle, WA 98107	Vice President 1996-1999 Manager Technical Services 1991-1999 Senior Scientist 1988-1999
University of Washington School of Fisheries Fisheries Research Institute Seattle, WA	Affiliate Research Professor 1991-2001 Research Professor 1981-1990 (LOA 1988-1990) Research Associate Professor 1976-1981 Senior Research Associate 1970-1976
Commercial Fisher (salmon and albacore)	1957-1968

B. Academic Background

Ph.D., Fisheries-1970, University of Washington, School of Fisheries
MS Degree-1968, University of Washington, Department of Oceanography
B.S. Degree-1965, University of Washington, Department of Oceanography

Five Closely Related Publications

Frid, A., J. Burns, G.G. Baker and R.E. Thorne 2008. Predicting synergistic effects of resources and predators on foraging decisions by juvenile Steller sea lions. Oecologia 10.1007/s00442-008-1189-5, 12 p.

Thorne, R.E. 2008. Walleye pollock as predator and prey in the Prince William Sound ecosystem. Pp: 289-304, In: G.H. Kruse, K. Drinkwater, J.N. Ianelli, J.S. Link, D.L. Stram, V. Wespestad and D. Woodby (eds), Resiliency of gadid stocks to fishing and climate change. Alaska Sea Grant, University of Alaska, Fairbanks

Thorne, R.E. and G.L. Thomas 2008. Herring and the "Exxon Valdez" oil spill: an investigation into historical data conflicts. ICES Journal of Marine Science 65(1):44-50.

Frid, A., Dill, L.M., Thorne, R. E., Blundell, G. M. 2007. Inferring prey perception of relative danger in large-scale marine systems. Evolutionary Ecology Research, Vol. 4.

Thomas, G.L. and R.E. Thorne 2003. Acoustical-optical assessment of Pacific herring and their predator assemblage in Prince William Sound, Alaska. Aquatic Living Resources **16**:247-253.

Five Other Significant Publications

Thomas, G.L, J. Kirsch and R.E. Thorne 2002. Ex situ target strength measurements of Pacific herring and Pacific sand lance, North American Journal of Fisheries Management **22**:1136-1145.

Thomas, G.L. and R.E. Thorne 2001. Night-time Predation by Steller Sea Lions. Nature **411**:1013.

McClatchie, S., R. Thorne, P. Grimes and S. Hanchet 2000. Ground truth and target identification for fisheries acoustics. Fisheries Research **47**:173-191.

Thorne, R.E. 1998. Review: experiences with shallow water acoustics. Fisheries Research **35**:137-141

Thorne, R.E. and G.L. Thomas 1990. Acoustic observation of gas bubble release by Pacific herring. Can. J. Fish. Aquat. Sci. **47**(10):1920-1928.

Recent Collaborations:

Bishop, M.A., Prince William Sound Science Center

Foster, M., ADF&G, Kodiak

Frid, A., Dalhousie University

Kline, T., Prince William Sound Science Center

Thomas, G.L., University of Miami

Budget Justification

Salary

Richard Thorne, P.I.: 3.0 months per year for years 1-3 and 1 month for FY13 are required for administration, cruise participation, supervision of data analysis and reporting.

Technician: 6 months are needed for field work, data analysis and technical support for years 1 and 2, 4 months are required for field work and data analysis in year 3, and 1 month for general support in FY13.

Staff Scientist: 4 months are required for the first year, 6 months per year for years two and three and 2 months for FY 13 for on-site supervision of cruise planning, cruise participation including direct capture effort for hydroacoustics and data analysis, synthesis and reporting. It is anticipated that the staff scientist will also be involved in the broader direct capture effort (funded elsewhere).

Travel

Request airfare (Seattle to Cordova) for Dr. Thorne for cruise participation and periodic on-site project management. Travel funds for P.I participation at the Alaska Marine Science Symposium are requested all years. Travel funds are requested for one program workshop in addition to the annual EVOS TC meeting. Travel for one scientific conference is requested for years two and four.

Contractual

This project requires 26, 34, and 24 days of vessel charter for years 1, 2 and 3 respectively for vessel to conduct proposed acoustic surveys including direct capture effort for acoustic surveys. Funds for this ship-time are incorporated in the overall PWSSC administrative proposal (PWS herring survey: Community Involvement, Outreach, Logistics, and Synthesis, P.I. W. Scott Pegau).

Miscellaneous

A total of $22,500 is requested for miscellaneous costs of supplies and services over the four-year period. Items include nets, equipment calibration, network costs, paper supplies, copier services, telephone, etc. No equipment is required for this project. PWSSC has three acoustic systems available for use.

Data Management and QA/QC Statement

The Principal Investigator on this project, Richard Thorne, will manage the project and oversee data acquisition, analysis and reporting. Dr. Thorne is very experienced in all phases. He was program coordinator for the University of Washington Marine Acoustics Program for 15 years and Technical Services Manager for BioSonics, Inc. for 9 years. He has considerable experience managing multi-million dollar programs. Dr. Thorne is knowledgeable about EVOS TC data formatting and reporting requirements. After 2009, Dr. Thorne plans to focus his professional workload on this specific project.

Historically, adult herring surveys have varied extensively depending on herring locations. Survey designs have been focused on achieving a single estimate of total adult herring biomass with 95% confidence intervals of about ±25%. Variance has been measured through replication (Cochran 1977; Scheaffer et al. 1986; Thomas and Thorne 2003). Juvenile assessment requirements are substantially different since they focus on location and habitat. Consequently, standardized designs that can be compared among seasons and years are desired. Modern GPS tracking capability allows these transects to be repeated with precision as illustrated in figures 3 and 7. Our emphasis over the past three years has been to establish such designs and protocols at 7 locations, including the 4 SEA bays. This design is more amenable to ANOVA type analysis procedures, which will get more powerful as the data set increases in size.

Modern hydroacoustic instruments collect data in digital format. These data are written directly on computer hard drives in a specialized DAT format that can be read with analysis programs. Acoustic data are GPS tagged. GPS locations of the beginning and end of transects are also hand-logged for backup. The raw acoustic data are backed up on USB drives within 24 hrs of collection, then archived on two computers as well as cds. Each sampled location typically produces about 100 MB of raw acoustic data. We collect data at a 40 log R, -90 dB threshold to insure all fish targets are detected.

Scientific echosounders are routinely calibrated with standard targets using scientifically-established procedures (Foote and MacLennan 1982; Foote et al. 1987; MacLennan and Simmonds 1992). Typically this is done before and after each survey. Modern hydroacoustic systems are very stable, so changes in calibration values are rare. PWSSC has a long history of calibrations on each of its systems. Calibration accuracy with a tungsten carbon sphere is ± 0.2 dB, which is equivalent to ± 5%. An illustration of the April 7 calibration of the primary PWSSC system is shown in Fig. 9. There has been not detectable change in the system performance over the past 3 years. Systems are also recalibrated by the manufacturer whenever they are returned for repair.

Data analysis procedures use industry-standard software. We currently use BioSonics Visual Analyzer 4.0. BioSonics, Inc. has been providing fisheries acoustics equipment and services since 1979 (www.biosonicsinc.com). Our primary analysis is echo integration, a technique that converts echo signals to fish density (either numerical or biomass depending on the scaling factors). The project principal investigator, Dr. Thorne, was among the pioneers of this technique (Thorne 1971). The principles of echo integration are well described in the scientific literature (Thorne 1983a,b, McLennon and Simmonds 1992; Gunderson 1993; Brandt 1996;

Medwin and Clay 1998). Analyzed data files are in industry standard Excel Format (csv) with all identifiers, environmental parameters, system parameters and geospatial parameters, and are FGDC compliant. PWSSC has a documented analysis procedure that includes all the input requirements of the data processing (threshold, TVG, time and depth limits, number of depth and time intervals, scaling factors and bottom tracking and editing standards). Individual csv files (one for each transect) are stored in computer files by year, season and location and backed up on a second computer. Various summaries are produced in Excel worksheets for comparative analyzes and statistical testing. All these processes are overseen by the project principal investigator.

The hydroacoustic system also collects detailed information on habitat depth characteristics. These characteristics can be readily derived from the analyzed data.

The direct capture effort starts with the permitting process to ADF&G. Biological permits establish limits to catches and reporting requirements. Recently we have been permitted a catch of 1000 fish per year. GPS locations are logged for all net sets. All catches are categorized on site by species and age. Samples are taken for specific analysis and treated and stored in accordance with the requirements of the P.I. for specific studies. Details of species, sizes and locations are reported to ADF&G at the end of each collection year. In the past year this reporting included length and weight frequencies of the catches, although that detail is not required for the report.

Currently we are developing web archiving procedures at PWSSC. The current project, EVOS TC Project # 070830, now in its final year, will also serve as a model for data formatting and archiving procedures since the data form will be very similar.

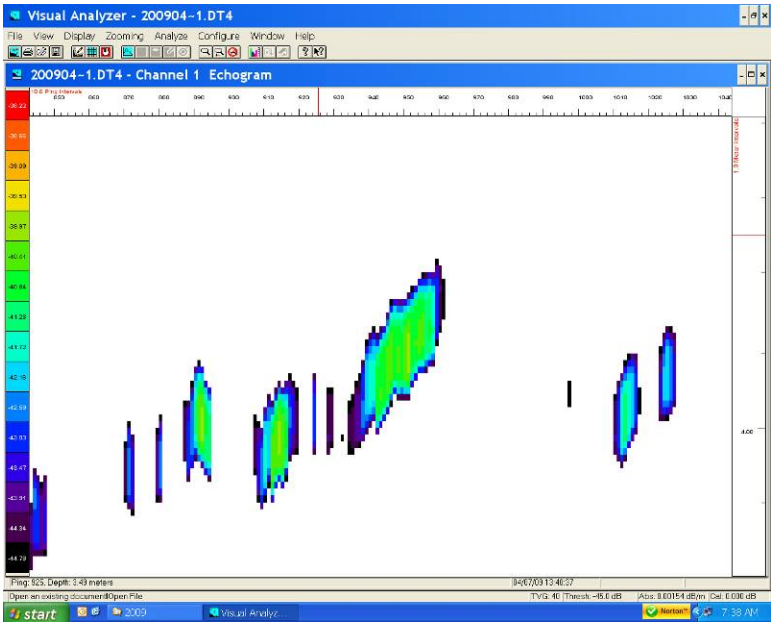

Fig. 9. Echogram of a 36 mm tungsten carbide sphere from April 7, 2009 calibration of PWSSC acoustic system.

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

Budget Category:	Proposed FY 10	Proposed FY 11	Proposed FY 12	Proposed FY 13	TOTAL PROPOSED
Personnel	$113.0	$129.0	$115.0	$36.0	$393.0
Travel	$3.0	$4.0	$2.4	$2.8	$12.2
Contractual	$4.0	$5.0	$5.0	$1.0	$15.0
Commodities	$2.0	$3.0	$2.0	$0.5	$7.5
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0
Indirect *(will vary by proposer)*	$ 34.2	$39.5	$34.8	$11.3	$119.8
SUBTOTAL	$156.2	$180.5	$159.2	$51.6	$547.5
General Administration (9% of subtotal)	$14.1	$16.2	$14.3	$4.6	$49.3
PROJECT TOTAL	$170.2	$196.7	$173.6	$56.2	$596.7
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: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4A
NON-TRUSTEE AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Project Title	Step	Budgeted	Costs	Overtime	Sum
Richard Thorne	Principal Investigator		3.0	13.0		39.0
tbn	Staff Scientist		4.0	8.0		32.0
tbn	Technician		6.0	7.0		42.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		13.0	28.0	0.0	
					Personnel Total	$113.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Seattle to Cordova, rt	0.6	3	0	0.0	1.8
Cordova to Anchorage for AMSS	0.3	1	2	0.2	0.6
Seattle to Anchorage, workshop	0.3	1	2	0.2	0.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.0

FY10

Project Title: PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B
PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

Contractual Costs: Description		Contract Sum
Misc		4.0
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$4.0

Commodities Costs: Description	Commodities Sum
Misc	2.0
Commodities Total	$2.0

FY10

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

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: Descriptior	Number of Units	Inventory Agency
Hydroacoustic System	2	PWSSC

FY10

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Project Title	Step	Budgeted	Costs	Overtime	Sum
Richard Thorne	Principal Investigator		3.0	13.0		39.0
tbn	Staff Scientist		6.0	8.0		48.0
tbn	Technician		6.0	7.0		42.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		15.0	28.0	0.0	
					Personnel Total	$129.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Seattle to Cordova, rt	0.6	3	0	0.0	1.8
Cordova to Anchorage for AMSS	0.3	1	2	0.2	0.6
Seattle to Anchorage, workshop	0.3	1	2	0.2	0.6
Conference Travel	0.4	1	4	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.0

FY11

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

Contractual Costs: Description	Contract Sum
Misc	5.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$5.0

Commodities Costs: Description	Commodities Sum
Misc	3.0
Commodities Total	$3.0

FY11

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

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: Descriptior	Number of Units	Inventory Agency
Hydroacoustic System	2	PWSSC

FY11

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Project Title	Step	Budgeted	Costs	Overtime	Sum
Richard Thorne	Principal Investigator		3.0	13.0		39.0
tbn	Staff Scientist		6.0	8.0		48.0
tbn	Technician		4.0	7.0		28.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		13.0	28.0	0.0	
					Personnel Total	$115.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Seattle to Cordova, rt	0.6	2	0	0.0	1.2
Cordova to Anchorage for AMSS	0.3	1	2	0.2	0.6
Seattle to Anchorage, workshop	0.3	1	2	0.2	0.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.4

FY12

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B
PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

Contractual Costs: Description		Contract Sum
Misc		5.0
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$5.0

Commodities Costs: Description	Commodities Sum
Misc	2.0
Commodities Total	$2.0

FY12

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

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: Descriptior	Number of Units	Inventory Agency
Hydroacoustic System	2	PWSSC

FY12

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Project Title	Step	Budgeted	Costs	Overtime	Sum
Richard Thorne	Principal Investigator		1.0	13.0		13.0
tbn	Staff Scientist		2.0	8.0		16.0
tbn	Technician		1.0	7.0		7.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		4.0	28.0	0.0	
					Personnel Total	$36.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Seattle to Cordova, rt	0.6	1	0	0.0	0.6
Cordova to Anchorage for AMSS	0.3	1	2	0.2	0.6
Seattle to Anchorage, workshop	0.3	1	2	0.2	0.6
Conference Travel	0.4	1	4	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.8

FY13

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

Contractual Costs:	Contract
Description	Sum
Other	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.0

Commodities Costs:	Commodities
Description	Sum
Misc	0.5
Commodities Total	$0.5

FY13

Project Title:PWS Herring Survey: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 13

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: Assessment of Juvenile Herring Abundance and Habitat Utilization
Lead PI: Richard Thorne

FORM 4B EQUIPMENT DETAIL