PROPOSAL SIGNATURE FORM

By submission of this proposal, I agree to abide by the Trustee Council's data policy (*Trustee Council Data Policy**, adopted July 9, 2002) and reporting requirements (*Procedures for the Preparation and Distribution of Reports***, adopted July 9, 2002).

PROJECT TITLE: Trends in Adult and Juvenile Herring Distribution and Abundance in Prince William Sound, submitted under the BAA

Printed Name of P.I. Richard E. Thorne

Signature of P.I. _____ Date _____

* **www.evostc.state.ak.usk/Policies/data.htm**

** **www.evostc.state.ak.us/Policies/Downladables/reportguidelines.pdf**

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PROPOSAL SUMMARY PAGE

Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in Prince William Sound, submitted under the BAA

Project Period: FY 07 - FY 09

Proposer(s): Richard E. Thorne
Prince William Sound Science Center (PWSSC)

Study Location: Prince William Sound (PWS)

Abstract

Information on abundance, distribution and condition of key herring life stages is needed as a basis for restoration. Critical barometers of the PWS herring population are the adult abundance and condition, as monitored in March, and the juvenile abundance and condition going into and coming out of the long winter period (October to March). Some of this information is currently provided through a program at PWSSC that focuses on herring as a critical food source for Steller sea lions. We propose to fill data gaps in this program with juvenile herring surveys in March of 2007 and 2008 and three additional surveys in FY 2009. These surveys can be conducted in a very cost efficient manner because of the much larger concurrent program that will conduct two surveys each year in FY 2007 and 2008. In addition, the direct capture effort associated with all surveys will be expanded, and biological samples will be available for other uses including disease, marking and stable isotope research. Several collaborations have been established in this regard with investigators at the University of Alaska, Fairbanks, Auke Bay and PWSSC.

FUNDING:

EVOS Funding Requested (Including G&A) = TOTAL: $433,600

FY 07 $ 103,400
FY 08 $ 103,400
FY 09 $ 226,800

Non-EVOS Funds to be Used = TOTAL: $600,000

FY 07 $350,000
FY 08 $250,000
FY 09 $ 0

Date: August 1, 2006

PROJECT PLAN

NEED FOR THE PROJECT

Statement of Problem

Any effort to restore the Prince William Sound (PWS) herring population, detect its natural recovery, or protect it from future damage, requires understanding the distributional characteristics of key life stages. Our current understanding of the herring population is derived primarily from three sources (1) annual monitoring of the adult population that has been conducted jointly by the Prince William Sound Science Center (PWSSC) and Alaska Department of Fish and Game (ADF&G) since 1993, (2) research conducted under the Sound Ecosystem Assessment (SEA) program, supported by the Exxon Valdez Oil Spill Trustee Council (EVOS TC) from 1994-1999, and (3) research on marine mammal and seabird predation on herring conducted by PWSSC since 2001. The annual monitoring of adult herring originally verified its collapse in 1993, detected a secondary collapse in 1998 after a brief recovery, and continues to monitor the lack of recovery to date (Thomas et al. 1997; Thomas and Thorne 2003; Thorne 2005a). The SEA program provided insights into younger life stages, including distributional characteristics of juvenile herring (Stokesbury et al. 2000; Brown and Norcross 2001; Foy and Norcross 2001; Norcross et al 2001). Recent research is documenting impacts of marine mammal and seabird predation and providing insights into the mechanism and timing of EVOS impacts (Thorne et al. 2003; Thorne 2005b; Appendix 1).

We believe that the critical barometers of the PWS herring population are the adult abundance and condition, as monitored in March, and the juvenile abundance and condition going into and coming out of the long winter period (October to March). Three yearly surveys are required to obtain this critical information: one on adults and two on juveniles. PWSSC is currently engaged in a four-year study (FY 2005-2008), funded by Congressional Earmarks and administered by the Alaska Regional Office of the National Marine Fisheries Service, that focuses on Steller sea lion and herring interactions in PWS and Kodiak, but includes monitoring adult and juvenile herring abundance and distribution in PWS at several key periods. All three of the critical stage/season surveys will be conducted in Prince William Sound during 2006 under this program for the first time in history. However, future PWS herring surveys in this program are limited to adult surveys in 2007 and 2008 and a single pre-winter juvenile survey in 2007. We propose to fill this gap with post-winter surveys for juveniles in 2007, 2008 and 2009, a pre-winter survey of juveniles in 2008 and an adult survey in 2009 (Table 1). In addition, we will expand the direct capture sampling program for all the herring surveys to insure adequate samples of all ages are available for other study uses. The existence of the large concurrent herring research program ($1,918,154 over 4 years) allows these information gaps to be filled at a relatively low cost, particularly in the first two years ($94,891 per year of which over half are vessel-related costs, compared to an $835,757 budget in the concurrent program, of which about $600,000 is directly matching after removing Kodiak and modeling components). Additionally, EVOS TC benefits from the direct connection

with the larger program that obtains detailed information on both adult and juvenile herring abundance and distribution and associated predator abundances and distributions.

Table 1. Matrix of currently-funded (*italics*) and proposed (**bold**) surveys on herring in Prince William Sound

Month	2006	Calendar Year 2007	2008	2009
Jan				
Mar	*Adult, Juvenile*	*Adult,* **Juvenile**	*Adult,* **Juvenile**	**Adult, Juvenile**
May				
Jul				
Sep				
Nov	*Juvenile*	*Juvenile*	**Juvenile**	

Although annual surveys have focused on adults, the joint PWSSC/ADF&G survey in March 2001 included measurement of a sizeable concentration of herring in Sawmill Bay that turned out to be 2-year old fish (Thorne 2002). The next year this group, the 1999 year class, became one of the larger recruitment classes and dominated the age distribution for several years. An even larger concentration of 2-year old fish was measured in Sawmill Bay during the recent survey of juveniles in March 2006 (Fig. 1). It appears Sawmill Bay may be a late-winter staging area for this age group. Nine humpback whales and 50 Steller sea lions were foraging on the concentration (Fig. 2), along with several hundred birds. This type of observation may lead to recruitment prediction, as well as greater understanding of the role of marine mammals as predators.

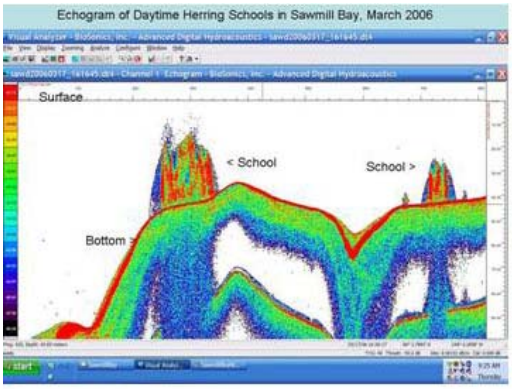

Fig. 1. Echogram of juvenile herring schools during day in Sawmill Bay, March 2006.

Fig. 2. Part of a group of Steller sea lions foraging on juvenile herring in Sawmill Bay, March 2006.

It is also critical to understand juvenile herring distribution in order to develop effective oil spill response strategies. For example, it is well documented from 14 years of acoustic surveys that 90% of the adult herring population may occupy a space less than 10 km^2. A similar situation may exist for 2 year old fish based on the observations in 2001 and 2006. Such distributions leave these fish extremely vulnerable to oil spills. It is well-documented that herring come to the surface on a nightly basis to gulp air in order to replace that lost from their swim bladders during vertical migration at dusk (Thorne and Thomas 1990; Thomas and Thorne 2001). Such surfacing behavior results in direct contact with any surface toxicants. It now appears likely that the EVOS spatial coverage caused differential mortality between adult and juvenile herring that contributed to errors in the age-structured analysis, which in turn caused errors in fishery harvest decisions and greatly hindered our understanding and historical response to the factors behind the PWS herring collapse (Appendix 1).

In addition to the information on herring abundance and distribution, this project will provide biological samples for age structure analysis, and these samples would be available for other uses including disease, marking and stable isotope research. Acoustic surveys provide an efficient framework for direct capture sampling because the location of the herring is determined from the acoustic observations, reducing the need for blind capture efforts to a few shallow-water habitats. The expanded direct capture effort includes supplemental sampling during the currently funded surveys as well as the additional proposed surveys in order to insure sufficient sample coverage for collaborating proposals (see later section).

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 (Fig. 3). The PWS herring crash is also implicated in the decline of the endangered western stock of Steller sea lions (Appendix 1).

The effort proposed herein is relevant to most of the 8 categories for herring proposals outlined in the Invitation. It is most directly a mapping effort, but the information is important for planning, modeling, predation and intervention. Sample acquisition as part of the program is critical for research in other areas such as disease and marking.

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 Table 1. In addition, an expanded direct capture effort will be made to insure acquisition of biological samples of all ages from a variety of locations as needed for other studies.

Fig. 3. Birds foraging on herring (a) above left, still frame from underwater video of diving birds foraging on herring school, (b) above right, cormorants associated with adult herring off Stockdale Harbor, (c) lower, cormorants associated with 2-year old fish in Sawmill Bay in March 2006 (see fig. 1).

Procedural and Scientific Methods

Each of the nine surveys over the three year period (see Table 1) will consist of an acoustic survey complemented by direct capture sampling. Historically, ADF&G in Cordova has provided the direct capture sampling using purse seines. ADF&G provided sampling for juveniles in March 06 under contract to PWSSC. This approach is expected to continue for adults. However, ADF&G priorities and vessel availability may require alternate approaches for juveniles. In addition, the experience of the SEA program was that age 0 and 1 herring are more effectively captured with other methodologies, including midwater trawls (Stokebury et al. 2000; Foy and Norcross 2001). The SEA program successfully utilized anchovy nets (250 x 34 m or 250 x 20 m, 25-mm stretch mesh) and small salmon fry seines (50 x 8 m, 3-mm stretch mesh) deployed in shallow water from a 6-m skiff (Brenda Norcross, personal communication). We intend to experiment with a variety of approaches during our upcoming fall juvenile herring survey, and should have established an effective procedure by the beginning of the effort proposed herein.

Historically, acoustic surveys involve considerable search time using sonars as well as aerial surveys (for marine mammal detection). Thus actual sampling effort is optimized. We propose to modify this approach to accommodate biological collections. While we will still emphasize acoustic detection of fish concentrations, we will also adopt a sampling plan developed by Brenda Norcross that includes 10 bays, based on historic observations of juvenile herring in spring and fall (Fig. 4). These include the four bays, Eaglek, Simpson, Whale and Zaikof Bays, that were sampled repeatedly during the SEA program (Norcross et al. 2001).

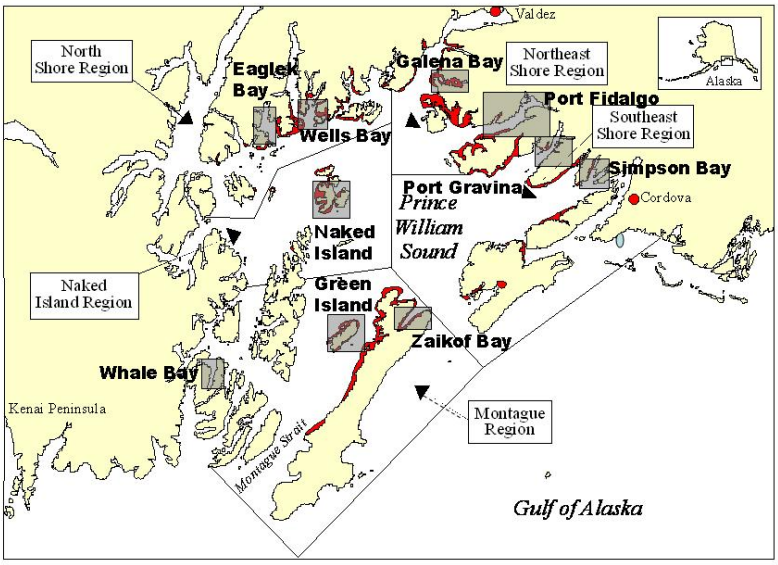

Fig. 4. Proposed 10-bay sampling area within PWS from Brenda Norcross (personal communication).

Over the years, PWSSC has developed relationships with local vessel operators, primarily ex-herring purse seiners. This relationship allows acquisition of relatively low-cost, but highly experienced vessel operators. The local connection also facilitates logistical operations and allows us to pick weather windows on very short notice, a critical factor in PWS winter period operations, where 70+ mph winds are not uncommon. Acoustic techniques, including specific applications in PWS, are well documented in the literature (Thorne 1977; Thorne 1983a,b; MacLennan and Simmonds 1992; Thorne 1998; McClatchy et al. 2000; Thomas et al. 1997; Thomas et al. 2002; Thomas and Thorne 2003; Thorne et al. 2003; Thorne 2005a). PWSSC has an inventory of modern digital acoustic equipment that includes four complete systems (one is on loan to ADF&G in Kodiak). While species identification is based primarily on direct capture, that effort is supplemented by underwater video cameras (Thorne et al. 2003; Thorne 2005a). PWSSC has three underwater camera systems for this operation (Fig. 5). PWSSC also has several infrared scanning systems, which facilitate night-time navigation in the complex near-shore environment occupied by herring (Thomas and Thorne 2001). They are also used for investigation of night-time foraging by marine mammals and seabirds (Fig. 6).

Data Analysis and Statistical Methods

The data analysis and statistical methods used in this program are detailed in Thomas and Thorne (2003). Procedures have been similar for the past 14 years, although analysis programs have evolved over the years with industry advances. The precision (95%) of estimated population biomasses, based on replicated surveys, is typically ±25%.

Figure 5. Example still shots, including pollock and herring schools, from underwater video cameras used in the PWSSC program.

Fig. 6. Still photo from infrared scanner video showing group of Steller sea lions hauled out at night, as seen from one-mile distance.

Description of Study Area

Coverage is comprehensive for PWS. Effort is allocated by several factors, including historical information, reports from fishermen, hunters and others transiting PWS, aerial surveys of seabirds and marine mammals, and community observations. Figure 4 illustrates the locations of particular interest for direct capture sampling.

Coordination and Collaboration with Other Efforts
This project will be coordinated and managed within the larger program on Steller sea lion food limitation research. A major collaborator is ADF&G, Cordova. Samples from this project will be available for other uses including disease, marking and stable isotope research. Substantial collaborations have been made with other proposals in response to the 07 Invitation. They include the following:

1) We have agreed to collect samples for the Nate Bickford and Brenda Norcross (UAF) proposal titled: Herring Restoration in PWS: Identifying Natal and Nursery Habitats".
2) We will provide samples for several investigators from the Prince William Sound Science Center in support of their research proposals. These include:
   i) Mary Anne Bishop and Kathy Kuletz "Avian Predation on Juvenile Herring",
   ii) Tom Kline, "Prince William Sound Herring Forage Contingency", and
   iii) Richard Crawford, "Characterization of Herring Nursery Habitat in Prince William Sound",
3) We have agreed to cooperate with two research efforts proposed from the Auke Bay Lab by Jeep Rice and Johanna Vollenweider, whale sighting data in the former case and biological samples in the latter.

These collaborative efforts largely overlap. The sample plan proposed by Bickford and Norcross should result in adequate sample amounts and coverage for all proposals. However, it should be noted that the expanded biological sampling effort exceeds the requirements for acoustic surveys, and does result in a budget increase of about 25% over that which would be required in this proposal for the acoustic surveys alone.

SCHEDULE

Project Milestones
One juvenile survey will added during March of each of the first two years of the project, along with the two surveys per year already funded (see Table 1). Three surveys will be completed in year three: juvenile surveys in November and March and an adult survey in March.

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

October	Project funding approved by Trustee Council
	Juvenile herring survey completed with matching funds

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

January	Annual Marine Science Symposium
March	Complete proposed juvenile herring survey #1
	Adult survey completed with matching funds

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

June	Complete analysis of adult and fall juvenile herring surveys

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

July	Complete analysis of proposed juvenile herring survey #1
August	Submit Annual Report

FY08 1st Quarter (October 1, 07 to December 31, 07)

October/November	Juvenile herring survey completed with matching funds

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

January	Annual Marine Science Symposium
February	Complete analysis of fall juvenile survey
March	Complete proposed juvenile herring survey #2
	Adult survey completed with matching funds

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

June	Complete analysis of adult herring survey

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

July	Complete analysis of proposed juvenile herring survey #2
August	Submit Annual Report

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

November	Complete proposed juvenile herring survey #3

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

January	Annual Marine Science Symposium
February	Complete analysis of proposed juvenile herring survey #3
March	Complete proposed juvenile herring survey #4
March	Complete proposed adult herring survey #1

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

May	Complete analysis of proposed adult herring survey #1
June	Complete analysis of proposed juvenile survey #4

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)

The PWSSC's project on Steller sea lion winter food limitation, the umbrella program for this research, incorporates community and traditional knowledge in several ways. We use local fishermen for our boat charters. We encourage fishermen and others operating on PWS to report observations of whales, Steller sea lions and herring. We have field demonstrated our technology to students at Tatitlek (Fig. 7), and have talked with Kate

McLaughlin about a similar demonstration at Chenega. We give at least one public seminar each year in Cordova. We routinely contribute articles on the research to the Breakwater, PWSSC's newsletter (www.pwssc.gen.ak.us/breakwater). We also work closely with ADF&G in Cordova on this project.

Fig. 7. Tatitlek students on board FV Kyle David at Two Moon Bay during demonstration of acoustic fish assessment technology, spring 2003

Resource Management Applications

This program has been a cooperative effort with ADF&G, Cordova, for the past 14 years. Information from this project is 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. Information on the broader program is also reported to the Alaska Regional Office of NMFS in Juneau.

PUBLICATIONS AND REPORTS

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

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D. Hay, A.J. Paul, R Stephanson, R. Toresen and D. Witherell (eds) Herring Expectations for a new Mellennium, Alaska Sea Grant College Program, AK-SG-01-04.

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Appendix 1- Herring and Oil Don't Mix: A Lesson from the Exxon Valdez Oil Spill

Richard E. Thorne and Gary L. Thomas

Proceedings, Oceans 06, September 18-20, 2006, Boston, MA

***Abstract* – Evidence of direct mortality to fishes exposed to oil is very limited. The 1989 Exxon Valdez Oil Spill had major impacts on marine mammals and seabirds, but was not implicated in the 1993 collapse of the Prince William Sound herring population because of the four year gap. However, we use several independent evidences, including changes in the predation behavior of Steller sea lions, to show that the collapse actually began in 1989. We show the failure to detect the actual timing of the collapse was due to deficiencies in the fishery model used to assess herring population abundance and lack of understanding about the vulnerability of herring. Finally, we show that the oil spill actually had greater impacts than originally believed as a result of catastrophic impacts on the ecosystem from the herring collapse.**

I. INTRODUCTION

Impacts of oil spills on marine mammals and seabirds are well documented [1]. Direct mortality results from contact with floating oil and long-term exposure to oil toxins residing in the spill affected areas. However, evidence for direct mortality to fishes exposed to oil is limited [2]. It is well documented that the commercial fishery for Pacific herring (Clupea pallasi) in Prince William Sound (PWS) collapsed in 1993, but links to the March 1989 Exxon Valdez Oil Spill (EVOS) appeared unlikely because of the four year gap between the oil spill and this collapse [3]. In addition, harm to herring from the oil spill was considered unlikely because average water-column concentrations of petroleum hydrocarbons were significantly below levels considered toxic for adult fish [4].

Previously, we presented evidence that the PWS herring population decline actually began in 1989, immediately after EVOS [5]. We found a high correlation between our acoustic estimates and the cumulative miles of spawn from agency aerial surveys. We used the correlation to hind cast the herring abundance and showed a decline beginning in 1989 that contrasted with the officially accepted pattern from the historic fishery models (Fig. 1). The difference is critical. EVOS is implicated if the collapse began in 1989.

We have continued to investigate this controversy over the timing. In this paper we add two important evidences that support our earlier timeline. First, we look at changes in the foraging behavior of a major predator on herring, the Steller sea lion (Eumetopias jubatus). Second, we examine the herring age structure and show that a change in the natural mortality of adult herring occurred in 1989. Finally, we demonstrate a mechanism of damage to adult herring by the oil spill, suggest how failure to understand the mechanism resulted in the erroneous conclusions that followed the oil spill, and examine broader implications of the herring collapse.

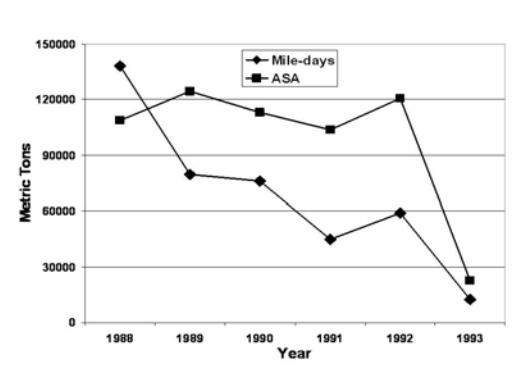

Fig. 1. Contrasting PWS herring population trends as originally estimated by an age-structured assessment model and more recently from a hind cast of the cumulative miles of spawn (mile-days).

II. METHODS

As a dominant biomass or keystone species [6-8], a major collapse of herring in Prince William Sound should have had detectable impacts on other species. We chose to look at Steller sea lions as an ecological indicator of this possible change for several reasons. First, there is considerable evidence of associations between Steller sea lions and herring [9]. Second, population trends between predator and prey are likely to be lagged, and thus not useful for our purpose. However, a herring population change could cause immediate and detectable changes in the foraging behavior of a highly mobile predator like Steller sea lions. Third, all evidence indicates that there were no direct mortalities of Steller sea lions from EVOS [10] that would confound the analysis. Finally, there is a considerable database on Steller sea lions because of their endangered status as well as possible implications of the highly-valued commercial pollock fishery in their decline [11].

Aerial surveys of Steller sea lions on various haulouts and rookeries have been conducted by the National Marine Fisheries Service (NMFS) for several decades [12,13]. These surveys are typically conducted in early June. There are two major and several transitional haulouts within PWS. The major haulouts are The Needle, which is in southern PWS, and Glacier Island, which is near a major herring over wintering area in northeastern PWS. There are several rookeries and major haulouts in the immediate vicinity of PWS, including Seal Rocks and Wooded Island. There are 13 years with NMFS counts of Steller sea lions in PWS and vicinity between 1973 and 2004, including 5 during the critical post-EVOS years of 1989 to 1993.

In addition to these historical data, we conducted 18 synoptic aerial surveys of foraging Steller sea lions in conjunction with acoustic herring surveys between 2000 and 2006. Ground truthing of our aerial surveys was provided by daytime visual and night-time infrared observations along the acoustic transects [9]. Most of these surveys were conducted in late March on prespawning concentrations.

Historical information on the abundance of Pacific herring in PWS includes aerial estimates of the length of spawn (milt) patches along beaches and an age-structured assessment (ASA) model [3,12,14,15]. The miles of spawn surveys are primarily conducted in April and have been conducted annually since 1973. Age data from herring in PWS are available since 1980. The ASA model has been run to forecast the PWS adult herring biomass most years since 1993 [3,14]. All runs of the model since 1994 show similar herring abundance trends from 1980 to 1992. We specifically used data from the 1995 run for this study with one exception. The natural mortality rate was changed for dates after 1992, when the collapse became apparent. We used the original forecast for 1993 [14] to retain the consistent natural mortality assumption.

The Prince William Sound Science Center (PWSSC) initiated acoustic/purse seine surveys of adult herring in 1993 after the apparent collapse of the stock [5,7]. These surveys are typically conducted in late March [16-19].

III. RESULTS

First, we verified the short term association between herring and Steller sea lions. Our aerial survey counts of Steller sea lions foraging on herring prespawning concentrations were positively correlated with the abundance of the herring as estimated from our synoptic acoustic surveys ($r = 0.88$ with 18 observations). Second, we found a positive correlation between the NMFS counts of Steller sea lions in PWS between 1973 and 2004 and our corresponding hind cast of herring abundance ($r = 0.78$; Fig. 2). The final step was to look at Steller sea lion trends in PWS during the critical time period. There was no NMFS count of Steller sea lions in PWS in 1988, but the Steller sea lion numbers decreased steadily between 1989 and 1993. Both the pattern of Steller sea lion decline and its magnitude (72%) compare well with the pattern and magnitude (82%) of the herring decline estimated from the mile- days of spawn (Fig. 3). The annual NMFS counts are positively correlated with the annual estimates from the mile days of spawn hind cast ($r = 0.75$) and negatively correlated with the estimates from the ASA model ($r = -0.21$).

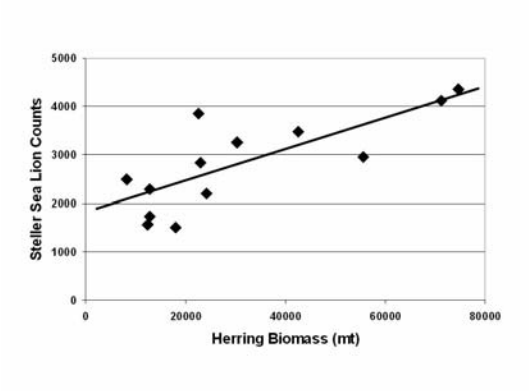

Fig. 2. Comparison of NMFS counts of Steller sea lions in the greater PWS region from 1973 to 2004 with corresponding herring abundance.

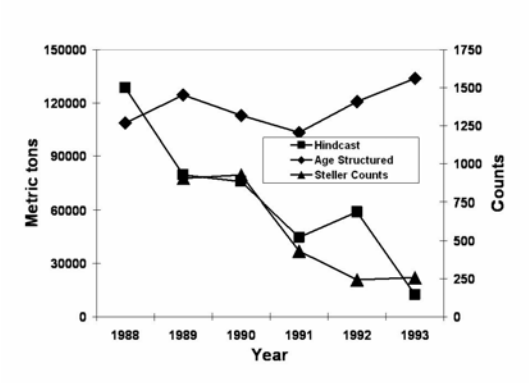

Fig. 3. Comparison of Steller sea lion abundance trends from NMFS aerial surveys in Prince William Sound with herring estimates from the mile-days of spawn and the age-structured assessment model for the critical post EVOS years.

It is clear from the above that the ASA was in error during the critical post-EVOS years. Next, we extended our comparison back to the beginning of age structure data collection in 1980. Prior to 1989, the biomass estimates from the ASA and the hind cast were very comparable both in trend and absolute magnitude (Fig. 4). The estimates began to diverge in 1989. The ASA model had a constant natural mortality assumption from 1980 until 1993. The version of the ASA model currently in use changed the mortality rate after 1992 in response to the obvious collapse of the population [3]. Our analysis shows that the mortality rate actually increased in 1989, causing the ASA model to substantially overestimate the herring biomass until the model was changed after the collapse was detected in 1993.

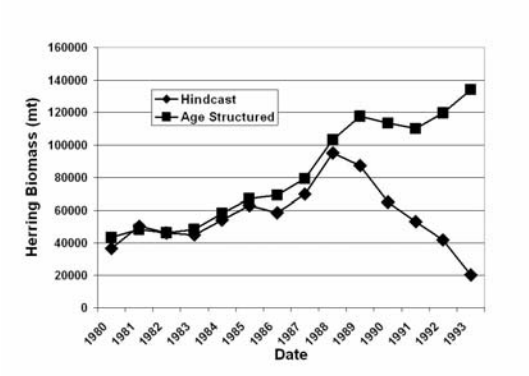

Fig. 4. Comparison of herring biomass estimates from the age-structured assessment model and the mile-days of spawn (hind cast) from 1980 to 1993. Data are smoothed with a weighted 3-year averaging function.

IV. DISCUSSION

ASA models almost universally assume constant natural mortality in adult year classes [3]. The mortality rate for the PWS herring ASA model was retroactively increased in 1993 because the collapse was obvious, and the change was justified by observations of disease in herring [3,20]. Prior to 1993 there was no direct evidence of mortalities to herring from the oil. However, this lack of direct evidence is not surprising. It is rare to observe direct mortalities in fish. Herring are exposed to intense predation from marine mammals, seabirds and a multitude of predator fishes [9]. Any impairment in condition greatly increases the probability for the herring to be eaten.

We have documented that Pacific herring migrate to the surface at night to gulp air, and thus are highly vulnerable to contact with a surface toxicant like an oil spill [9,21] . It is well documented that EVOS overlapped adult herring areas [1], so it is highly likely that herring ingested oil when attempting to gulp air at the surface. As a consequence, arguments that herring were not impacted by EVOS because water column hydrocarbon levels were low [4] are not relevant. Toxicologists need to examine this surfacing behavior as a primary mechanism of exposure in fish since it is virtually unstudied by science at this time.

It is also well documented that adult herring populations are highly aggregated during late winter, while juveniles are more cosmopolitan [5,22]. Our surveys over the past 14 years have shown occasions where over 90% of the adult population were distributed within a total area of 10 km^2, leading to extreme vulnerability.

Herring begin to recruit to the adult population at age 3. The 1988 year class in PWS was initially seen as 38% of the age composition in 1991 and a dominating 85% in 1992, indicating an extremely large recruitment and a very large herring population [14]. However, if the natural mortality of adult herring increased in 1989, then the 1988 year class would appear to be relatively abundant only because the older herring were less abundant then assumed. The disparity would be even greater if the adult herring were affected more by the oil than the juveniles, a likely scenario given their different distributional patterns relative to the extent of the oil spill.

Finally, we examined broader implications of the herring population collapse. We had chosen Steller sea lions as our ecological indicator because they are highly mobile and were not directly impacted by the oil spill. There are no rookeries within PWS, so the abundance trends of Steller sea lions that we examined primarily represent geographic changes in foraging behavior rather than overall population trends. However, a catastrophic local impact can have long-term impacts on a predator population. We compared all NMFS census sites for Steller sea lions in the Gulf of Alaska (GOA) that were in common to both 1989 and 2000. There was an overall pattern of decline. When we partitioned the decline by geographic area, we found the magnitude of

decline was a direct function of distance from PWS: 86% in PWS, 72% in the remaining eastern GOA, 62% in the central GOA and only 29% in the western GOA.

The Exxon Valdez Oil Spill Trustee Council, which oversees research on oil spill restoration issues [23], lists five resources besides herring that are considered "non-recovered". Three of the five are well documented to focus on herring as a food source. Interestingly, the list does not include Steller sea lions, which are not considered to be impacted. Our evidence suggests that whatever happened to cause the overall population decline of the western stock of Steller sea lions in the previous decade, it centered in PWS. The catastrophic loss of critical winter-period forage associated with the PWS herring population crash probably was a major factor in the decline [9,24].

V. CONCLUSIONS

Our analysis suggests that EVOS had much broader and much more profound impacts than previously recognized. The failure to fully recognize these impacts is the result of obvious deficiencies in the scientific methods that have been historically applied.

Acknowledgements

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Employment History

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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

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

Recent Publications

Churnside, J.H. and R.E. Thorne 2005. Comparison of airborne lidar measurements with 420 kHz echos-sounder measurements of zooplankton. Applied Optics **44**(26):5504-5511

Thorne, R.E. 2005. Monitoring Pacific herring abundance with combined acoustic and optical technologies. Proc. Oceans05, Washington D.C. Sept 20-23, 2005

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Other Significant Publications

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Tarbox, K.E. and R.E. Thorne, 1996. Assessment of adult salmon in near-surface waters of Cook Inlet, Alaska. ICES Journal of Marine Science **53**:397-401.

Thorne, R.E. 1983. Hydroacoustics. Chapt. 12 in L. Nielson and D. Johnson (eds)., Fisheries Techniques. American Fisheries Society, Bethesda, MD

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Resume: **Richard E. Crawford**

Education

Ph.D./Zoology	University of Maine, Orono, Maine	1978
MS/Fisheries Biology	Humboldt State University, Arcata, CA	1975
BS/Zoology	University of Rhode Island, Kingston, RI	1972

Employment History

Director, Owner and Operator 2001 – April 2006
Nautilus Environmental Services, Centerville, Massachusetts.

Contract Research Assistant 2003-2005
Woods Hole Research Center, Woods Hole, MA 02543

Visiting Investigator 1999-2003
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

Research Program Coordinator 1992-1999
Waquoit Bay National Estuarine Research Reserve, Waquoit, Massachusetts.

Research Scientist 1984-1992
Department of Fisheries and Oceans, Winnipeg, Manitoba.

Academic Background

Ph. D. 1978. University of Maine, Orono, Maine. Environmental Ecology of Fishes.
MS. 1975. Humboldt State University, Arcata, California. Fisheries Ecology and Aquaculture.
BS. 1972. University of Rhode Island, Kingston, Rhode Island. Major in Zoology.

Recent Publications

Crawford, R.E., and T.A. Stone. 2005. Assessing Relative Eutrophication of Coastal Embayments with Calibrated Aerial Video Imagery. Final Report to NOAA/UNH Cooperative Institute for Coastal and Environmental Technology (CICEET), UNH. 78 p.

Gaines, A.G., and R.E. Crawford. 2004. Southgate Pond: Geology and Ecology of a Tropical Coastal Pond in St. Croix, USVI. SCR Technical Report #4, The Coast & Harbor Institute, Woods Hole, Mass. 72 pp.

Crawford, R.E. 2002. Secondary wake turbidity from small boat operation in a shallow sandy bay. J. Coast. Res., 37: 49-64.

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Crawford, R.E., and J. Jorgenson. 1996. Quantitative studies of Arctic cod (*Boreogadis saida*) schools: Important energy stores in the Arctic food web. Arctic 49: 181-193.

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Crawford, R.E., and C.G. Carey. 1985. Retention of winter flounder larvae within a Rhode Island salt pond. Estuaries 8: 217-227.

Recent Collaborations

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Thomas Stone	Woods Hole Research Center, Falmouth, MA.
Dr. Peter Sampoo	Barnstable, Massachusetts Conservation Commission
Capt. Thomas Hall	Rhode Island Lobstermen's Association (Cooperative Research)

Budget Justification – FY07 ($103.4) **FY 07 – FY 09 = $433.6K**

Salary: ($34.3)

Richard Thorne, P.I.: Request 0.5 mos for project administration. Matched by 6 mos of support from grant award number NA04NMF4390161, National Marine Fisheries Service ($6.7K)

Richard Crawford, Senior Scientist: Request 2 mos for field work and analysis. Matched by 4 mos of support from grant award number NA04NMF4390161, National Marine Fisheries Service ($15K)

James Thorne, Technician: Request 2 mos for field work and technical support. Matched by 4 mos of support from grant award number NA04NMF4390161, National Marine Fisheries Service($12.6)

Travel: ($.9K)

Request airfare (Cordova to Anchorage, rt) and 3 days per diem for participation by one senior researcher in annual EVOS marine science meeting.

Contractual: ($39.1)

Vessel charter costs: Request 9 days charter at $1500/day for vessel to conduct acoustic survey of juvenile herring in Prince William Sound. Amount and costs are based on 14 years of experience with similar surveys in PWS. Two of the nine days are in support of collaboration with other proposals. ($14.K)

Biological sampling: Request 10 days charter at $2500/day for purse seiner and/or subcontract with ADF&G, Cordova, for purse seine and other direct capture operations in support of acoustic surveys. Costs are based on recent experience in PWS and Kodiak for similar efforts. About half the sampling effort is in support of collaboration with other proposals. ($25.K)

Miscellaneous: (Services/Contractual: $.6K)(Commodities: $1.3K)

A total of $1,900 is requested for miscellaneous costs of supplies and services. Items include network costs, paper supplies, copier services, telephone, ect.

Budget Justification – FY08 ($103.4K)

Salary: ($34.3K)

Richard Thorne, P.I.: Request 0.5 mos for project administration. Matched by 6 mos of support from grant award number NA04NMF4390161, National Marine Fisheries Service ($6.7K)

Richard Crawford, Senior Scientist: Request 2 mos for field work and analysis. Matched by 4 mos of support from grant award number NA04NMF4390161, National Marine Fisheries Service ($15.K)

James Thorne, Technician: Request 2 mos for field work and technical support. Matched by 4 mos of support from grant award number NA04NMF4390161, National Marine Fisheries Service ($12.6K)

Travel: ($.9K)

Request airfare (Cordova to Anchorage, rt) and 3 days per diem for participation by one senior researcher in annual EVOS marine science meeting.

Contractual: ($39.1K)

Vessel charter costs: Request 9 days charter at $1500/day for vessel to conduct acoustic survey of juvenile herring in Prince William Sound. Amount and costs are based on 14 years of experience with similar surveys in PWS. Two of the nine days are in support of collaboration with other proposals. ($14.K)

Biological sampling: Request 10 days charter at $2500/day for purse seiner and/or subcontract with ADF&G, Cordova, for purse seine and other direct capture operations in support of acoustic surveys. Costs are based on recent experience in PWS and Kodiak for similar efforts. About half the sampling effort is in support of collaboration with other proposals. ($25.K)

Miscellaneous: (Services/Contractual: $.6K)(Commodities: $1.3K)

A total of $1,900 is requested for miscellaneous costs of supplies and services. Items include network costs, paper supplies, copier services, telephone, ect.

Budget Justification – FY09 ($226.8K)

Salary: ($70.4K)

Richard Thorne, P.I.: Request 1 mos for project administration. Matched by 6 mos of support from grant award number NA04NMF4390161, National Marine Fisheries Service ($14.K)

Richard Crawford, Senior Scientist: Request 4 mos for field work and analysis. Matched by 4 mos of support from grant award number NA04NMF4390161, National Marine Fisheries Service ($31.K)

James Thorne, Technician: Request 4 mos for field work and technical support. Matched by 4 mos of support from grant award number NA04NMF4390161, National Marine Fisheries Service ($26.K)

Travel: ($1.K)

Request airfare (Cordova to Anchorage, rt) and 3 days per diem for participation by one senior researcher in annual EVOS marine science meeting.

Contractual: ($92.5K)

Vessel charter costs: Request 21 days charter at $1500/day for vessel to conduct acoustic survey of juvenile herring in Prince William Sound. Amount and costs are based on 14 years of experience with similar surveys in PWS. ($32.K)

Biological sampling: Request 24 days charter at $2500/day for purse seiner and/or subcontract with ADF&G, Cordova, for purse seine and other direct capture operations in support of acoustic surveys. Costs are based on recent experience in PWS and Kodiak for similar efforts. About half the sampling effort is in support of collaboration with other proposals. ($60.K)

Miscellaneous: (Services/Contractual: $1.K)(Commodities: $1.8K)

A total of $2,800 is requested for miscellaneous costs of supplies and services. Items include network costs, paper supplies, copier services, telephone, ect.

Data Management and QA/QC Statement

As detailed in the project plan, Procedures and Scientific Methods (p. 5-7), including references therein, the acoustic survey design is directed or adaptive, that is, sampling locations are determined using high speed sampling techniques, primarily sonar. Actual sampling is then systematic within the location. Precision is determined through replication with a goal to achieve 95% precision at ±25%. Biological samples are both directed and systematic, that is, samples are taken from both acoustically detected concentrations and selected blind stations. Biological sample sizes will depend on user-requests.

Acoustic data in this program are collected in digital format with scientific echosounders that are routinely calibrated with standard targets using scientifically-established procedures. All acoustic data are GPS tagged. Raw acoustic data are triple copied and archived on computers and cds.

Data analysis procedures use industry-standard software. Analyzed Data files are in industry standard Excel Format (csv) with all identifiers, environmental parameters, system parameters and geospatial parameters, and are FGDC compliant. An example metadata file is shown in Table 2.

Data category is species-specific. Procedures for sample handling and custody will be developed in conjunction with collaborators as described on page 9.

We participate in the Prince William Sound Regional Citizens' Advisory Council's project catalog.

Table 2-Example Data File Format

DT ANALYSIS REPORT

20060330

DATAFILE INFORMATION

Analysis Version:						
File Name:	C:\Herring\2006\Mar06Leg3\2Moon\2MN20060329_203104.dt4					
Data Threshold:	-70	dB				
Threshold Type:	squared					
Ping Rate:	1	pps				
Collection Range:	0.99	to	99.99			
Pulse Width:	0.4	ms			**Identifiers**	
Absorption Coefficient:	0.00152	dB/m		Contact	R. Thorne	PWSSC
Salinity:	31.8	ppt			P.O. Box 705	Cordova, AK
Water Temperature:	4.3	deg C				99574
Sound Velocity:	1446.61	m/s				

TRANSDUCER INFORMATION

			Project	Steller Sea Lion Winter Food Limitation	
Serial Number:	DTX05100				
Beam Width:	5.9	deg	Vessel	Kyle David	
Transmit Frequency:	70000	Hz			
Transmit Source Level:	223.8	dB//uPa	Location	Two Moon Bay	
Receive Sensitivity:	-42	dBC/uPa		PWS	
Calibration Correction Narrow Beam:	0	dB			
Beam Pattern Factor:	0.000958				

ANALYSIS PARAMETERS

Analyzed As: Single-Beam			
Ping Range:	1	to	953
Sample Range:	2	to	97
Data Threshold:	-70	dB	
Number Strata:	19		
Number Reports:	20		
Density Scaling Constant:	3.79E-16		

BOTTOM TRACKER PARAMETERS AND RESULTS

Bottom Threshold:	-30	dB
Bottom Width:	0.09	m
Blanking Threshold:	-60	dB

Blanking Zone:	0.99	m
Blanking Type:	FIXED	
Alarm limit:	5	pings
Tracking Window:	1.74	m
Number processed:	953	pings
Number found:	952	pings
Find rate:	99.90%	

VERTICAL INTEGRATION RESULTS

STRATA	TOP	BOTTOM	Sv (dB)	Applied Sigma	FPCM
1	2	7	-5.50E+01	6.00E-04	5.27E-03
2	7	12	-5.53E+01	6.00E-04	4.97E-03
3	12	16.99	-6.07E+01	6.00E-04	1.41E-03
4	16.99	21.99	-5.99E+01	6.00E-04	1.69E-03
5	21.99	26.99	-6.35E+01	6.00E-04	7.37E-04
6	26.99	31.99	-6.80E+01	6.00E-04	2.64E-04
7	31.99	36.99	-7.06E+01	6.00E-04	1.45E-04
8	36.99	41.99	-7.75E+01	6.00E-04	2.98E-05
9	41.99	46.99	-8.41E+01	6.00E-04	6.55E-06
10	46.99	51.99	-6.50E+01	6.00E-04	5.25E-04
11	51.99	56.99	0.00E+00	6.00E-04	0.00E+00
12	56.99	61.99	0.00E+00	6.00E-04	0.00E+00
13	61.99	66.99	0.00E+00	6.00E-04	0.00E+00
14	66.99	71.99	0.00E+00	6.00E-04	0.00E+00
15	71.99	76.99	0.00E+00	6.00E-04	0.00E+00
16	76.99	81.99	0.00E+00	6.00E-04	0.00E+00
17	81.99	86.99	0.00E+00	6.00E-04	0.00E+00
18	86.99	91.99	0.00E+00	6.00E-04	0.00E+00
19	91.99	96.99	0.00E+00	6.00E-04	0.00E+00

HORIZONTAL INTEGRATION RESULTS

REPORT	TIME AND DATE	Depth	Latitude	Longitude	Sv (dB)	Applied Sigma	FPUA
1	03/29/06 20:31:04	15.45	60° 45.3021' N	146° 31.8157' W	-6.46E+01	6.00E-04	5.43E-02
2	03/29/06 20:31:51	20.88	60° 45.3026' N	146° 31.9193' W	-6.63E+01	6.00E-04	3.80E-02
3	03/29/06 20:32:39	26.07	60° 45.2980' N	146° 32.0361' W	-6.66E+01	6.00E-04	3.43E-02
4	03/29/06 20:33:26	29.43	60° 45.2938' N	146° 32.1537' W	-6.33E+01	6.00E-04	7.48E-02
5	03/29/06 20:34:14	25.96	60° 45.2903' N	146° 32.2730' W	-6.38E+01	6.00E-04	6.68E-02
6	03/29/06 20:35:02	29.55	60° 45.2868' N	146° 32.3913' W	-6.55E+01	6.00E-04	4.44E-02
7	03/29/06 20:35:49	30.15	60° 45.2838' N	146° 32.5047' W	-7.44E+01	6.00E-04	5.88E-03

	03/29/06		60°	146°			1.38E-
8	20:36:37	29.1	45.2798' N	32.6221' W	-7.07E+01	6.00E-04	02
	03/29/06		60°	146°			9.43E-
9	20:37:25	23.72	45.2731' N	32.7400' W	-6.21E+01	6.00E-04	02
	03/29/06		60°	146°			8.64E-
10	20:38:12	19.84	45.2643' N	32.8513' W	-6.27E+01	6.00E-04	02
	03/29/06		60°	146°			1.18E-
11	20:39:00	18.29	45.2639' N	32.9764' W	-7.14E+01	6.00E-04	02
	03/29/06		60°	146°			5.82E-
12	20:39:48	23.75	45.2608' N	33.1017' W	-6.23E+01	6.00E-04	02
	03/29/06		60°	146°			7.85E-
13	20:40:35	39.79	45.2571' N	33.2179' W	-6.31E+01	6.00E-04	02
	03/29/06		60°	146°			9.73E-
14	20:41:23	46.6	45.2531' N	33.3384' W	-6.22E+01	6.00E-04	02
	03/29/06		60°	146°			1.28E-
15	20:42:11	47.91	45.2470' N	33.4533' W	-6.09E+01	6.00E-04	01
	03/29/06		60°	146°			4.31E-
16	20:42:58	46.06	45.2435' N	33.5715' W	-6.24E+01	6.00E-04	02
	03/29/06		60°	146°			4.04E-
17	20:43:46	49.14	45.2399' N	33.6887' W	-6.60E+01	6.00E-04	02
	03/29/06		60°	146°			9.63E-
18	20:44:34	37.75	45.2371' N	33.8069' W	-6.21E+01	6.00E-04	02
	03/29/06		60°	146°			2.10E-
19	20:45:21	24.33	45.2326' N	33.9183' W	-5.84E+01	6.00E-04	01
	03/29/06		60°	146°			1.28E-
20	20:46:09	17.11	45.2293' N	34.0353' W	-6.09E+01	6.00E-04	01

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2006 - September 30, 2007

Budget Category:	Authorized FY 2006	Proposed FY 2007	Proposed FY 2008	Proposed FY 2009				
Personnel		$ 34.3	$ 34.3	$ 70.4				
Travel		$ 0.9	$ 0.9	$ 1.0				
Contractual		$ 39.1	$ 39.1	$ 92.5				
Commodities		$ 1.3	$ 1.3	$ 1.8				
Equipment		$ -	$ -	$ -				
Subtotal	$0.0	$ 75.6	$ 75.6	$ 165.7				
Indirect at 25.57%		$ 19.3	$ 19.3	$ 42.4				
Project Total w/o G&A	$0.0	$ 94.9	$ 94.9	$ 208.1	Estimated FY 2007	Estimated FY 2008	Estimated FY 2009	Project Total
Trustee Agency GA (9% of Project Total)		$ 8.5	$ 8.5	$ 18.7				
Project Total w/G&A		$ 103.4	$ 103.4	$ 226.8	$103.4	$103.4	$226.8	$433.6
Full-time Equivalents (FTE)		0.4	0.4	0.8				
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$350.0	$250.0					

Comments:
Matching Program of $600,000 over three-year period

FY07 - FY 09

Project Number: 070830
Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA
Name: Richard Thorne

FORM 4A
Non-Trustee
SUMMARY

Prepared: Final Revision 8/11 @ 6:14 p.m.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2006 - September 30, 2007

Personnel Costs:				Months	Monthly		Proposed
	Name	Position Description		Budgeted	Costs	Overtime	FY 2007
	Richard Thorne	Principal Investigator		0.5	13.3		6.7
	Richard Crawford	Staff Scientist		2.0	7.5		15.0
	James Thorne	Technician		2.0	6.3		12.6
		Subtotal		4.5	27.1	0.0	
						Personnel Total	$34.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2007
	EVOS Annual Meeting	0.3	1	3	0.2	$0.9
					Travel Total	$0.9

FY07

Project Number: 070830
Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA
Name: Richard Thorne

FORM 4B
Personnel
& Travel
DETAIL

Prepared: Final Revision 8/11 @ 6:14 p.m.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

Contractual Costs:	Proposed
Description	FY 2007
Vessel Charter - Acoustic (9 days @ $1500)	14
Vessel Charter - Biological Sampling (10 days @$2500)	25.0
Network Services - 100 per FTE month	0.4
Phone, Fax, printing, etc.	0.2
Contractual Total	39.1

Commodities Costs:	Proposed
Description	FY 2007
	0.0
Misc - PWSSC	1.3
	0.0
Commodities Total	1.3

FY07

Project Number: 070830
Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA
Name: Richard Thorne

FORM 4B
Contractual
&
Commodities

Prepared: Final Revision 8/11 @ 6:14 p.m.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2007
Those purchases associated with replacement equipment should be indicated by placement of an R.			
		New Equipment Total	0.0

Existing Equipment Usage:	Number	
Description	of Units	
Scientific Acoustic System (BioSonics DTX)	3	
Underwater Video Camera	3	
Infrared Scanner	2	

FY07

Project Number: 070830
Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA
Name: Richard Thorne

FORM 4B
Equipment
DETAIL

Prepared: Final Revision 8/11 @ 6:14 p.m.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2008
	Richard Thorne	Principal Investigator	0.5	13.3		6.7
	Richard Crawford	Staff Scientist	2.0	7.5		15.0
	James Thorne	Technician	2.0	6.3		12.6
		Subtotal	4.5	27.1	0.0	
					Personnel Total	$34.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2008
	EVOS Annual meeting	$300	1	3	0.2	$0.9
					Travel Total	$0.9

FY08

Project Number: 070830
Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA
Name: Richard Thorne

FORM 4B
Personnel
& Travel
DETAIL

Prepared: Final Revision 8/11 @ 6:14 p.m.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

Contractual Costs:	Proposed
Description	FY 2008
Vessel Charter - Acoustic (9 days @ $1500)	14
Vessel Charter - Biological Sampling (10 days @$2500)	25.0
Network Services - 100 per FTE month	0.4
Phone, Fax, printing, etc.	0.2
Contractual Total	39.1

Commodities Costs:	Proposed
Description	FY 2008
Misc - PWSSC	1.3
Commodities Total	1.3

FY08

Project Number: 070830
Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA
Name: Richard Thorne

FORM 4B
Contractual
&
Commodities

Prepared: Final Revision 8/11 @ 6:14 p.m.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2008
Description			
Those purchases associated with replacement equipment should be indicated by placement of an R.			
		New Equipment Total	0.0

Existing Equipment Usage:	Number of Units	
Description		
Scientific Acoustic System (BioSonics DTX)	3	
Underwater Video Camera	3	
Infrared Scanner	2	

FY08

Project Number: 070830
Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA
Name: Richard Thorne

FORM 4B
Equipment
DETAIL

Prepared: Final Revision 8/11 @ 6:14 p.m.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2006 - September 30, 2007

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2009
	Richard Thorne	Principal Investigator	1.0	13.6		14
	Richard Crawford	Staff Scientist	4.0	7.7		31
	James Thorne	Technician	4.0	6.5		26
		Subtotal	9.0	27.8	0.0	
					Personnel Total	$70.4

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2009
	EVOS Annual meeting	$400	1	3	0.2	$1.0
					Travel Total	$1.0

FY09

Project Number: 070830
Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA
Name: Richard Thorne

FORM 4B
Personnel
& Travel
DETAIL

Prepared: Final Revision 8/11 @ 6:14 p.m.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2006 - September 30, 2007

Contractual Costs:	Proposed
Description	FY 2009
Vessel Charter - Acoustic (21 days @ $1500)	32
Vessel Charter - Biological Sampling (24 days @$2500)	60.0
Network Services - 100 per FTE month	0.7
Phone, Fax, printing, etc.	0.3
Contractual Total	92.5

Commodities Costs:	Proposed
Description	FY 2009
Misc	1.8
Commodities Total	1.8

FY09

Project Number: 070830

Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA

Name: Richard Thorne

FORM 4B
Contractual
&
Commodities

Prepared: Final Revision 8/11 @ 6:14 p.m.

2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2009
Description			
Those purchases associated with replacement equipment should be indicated by placement of an R.			
		New Equipment Total	0.0

Existing Equipment Usage:	Number of Units	
Description		
Scientific Acoustic System (BioSonics DTX)	3	
Underwater Video Camera	3	
Infrared Scanner	2	

FY09

Project Number: 070830
Project Title: Trends in Adult and Juvenile Herring Distribution and Abundance in PWS, Submitted under the BAA
Name: Richard Thorne

FORM 4B
Equipment
DETAIL

Prepared: Final Revision 8/11 @ 6:14 p.m.