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 July 9, 2002) and reporting requirements *(Procedures for the Preparation and Distribution of Reports***, adopted July 9, 2002).

PROJECT TITLE: Using otolith chemistry to discriminate Pacific herring stocks in AK

Printed Name of PI: **Edward O. (Ted) Otis**

Signature of PI:  Date 8/1/06

Printed Name of co-PI: **Nate Bickford**

Signature of co-PI: _____ Date 8/1/06

Printed Name of co-PI: _____

Signature of co-PI: _____ Date _____

* Available at http://www.evostc.state.ak.us/pdf/admin/datapolicy.pdf
** Available at http://www.evostc.state.ak.us/pdf/admin/reportguidelines.pdf

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Project No: _____
Date Received: _____

FYO7 INVITATION PROPOSAL SUMMARY PAGE

(To be filled in by proposer)

Project Title:
Using otolith chemistry to discriminate Pacific herring stocks in AK

Project Period:
October 2006 to September 2007 (FY07)

Proposer(s):
Ted Otis, Alaska Department of Fish and Game, 3298 Douglas Place, Homer, AK 99603, (907) 235-8191, ted_otis@fishgame.state.ak.us , and
Nate Bickford, University of Alaska, P.O. Box 757220 Fairbanks, Alaska 99775, (907) 474-6469, nate@sfos.uaf.edu

Study Location:
Gulf of Alaska (Sitka, Prince William Sound, Kodiak, Cook Inlet) and Bering Sea (Dutch Harbor, Togiak, Kuskokwim Bay)

Abstract:

This proposal is an extension of EVOS Project 050769, which is currently assessing the temporal stability of stock discrimination criteria derived from fatty acid analysis (FAA) of herring cardiac tissues. In 2006, Otis (050769) collected heads from fish sampled for FAA so chemical analysis of the otoliths could be conducted to evaluate which technique was most effective for determining herring stock structure at fine spatial scales. In this study, Dr. Nate Bickford (EVOS Project 060782) will process those samples using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) to determine whether otolith chemistry can be used to corroborate FAA techniques for determining fine scale structuring within and among Alaska's herring stocks (e.g., Sitka, PWS, Kamishak, Kodiak, Dutch Harbor, Togiak, and Kuskokwim Bay). Results will be published and should allow researchers to better define ecologically significant stock boundaries, likely affecting how commercially exploited herring populations are assessed and managed.

Keywords: Pacific herring, stock identification, otolith chemistry, Gulf of Alaska, Bering Sea

Funding: EVOS Funding Requested FY07 $66.4
(Includes 9% GA)

TOTAL: $66.4

NON-EVOS Funds to be used: FY07 $394.3

TOTAL: $394.3

Date: 30 July 2006

I. NEED FOR THE PROJECT

A. Statement of Problem

Despite decades of study and over a hundred years of commercial exploitation targeting Pacific herring (*Clupea pallasi*), considerable uncertainty continues to exist regarding: 1) the scale at which population structure exists within large geographic areas and, 2) the degree to which herring return to natal areas to spawn. These fundamental life history traits are directly relevant to how herring stocks should be assessed and managed (Hourston 1982; Wheeler and Winters 1984; Hay and McCarter 1997; McQuinn 1997, Begg et al. 1999). State fishery managers require a tool that can identify ecologically significant population structuring among adjacent spawning aggregations that are exploited during spring sac-roe herring fisheries. They also require a mixed-stock analysis tool that allows them to investigate whether fall/winter herring fisheries (e.g., food/bait fisheries) target the local spawning stock or a mixture of nearby stocks that aggregate during winter. The ability to manage stocks discretely is a principal component of sustainable fisheries management- one that requires the ability to accurately apportion the catch from mixed stock fisheries.

Researchers have attempted to use many different techniques to distinguish among herring stocks, including: scale pattern analysis (Rowell 1981), tagging studies (Hourston 1982), morphometrics and meristics (Schweigert 1990), microsatellite DNA (O'Connell et al. 1998, Beacham et al. 2002), fatty acid analysis (Grahl-Nielsen and Ulvund 1990, Otis and Heintz 2003) and otolith microchemistry (Otis and Heintz 2003). Many traditional stock identification techniques have proven to be unreliable on marine forage fish, particularly at fine spatial scales. For example, O'Connell et al. (1998) found that herring from Prince William Sound (PWS) and the Bering Sea were genetically divergent, but they were unable to find similar divergence among stocks sampled within the north Gulf of Alaska (GOA). Similarly, Beacham et al. (2002), and also Small et al. (2005), found very little microsatellite variation in herring along the British Columbia coast and Puget Sound, respectively, except where differences in spawning timing were great enough to effectively isolate select spawning aggregations. Bentzen et al. (1998; *Appendix E in Seeb et al. 1999*) found that the magnitude of genetic variation observed among sampling years within locations was equal to or greater than the variation observed among sea basins for Gulf of Alaska and Bering Sea herring. Bentzen et al. (1998) concluded that detectable genetic separation of spawning aggregates from the same race (e.g., GOA) may not be possible on spatial scales less than 1,000 km, unless spawning timing is substantially distinct.

The difficulty encountered with genetic markers is likely due to the relatively high stray rates exhibited by herring (e.g., Tester 1949; Cushing and Burd 1957; Hourston 1982; Wheeler and Winters 1984). Very little gene flow between populations is necessary to compromise the ability of allozyme markers to discriminate among putative stocks (Smith and Jamieson 1986; Bembo et al. 1996; Waples 1998). In particular, Waples (1998) observed that "because the amount of migration necessary to obscure most genetic evidence of stock structure (only a handful of individuals per generation) is generally inconsequential as a force for rebuilding depleted populations on a time scale of interest to humans, there is no guarantee that genetic methods alone will provide sufficient precision for key management decisions involving marine species".

Thus, herring managers have continued to seek a tool that allows them to identify population structure within and among their respective management areas.

In the absence of more definitive tools, many fishery managers have traditionally used spawning timing and location as proxies to roughly define herring stock structure. The logical assumption is, the greater the temporal and spatial separation between spawning aggregates, the greater the likelihood that they are discrete stocks. However, problems can arise when mixing of putative stocks occurs across jurisdictional boundaries. Anecdotal observers have reported examples in which the abundance of one presumptive spawning stock "crashes" while an adjacent area's presumptive stock simultaneously increases by a commensurate amount. Such observations of "spawner relocation" highlight the behavioral complexity of herring (Overholtz 2002; Hay and McKinnell 2002; Huse et al. 2002) and raises questions regarding stock discreteness and population "sub-units" (Stephenson 1999).

Stephenson (1999) states "…there has been little attention paid recently to the complexity of spawning components within management units. Several marine finfish species appear to have more complex stock structure than is recognized, and in many cases, management units contain stock complexes or metapopulations with several spawning components rather than single discrete populations. Unfortunately, these spawning components are typically difficult to define from traditional fisheries data, or to discriminate by conventional stock identification techniques". Stephenson (1999), and this proposal hereafter, uses the term population "sub-unit" to characterize temporally/spatially dispersed spawning components within larger, traditionally recognized stocks. Stephenson (1999) warns that "failure to recognize or to account for this complex stock structure in management may lead to erosion of spawning components, with unknown ecological consequences".

Two relatively new techniques have recently shown great potential for discriminating population sub-units within Alaskan herring stocks- fatty acid analysis (FAA) and otolith microchemistry. Otis and Heintz (2003) and Otis and Heintz (2004) provide full descriptions of the success they and others have had using FAA to discriminate sub-units of marine fish populations. This proposal will focus on the application of otolith microchemistry for discerning distinct sub-units within Alaska's major herring stocks (e.g., Sitka, Prince William Sound, Cook Inlet, Kodiak, Bering Sea).

Otoliths (fish ear stones) are composed of $CaCO_3$ in the form of aragonite. The otolith forms through concentric additions of mineralized tissue around a central nucleus with daily additions during the larval and early juvenile stages of life (Pannella 1980, Campana 1999).Otoliths are acellular, so once accreted, the material is not resorbed or reworked to any significant degree (Campana and Nielson 1985). The microchemistry of the otolith, as well as the physical banding patterns, provide unique insights into the environmental history of the fish but also provide information about major physiological stresses such as mating, low winter temperatures, and starvation (Berghahn and Karakiri 1990, Metcalfe et al. 1992, Smith 1992, Zhang and Runham 1992, Molony 1996). The minor and trace element composition of otoliths may allow for the reconstruction of the composition of aquatic systems in which the fish lived (Kalish 1991, Gunn et al. 1992, Radtke and Shafer 1992, Secor et al. 1992, Campana, 1999, Kennedy *et al.* 2002, Dorval *et al.* 2002, Wells et. al. 2003, Dorval *in press*).

The use of otoliths as records of environmental exposure is based on the premise that otolith microchemistry reflects differences in water chemistry in the environment (Radtke and Shafer 1992, Campana and Gagne 1995). The trace elemental composition of fish otoliths is determined by the elemental composition of the endolymph (Kalish 1989, 1991). The concentration of various trace elements in the environment and the physiology of the fish largely determine the composition of the endolymph. Physiological processes may be modified by temperature (Kalish 1991), or subtle differences in the genetics of the fish affecting the uptake of various elements and their inclusion in the endolymph (Thresher et al. 1994).

Otolith microchemistry has been used to identify stocks of pink snapper, (Edmonds et al. 1989), orange roughy (Edmonds et al. 1991), yellow-eye mullet (Edmonds et al. 1992), Atlantic cod (Campana and Gagne 1995, Campana et al. 1995), walleye (Bickford and Hannigan 1990) and salmonids (Kalish 1990) among others. Thresher (1999) provides a comprehensive review of the use of otolith elemental composition as stock discriminators and offers some cautionary suggestions for researchers interested in employing this promising technique.

Successful application of otolith elemental analysis for stock discrimination is likely dependent on the extent of the differences in water chemistry between the environments inhabited by each stock and the precision of the instruments used to measure trace elements. Laser ablation-inductively coupled plasma- mass spectrometry (LA-ICP-MS) can be used to analyze trace elements at specific loci (30 μm) on the otolith (Gray 1985, Denoyer et al. 1991). Electron microprobes (EM) also allow analysis of specific loci (5-7 μm), albeit at reduced resolution (parts per thousand, pers. comm. K. Severin, UAF Dept. of Geology and Geophysics). Techniques that target specific loci, such as EM and LA-ICPMS, are most appropriate for identifying stocks that spawn in different environments but later reside in similar environments (Coutant and Chen 1993).

Otis and Heintz (2003) had limited success discriminating differences among herring spawning aggregates at fine spatial scales (e.g., within the Gulf of Alaska) using an EM. Recently, using more precise instruments (LA-ICP-MS) that measure in parts per billion (ppb), Dr. Nate Bickford (EVOS Project 060782), with the Fisheries Otolith Group (FOG) at UAF, has used otolith elemental analysis to identify distinct herring sub-units in Prince William Sound and Sitka Sound (Figure 1). Bickford collected at least 25 juveniles in five nursery bays in PWS and analyzed the otolith cores using LA-ICP-MS to evaluate whether fish from different nursery bays came from the same, or different sources. Evaluation of the Ba/Ca and Sr/Ca ratios in the otolith cores suggested there were three distinct spawning source signatures (Figure 1A). Fish sampled from Eaglek and Simpson bays had two independent spawning sources. Fish sampled from Whale and Zaikof bays shared a single spawning source. Jack Bay fish did not have a discernable spawning source. These results suggest there may be three distinct spawning sub-units that support at least four nursery bays in Prince William Sound.

In Sitka Sound (SS), Bickford analyzed at least 25 adults collected from spawning grounds located in three zones: zone one represented the most northern section of the sound, zone two the middle section, and zone three the southern-most section. Adult fish otoliths were analyzed at the core and the edge. The core represents the signature of hatch location and the edge

represents the collection site. When the fish otolith cores from each zone where compared, zone two and three were statistically similar, whereas zone one was significantly different ($p<0.001$). This suggests that there are two stock sub-units in SS.

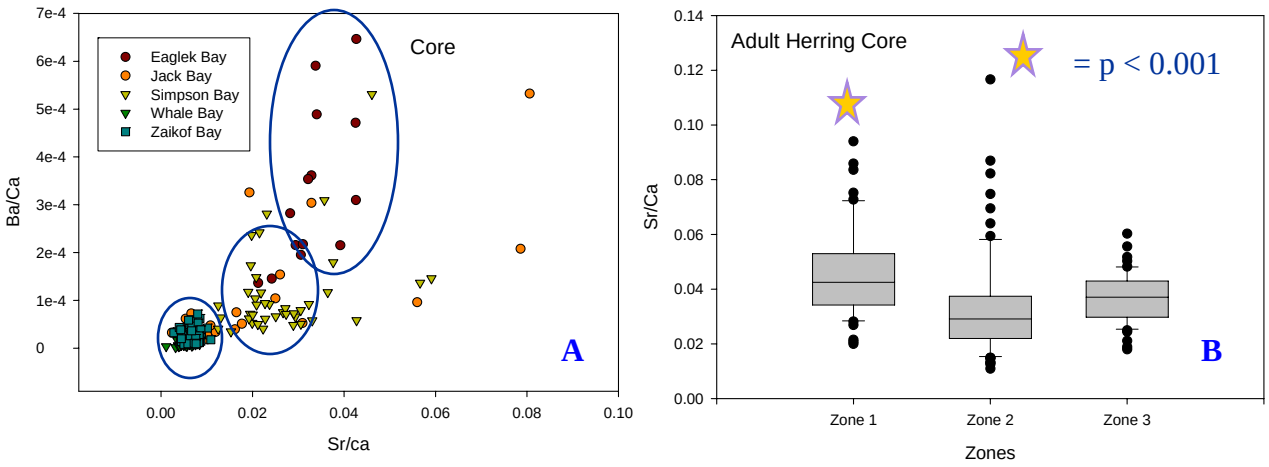

Figure 1. Otolith chemistry data from Pacific herring sampled in (A) Prince William Sound (PWS) and (B) Sitka Sound (SS). In PWS, three distinct groups were resolved from five locations sampled by EVOS Project 060782; 1st is Whale and Zaikof bay fish, 2nd is Simpson Bay fish, and 3rd is Eaglek Bay fish. In SS, differences in otolith microchemistry suggest zone one fish (northern-most section) are a distinct group from zone two and three fish (middle and southern-most sections).

B. Relevance to Program Goals and Scientific Priorities

The proposed project is intended to address program goals outlined under the *Injured Resources and Services* section *(Appendix A: Herring Studies)* of the 2007 RFP. Specifically, this project should result in information and techniques useful towards the future refinement of PWS herring models used by EVOS-TC researchers (e.g., Biological Model of Herring Life Stages, and Circulation and Larval Drift Models). It should also contribute to the "*Marking Studies*" component of *Appendix A* in the 2007 RFP, by providing further samples for otolith chemical analysis. The proposed study may also have relevance towards recovery of the commercial sac-roe herring fisheries in Prince William Sound and Lower Cook Inlet.

This study offers the unique opportunity to compare results from two cutting-edge marine stock identification techniques applied to the same sample sets. The new stock identification techniques we're evaluating have tremendous potential to augment existing ADF&G stock assessment and management strategies. If we achieve the results we expect, fishery managers will gain a valuable tool to help them define ecologically significant stock boundaries for exploited herring spawning aggregations (spring sac roe fisheries) and determine the stock

contribution for herring harvested in mixed-stock food/bait fisheries. Ultimately, the ability to identify the stock of origin for herring collected away from their natal spawning areas would provide a basis for better understanding the important role herring play in the marine ecosystem by enabling studies directed at: larval dispersal patterns, home ranges of individual populations, locations of stock specific over-wintering areas, and perhaps the degree to which Pacific herring home back to their natal spawning areas. Recipients of the potential benefits resulting from this project include ADF&G (improved stock assessment and fishery management plans), EVOS-TC researchers looking to refine herring models for PWS, subsistence and commercial herring fisherman (improved management of sac roe and food/bait fisheries), and herring researchers statewide (ability to define stock of origin for herring sampled away from natal spawning areas).

II. PROJECT DESIGN

A. Objectives

The goal of this project is to determine whether otolith microchemistry is useful for discriminating population sub-units within traditionally recognized stocks of Pacific herring in Alaska (e.g., Sitka, PWS, Kamishak, Kodiak, Togiak, Dutch Harbor, Bering Sea). Because otolith samples were collected from the same individual fish used to evaluate the temporal stability of fatty acid compositions (EVOS Project 050769), this project offers the unique opportunity to directly compare two cutting edge herring stock identification techniques.

Accurate knowledge of stock structure is relevant to the manner in which state officials assess and manage the commercially and ecologically important herring resource. The ability to identify the stock of origin for herring collected away from their natal spawning areas would also have tremendous utility to managers of fisheries that may be harvesting mixed stocks (e.g. herring food/bait fisheries). For these purposes, we propose the following objectives:

Objective 1) Using samples from the same individual fish, assess whether population sub-unit boundaries derived from otolith chemistry match those derived by fatty acid analysis.

This objective addresses the following hypothesis:

1). At spawning, the variation in otolith chemistry within a spawning stock is equal to the variation observed between that stock and other spawning stocks.

This hypothesis attempts to corroborate and expand upon the results described in Otis and Heintz (2003), as well as the results forthcoming from EVOS Project 050769. Evaluation of this hypothesis will also establish the extent to which otolith microchemistry naturally varies across all contributing members (i.e., sexes, cohorts) of a putative spawning stock.

Objective 2) Assess whether the stock(s) of origin for herring collected during fall/winter can be determined by comparing their otolith chemistry to those of local area spawning aggregations.

This objective addresses the following hypothesis:

2). The variation in otolith microchemistry within herring schools aggregating during fall/winter is equal to the variation observed between herring schools using the same general area for spring spawning.

This hypothesis evaluates whether or not otolith chemistry from spawning herring can be used to determine the stock(s) of origin for herring sampled/harvested during other times of the year.

B. Procedural and Scientific Methods

This project will utilize otolith samples collected from at least eleven locations in five regions of Alaska (Table 1). Along with the fatty acid samples needed for their project, Otis and Heintz (EVOS Project 050769) also collected herring heads and caudal fin clips in 2006 to facilitate future otolith microchemistry and genetic analyses. *(Note: We opted not to include a genetic component in this proposal after Dr's Jim and Lisa Seeb (ADF&G Gene Conservation Lab) indicated there was very little chance current genetic techniques would find evidence of structuring at the spatial scale we're interested in. See Statement of Problem section for justification for excluding genetics from this project. ADF&G will hold the genetic samples (preserved in ETOH) collected during Project 050769 for potential future analysis).*

Unfortunately, low stock abundance and correspondingly low spawning activity contributed to failed attempts to collect fatty acid and otolith samples from major spawning aggregates in PWS in 2006. Given the importance of that region to this project, we propose to attempt to collect fatty acid and otolith samples from three locations in PWS in Spring 2007 (Table 1). To facilitate the most robust evaluation of Objectives 1 and 2, we will analyze the microchemistry of otoliths from the same subset of individual fish processed for FAA during EVOS Project 050769, including the PWS samples we intend to collect in 2007.

Table 1. Sampling locations, dates, and sample sizes for herring collected for fatty acid and otolith microchemistry analyses.

Region	Sample location(s)	Sample date(s)	Sample Type	Sample size (2006)	Sample size (2007)
Sitka	Sitka Sound	Mar 25-Apr 5	Spring (spawning)	30	0
	Hoonah	Apr 10-20	Spring (spawning)	30	0
Prince William Sound	Montague Island	Apr 15-20	Spring (spawning)	0	30
	NE (Gravina Bay)	Apr 5-10	Spring (spawning)	0	30
	N (Fairmont Bay)	Apr 15-20	Spring (spawning)	0	30

Westward (Kodiak)	Kiliuda Bay	Apr 15	Spring (spawning)	30	0
	Uganik Bay	Apr 15-30	Spring (spawning)	30	0
	Uganik Bay	Nov-Jan	Winter (food/bait fishery)	30	0
	Dutch Harbor	July 15	Summer (food/bait fishery)	30	0
Kamishak Bay	Chenik Head	April 25-May 5	Spring (spawning)	30	0
	Iniskin Bay	May 15-25	Spring (spawning)	30	0
Togiak	Nunavachak	May 1-10	Spring (spawning)	30	0
	Hagemeister Is.	May 10-15	Spring (spawning)	30	0
Kuskokwim Bay	Nelson Island	May 15-30	Spring (spawning)	30	0
	Goodnews Bay	May 25-Jun 5	Spring (spawning)	30	0
			Total samples	360	90

At collection, the length and sex of sampled fish was recorded and a scale sample was removed for aging. In contrast to Otis and Heintz (2003), the proposed study sampled randomly from all available age classes and sexes. Heads from herring sampled in 2006 were removed, deposited in bags pre-labeled to match fatty acid and genetic samples, and then stored frozen so otoliths could be extracted later.

Otolith Chemistry

Sagittal otoliths will be extracted from Pacific herring using standard techniques (Campana et al. 1995; Campana 1999; Bickford et al. 2003). Otoliths will be removed from the fish and placed in centrifuge tubes to dry until processing. We will thin section the otoliths, using a Beuhler isomet low speed saw and the exposed otolith core will be used for aging and chemical analysis. Thin sectioned otoliths will be polished with fine grit and velvet polishing pads (Beuhler) until the core is distinctly visible. Otoliths will be randomly analyzed with dry laser ablation (LA; New Wave 213 nm Nd:YAG) - inductively coupled plasma – mass spectrometry (ICP-MS; 7500c Agilent). ICP-MS instruments can also assay inter-element ratios, such as Sr/Ca, with precision (0.05% relative standard deviation [RSD]) approaching that of thermal ionization mass spectrometry. We envision that Mg/Ca, Mn/Ca, Sr/Ca and Ba/Ca ratios will be assayed in the otoliths along with other trace elements that provide a distinguishable signature.

The center of the otolith, the core, represents larval otolith deposition. We will use core otolith chemistries to compare fish from various collections sites. This will identify the number of population sub-units that otolith chemistry can identify. The chemistry of the core region of the otolith records the chemistry of the natal habitat. In spawning fish the chemistry of the outer edge can be matched to core chemistries to assess whether the fish returned to their natal grounds for spawning. Finally, a relational database will be constructed and the data statistically

parameterized so that individual fish can be classified to their nursery area based on these geochemical signatures.

Fatty Acid Analysis

Refer to Otis and Heintz (2005: EVOS Project 050769) for details concerning how fatty acid samples were collected and analyzed. These same procedures will be used to process the fatty acid samples collected in PWS in 2007.

C. Data Analysis and Statistical Methods

Differences in the microchemistry of otoliths collected from spawning aggregates at a given site will be determined by multivariate analysis of variance (MANOVA). Linear discriminate analysis will be used to establish classification criteria for known stocks and to sort unknown samples into groups. Outliers that do not fall clearly within the range of one of the known stocks will be classified as unknown stocks. Classification accuracy will be estimated using cross-validation procedures. Wilk's lambda with α set to 0.05 will be used to test the hypothesis that the variation in otolith chemistry within a spawning stock is equal to the variation observed between that stock and other spawning stocks (*Hypothesis 1*).

Differences detected among stocks/population sub-units will be further examined by descriptive discriminant analysis (DA) to identify which groups differ. DA resolves differences among groups by identifying a series of canonical functions, each of which is a linear combination of the response variables. These functions progressively reduce the error in the data set. The number of functions that account for the error represents the dimensionality of the data set, which is determined by iteratively fitting a function and testing the hypothesis that the residual error is equal to zero (Huberty 1994). Bi-plots for each function will be constructed to examine how the functions separate the data. We will also examine the pooled within group canonical structure to identify which trace elements of otoliths exert the most influence on the separating functions. The results of the MANOVAs will be further examined by predictive discriminant analysis to examine the robustness of the conclusions. The analysis will employ the leave-one-out method to determine how frequently the discriminant functions accurately identify "unknown" samples. Results of these tests will be expressed as the probability of correctly identifying members of a test group to the appropriate stock or sub-unit. A similar approach will be used to determine the probability of correctly identifying members of the fall/winter herring samples to the appropriate spawning stock or sub-unit (*Hypothesis 2*). The MANOVAs and discriminant analyses will be performed in SAS release number 6.12 using the non-parametric DISCRIM procedure. Prior to analysis, the homogeneity of the covariance matrices will be examined. If they are found to be not homogenous then correlation matrices will be used.

D. Description of Study Area

Our study area includes sampling locations extending from Sitka Sound (~57º N Latitude, 136º W Longitude), north to Prince William Sound (~61º N Latitude) and west to Dutch Harbor (~54º

N Latitude, 167º W Longitude; Figure 1). Except for Dutch Harbor, Togiak and Kuskokwim Bay (Goodnews Bay, Nelson Island), which are in the Bering Sea, all sampling locations are within the Gulf of Alaska (GOA), with most of the samples coming from locations in the Northern Gulf of Alaska (NGA). Pacific herring can be found spawning at many locations along Alaska's ubiquitous coastline with commercially viable populations of interest to this study being located in Sitka Sound, Prince William Sound, Kamishak Bay (Lower Cook Inlet), Kodiak Island, Togiak Bay, and Kuskokwim Bay.

E. Coordination and Collaboration with Other Efforts

This collaborative project (ADF&G-Commercial Fisheries, Univ. of Alaska-Fairbanks) builds upon the results of several EVOS-funded studies (Projects 02538, 050769 and 060782). Project 02538, conducted by Principal Investigators Otis and Heintz, demonstrated the potential for using fatty acid analysis of herring hearts to discriminate among spawning aggregates sampled from Sitka, Prince William Sound, Kamishak Bay, Kodiak, and Togiak. Project 050769, also conducted by Otis and Heintz, is currently evaluating the temporal stability of fatty acids used to discriminate among Alaska herring stocks. Project 060782, conducted by Dr. Nate Bickford, is using otolith chemistry to determine herring natal spawning areas, larval drift, and juvenile rearing areas in PWS. In this study we propose to use LA-ICP-MS to chemically analyze otoliths from the same fish Otis and Heintz used to evaluate fatty acid composition of heart tissue as a stock identification tool. Most of the otoliths necessary for this project were collected and preserved during the spring and fall/winter of 2006 during field operations for Project 050769 (Table 1). Collection of those samples used existing ADF&G-CF sampling platforms and staff, facilitating considerable cost-savings. A few additional samples from PWS will be collected in Spring 2007 by ADF&G staff as additional cost-share measures. NMFS-Auke Bay Lab staff also offered to collect samples for this project if their FY07 EVOS proposal is funded (R. Heintz, pers. comm., EVOS Proposal entitled: *Are herring (Clupea pallasi) energetics in PWS a limiting factor in successful recruitment of juveniles and reproduction of adults*; J. Vollenweider and R. Heintz, Principal Investigators). Due to these extensive collaborations for 2006 and 2007 sample collections, all the present project requires is funding to process the otoliths and analyze and write up the results.

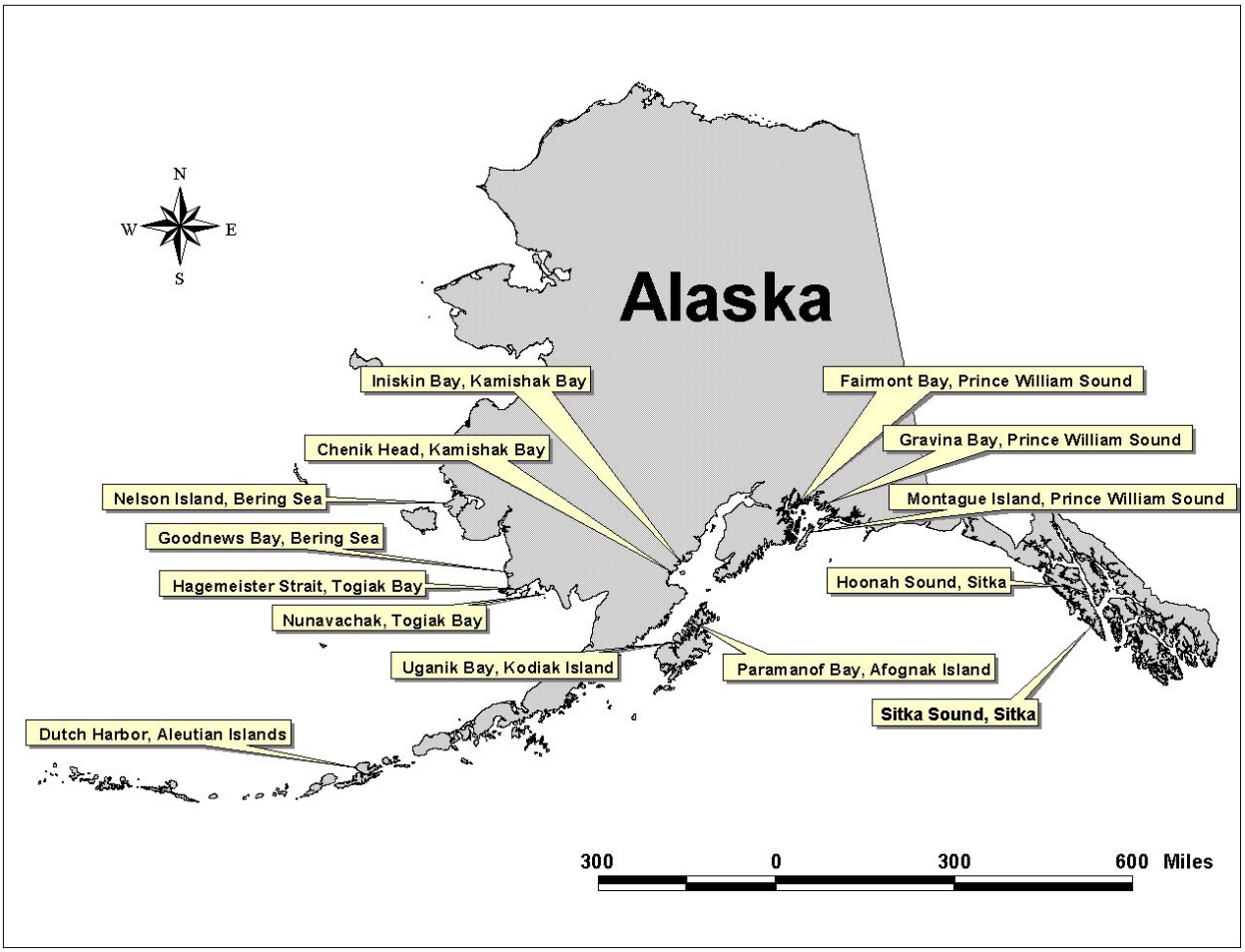

Figure 1. Map of Alaska illustrating the 14 target locations from which Pacific herring samples were/will be collected to evaluate the utility of heart tissue fatty acid markers and otolith chemistry as stock identification tools.

III. SCHEDULE

A. Project Milestones

Objective 1. Using samples from the same individual fish, assess whether population sub-unit boundaries derived from otolith chemistry match those derived by fatty acid analysis.
To be met by September 2007

Objective 2. Assess whether the stock(s) of origin for herring collected during fall/winter can be determined by comparing their otolith chemistry to those of local area spawning aggregations.
To be met by September 2007

B. Measurable Project Tasks

FY 07, 1st quarter (October 1, 2006-December 31, 2006)

October:	Project funding approved by Trustee Council
November-December:	Extract, section, and polish otoliths

FY 07, 2nd quarter (January 1, 2007-March 31, 2007)

January (tentative):	Annual GEM Workshop
January-March:	Begin LA-ICP-MS chemical analysis of otoliths

FY 07, 3rd quarter (April 1, 2007-June 30, 2007)

April:	Collect PWS spawning samples (hearts & otoliths)
April-June:	Complete LA-ICP-MS chemical analysis of otoliths
	Begin chemical analysis of hearts

FY 07, 4th quarter (July 1, 2007-September 30, 2007)

July:	Complete chemical analysis of hearts
July-August:	Complete statistical analysis of data, begin final report
September 30:	Submit Final Report

IV. RESPONSIVENESS TO KEY TRUSTEE STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

Because this is a lab study evaluating a developing technology, there is not much room for incorporating TEK at this stage. However, we do envision opportunities to engage interested subsistence/commercial fisherman and coastal community members through various outreach endeavors. Along with presenting project results at at least one professional meeting in 2007, we will post our results on a project website: www.herringstockid.info

B. Resource Management Applications

This project has tremendous resource management potential. It proposes to develop stock discrimination tools that may help resolve questions concerning the scale at which ecologically significant herring stock sub-units exist in PWS and the greater Gulf of Alaska. A tool that is able to discriminate herring stocks over fine spatial scales would have great value to fishery managers. In the near term, this tool could be used to resolve a number of pressing commercial fishery management questions regarding stock structure in the Bering Sea (e.g., What is the stock composition of herring harvested in Dutch Harbor's food/bait fishery) and Gulf of Alaska (e.g., Do spatially/temporally dispersed spawning aggregations in Kamishak Bay [or Prince William Sound, Kodiak, or Sitka] represent ecologically significant stock sub-units?). Ultimately, the ability to identify the stock of origin for herring collected away from their natal spawning areas would provide a basis for better understanding the important role herring play in the marine ecosystem by enabling studies directed at: larval dispersal patterns, home ranges of individual

populations, locations of stock specific over-wintering areas, and perhaps the degree to which Pacific herring home back to their natal spawning areas. This proposal has broad support from ADF&G Management/Research staff, as demonstrated by their efforts to collect otolith samples from their respective areas during EVOS project 050769 to facilitate this project (e.g., Sitka [Marc Pritchett], PWS [Steve Moffitt], Lower Cook Inlet [Ted Otis/Lee Hammarstrom], Kodiak [Mark Witteveen, Kevin Brennan], Togiak [Lowell Fair/Tim Baker], and Kuskokwim Bay [Craig Whitmore/John Linderman]).

V. PUBLICATIONS AND REPORTS

This project will provide a peer-reviewed final report on the identification of Alaska herring stocks based on differences in otolith microchemistry, as well as an evaluation of how the otolith microchemistry results compare to those derived by fatty acid analysis (EVOS Project 050769). Because this is a one-year project, a final project report will be submitted on September 30, 2007, in lieu of an annual report. We also intend to seek publication of an article tentatively entitled "Evaluation of otolith chemistry and heart tissue fatty acid analysis for discriminating Pacific herring stocks in Alaska" in the refereed journal *Transactions of the American Fisheries Society* (to be submitted in September 2008).

VI. PROFESSIONAL CONFERENCES

We will present a project update (poster) at the annual Marine Science workshop in January 2007 and we intend to give an oral presentation at the Alaska Chapter Meeting of the American Fisheries Society in November 2007 (location to be determined). Travel funds have been requested to meet each of these obligations.

Literature Cited

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RESUME

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Education:
Master of Science, Fisheries Science, University of Arizona, 1994.
Bachelor's of Science, Environmental Science, University of New Hampshire, 1988.

Professional Experience: *April 1996-present*: Area Finfish Research Biologist for Lower Cook Inlet, Alaska Department of Fish and Game- Comm. Fish., Homer, AK. Supervised by Lowell Fair. Responsible for assessment and forecasting of Kamishak Bay herring stock; directs salmon and herring catch/escapement-sampling programs; forecasts Lower Cook Inlet salmon returns; develops new approaches to monitoring salmon escapement (e.g., remote video and time-lapse recording). Writes grants to secure outside funding for research projects, acts as principal investigator. *April 1994-March 1996*: Fishery Bio-technician, Kenai Fishery Resources Office, U.S. Fish and Wildlife Service, Kenai, AK. Supervised by Gary Sonnevil. Project leader for Andreafsky River (Yukon) adult salmon enumeration project: constructed and deployed resistance board/floating weir to count adult salmon; project leader for Kenai River rainbow trout radio-telemetry project: surgically implanted radio transmitters and tracked fish using mobile receivers and remote data loggers. *June 1991-March 1994:* Graduate Research Asst., Univ. of Arizona, Dept. of Renewable Natural Resources, Tucson, AZ. Supervised by Dr. O. Eugene Maughan. Designed and implemented field studies to assess the composition, abundance, and distribution of fishes in streams tributary to the Colorado River in Grand Canyon. Co-managed field study to inventory aquatic habitat available to stream fishes in Grand Canyon. *August 1987-June 1991 (intermittent*): Fishery Bio-technician, Kenai Fishery Resources Office, U.S. Fish and Wildlife Service, Kenai, AK. Supervised by Gary Sonnevil. Project Leader or team member on various field projects including: assessing adult salmon returns using weirs (Uganik R, Kodiak); developing new approaches to aging Dolly Varden and lake trout otoliths; enumerating emergent salmon fry (Tustumena Lake); investigating steelhead distribution and angler effort (Cold Bay); investigating run-timing and migration rates of chinook salmon (Kuskokwim River); and inventorying salmon spawning habitat (Ayakulik R., Kodiak).

Publications and Reports:

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Otis Resume Cont'd

Publications and Reports (cont'd):

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Recent Project Collaborators (≤ 4 years)

William Bechtol, ADF&G-Commercial Fisheries, Homer
Dr. Nate Bickford, University of Alaska-Fairbanks
Mark Dickson, ADF&G-Commercial Fisheries, Homer
Dr. Ken Goldman, ADF&G-Commercial Fisheries, Homer
Lee Hammarstrom, ADF&G-Commercial Fisheries, Homer
Ron Heintz, NMFS-Auke Bay Lab
Colleen Matt, National Park Service, Lake Clarke National Park
Joe Meehan, ADF&G-Wildlife Conservation, Anchorage
Steve Moffitt, ADF&G-Commercial Fisheries, Cordova
Josh Peirce, ADF&G-Wildlife Conservation/Univ. of Alaska-Fairbanks
Dr. Ken Severin, University of Alaska-Fairbanks
Margaret Spahn, ADF&G-Commercial Fisheries, Homer
Coowe Walker, ADF&G, Kachemak Bay Research Reserve, Homer
Dr. Mark Wipfli, University of Alaska-Fairbanks
Mark Witteveen, ADF&G-Commercial Fisheries, Kodiak
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Education:

NSF Polar Post – Doctoral Work - University of Alaska Fairbanks. Research: Movement patterns of fish in the Bering Sea and Gulf of Alaska, *2004 - Present*

PhD - Environmental Science (emphasis in biology and chemistry) Arkansas State University. Research: "Linkages between Hydrology and Essential Fish Habitat" *2000 - 2004*

M.S. - Biology Appalachian State University. Research: "Survey of Gastrointestinal Helminths in Small Mammals in Watauga County, NC and Changes in Parasite Populations Due to Changes in Host Species and Changes in the Season" *1997 -2000*

B.S. – Biology Lenoir-Rhyne University. Research: "The Caloric Content of Wild and Captive Bears Diet and the Difference in Calories Used by Captive Bears and Wild Bears" *1993 -1997*

Experience

Affiliated Research Faculty: ESTES Department in the College of Natural Sciences and Mathematics – UAF *2005 – Present*

Laboratory Manager: the Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) located in the Advanced Instrumentation Laboratory in the College of Natural Sciences and Mathematics – UAF *2005 – Present*

NSF Polar Regions Post Doctoral program Post-Doc: Identifying movement patterns and stock identification in fish from the Bering Sea and Gulf of Alaska. *2004 - Present*

Water Rock Life Lab (ASU) Post Doc: CRUI: Environmental Life History of Freshwater Fish using Otolith Microchemistry *2004*

Environmental Sciences Program (ASU) Graduate Assistant: *2001 - 2004*

Grant and Contract Funding

AYK-SSI - Factors Affecting Juvenile AYK Chum Salmon Growth and Condition $1,955,486 Co-Pi

Sea Grant – Mentoring Undergraduates in Fisheries Techniques $10,000 PI

EVOS – Pacific Herring study - Using otolith chemical analysis to determine larval drift of Prince William Sound Pacific herring (*Clupea pallasii*). $52,000 PI

OSRI – Pacific Herring in Prince William Sound - Identifying past habitat use and essential habitat of Pacific herring (*Clupea pallasii*).-$33,000 Co-Pi

Sitka herring and salmon study – Stock delineation and natal homing in herring and sockeye salmon. $30,000 Co-Pi.

NSF Polar Programs Post Doctoral Fellowship – "Identifying movement patterns and stock identification in fish from the Bering Sea and Gulf of Alaska." $140,000. Principal Investigator

Arkansas Water Resources – "Otoliths and Environmental Life History of Freshwater Fish", $20,000. Co-Principal Investigator

NSF DBI 0328832 (2003-2007) "CRUI: Assessing Environmental Life Histories of Freshwater Fish: Applications of Otolith Microchemistry". $698,626. Project Manager (2003-2004).

Relevant Publications

Journal Articles

Bickford, N., and Hannigan, R. 2005. Stock identification of Walleye (*Sander vitreum*) using otolith chemistry in the Eleven Point River, AR North American Journal of Fisheries Management. 25: 1542-1549.

Sako, A., O'Reilly, C.M., Hannigan, R., Bickford, N., and Johnson, R.L. 2004. Stock identification of two clupeid species, *Stolothrissa tanganicae* and *Limnothrissa miodon* in Lake Tanganyika using otolith microchemistry. Geochemistry: Exploration, Environment, Analysis. 5:

Bickford, N.A. and Hannigan, R.E. 2003. Trace element chemistry of fish tissues: Uptake routes in genus *Moxostoma*. Environmental Geoscience 11(2): 226-236.

Christian, A.D., Bouldin, J., Bickford, N., McCord, S.B., Sako, A., and Ferris, J. 2003. Winter and spring water quality of Big Creek watershed, Craighead County, AR: Nutrients, habitat, and macroinvertebrates. Journal of the Arkansas Academy of Sciences 57: 27 -36

Book Chapter

B. Hamilton, N. Bickford, and R. Hannigan, "Elemental chemistry of endolymph and otolith: Passive recorder or active writer", bibl. Geological Society of America Special Publication, GSA Press, Denver CO., (). *Book* Submitted of Collection: D. Sarkar, R. Datta and R. Hannigan, "Current Perspectives in Environmental Geochemistry"

Invited Presentations

Howard, R, Bickford, N., and Hannigan, R. Environmental life history of walleye (*Sander vitreum*) in Greer's Ferry Lake. ASLO Aquatic Science Meeting, Salt Lake City, Utah 2005.

Bickford, N., and Hannigan, R. "Hydrochemical variations in a Spring-Fed River, Spring River Arkansas". Southwest regional meeting of the American Chemical Society Oklahoma City, OK. 2003.

Bickford, N.A., Hamilton, B., and Hannigan, R.E Trace elements chemistry in a spring-fed river (Spring River, Arkansas): Ecotoxicological implications of chemical weathering. Southcentral-Southeast sectional meeting of the Geological Society of America. Memphis TN. 2003.

Collaborators

Norcross, Brenda – University of Alaska Fairbanks
Hannigan, Robyn – Arkansas State University
Brown, Randy – United States Fish and Wildlife
Spangler, Rob – Forest Service

Budget Justification

Otis/Bickford: Using Otolith Chemistry to Discriminate Pacific Herring Stocks in AK

Note: Non-agency funding is required for this project because ADF&G does not have the lab facilities/expertise to conduct this type of chemical analysis, nor does ADF&G have in-house funding to develop new technologies at the present time.

Fiscal Year 2007: $66.4K

The objectives of this study are to 1) *assess whether population sub-unit boundaries derived from otolith chemistry match those derived by fatty acid analysis,* and 2) *Assess whether the stock(s) of origin for herring collected during fall/winter can be determined by comparing their otolith chemistry to those of local area spawning aggregations.* The work on fatty acid composition is already underway (Project 050769).

This budget is intended to fund the otolith chemistry analysis and the synthesis of the two methods. The total funds requested are $69.2K.

F. Project Costs: Budget summary and justification

Personnel: $39.7K
$7.5K for Otis (1 mo) to collect samples, assist with data interpretation, and co-author reports and manuscripts.
$8.1K for Bickford (1 mo) to manage data QA/QC, conduct chemical analysis and data interpretation, coordinate technicians, and co-author reports and manuscripts.
$24.1K for Research Technician(s) (5 mos) to handle: organization of samples, sample preparation and analysis, and GIS processing.

*Benefits**:***
University staff benefits are applied according to UAF's benefit rates for FY07, negotiated with the Office of Naval Research (ONR). A copy of the rate proposal is available at: http://www.alaska.edu/ controller /cost-analysis/cost_reports.html.

Travel: $2.5K
$2.5K for Otis and Bickford to attend annual EVOS Marine Science Meeting to disseminate project results.

Contractual Services: $5.3K
$4.5K for otolith trace elements processing costs (*Note: $10 per sample for 450 otolith samples to run the LA-ICP-MS, which will include the associated costs of the running the ICP-MS, including electricity, water demands, micro-pipettes, sample and skimmer cones, torch, and ultra-pure carrier gas and ICP-MS standards as the project dictates. Because Dr. Bickford has access to the LA-ICP-MS, sample cost only includes maintenance cost of the instrument)***.**
$0.8K is needed for sample shipping costs and project web site update/maintenance.
Funds are also requested for journal publication page costs, report copies, etc.

Commodities/Supplies: $3.2K
$2.0K for expendable sampling supplies to chemically analyze otoliths (e.g., argon gas, ultra-pure acids, saw blades for otolith preparation, polishing pads, etc.), and
$1.2K for miscellaneous lab, printing, and office supplies.

Univ. of Alaska-Fairbanks Indirect Costs*: *($10.2K)

Facilities and Administrative (F&A) Costs are negotiated with the Office of Naval Research and for research are calculated at 25% of the Total Direct Costs (TDC). TDC includes Total Direct Costs minus subcontracts in excess of $25,000 and equipment. Regarding subcontracts, the indirect rate is 25% of the first $25,000 of each subcontract, plus 5% of each subcontract's cost in excess of $25,000 and less than $250,000, plus 2% of each subcontract's cost in excess of $250,000. A copy of the agreement is available at: http://www.alaska.edu/ controller/cost-analysis/negotiated_agreements.html. To cover costs through the Trustee Council's general administration (GA), an additional 9% indirect is added to the budget to be paid to Alaska Department of Fish and Game per RFP instructions.

ADF&G – G&A*: *($5.5K)

Cost-share funds*: (*$394.3K)
$66.3K: Cost-share provided by ADF&G for ocean going research vessels, air charters, skiffs, and staff to facilitate statewide sample collections in 2006.
$28.0K: Cost-share provided by ADF&G for ocean going research vessel, air charters, skiff, and staff to facilitate PWS sample collection in 2007.
$300.0K: Cost-share provided by Univ. of Alaska-Fairbanks for use of lab facilities and instruments to conduct chemical analysis of otoliths (e.g., LA-ICPMS Instrument, Buehler Isomet saw, polishing equipment, microscope with digital enhancement).

Data Management and Quality Assurance/Quality Control Statement

1. **Study design.** The study design is a stratified random sample. The sampling strata include stocks and times. Table 1 of the proposal outlines sample collection locations and dates. Sample sizes are based on the results of previous studies (*See Otis and Heintz 2003*).

2. **Acceptable data.** Acceptable otolith chemistry data will need to conform to standard QA criteria employed the Fisheries Otolith Laboratory at UAF.

3. **Data characteristics.**

    a. Fish data include lengths, weights, ages and sex of herring, which can be mapped onto ADF&G stock assessments based on spawning surveys. See *Appendix A* for MetaLite metadata characteristics.
    b. Otolith chemistry data will be measured using a laser ablation (LA; New Wave UP 213nm Nd:YAG) inductively coupled plasma – mass spectrometry (ICP-MS; Agilent 7500c) in the Advanced Instrumentation Laboratory on the UAF campus. These analyses will be preformed on thin sections of otoliths on a transect extending from the core across to the otolith margin. All analyses will be calibrated using the external matrix-matched standard USGS MACS-1 (carbonate standard). Each sample measurement will be preceded by a gas blank measurement with re-calibration (gas blank and MACS-1) every 10 samples. Concentrations of all elements will be calculated relative to MACS-1 after proper correction for gas blank, matrix, and drift effects. Software used for analysis also contains QA/QC measures which will halt analysis if data starts to drift.

4. **Algorithms to convert signals from sensors to observations.** Linear calibrations will be used to calculate otolith chemistry concentrations from the LA-ICP-MS.

5. **Sample handling and custody.** Biological information for each sample will be entered onto a custody sheet. The custody sheet has columns for sample identification number (SIN), fish length, weight, age, sex, date of processing, processor's sample identification number, the processor's name, and a column for any comments that might be important in interpretation. Examples of commentary would be any noticeable evidence of disease or parasites. Processors will be issued custody sheets, which will be shipped to Fisheries Otolith Laboratory (FOG) with the samples. The sample numbers will be assigned in the field and correlated with the processor's sample identification number. Sample identification numbers on custody sheets will be used to track the progress of samples through the analytical process and to correlate those results with the initially collected biological information. Otolith chemistry and biological data will be maintained in a database, after completion of the report, a copy of the data will be issued to ADF&G.

6. **Calibration and performance of analytical instruments.** The instrument must be calibrated before analysis of any samples with at least a blank and multiple standards. A Linear through zero curve type is used for all analytes. The calibration blank will be run as a blank, before the analysis of any actual calibration standards. MACS-1 will be used (Table D.1; Trace Elements in calcite) as an external standard to monitor precision. In addition, a calibration gas blank monitored the process and re-calibration will be done every 6 samples. Concentrations of all elements will be calculated from the calibration

curve after proper correction for control blank, matrix and drift effects using the Newwave Glitter software. Based on measurements of MACS-1 the reported values will be better than 3% error for all elements of interest. The following isotopes will be monitored with isobaric correction equations built-into the analytical method as specified by EPA 200.8. ^{24,25,26}Mg, ^{44}Ca, ^{55}Mn, ^{86,87,88}Sr, ^{135,137,138}Ba, and ^{235,238}U. Whole element concentrations will be calculated based on calibrations and relative abundance of isotopes. In the case of multi-isotope elements the reported concentration represents an average of the measured concentrations calculated independently for each isotope. All multi-isotope concentrations will be within 1% of each other.

7. **Data reduction and reporting.** All data will be tabulated by stock and time. Stocks will be compared using MANOVA, to test for differences within stocks with respect to time and differences among stocks regardless of time. See the proposal for details. Differences will be further evaluated by discriminate function analysis. The statistical software will be SAS.

Appendix A.

MetaLite Metadata File

Using_otolith_chemistry_to_discriminate_Pacific_herring_stocks_in_AK.txt

Identification_Information:
  Citation:
    Citation_Information:
    Originator: Ted Otis
    Publication_Date: 20060803
    Title: Using otolith chemistry to discriminate Pacific herring stocks in AK
    Geospatial_Data_Presentation_Form: map
    Publication_Information:
      Publication_Place: Homer, AK
      Publisher: Alaska Department of Fish and Game
    Online_Linkage: www.herringstockid.info
  Description:

Abstract: This proposal is an extension of EVOS Project 050769, which is currently assessing the temporal stability of stock discrimination criteria derived from fatty acid analysis (FAA) of herring cardiac tissues. In 2006, Otis (050769) collected heads from fish sampled for FAA so chemical analysis of the otoliths could be conducted to evaluate which technique was most effective for determining herring stock structure at fine spatial scales. In this study, Dr. Nate Bickford (EVOS Project 060782) will process those samples using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) to determine whether otolith chemistry can be used to corroborate FAA techniques for determining fine scale structuring within and among Alaska's herring stocks (e.g., Sitka, PWS, Kamishak, Kodiak, Dutch Harbor, Togiak, and Kuskokwim Bay). Results will be published and should allow researchers to better define ecologically significant stock boundaries, likely affecting how commercially exploited herring populations are assessed and managed.

Purpose: This project proposes to develop stock discrimination tools that may help resolve questions concerning the scale at which ecologically significant herring stock sub-units exist in PWS and the greater Gulf of Alaska. Ultimately, the ability to identify the stock of origin for herring collected away from their natal spawning areas would provide a basis for better understanding the important role herring play in the marine ecosystem by enabling studies directed at: larval dispersal patterns, home ranges of individual populations, locations of stock specific over-wintering areas, and perhaps the degree to which Pacific herring home back to their natal spawning areas.

Supplemental_Information: This collaborative project (ADF&G-Commercial Fisheries, Univ. of Alaska-Fairbanks) builds upon the results of several EVOS-funded studies (Projects 02538, 050769 and 060782). Project 02538, conducted by Principal Investigators Otis and Heintz, demonstrated the potential for using fatty acid analysis of herring hearts to discriminate among spawning aggregates sampled from Sitka, Prince William Sound, Kamishak Bay, Kodiak, and Togiak. Project 050769, also conducted by Otis and Heintz, is currently evaluating the temporal stability of fatty acids used to discriminate Alaska herring stocks. Project 060782, conducted by Dr. Nate Bickford, is using otolith chemistry to determine herring natal spawning areas, larval drift, and juvenile rearing areas in PWS. In this study we propose to use LA-ICP-MS to chemically analyze otoliths from the same fish Otis and Heintz used to evaluate fatty acid composition of heart tissue as a stock identification tool.

Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20060325
Ending_Date: 20070425
Currentness_Reference: ground condition
Status:
Progress: Planned
Maintenance_and_Update_Frequency: As needed
Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: 167
East_Bounding_Coordinate: 136
North_Bounding_Coordinate: 61
South_Bounding_Coordinate: 54
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: Pacific herring
Theme_Keyword: otolith
Theme_Keyword: chemistry
Theme_Keyword: stock identification
Theme_Keyword: fatty acid analysis
Theme_Keyword: fisheries
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: Prince William Sound

Place_Keyword: Sitka
Place_Keyword: Kamishak
Place_Keyword: Kodiak
Place_Keyword: Togiak
Place_Keyword: Kuskokwim Bay
Place_Keyword: Dutch Harbor
Place_Keyword: Gulf of Alaska
Place_Keyword: Bering Sea
Temporal:
Temporal_Keyword_Thesaurus: None
Temporal_Keyword: 2006
Temporal_Keyword: 2007
Access_Constraints: none anticipated
Use_Constraints: upon request
Browse_Graphic:
Browse_Graphic_File_Name: to be determined
Browse_Graphic_File_Description: to be determined
Browse_Graphic_File_Type: to be determined
Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Point
Distribution_Information:
Distributor:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Ted Otis
Contact_Organization: Alaska Department of Fish and Game
Contact_Address:
Address_Type: Mailing and Physical Address
Address: 3298 Douglas Place
City: Homer
State_or_Province: AK
Postal_Code: 99603
Country: USA
Contact_Voice_Telephone: 907-235-8191
Contact_Facsimile_Telephone: 907-235-2448
Contact_Electronic_Mail_Address: ted_otis@fishgame.state.ak.us
Resource Description: to be determined
Distribution_Liability: The Alaska Department of Fish and Game shall not be held liable for improper or incorrect use of the data described and/or contained herein.
Metadata_Reference_Information:
Metadata_Date: 20060803
Metadata_Contact: Ted Otis
Contact_Information:
Contact_Person_Primary:
Contact_Person: Ted Otis
Contact_Organization: Alaska Department of Fish and Game

Contact_Address:
Address_Type: Mailing and Physical Address
Address: 3298 Douglas Place
City: Homer
State_or_Province: AK
Postal_Code: 99603
Country: USA
Contact_Voice_Telephone: 907-235-8191
Contact_Facsimile_Telephone: 907-235-2448
Contact_Electronic_Mail_Address: ted_otis@fishgame.state.ak.us
Metadata_Standard_Name: *FGDC Content Standards for Digital Geospatial Metadata*
Metadata_Standard_Version: *FGDC-STD-001-1998*

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

Budget Category:	Authorized FY 2006	Proposed FY 2007
Personnel		$7.5
Travel		$1.1
Contractual		$51.8
Commodities		$0.5
Equipment		$0.0
Subtotal	$0.0	$60.9
General Administration		$5.5
Project Total	$0.0	$66.4
Full-time Equivalents (FTE)		0.1
	Dollar amounts are shown in thousands of dollars.	
Other Resources		

Original budget included $2,100 in travel expenditures that were removed during the proposal review processes. Travel request removed was the American Fisheries Society meeting in FY 07. This also resulted in a reduction of UAF Indirect and ADF&G G&A in the amount of $700.

FY07

Prepared: 30 July 2006

Project Number: 070769
Project Title: Using Otolith Chemistry to Discriminate Pacific Herring Stocks in Alaska
Agency: Alaska Department of Fish and Game

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

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2007
						0.0
T. Otis	Fishery Biologist III	18J	1.0	7462.4		7.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	7462.4	0.0	
					Personnel Total	$7.5

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2007
						0.0
T. Otis	RT travel to Anch to attend EVOS Meeting	300.0	1	4	200.0	1.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1.1

FY07

Prepared: 30 July 2006

Project Number: 070769
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2007 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2006 - September 30, 2007

Contractual Costs:	Proposed
Description	FY 2007
Sample shipping costs	0.3
Project Web Site Updates and Maintenance	0.5
4A/B Link	51.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$51.8

Commodities Costs:	Proposed
Description	FY 2007
Misc. Printing and Office supplies	0.5
Commodities Total	$0.5

FY07

Prepared: 30 July 2006

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Agency: Alaska Department of Fish and Game

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F
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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
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency
Desktop computer	1	ADF&G
Laptop computer	1	ADF&G

FY07

Prepared: 30 July 2006

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

Budget Category:	Authorized FY 2006	Proposed FY 2007
Personnel		$32.2
Travel		$1.4
Contractual		$4.5
Commodities		$2.7
Equipment		$0.0
Subtotal	$0.0	$40.8
Indirect		$10.2
Project Total	$0.0	$51.0
Full-time Equivalents (FTE)		0.5
	Dollar amounts are shown in thousands of dollars.	
Other Resources		

Comments:

Total project cost-share funds: $394,300 (details listed below)

$300,000: Univ. Alaska-Fairbanks equipment use (LA-ICPMS Instrument, Buehler Isomet Saw, Polishing equipment, Microscope)
$58,500: ADF&G Vessel Charter costs (to collect/transport samples in 2006)
$7,800: ADF&G Air Charter costs (to transport amples in 2006)
$25,000: ADF&G Vessel Platforms (to collect samples in 2007)
$3,000: ADF&G staff time (to collect samples in 2007)

FY07

Project Number: 070769
Project Title: Using Otolith Chemistry to dDscriminate Pacific Herring Stocks in AK
Non-Trustee Organization: University of Alaska-Fairbanks
(Lead Agency: Alaska Department of Fish and Game)

Prepared: 30 July 2006

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
	Nate Bickford	CO-PI		1.0	8104.0		8.1
	Technician	Technician		5.0	4818.0		24.1
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		6.0	12922.0	0.0	
						Personnel Total	$32.2

Travel Costs:				Ticket	Round	Total	Daily	Proposed
	Description			Price	Trips	Days	Per Diem	FY 2007
	Bickford	Alaska Marine Science Symposium	Present Result	350.0	1	5	210.0	1.4
								0.0
								0.0
								0.0
								0.0
								0.0
								0.0
								0.0
								0.0
								0.0
								0.0
							Travel Total	$1.4

FY07

Prepared: 30 July 2006

Project Number: 070769
Project Title: Using Otolith Chemistry to dDscriminate Pacific Herring Stocks in AK
Non-Trustee Organization: University of Alaska-Fairbanks
(Lead Agency: Alaska Department of Fish and Game)

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

Contractual Costs:		Proposed
Description		FY 2007
LA-ICP-MS instrament time	450 samples @ $10 per sample	4.5
	Contractual Total	$4.5

Commodities Costs:	Proposed
Description	FY 2007
Lab Supplies	2.0
Printer cost	0.7
Commodities Total	$2.7

FY07

Prepared: 30 July 2006

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

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2007
Description			
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
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		
UAF:	LA-ICPMS Instrument	1
	Buehler Isomet Saw	1
	Polishing equipment	1
	Microscope with digital enhancement	1

FY07

Project Number: 070769
Project Title: Using Otolith Chemistry to dDscriminate Pacific Herring Stocks in AK
Non-Trustee Organization: University of Alaska-Fairbanks
(Lead Agency: Alaska Department of Fish and Game)

Prepared: 30 July 2006