Sitka Tribe of Alaska

Tribal Government for Sitka, Alaska

July 30, 2007

Michael Baffrey, Executive Director
Exxon Valdez Oil Spill Trustee Council
441 West 5th Avenue, Suite 500
Anchorage, AK 99501-2340

RE: Sitka Tribe of Alaska's project extension through FY08, Project 070834 - Identification of Essential Habitat for Pacific Herring

Dear Mr. Baffrey:

Please find attached, the Sitka Tribe of Alaska's revised Detailed Project Description, including updated budget sheets for FY08 Exxon Valdez Oil Spill Trustee Council Proposal, "Identification of Essential Habitat for Pacific Herring (*Clupea pallasi*) in Sitka Sound for Comparison to Prince William Sound." I have also attached a brief summary of our accomplishments and progress to date.

On November 14, 2006, Sitka Tribe was notified that their FY07 proposal was selected to receive funding. The project began on January 23, 2007 when the official paperwork was signed by both parties, and will continue through June 2008. The revised Detailed Project Description and budgets are to extend the current research project through September 30, 2008.

Located in the southeast region of Alaska, the Sitka Tribe is the federally recognized tribal government for over 4,200 enrolled tribal citizens. Pacific herring are of vital cultural and dietary importance to our tribal citizens and to many tribal and non-tribal residents of Southeast Alaska. The Sitka Tribe has been actively involved in collaborative management of herring for several years and is determined to contribute to scientific and management tools in its collaboration with State and Federal partners in management.

If we are to receive funding for the project extension, Sitka Tribe of Alaska will continue to collaborate with scientists from the University of Alaska Fairbanks, conducting trace element microchemistry on adult and juvenile herring otoliths. Sitka Tribe will identify the essential habitat of Pacific herring in Sitka Sound for comparison to that found in Prince William Sound. If you have any questions, do not hesitate to contact Heather Woody, Research Biologist at 907-747-3207.

Sincerely,

Heather Meuret-Woody
Principal Investigator

Sitka Tribe of Alaska
Summary of Progress to Date
November 14, 2006 - July 27, 2007

Project Title: Identification of Essential Habitat for Pacific Herring in Sitka Sound for Comparison to Prince William Sound

Project Number: 070834

Project Period: October 1, 2006 – June 30, 2008

Principal Investigator: Heather Meuret-Woody, Sitka Tribe of Alaska, 456 Katlian Street, Sitka, AK 99835, (907) 747-3207, hwoody@sitkatribe.org.

Collaborator: Nate Bickford, PhD, University of Alaska Fairbanks School of Fisheries and Ocean Sciences, P.O. Box 757220, Fairbanks, AK 99775, (907) 474-6469, nate@sfos.uaf.edu.

Study Location: Sitka Sound, Sitka Alaska, Southeast Alaska

Key Words: Clupea pallasi, Pacific herring, essential habitat, otolith microchemistry, restocking, reclamation

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November 14, 2006:	Project funding approved by the Trustee Council.
December 10-12, 2006:	Attended EVOS Herring Restoration Steering Committee in Anchorage and presented the funded project.
January 18-19, 2007:	Collected and processed juvenile herring samples during ADF&G winter bait and test fishery.
January 23, 2007:	Sitka Tribe signed the contract agreement with ADF&G, EVOS. The date of the contract term was incorrect, so the EVOS office was notified. On February 22, 2007, Sitka Tribe signed the amendment to the contract agreement with ADF&G, EVOS.
January 21-24, 2007:	Attended Alaska Marine Science Symposium and also attended EVOS Herring Steering Committee workshop on January 23.
February to May 2007:	Finished collecting juvenile herring otolith samples in early April. Succeeded in collecting over 400 pairs of juvenile herring otolith samples. Adult herring in Sitka Sound

	began spawning on 04/02 and continued through 04/23. Succeeded in collecting over 390 pairs of adult herring otolith samples, including otolith samples from inside troll-caught king salmon as well as herring samples from Hoonah Sound on 05/04.
May 16, 2007:	Coordinated contract between Sitka Tribe and University of Alaska Fairbanks (UAF) for trace element analysis services. Contract was approved and signed by Sitka Tribe on 05/16 and delivered to UAF.
June to July 2007:	STA is waiting for UAF to approve and sign the contract for services, so that the analytical services can begin. Delivered Sitka Sound herring otolith samples to Dr. Nate Bickford at the University of Alaska Fairbanks to begin preparation for trace element analysis on the core and edge portions. (Mailed 6/12, received 7/2).

Sitka Tribe of Alaska
456 Katlian Street
Sitka, Alaska 99835
907-747-3207
FAX: 907-747-4915

Tribal Council Resolution 2007 - 133

Authorization and Support for Application to the Exxon Valdez Oil Spill Trustee Council to Continue Sitka Tribe's Herring Otolith Research in FY 08

WHEREAS, Sitka Tribe of Alaska is the federally recognized tribal government responsible for the health, safety, welfare and cultural preservation for more than 4,084 enrolled Tribal Citizens residing in Sitka, Alaska; and

WHEREAS, the relationship between the Alaska Native people in Southeast Alaska and the resources of the land and sea is so close that an entire culture is reflected in the traditional laws passed on from generation to generation which mandate conservation and perpetuation of subsistence resources; and

WHEREAS, Article VII Section (91)(h) of the Constitution of the Sitka Tribe of Alaska specifically directs the Sitka Tribal Council "to protect and preserve the Tribal property and the wildlife and natural resources within those areas under the jurisdiction of the Tribe;" and

WHEREAS, The Exxon Valdez Oil Spill Trustee Council has made funds available for Fiscal Year 2008 for Non-Trustee Agency organizations to research and identify natal and rearing habitat of larval and juvenile Pacific herring through the analysis of otolith trace elements; and

WHEREAS, Sufficient funding is necessary to continue the Pacific herring otolith project within the Tribe;

NOW THEREFORE BE IT RESOLVED, that the Tribal Council of the Sitka Tribe of Alaska hereby authorizes Tribal Staff to request funding from the Exxon Valdez Oil Spill Trustee Council funding opportunity program for continued herring otolith research.

CERTIFICATION

The foregoing Resolution was adopted at a duly called and convened meeting of the Tribal Council of Sitka Tribe of Alaska held on **July 18, 2007** at which a quorum was present by a vote of _7_ **In Favor,** _0_ **Against,** _2_ **Absent,** _0_ **Abstain.**

Lawrence Widmark

Lawrence A. Widmark, Chairman
Sitka Tribal Council

Attest:

Roxanne Houston

Sitka Tribe of Alaska - Tribal Secretary

Sitka Tribe of Alaska

Identification of Essential Habitat for Pacific Herring (*Clupea pallasi*) in Sitka Sound for Comparison to Prince William Sound

Exxon Valdez Oil Spill Trustee Council
Submitted Under BAA
Non-Trustee Agency

2008 Proposal for Continued Funding

August 4, 2006
Revised July 30, 2007

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 June 27,2007).

PROJECT TITLE: Identification of Essential Habitat for Pacific Herring *(Clupea pallasi)* in Sitka Sound for Comparison to Prince William Sound

Printed Name of PI: Heather Meuret-Woody

Signature of PI:  Date 07/11/2007

Printed Name of co-PI: _____

Signature of co-PI: _____ Date

Printed Name of co-PI: _____

Signature of co-PI: _____ Date

* Available at www.evostc.state.ak.us/Policies/data.htm
** Available at www.evostc.state.ak.us/Policies/guidelines.htm

Trustee Council Use Only
Project No: ____
Date Received: ____

PROPOSAL SUMMARY PAGE
(To be filled in by proposer)

Project Title: Identification of Essential Habitat for Pacific Herring (*Clupea pallasi*) in Sitka Sound for Comparison to Prince William Sound

Project Period: July 1, 2008 – September 30, 2008

Proposer: Heather Meuret-Woody, Sitka Tribe of Alaska, 456 Katlian Street, Sitka, Alaska 99835, (907) 747-3207, hwoody@sitkatribe.org.
Collaborator: Nate Bickford, PhD, Hydro-Geochemical-Ecologist, University of Alaska Fairbanks School of Fisheries and Ocean Sciences, P.O. Box 757220, Fairbanks, AK 99775, (907) 474-6469, nate@sfos.uaf.edu.

Study Location: Sitka Sound, Sitka Alaska, Southeast Alaska

Abstract: Once herring hatch and the larvae drift to retention areas, they begin metamorphosis. As juveniles, herring forage in productive waters of the North Pacific. Adult herring then return to natal beaches to spawn. What is unknown is where the herring go and if certain regions contribute more to the spawning population. Once we know which population contributes more to the spawning groups, we can then identify those variables that enhance the life histories of the source population. We can identify these groups and track their movements using otolith chemistry. The adult herring that return to spawn are the survivors. If most of the survivors come from a distinct population, then we need to know which population survive and why. This will allow managers to protect the most important populations and also identify those environmental variables needed to enhance other populations.

Funding:
EVOS Funding Requested: FY 08 $23.5
(must include 9%GA)
TOTAL: $23.5
Non-EVOS Funds to be Used: FY 08 $7.9

TOTAL: $31.4

Date: July 30, 2007

I. PROJECT PLAN

A. Statement of Problem

Native people throughout coastal Alaska, including Sitka Sound, have relied heavily upon Pacific herring *(Clupea pallasi)* as a subsistence food source. Herring eggs are one of the most prioritized traditional food sources for many Alaska coastal tribes, including Sitka Tribe of Alaska. The herring eggs are harvested on western hemlock branches, kelp (*sp. Macrocystis*), or hair seaweed (*Ne*) (Schroeder and Kookesh, 1990). Ninety-seven percent of Sitka Tribal households utilize herring eggs (Schroeder and Kookesh, 1990). An average Sitka Tribal household utilizes 177 pounds of subsistence herring eggs per year (Schroeder and Kookesh, 1990). The State Board of Fisheries set the amount reasonably necessary for subsistence use of herring eggs between 105,000 and 158,000 lbs as specified in 5 AAC 01.716(b), just for Sitka alone. Sitka Tribe has been conducting subsistence herring harvest surveys in subsistence households since 2002, to document the importance of herring to native people's diet and culture. The estimated harvest of herring roe by subsistence users in Sitka in 2003 was 278,799 pounds harvested on hemlock branches, hair seaweed and *Macrocystis* kelp (Turek, 2004).

Since the early 20th century, Pacific herring stocks have been heavily targeted by a massive commercial fishing industry and a bounty of herring reduction plants. Elsewhere, previously healthy herring populations have been challenged by habitat loss or environmental degradation, as in the case of Prince William Sound herring. In March 1989, during a period of high biomass, the tanker vessel *Exxon Valdez* ran aground on Bligh Reef in northeastern PWS and spilled 42 million liters of crude oil. Immediately following the oil spill, herring spawned in PWS. In 1989, herring embryos and larvae had low survival, morphologic and genetic damage and herring larvae had slow growth rates (Norcross et al., 1996). Estimates of spring spawning herring biomass from 1989 through 2000 ranged from 102,481 metric tons in 1992 to 14,378 metric tons in 1994 (Morstad et al., 1998; Wilcock & Funk, ADFG, pers. comm.). Herring catches were reduced in 1993 (Funk, 1995; Marty et al., 1998, 1999), and the fisheries were closed from 1994 to 1996. The harvest prior to the collapse was 48,317 metric tons in 1992; the highest catch since 1993 was 10,979 metric tons in 1997. However, the population of herring in PWS again collapsed in 1999 (Marty et al., 2003).

As a comparison to the PWS herring stock, Sitka's herring stocks remain healthy and relatively intact, and can in fact be used as a control group, providing baseline data to compare to other depleted herring stocks around the region. The Sitka Sound spawning herring biomass averages 47,721 tons, but as much as 80,000 tons of herring come into Sitka Sound to spawn annually (Gordon, 2005). The highest commercial sac roe catch since 1989 was 12,515 metric tons harvested in 2006 (Davidson et al., 2006). Sitka's herring population is stable and supports one of Alaska's largest subsistence herring harvests as well as one of the largest commercial herring sac-roe fisheries in the world. Sitka Sound commercial herring fishery occurs during the spring when herring are harvested for their roe. Herring populations are assessed annually to determine whether individual spawning stocks are above threshold and to determine the appropriate harvest rate (Funk, 1993). The threshold level is the herring biomass needed to meet minimum spawning requirements. The established threshold level for the Sitka Sound herring sac roe fishery is 20,000 tons (Funk, 1993). The Sitka Sound herring fishery is managed to allow the maximum exploitation rate of 20% of the spawning population (Funk, 1993). This estimate is the result of applying the stock specific Age Structured Analysis (ASA) model for the Sitka

Sound herring population using time series of spawn deposition data, spawning age composition, and commercial age composition (Gordon et al., 2007).

The Trustee Council has classified Pacific herring in PWS as a non-recovering injured resource based on population trends that became evident four years after the *Exxon Valdez* oil spill. One of the Council's long-term goals is to restock Pacific herring in Prince William Sound. The factors that continue to impede herring recovery in PWS are not well understood. To date, there has been no satisfactory answer to explain the lack of recovery of herring in PWS.

This proposal is being submitted to continue addressing herring restoration in PWS by using trace elements in herring otoliths as markers to identify successful spawning and juvenile habitats in a control population, such as the healthy and intact herring population located in Sitka Sound. The identification of essential herring habitat in Sitka Sound can be compared to PWS essential herring habitat. Restoration and enhancement of herring in PWS cannot take place without knowledge of location of successful spawners and of productive nursery areas.

The reasons that the herring populations in Prince William Sound have not recovered sixteen years after the *Exxon Valdez* oil spill is unknown. One of the Trustee Council's recovery objectives for Pacific herring in PWS is a highly successful year class that is recruited into the population, and when other indicators of population health are within normal bounds. Herring are an important part of the marine ecosystem, as forage fish they are the staple source of food for many marine mammals, birds and fish. In Sitka Sound, herring is the food for thousands of congregating Steller sea lions (*Eumetopias jubatus*) and hundreds of humpback whales (*Megaptera novaeangliae*), both of which are endangered species. Once herring decline, species that rely on herring as a food source will more than likely decline as well.

It is important to investigate and understand the limiting factors that are preventing herring populations from recovering in Prince William Sound. A major factor effecting herring is their habitat preference during all life stages. Essential fish habitat is difficult to identify, much less conserve or improve. Therefore, it is critical to protect those habitats that contribute a disproportionate large number of recruits to future generations. It is quite often difficult to identify these source habitats and distinguish them from those habitats that may contain significant biomass but produce few recruits (sink habitats). In the case of Pacific herring in PWS, recruitment success has been measured by comparing the abundance of spawning adults in different habitats thereby approximating the relative importance of different natal and nursery habitats (Norcross et al., 2001a). The technology of otolith chemistry allows researchers to investigate survivorship, and as a result, identify essential spawning habitats. Trace element chemistry preserved by the otoliths provides powerful insight into the environmental life history of fishes. For example, otolith chemistry has been used to determine population structure and dynamics at both large (between estuaries) and small spatial scales (between sea grass habitats within an estuary) (Thorrold et al., 2001). Chemical analysis of trace element concentrations in otoliths can be used to identify the geographic signatures of natal habitats used by fishes captured either as juveniles or adults (Bickford et al., 2003).

This investigation will continue using otolith microchemistry to identify the essential habitat of Pacific herring in Sitka Sound (Figure 1.) for comparison to the essential habitat of Pacific herring in Prince William Sound (PWS). The proposed research will explore the utility of otolith (fish ear stone) chemistry in the reconstruction of past habitat use, the identification of essential habitat, and the connectivity between Pacific herring populations within Sitka Sound for comparison to herring populations in PWS. During a stock identification project, Sitka Tribe

collected herring otolith samples from adults in Sitka Sound in 2005 and 2006 from three different zones (Figure 2.). The adult herring otolith samples were analyzed for trace element concentrations at the Advanced Instrumentation Laboratory at the University of Alaska Fairbanks. The results show that when we plot edge chemistries of Pacific herring we see two separate chemical areas, zone 1, and a combined chemical area of zone 2 and zone 3. This indicates two distinct hatch locations for Pacific herring in Sitka Sound (Figure 3). We can also see two hatch locations in the core chemistry plot (Figure 4). These archived otolith samples can be used to compare microchemistry signatures with juvenile herring otoliths, as stated in the objectives of this proposal. In Sitka Sound, the identification of essential habitat utilized by a control population will have profound consequences for the Pacific herring reclamation in PWS.

To date there has been no way to correlate larval, juvenile, and adult populations for Pacific herring. Otolith microchemistry offers researchers a way of identifying the temporal and spatial migrations of larval, juvenile, and adult herring. The use of otoliths to describe the potential transport of herring larvae from spawning sites to nursery areas, and the identification of the most important areas, will aid researchers in understanding the recovery status of herring and achieve the goals of the 1994 Restoration Plan (Bickford et al., 2003).

The lifecycle of Pacific herring in Sitka Sound is conducive to otolith chemical analysis. Sitka Sound herring mature at 3-4 years old and annually migrate to coastal waters to consistently spawn in intertidal and shallow subtidal shores. Sitka Sound herring use the same regions to spawn; exact locations and concentrations may vary year to year, however the core spawning area is northern Sitka Sound. Herring have been known to live as long as 15 years (Woodby et al., 2005). Adult herring begin migrating in March to spawn on an estimated 35 – 104 nautical miles of coastline in Sitka Sound, lasting from 4 to as long as 15 days (Gordon, 2005). Spawning in Sitka Sound usually occurs in March and April, and can occur through May in some areas. Herring generally spawn on intertidal eel grass beds, kelp, seaweed, and rocky substrates. The eggs are adhesive, and survival is better for those eggs that stick to intertidal vegetation than for those, which fall to the bottom (Funk, 1994). Milt, released by the males, drifts among the eggs and fertilizes them (Funk, 1994). The Sitka Sound herring run averages 47,721 tons, but as much as 80,000 tons of herring come into Sitka Sound to spawn annually (Gordon, 2005). Sitka Sound herring eggs incubate in these spawning areas for about 14 days before hatching as larvae in May and June (Funk, 1994). The planktonic herring larvae tend to drift in the currents to the northern end of Sitka Sound, which serves as a retention area (Haldorson and Collie, 1990). Metamorphosis of the larval herring begins to occur in June of that same year (Stokesbury et al., 2002). The herring then become nektonic and swim to favorable habitats in nearshore nursery areas (Norcross et al., 2001). In August, the young herring begin to form schools and aggregate at the heads of bays, far from coastal waters (Brown et al, 2002; Stokesbury et al., 2000). These populations stay isolated in their respective nursery bays until June of their second year (Stokesbury et al., 2000). At that time, the cohort of herring leaves the bays and joins adult schools (Stokesbury et al., 2000).

Throughout the life of a herring, as it migrates among Sitka Sound fjords and bays, the trace element content of the water is recorded in the otolith. This creates a permanent record of habitat use by an individual fish. Otolith bands are accrued during the fish's time of residence in the spawning areas, thus recording the unique spatial chemical signatures. Otoliths are formed in the latter part of the egg stage. The initial deposition of material becomes the core of the otolith (Wright et al., 2002). As the juvenile herring grows it accretes bands of new material, which

surrounds its original core deposit. Daily bands, monthly bands, and yearly bands are accrued as layers. Growth is recorded as assorted bandwidths inside the otolith, much as a tree accumulates annual rings. The daily, monthly, and annual bands have long been used as detectors of age and growth rate in fish (Campana & Thorrold, 2001). In recent years the chemical compositions of individual bands have been used to identify past habitat use of the fish (Rooker et al., 2003; Campana & Thorrold, 2001; Thresher, 1999). The incorporation and the concentration levels of trace metals in the otoliths are a function of abiotic (i.e., temperature, salinity) and biotic (i.e., diet, fish growth rate) conditions (Thresher, 1999).

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The Exxon Valdez Oil Spill Restoration Plan of 1994 set recovery objectives, strategies and goals for Pacific herring in PWS. One of the Trustee Council's recovery objectives for Pacific herring in PWS is a highly successful year class that is recruited into the population, and when other indicators of population health are within normal bounds. This project meets the objective and will provide information needed to improve the management and recovery of this important commercial and subsistence species. Exxon Valdez Oil Spill Trustee Council has identified Pacific herring as not recovered to a healthy and productive state and the Council stated herring do not exist at pre-spill abundance. This project will focus on the reproductive success and identification of essential fish habitat that supports large amounts of recruits using a healthy herring population, located in Sitka Sound, as a control group. The continuation of this project will contribute greatly to the knowledge of herring recovery in Prince William Sound.

The project will determine chemical trace metal signatures found in rearing and spawning areas. Through otolith chemical analysis, the spatial and temporal description of where herring spend their early life history can be identified. This technique is necessary to identify those habitats where enhancement of the herring population is needed. The first step would be to protect the population that would be considered the source group, with the hopes that more fish would be added to the environment. The second part would be to identify similar habitats without herring and seed new herring into the environment. To do any of these steps we will need to identify source and sink habitats that control herring population numbers (Bickford et al., 2003).

The data can also be used to consider the effect the *Exxon Valdez* oil spill continues to have on the recovery of herring populations in PWS. Using the data, we hope to identify where herring were spawned (natal), where they spent time after spawning (nursery), where they go to spawn, and whether or not they spawn at their natal beach. This data can tell us about survival between the life stages, and which habitats contribute more to the population.

II. PROJECT DESIGN

There has been a consistent downward trend in the biomass of Pacific herring in Prince William Sound. These sub-tidal and tidal spring spawners have distinct spawning strategies, as well as unique habitat needs and life histories. Currently the methods applied to identify spawning habitats and recruitment successes include spawn deposition dive surveys, which allocates habitat based on the presence of spawning adults. The proposed research will explore the utility of otolith chemistry in the reconstruction of past habitat use, the identification of essential habitat, and the connectivity between herring populations within Sitka Sound for comparison to PWS. The identification of essential spawning habitat, and the ability to assess

recruitment within major herring populations, will have profound consequences for these forage fish. The results will assist in the prioritization of restoration of essential habitats, as well as in the continued management and sustainability of herring fisheries.

A. Objectives

The primary objective is to obtain information leading to better identification of essential fish habitat in Prince William Sound. By using trace element signatures of edge portions of juvenile herring otoliths, we will identify the otolith chemical signature of individual rearing bays within Sitka Sound.

Objective 1. Use trace element signatures of edge portions of adult herring otoliths to identify the otolith chemical signature of spawning areas within Sitka Sound.

Objective 2. Use trace element signatures of core and edge portions of juvenile and adult herring otoliths to identify nursery grounds and natal habitat (source vs. sink) in Sitka Sound.

Objective 3. Compare the source and sink habitats of Sitka Sound to the source and sink habitats of Prince William Sound.

Otolith chemical analysis can be used to identify spawning grounds, and nursery grounds of herring. The chemical ratios found in the edge portions of the herring otoliths will be distinct to the area of collection. Thus a comparison between the core portions of the adult and juvenile herring otoliths can be made. Sitka Tribe will be able to identify where the adult spawning survivors originate, which habitats contribute more biomass, and which nursery grounds contribute the most to the adult populations.

B. Procedural and Statistical Methods

Collection

Sitka Sound herring migrate to shallow spawning beaches around March and April. Sitka Tribe will use their 24' aluminum boat for transportation to and from the sample sites. A 5' diameter monofilament cast net, thrown from the boat or from shore, will be used to capture spawning herring. The herring will be placed in 5-gallon buckets and transported to town for biological sampling and otolith collection. Sea surface temperature and salinity will be sampled at 1 fathom at each collection site using an YSI 85 hand-held meter. A Garmin eTrex Legend hand-held GPS unit will be used to record coordinates of collection locations, and the coordinates will be downloaded into maps created in ArcMap GIS 9.2.

A random sample of 50 spawning adult herring from each collection site will be sampled for otoliths, weight, length, sex, and maturity. The fish will be lightly rinsed and each fish will be wiped down to remove excess slime and debris. Each fish will be weighed to the nearest 0.01 g using an Ohaus Scout Pro digital scale. Each fish will be measured from snout to hypural plate to the nearest 0.01 mm using Tesa IP65 waterproof digital calipers. Sex will be determined by a visual inspection and will be classified as mature, spent, or immature. Sagittal otoliths will be excised from adult herring in a clean environment using standard techniques (Bickford et al., 2003; Campana, 1999; Campana, et al., 1995). The otoliths are then rinsed and cleaned with

distilled water, and placed in micro centrifuge tubes. Each tube is labeled with the fish identification number, date and collection site information. All juvenile herring otolith pairs will be sent to Dr. Nate Bickford at UAF for trace metal analysis.

Juvenile herring begin appearing in the local bays of Sitka Sound in January, and continue aggregating throughout the summer months. All juvenile herring will be collected with several methods: cast net, beach seine, mid-water trawl, and jigging. Sitka Tribe has been very successful at collecting juvenile herring in early spring. The local ADF&G samples herring during the winter test fishery, and many juveniles are observed during this time. ADF&G hires commercial boats to seine, jig and mid-water trawl for herring samples in January. If needed, Sitka Tribe will have access to the winter test fishery herring for sampling juveniles.

A random sample of 50 juvenile herring from each sample site will be collected. The juvenile herring will be placed in 5-gallon buckets and transported to a processing station for biological sampling and otolith collection. All juvenile fish are lightly rinsed of excess debris and slime. The fish are identified as 1-50 according to date and sample site. The digital scale is wiped clean and zeroed before weighing each juvenile fish. All juvenile fish are placed on the Ohaus Scout Pro digital scale, weighed to the nearest 0.01 g, and then placed in a dissecting pan. All juvenile fish are then measured to the nearest 0.01 mm from the snout to the hypural plate using Tesa IP65 waterproof digital calipers. Because these are immature fish, they will not be sexed. Sagittal otoliths will be extracted from herring in a clean environment using standard techniques (Bickford et al., 2003; Campana, 1999; Campana, et al., 1995). Sagittal otoliths will be excised from juvenile herring in a clean environment using standard techniques (Bickford et al., 2003; Campana, 1999; Campana, et al., 1995). The otoliths are then rinsed and cleaned with distilled water, and placed in micro centrifuge tubes. Each tube is labeled with the fish identification number, date and collection site information. All juvenile herring otolith pairs will be sent to Dr. Nate Bickford at UAF for trace metal analysis.

Otolith Chemical Analysis

Sagittal otoliths will be thin sectioned using a Beuhler isomet low speed saw. This will expose the otolith core and edge for chemical analysis and aging (Campana, 1999). The sagittal otoliths will be analyzed for concentrations of trace metals 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 located at the University of Alaska Fairbanks. These analyses will be performed 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. Concentration of all elements will be calculated relative to MACS-1 after proper correction for gas blank, matrix, and drift effects. Elemental abundances will be compared to relative to Calcium content among otolith samples (Campana, 1999; Campana & Neilson, 1985).

C. Data Analysis and Statistical Methods

Statistical analysis will include analysis of variance (ANOVA $\alpha = 0.05$) to distinguish differences in the otolith chemical signature (Mg/Ca, Mn/Ca, Sr/Ca, Sr^{86}/Sr^{87}, and Ba/Ca):

- Juvenile edge (nursery) vs. juvenile core (natal) if the signature is the same then the fish has not left spawning grounds.

- Juvenile core (natal) vs. juvenile core (natal) if the signature is the same then the fish were spawned in the same area.
- Juvenile edge (nursery) vs. adult area just outside the core (nursery) if the signature is the same then the adult used the same nursery habitat as the juvenile.
- Adult edge (spawning area) vs. adult core (natal) if the signature is the same then the adult returned to spawn in the same area it hatched in.
- Adult core (natal) vs. adult core (natal) if the signature is the same then the adults were hatched in the same area.

Linear discriminant analysis (LDA) explicitly attempts to model the difference between classes of data. The LDA results will distinguish geographically the distinct groups of herring and allow us to classify the individuals into groups (i.e., natal group, nursery group).

D. Description of Study Area

The collection of adult and juvenile Pacific herring otoliths and the associated biological and oceanographic data will be in Sitka, Alaska, located in northern Southeast Alaska, 57.046, -135.333. Sitka Sound is located on the outermost coast of Baranof Island and is a slightly enclosed sea separated from the Gulf of Alaska by a myriad of barrier islands (Figure 1.). The rocky coastline is similar to the coastline in Prince William Sound, and it consists of numerous islands, inlets, bays, and deep fjords. At 57° N, Sitka Sound produces strong spring phytoplankton blooms with a short growing season. In this northern location the combination of light and temperature restrictions create environmental conditions for Pacific herring that are somewhat different from those experienced by Atlantic herring (*Clupea harengus*) or by Pacific herring found in more southerly regions of the west coast of North America (Norcross et al., 2001). Sitka Sound supports one of the world's largest commercial herring sac-roe fisheries, which harvests 20% of the biomass each year, as well as supporting Alaska's largest subsistence herring egg harvest. Sitka Sound herring generally spawn on 40 to 80 miles of coastline each spring.

Figure 1. Sitka Sound, Sitka Alaska includes over 80 miles of shoreline.

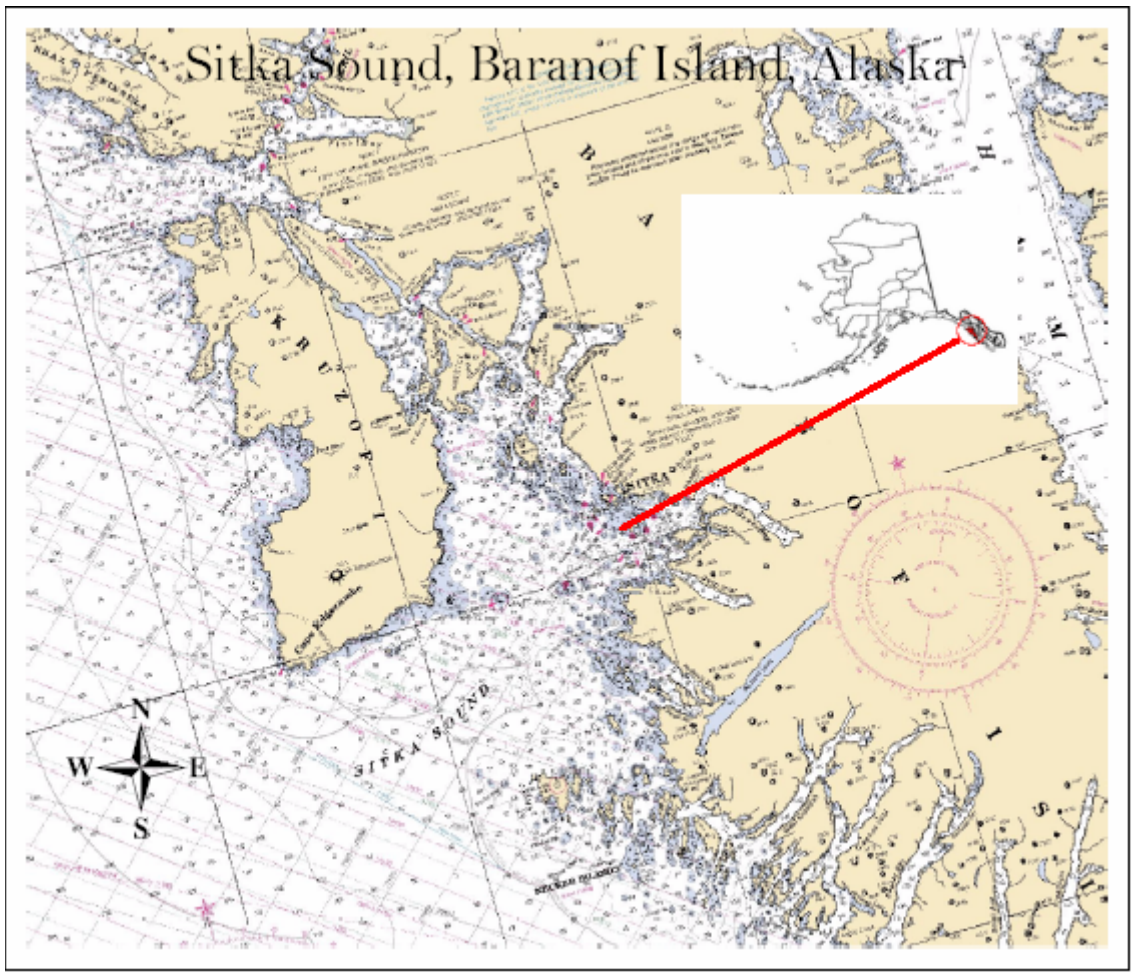


Figure 2. Sitka Tribe of Alaska's 2005 and 2006 herring otolith collection sites in Sitka Sound.

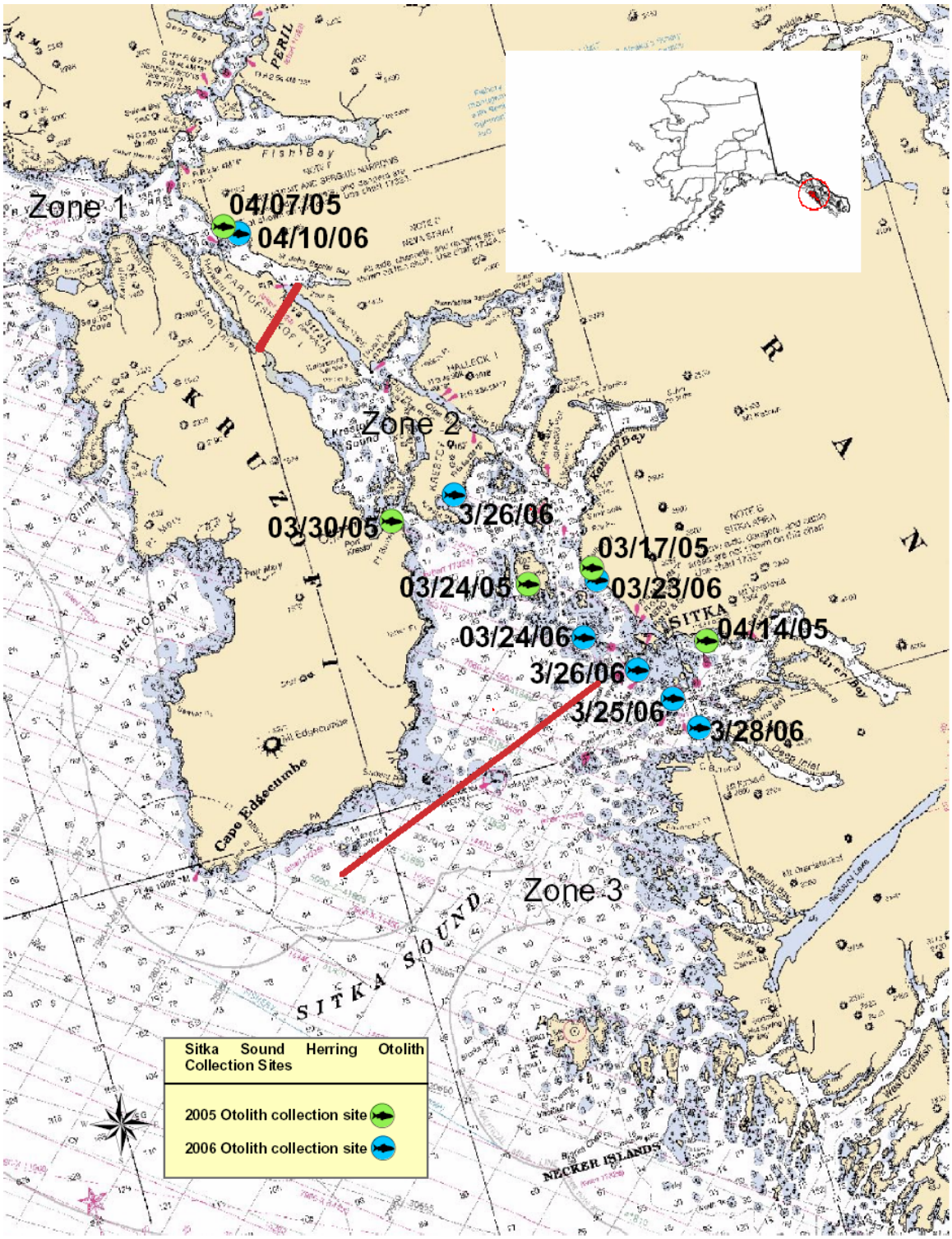


Figure 3. Sr/Ca edge chemistries of adult herring otoliths from Sitka Sound.

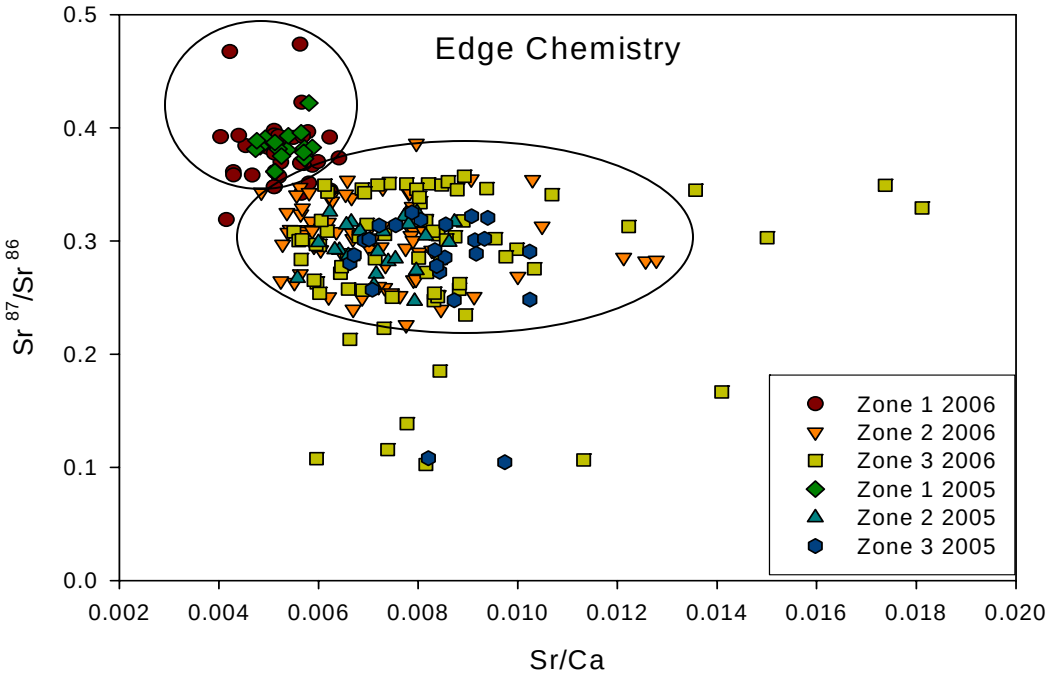
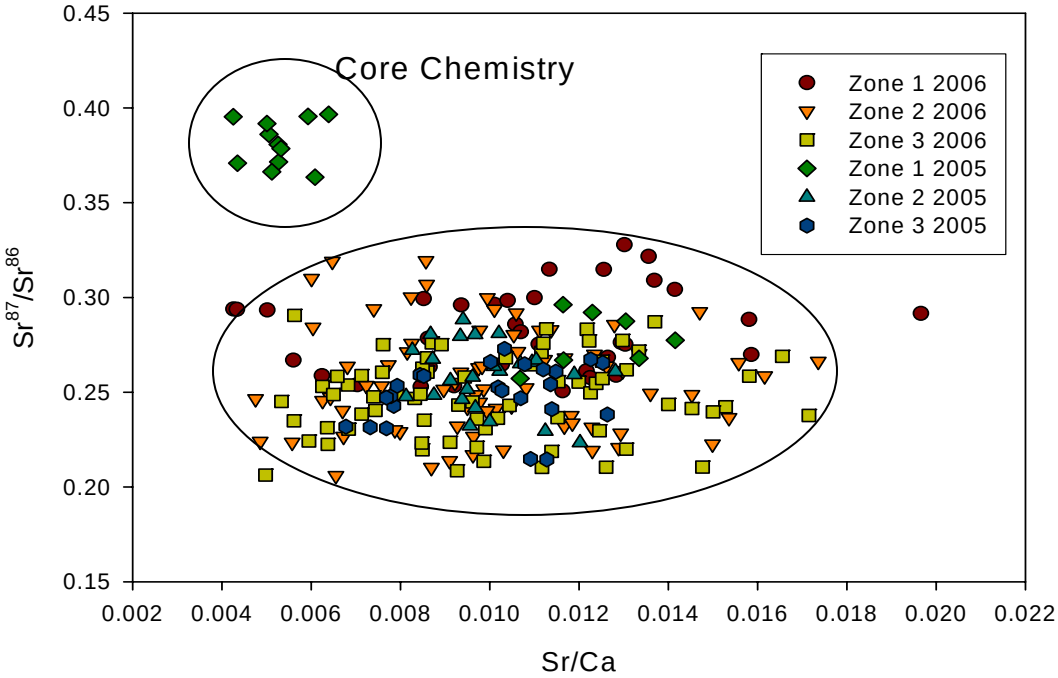


Figure 4. Sr/Ca core chemistries of adult herring otoliths from Sitka Sound.



E. Coordination and Collaboration with Other Efforts

Sitka Tribe of Alaska's project proposal complements the University of Alaska Fairbanks proposal, "Identification of essential habitat for Pacific herring (*Clupea pallasi*) in Prince William Sound," submitted by Dr. Nate Bickford and Dr. Brenda Norcross. Dr. Nate Bickford will continue to collaborate with Sitka Tribe on this project. Sitka Tribe of Alaska will continue to coordinate a contract with the University of Alaska Fairbanks to conduct otolith microchemical analysis on the healthy herring population in Sitka Sound, using adult and juvenile herring to identify essential habitat. A comparison of Sitka's identified source and sink herring habitat will be compared to Prince William Sound's identified source and sink herring habitat. From 2004 to 2007, Heather Meuret-Woody, Sitka Tribe of Alaska Biologist, has collected adult and juvenile Pacific herring during spawning and hatch phases to use in otolith chemical analysis from Sitka Sound. The sample design was coordinated with Dr. Brenda Norcross and Dr. Nate Bickford. Dr. Nate Bickford performed chemical analyses of the herring otoliths at the UAF Advanced Instrumentation Laboratory. Analysis of the 2005 and 2006 collections have been completed. The result of the chemical analyses can distinguish two distinct herring stocks in Sitka Sound, both of which are healthy. Comparison of habitats between Prince William Sound herring and the healthy Sitka Sound stock may provide insight into the lack of Prince William Sound herring recovery. Geochemical signatures in otoliths of herring in Prince William Sound (Bickford, EVOS project) and Sitka Sound (Meuret-Woody) have been shown to successfully identify life-stage specific habitats. Both projects require additional sampling to expand the temporal and spatial scales of collections. Concurrent sampling in Prince William Sound and Sitka Sound is necessary to allow us to describe life history aspects of Pacific herring due to interannual variability in the environment. The identification of essential habitat used by herring in Sitka Sound will allow for direct correlation and comparison with apparent essential habitat as identified in Prince William Sound.

III. SCHEDULE

A. Project Milestones

Objective 1. Analyze trace elements of edge and core portions of adult herring otoliths as indicator of spawning area.
To be completed by December 2007.

Objective 2. Analyze trace elements of edge and core portions of juvenile herring otoliths as indicator of nursery grounds and natal areas.
To be completed by December 2007.

Objective 3. Use otolith data to identify source and sink habitat in Sitka Sound. Use the identification of source and sink habitat in Sitka Sound to compare with source and sink habitats in Prince William Sound.
To be completed by September 2008.

B. Measurable Project Tasks

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

November 14: Project funding approved by Trustee Council

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

January 23: Contract agreement signed
January 18: Began collecting juvenile herring otoliths
January 21-24: Attended the Alaska Marine Science Symposium
March 15: Began adult herring otolith collection

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

April: Continued collecting juvenile and adult herring otoliths
May 30: Finished 2007 juvenile and adult collections and otolith extraction
June: Coordinated contract for services with UAF Laboratory

FY07, 4th quarter (July 1, 2007-September 30, 2007)

July 1: Delivered otolith samples to UAF
July 30: Begin analyzing edge portion of adult and juvenile herring otoliths
July 30: Begin analyzing core portions of adult and juvenile herring otoliths
September 1: Annual report for Trustee Council due

FY08, 1st quarter (October 1, 2007 – December 31, 2007)

December 15: Finish analyzing otoliths and begin interpreting data

FY08, 2nd quarter (January 1, 2008 – March 31, 2008)

January-March: Finish interpreting data and begin drafting final report
January 23-27: Attend the Alaska Marine Science Symposium

FY08, 3rd quarter (April 1, 2008 – June 30, 2008)

May: Visit Tribal organization in PWS
June 30: Finish coordinating UAF contract for services

FY08, 4th quarter (July 1, 2008 – September 30, 2008)

July 1: Project extension begins
September 30: End project
April 15, 2009: Submit final draft report to Trustee Council

IV. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

Sitka Tribe is one of the strongest advocates for herring in Southeast Alaska. Sitka Tribe has a herring committee composed of subsistence herring egg harvesters. The herring committee and the Sitka Tribal Council communicate with other Alaska Tribes, community citizens, and federal and state agencies regarding the Sitka Sound herring regularly. Traditional knowledge of Sitka Sound herring exists within the subsistence herring egg harvesters and the Sitka Tribe. This knowledge base fuels Sitka Tribe's advocacy efforts daily. The Sitka Tribe biologist

proposes to visit a community and/or Tribal organization in Prince William Sound by June 30, 2008 to share with them the research project and data collected in Sitka Sound, and how this information relates to herring in Prince William Sound. Sitka Tribe hopes to involve other interested Tribes in otolith microchemistry and fisheries research. The identification of essential herring habitat from this research would be available to PWS Tribes.

B. Resource Management Applications

By examining otoliths from adult herring, we can identify survival from egg through juvenile stages, and survival from juveniles to adults. Survivorship of juveniles is defined as successful transport of healthy larvae from specific spawning beaches to nursery grounds. By examining otoliths from a control population, such as the healthy and intact herring population located in Sitka Sound we will be able to determine what the natural source habitats are that recruit the most survivors into the biomass, and the connectivity between Pacific herring populations within Sitka Sound. We will find out what makes a healthy population of herring work. Thus we can apply this information to herring populations in Prince William Sound to assess why the herring have not rebounded since the 1989 *Exxon Valdez* oil spill. The identification of essential herring habitat from this research would be available to federal and state agency managers.

V. PUBLICATIONS AND REPORTS

Sitka Tribe of Alaska will report to the Exxon Valdez Oil Spill Trustee Council on the proposed research project in an annual report due September 1 of each fiscal year, and one final report. The final report will reflect peer review comments. Sitka Tribe is also prepared to provide oral briefings of their findings to the Trustee Council.

VI. BUDGET JUSTIFICATION FY08: $23.5K

The proposed budget for this research is for $23,500 for FY08, which includes $2,000 for the Trustee Council's General Administration (9% G&A). This includes one full-time biologist and the necessary equipment to perform the work plan, as well as contracting fees for analytical services and Sitka Tribal Administration. Sitka Tribe proposes to in-kind match $7,900 for this research.

Personnel: $15.1K

The proposed budget of $11,025 includes one full-time research biologist at $3,675 per month for 3 months, plus the associated fringe benefits at 37% ($4,079).

Travel: $0K

There is no proposed travel during July 1, 2008 – September 30, 2008.

Contractual: $0K

The FY07 budget included a $25,000 contract between Sitka Tribe of Alaska and the University of Alaska Fairbanks to conduct microchemical analysis on herring otoliths and provide data interpretation. The contract will end June 30, 2008, and is not included in this FY08 budget.

Commodities: $1.2K
Sitka Tribe of Alaska's Resources Protection office is located off-site from the Sitka Tribal Administration building. The proposed budget includes $950 for 3 months (July 1, 2008 – September 30, 2008) of office space rent and $180 for phone and internet.

Equipment: $0.0K
No equipment will be purchased with this funding.

In-Kind Match: $7.9K
The proposed budget includes an in-kind match of $7,900 provided by Sitka Tribe of Alaska. The in-kind match includes the use of ArcMap GIS 9.2 mapping software to document collection sites ($3,000), and use of a HP laser printer ($3,000). In addition, 10% of the Resources Protection department supervisor's salary and fringe for 3 months will be used as a cash match ($1,900).

Indirect Costs: $5.3K (Non-EVOS)
The proposed budget includes $5,300 of indirect costs. Sitka Tribe's 2006 approved indirect cost rate is 32.7%. Sitka Tribe is still negotiating its 2007 indirect rate with the US Department of the Interior, National Business Center. Sitka Tribe's indirect costs cover administrative supervision, legal consultation, financial reporting, and accounting services.

General Administration: $1.9K (EVOS)
The proposed budget includes 9%, or $1,900 to cover the costs of Trustee agencies through the Trustee Council's general administration.

VII. LITERATURE CITED

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2008 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2007 - September 30, 2008

Budget Category:	Authorized FY 2007	Proposed FY 2008
Personnel	$83.8	$15.1
Travel	$3.0	$0.0
Contractual	$25.0	$0.0
Commodities	$3.3	$1.2
Equipment	$0.0	$0.0
Subtotal	$115.1	$16.3
Indirect 32.70%	$37.6	$5.3
Project Total w/o GA	$152.7	$21.6
Trustee Agency GA (9%)	13.7	$1.9
Project Total w/GA	166.4	$23.5
Full-time Equivalents (FTE)	1.6	0.3
Other Resources	$30.0	$7.9

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

Comments:

Rounded all numbers in the detail below to thousands; re-linked the above figures adding the % in the calculations; The total has not changed, however the G&A for TC Agency was rounded down .1 and the commodities for Sitka Tribe rounded up .1 ($180 rounded to .2); Made respective changes to the Budget Justification and revised the numbers on the Proposal Summary to rounded to thousands. Filled in the PJ # for FY 08.

Sitka Tribe proposes $7.9K in-kind contribution to accomplish work plan.
The in-kind contribution includes: HP laser printer for office use ($3K); ArcMap GIS 9.2 software to document collection sites ($3K); supervisor's salary and fringe match ($1.9K).

Sitka Tribe of Alaska's current approved Indirect Rate is 32.7%.

Personnel costs includes the salary of one full-time biologist for 3 additional months, plus 37% for associated fringe benefits.

FY08

Prepared:

Project Number: 080834
Project Title: Identification of essential habitat for Pacific herring in Sitka Sound for comparison to PWS
Name: Sitka Tribe of Alaska

2008 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2007 - September 30, 2008

Jul-07

Personnel Costs:				Months	Monthly	
	Name	Position Description		Budgeted	Costs	Overtir
	Heather Meuret-Woody	PI, Research Biologist		3.0	5034.8	
			Subtotal	3.0	5034.8	(
						Personnel To

Travel Costs:		Ticket	Round	Total	Da
	Description	Price	Trips	Days	Per Die
					Travel To

FY08

Project Number: 080834
Project Title: Identification of essential habitat for Pacific herring in Sitka Sound for comparison to PWS
Name: Sitka Tribe of Alaska

Prepared:

2008 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2007 - September 30, 2008

	Jul-07
Contractual Costs:	
Description	
Contractual To	
Commodities Costs:	
Description	
Phone and internet services	
Office space rent	
Commodities Tot	

FY08

Project Number: 080834
Project Title: Identification of essential habitat for Pacific herring in Sitka Sound for comparison to PWS
Name: Sitka Tribe of Alaska

Prepared:

2008 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2007 - September 30, 2008

Jul-07

New Equipment Purchases:	Number of Units	U Pri
Description		

Those purchases associated with replacement equipment should be indicated by placement of an R. **New Equipment To**

Existing Equipment Usage:	Number of Units
Description	
24' aluminum boat with 90 hp outboard	
YSI oceanographic instrument	
Sampling and dissecting equipment	
Arc View GIS 9.2 mapping software	
Garmin Etrex GPS unit	
Ohaus Scout Pro balance	
Tesa-Cal electronic digital calipers	
Field microscope	
HP Laser printer	

FY08

Project Number: 080834
Project Title: Identification of essential habitat for Pacific herring in Sitka Sound for comparison to PWS
Name: Sitka Tribe of Alaska

Prepared: