Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years

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Restoration Category:	Research and monitoring
Proposers:	Daniel Mann and Bruce Finney, University of Alaska
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	
Alaska Sea Life Center:	No
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Cost FY 02:	$88,100
Cost FY 03:	$28,200
Geographic areas:	Eshamy and Solf Lakes (Prince William Sound), Upper Russian Lake (Kenai River watershed) Delight & Desire Lakes (Kenai Fjords)
Injured Resource/Service:	Sockeye salmon

ABSTRACT

We want to reconstruct the last 2000 years of changes in sockeye salmon abundance in Eshamy Lake (Prince William Sound), Delight and Desire Lakes (Kenai Fjords), and Upper Russian Lake (Kenai River watershed) by analyzing ^{15}N in lake sediments. This new data will be synthesized with ongoing studies at Karluk Lake (Kodiak Island). Our research question is: *What is the normal variability in sockeye salmon populations in the Gulf of Alaska?* This research contributes to development of the GEM program by providing a valuable historical perspective on present conditions and by developing new hypotheses about the climatic causes of population fluctuations in Gulf of Alaska salmon.

INTRODUCTION

A. Laying a foundation for GEM

A priority for proposals solicited by EVOS for FY 02 is to establish a foundation for the GEM program. The primary mission of the Gulf Environmental Monitoring Program is to understand how natural and human-caused changes affect marine ecosystems in the northern Gulf of Alaska (GOA). We can learn a lot about present ecosystems by documenting their past responses to global changes and human activities. Information on ecosystem history can help us predict future changes. Here we propose a retrospective study of sockeye abundance in Prince William Sound and in the Kenai River watershed using the stable isotope tracers present in the sediments of spawning lakes. Our goal is to describe changes in sockeye salmon abundance over the last several millennia and to relate these changes to shifts in the climate/ocean system of the GOA and to human activities.

B. Sockeye salmon

Sockeye are an important for Native subsistence and for commercial and recreational fishing. The Trustee Council has previously made large investments in sockeye salmon recovery by purchases of stream bank, lakeside, and watershed habitats and by funding studies that detail the effects of over escapement caused by the spill. The over escapement impact was caused by the return of larger than normal numbers of spawning fish because of fisheries closures resulting from concern over oil contamination. Increased juvenile sockeye populations caused overgrazing of zooplankton stocks in spawning lakes, with consequent effects throughout the food chain. Growth rates were reduced during the freshwater part of the sockeyes' life history, and declines occurred in the health of adult fish. We have little idea about the relative severity of these over escapement effects relative to natural, prehistoric variations in sockeye populations.

C. The importance of retrospective studies

Retrospective studies like the one we propose here directly address the GEM program's goals of detecting and understanding of changes in the GOA ecosystem. To detect trends of change, we need historical data. To disentangle human-caused from nature-caused changes, we need historical data that extend back before the arrival of Europeans in the region (e.g., Finney et al., 2000). To understand the marine ecosystem, we need to describe the natural changes upon which human influences are superimposed. By understanding what happened in the past, we gain valuable perspectives on the present. In this time of global changes, learning how species and ecosystems responded to previous shifts in the environment can inform us about their future responses.

D. Previous retrospective studies of salmon populations

Finney et al. (2000) describe a 300-year record of sockeye population changes in seven lakes on Kodiak Island and the Alaska Peninsula using measurements of marine-derived nitrogen preserved in the bottom sediments of spawning lakes (Fig. 1). Marked changes in population size were found both before and after the start of intensive fisheries around AD 1900. The prehistoric changes are related to climate change (see next section), and the post-1900 changes to a combination of both climate change and fishery activity. The ^{15}N method provides a powerful tool for reconstructing changes in salmon populations in the GOA region.

BACKGROUND

A. Recent changes in the GOA atmosphere/ocean system

The northern Gulf of Alaska has seen dramatic environmental changes over the last several millennia, many of which resulted from shifts in the position and intensity of the Aleutian Low (Cayan and Peterson, 1989; Lackmann and Gyakum, 1996; Mock et al., 1998). The intensity of the Aleutian Low varies at all time scales, though only those within the span of the instrumental record (ca. 100 years) are known with any certainty (Francis et al., 1997). The best studied of these variations is the Pacific Interdecadal Oscillation (PDO), which is the coupled variation in sea surface temperature (SST) and sea level pressure (SLP) resulting from the alternation between two, self-reinforcing, and quasi-stable circulation regimes in the North Pacific climate system (Latif and Barnett, 1996; Minobe, 1997; Overland et al., 1999). The PDO has undergone two complete oscillations since AD 1900 (Mantua et al., 1997). During positive phases of the PDO, the Aleutian Low moves eastward and intensifies, resulting in increased precipitation along the coast of the Gulf of Alaska. SSTs are cooler in the Alaska Gyre but warmer in nearshore waters. During negative phases of the PDO, the central northeastern Pacific warms, the Aleutian Low weakens, coastal precipitation lessens, and nearshore temperatures warm. Longer time-scale fluctuations (centuries to millennia) have occurred repeatedly in the North Pacific climate system (Mann et al., 1999). Studies of coastal tree rings extend the PDO record back to AD 1760 (Wiles et al., 1996, 1998, 199a).

Most of our proxy data for GOA climate prior to AD 1900 come from terrestrial sources (Mann and Hamilton, 1995). Both the Medieval Warm Period (ca. AD 900-1250) and the Little Ice Age (ca. AD 1250-1900) occurred in the GOA region, where they are evidenced by glacier fluctuations and by climatic changes recorded in tree rings (Wiles and Calkin, 1994; Wiles et al., 1998; Wiles et al., 1999 b). Fluctuations in summer temperature of several degrees centigrade are suggested (Wiles et al., 1996). The Medieval Warm Period is especially interesting for us today because it was the last time when global temperatures approached their post-1900 AD levels.

Moving further back in time, the Neoglacial interval (ca. 6000 BP – AD 1900) saw alternating cold and warm intervals each lasting several hundred years to one millennium (Calkin, 1988). Precipitation fluctuated as well, and in combination with temperature changes, caused snowlines to rise and fall by several hundred meters. Transitions from milder to colder conditions during the Neoglacial occurred rapidly in the space of several years to several decades. In general terms, the magnitudes and rates of natural climate changes occurring in the GOA over the last several millennia are similar to those predicted to occur over the next several centuries (Mann et al., 1999). In effect, nature has done a series of experiments in the past about how the GOA ecosystem may respond to future changes in the atmosphere-ocean system.

B. Salmon responses to changes in the atmosphere/ocean system

Climatic shifts have dramatic effects on the biota of the North Pacific, including salmon, at a variety of time scales. Climate variability is linked to ecosystem change in the North Pacific primarily through its forcing effects on lower trophic levels (Francis et al., 1997). These effects work their way through the food web and are modified as they proceed by species' life histories, subsistence strategies, and by top-down effects like predation. Intensification of the Aleutian Low during phases of positive PDO triggers increased zooplankton biomass in the Alaskan Gyre, probably in response to increased wind-induced upwelling and vertical mixing (Brodeur and Ware, 1992; Brodeur et al., 1996; Sugimoto and Tadokoro, 1997). Phytoplankton and zooplankton populations seem to have increased during the reorganization of upper ocean circulation in response to the 1976/1977 regime shift (Francis et al., 1998).

Some of the most dramatic effects of climatic shifts on the marine biota are evident in the histories of salmon catches (Downton and Miller, 1998). Salmon catches in Gulf of Alaska waters closely track the PDO oscillation, with stock size positively correlated with the average winter/spring strength of the Aleutian Low (Beamish and Bouillon, 1993; Mantua et al., 1997). Northern (Alaskan) and southern (Oregon, California) salmon stocks vary roughly 180^{o} out of phase (Francis and Sibley, 1991; Gargett, 1997).

There is no generally accepted explanation for how the Aleutian Low controls salmon populations in the North Pacific (Francis et al., 1998). One possible explanation is that increased wind mixing stimulates primary productivity in the Alaska Gyre, which provides more food for young salmon during the early marine stages of their lives. Gargett (1997) suggests that the critical link between physical forcing and salmon survival is the enhanced water-column stability in coastal areas during positive PDO phases, which increases primary productivity and subsequently food supply for salmon juvenile stages. Increased stream flow caused by increased rainfall in coastal areas during positive PDO phases may increase spawning success and hatchling survival. Probably all these factors interact to increase salmon stocks during positive phases of the PDO. Historical records are too short to tell us how climate/oceanographic parameters affect salmon populations.

C. Stable Isotopes in lake sediments as records of salmon abundance

Measurements of the natural abundance of stable isotopes make it possible to trace the flow of selected elements in ecosystems (Fry and Sherr, 1984; Owens, 1987; Peterson and Howarth, 1987; Wada et al., 1987). This has application in anadromous Pacific salmon systems because of the dichotomous nature of the two important nitrogen (N) sources, which are marine N from the decay of carcasses of returning adult salmon, and atmospheric N_2 (Kline, 1991). The two sources of N can be distinguished by del^{15}N, which is defined as the per mil difference in $^{15}N/^{14}N$ compared to an air N_2 isotope standard. The premise underlying the use of stable isotope abundance is the relative enrichment of ^{15}N in Pacific salmon (~ +12) in comparison with atmospheric N_2 (0). Food webs based on N_2 fixation tend to be low in ^{15}N (Minagawa and Wada, 1984; Owens, 1987; Wada and Hattori, 1991).

When Pacific salmon return to freshwater to spawn and die, they import significant quantities of marine-derived nutrients. Because these nutrients carry a distinctive signature of heavy nitrogen (^{15}N), the amount of ^{15}N present in the accumulating in the sediments of the spawning lake can be used as a proxy for escapement (Kline, 1991). Studies have quantified the proportion of marine-derived nitrogen (MDN) released by adult salmon as a result of spawning migration (Kline et al., 1993). Measurable shifts in the MDN content of juvenile sockeye have been observed between years of strong and weak escapement. The N-isotope composition of lake biota reflects the recent history of MDN import into the lake ecosystem (Kline et al., 1993; 1994). In some lakes, this signal is transferred to the underlying sediments. Downcore changes in the abundance of MDN can reflect changes in the number of returning adult salmon (Finney et al., 2000).

D. Preliminary data for this study

Data from Karluk and Frazer Lakes on Kodiak Island indicate that sedimentary del^{15}N effectively tracks sockeye escapement (Fig. 1, Finney et al., 2000). We chose Frazer Lake as a test case for this method, as the lake was a "barren system" isolated by a waterfall from salmon prior to stocking in the late 1950s. Subsequently, a fish bypass was constructed and run size significantly increased, with an average escapement of about 200,000 since 1980 (Blackett, 1979; ADF&G, written comm., 1994). Such a large increase in escapement is clearly recorded by sedimentary del^{15}N (Fig. 1). The enrichment in del^{15}N is significant and strongly supports the hypothesis that sediment del^{15}N is influenced by salmon input of MDN. Similarly, data from Karluk Lake indicate a strong relationship between sediment del^{15}N and salmon escapement (Finney et al., 2000). Karluk Lake, one of the greatest sockeye systems in the world, had historical returns >5 million fish. Escapements averaged more than 1 million fish from the turn of the century until about 1935 but then fell to an average of less than 300,000 in the 1960s and 70s (Fig. 1; Koenings and Burkett, 1987a, ADF&G, written comm., 1994). The sedimentary del^{15}N in Karluk is significantly higher than Frazer, and it is consistent with greater salmon escapement. The large decline in sedimentary del^{15}N of about 3 parts per mil towards the top of the core reflects the decline in escapement in this system since the 1930s. These results indicate that sedimentary del^{15}N provides a valuable tool for reconstructing long-term changes in sockeye abundance.

In 2000 we retrieved four cores each from Solf and Eshamy Lakes in Prince William Sound. Solf is a “barren” lake into which salmon have been recently introduced, and Eshamy Lake naturally supports a vigorous sockeye run (Table 1). Preliminary analysis of one of the Eshamy Lake cores shows a striking del^{15}N record (Fig. 2). We have not obtained any radiocarbon dates from Eshamy Lake yet, though the presence of a shift in vegetation from alder to spruce at 130 cm depth in the core suggests that the core base probably dates to ca. 4000 years B.P. By comparison with previously analyzed lakes (Fig. 1), we judge that Eshamy Lake has the potential to provide an excellent del^{15}N record of sockeye spawning populations. Solf Lake will serve as a control for possible changes in non-salmon (e.g., aerosol) input of del^{15}N into Prince William Sound lakes.

Table 1. Characteristics of Study Lakes

Lake	***Region***	***Lake type***	***Surface area (km^2)***	***Escapement (1000s fish)***	***Escapement/Area (1000s fish/km^2)***
Eshamy	Prince William Sound	clear	3.6	40	11.1
Solf	Prince William Sound	clear, *control*	0.7	0	0*
Upper Russian	Kenai River	clear	4.6	75	16.3
Karluk	Kodiak Island	clear	39.5	1,000	25.3
Frazer	Kodiak Island	clear, *control*	16.6	(217)**	(13.1)**

*Stocking began in 1998; fish ladder constructed in 2000.
** Stocking began in 1950s; fish ladder built then.

NEED FOR THIS PROJECT

A. The Problem: What is "normal" for sockeye populations?

The recovery objective set by the EVOS Trustee Council for sockeye salmon is that adult returns-per-spawner should regain normal levels. But what is normal? If both the global environment fisheries management were stable then we might be able to define "normal". But change reigns in both nature and society, and what is normal for the last several decades may be unusual over longer time spans.

The retrospective studies we propose here can establish long-term, baseline records of changes in salmon populations in the GOA. We can use these records to define normalcy by estimating the frequency with which the observed population size occurred in the past. By knowing the extremes of natural population fluctuations in the past, we can identify abnormal population excursions as they occur in the future.

Understanding how environmental factors affect salmon populations is crucial for fisheries management in a time of global change. Also, sockeye may prove to be a useful indicator species for events within the larger GOA ecosystem. Before we can use sockeye as an indicator species, we need to understand how nonhuman factors control their numbers. From retrospective studies, we can generate testable hypotheses about how changes in the atmosphere/ocean system of the GOA will affect salmon populations in the near future. Nature has performed a series of experiments in past millennia, and we can gain access to the results of these experiments through analyses of del^{15}N in lake sediments.

B. Links: Giving GEM a time perspective

The goals of GEM are to detect, understand, and predict ecosystem changes in the GOA with the purpose of informing and assisting resource managers. Besides providing a more rigorous means of defining what is normal, our study will help lay the foundations for GEM by generating hypotheses that relate changes in the atmosphere/ocean system of the GOA to fluctuations in salmon numbers. The past is the key to the present, and climate has varied repeatedly over the last 2000 years. How did sockeye population respond to changes of several C^o in the past? The last time temperatures were as warm as today was during the Medieval Warm Period (AD 900-1250). How did sockeye populations respond to this previous warm period?

C. Study Sites

This study involves sockeye lakes in the northern GOA region that were affected by over escapement after the 1989 oil spill (Eshamy and Upper Russian Lakes) and two recently formed lakes in McCarty Fjord (Delight and Desire Lakes). Detailed sediment chemistry has been completed in the two Kodiak Island lakes, Karluk and Frazer (Fig. 2). Preliminary analysis has been done on Eshamy Lake (Fig. 1) in Prince William Sound. The field work we propose here is to core Upper Russian Lake in the Kenai River watershed in the spring of 2002. Delight and Desire Lakes, which rarely freeze, will be cored from rafts during the summer of 2002. We will use Solf Lake on Knight Island as a control for Eshamy Lake. Sedimentary ^{15}N levels in Solf Lake will provide a record of the background level of aerosol input of ^{15}N into PWS lakes. The Solf Lake cores also will be used to test the sensitivity of the ^{15}N method in picking up the first significant entry of anadromous fish into a lake that was barren prior to recent sockeye introductions.

COMMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Archaeological records contain unsynthesized data concerning the interactions between humans and salmon populations during prehistoric times (see review in Mann et al., 1999). We suspect there is also a rich oral tradition in Native communities about the history and causes of changes in salmon abundance. Within the time constraints of this one-year project, our goals are to get data on sockeye population history and then to develop hypotheses about salmon-climate interconnections. Once we have the science figured out, we want to turn to the local people, the people actually living on the land, to share our ideas and get their ideas back. We anticipate asking EVOS for additional funds in FY 2003 to pay for several trips to Kodiak Island and to villages in PWS and on the Kenai Peninsula, where we will give brief presentations showing our results and initiate conversations about what factors control salmon populations in the GOA region.

PROJECT DESIGN

A. Objectives

We intend to reconstruct sockeye abundance in Eshamy, Upper Russian, Delight, and Desire Lakes using established methods of isotope analysis of lake-bottom sediments that are retrieved by coring. The specific objectives of this study are:

1) Develop sediment-core chronologies and measure downcore changes in lake-productivity indicators (organic C and C/N ratios) as well sedimentary del^{15}N.

2) Compare sediment data corresponding to the past few decades (e.g., the period of intensive investigations by ADF&G) to salmon population statistics. We then will develop calibration relationships between del^{15}N and salmon numbers.

3) Reconstruct paleolimnologic changes in each lake over the past several thousand years, using the results of Specific Objectives 1 and 2. Specifically, we will reconstruct time-series of lake productivity, input of marine-derived nutrients, and salmon escapement.

4) Compare del^{15}N records from PWS and the Kenai Peninsula to Finney's published and ongoing work on Kodiak Island. This synthesis will result in a valuable new perspective on changes in sockeye abundance in the GOA at decadal time scales over the last several millennia.

5) Compare reconstructed sockeye population fluctuations with published data sets on paleoclimatic changes in the GOA region. These data sets include tree rings, glacial records, and pollen records of vegetation change. From these comparisons, we will develop a series of hypotheses about how changes in the atmosphere/ocean system affect salmon populations.

B. Methods

1) Sediment cores

We already have cores from Eshamy, Solf, Karluk, and Frazer Lakes. Upper Russian, Delight, and Desire Lakes will be cored for the first time in this study. Existing cores from Karluk and Frazer Lakes that extend deeper than ones already described by Finney et al. (2000) are currently being analyzed in another project. The Kodiak cores will cover the same time scales as present in the Eshamy Lake record and, hopefully, as in the Upper Russian record.

Coring sites are identified from bathymetric maps, and sites are selected to avoid gravity-flow deposition and complicated bottom topography. We will obtain at least two, 1- 2 m long cores using the percussion corer that we built last year to obtain cores from each lake. High quality surface cores will be obtained with a device (Glew corer) designed for sampling unconsolidated sediments and obtaining an undisturbed sediment-water interface. The cores will be stored in a cold room and excess material archived for future studies.

Cores will be described for lithology, texture, color, and other properties, and photographed. Each core will be continuously scanned for magnetic susceptibility. Magnetic susceptibility, a measure of the abundance of magnetic minerals, provides important stratigraphic and sedimentologic information (e.g., King et al., 1983). For example, magnetic susceptibility is sensitive to volcanic ash abundance; visually undetected ashes often are easily detected in susceptibility profiles. Ash layers should be common in many of the lakes, given the close proximity to active volcanoes, and they are useful for correlating between cores and between different lakes. Sediment chronologies will be determined by a combination of ^{210}Pb-dating (Bruland et al., 1974) in the upper several tens of centimeters and by AMS-^{14}C dating of terrestrial plant macrofossils in sediments older than several centuries.

<u>2) Reconstructing changes in sockeye salmon abundance</u>
Changes in input of marine-derived nutrients (MDN) will be determined by analysis of del^{15}N. As discussed earlier, downcore changes in the abundance of MDN (from del^{15}N) reflect changes in the number of returning adult salmon, and thus is a proxy for escapement. Organic carbon content, C/N ratio, and del^{13}C also indicate changes in organic matter source (Hedges and Parker, 1976; Meyers, 1990). Time-series of organic C content, C/N ratios, and stable C and N isotopes will shed light on changes in the source and supply rate of organic matter. We will calibrate our MDN-based reconstructions in sockeye salmon escapement with recorded escapement records. The lakes we propose to study have had significant changes in escapement during the past few decades. These variations allow us to determine how well sedimentary del^{15}N reflects escapement (e.g., Fig. 1). Using recent calibrations, we will estimate prehistoric escapements from downcore changes in del^{15}N.

C. Cooperating agencies, contracts, and other agency assistance

Though no formal collaborations are planned with federal agencies within this brief project, in fact we are collaborating closely with ADF&G and USFWS in ongoing, similar studies of salmon paleoecology (e.g., Schmidt et al., 1997).

SCHEDULE

A. Project Tasks and Endpoints

December 31, 2001:	Complete del^{15}N analyses on Eshamy Lake and Solf Lake (control) cores; submit samples for ^{14}C and ^{210}Pb dating.
January, 2002:	Present preliminary results at Restoration Workshop and discuss their implications for design of GEM monitoring studies.
mid-March, 2002:	Core Upper Russian Lake.
June 30, 2002:	Complete del^{15}N analyses on cores from Upper Russian Lake; submit samples from this lake for ^{14}C and ^{210}Pb dating. Core Delight and Desire Lakes in Kenai Fjords.

July 31, 2002:	Complete literature reviews of proxy data describing climate/oceanographic changes in the northern GOA over the last several millennia. Develop hypotheses relating changes in salmon populations to climatic changes.
September 1, 2002:	Submit manuscript for publication in peer-reviewed journal concerning the applications of retrospective records of sockeye populations in fisheries management.
October 1, 2002:	Submit manuscript for publication in peer-reviewed journal concerning climate-oceanographic drivers of salmon populations in the GOA region. Also, develop a public lecture aimed at informing communities in the GOA region about our research.
December 7, 2002:	Present major finding at the American Geophysical Union Fall meeting.
January, 2003:	Present results and discuss implications for GEM projects at Restoration Workshop.
April, 2003:	Submit final report to EVOS.

PUBLICATIONS AND REPORTS

We plan on two publications published in peer-reviewed scientific journals. The first one concerns the use of retrospective data on sockeye salmon escapement inferred from lake-sediment records in fisheries management. Possible journals are *Fisheries Oceanography* and *Canadian Journal of Fisheries and Aquatic Science.* Our second publication will concern the connections between salmon populations and climatic change in the Gulf of Alaska region. Our target journal for publication is *Journal of Geophysical Research*.

PROFESSIONAL CONFERENCES

We will present our results at two scientific meetings, the American Geophysical Union meeting in San Francisco and a meeting of the American Fisheries Society.

PRINCIPAL INVESTIGATORS (see curricula vitae below)

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FY 02 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001- September 30, 2002

Budget Category:	Authorized FY 2003	Proposed FY 2002
Personnel		$0.0
Travel		$0.0
Contractual		$82.3
Commodities		$0.0
Equipment		$0.0
Subtotal		$82.3
General Administration		$5.8
Project Total		$88.1
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2003	Estimated		
		$18.8			

Dollar amounts are shown in thousands of dollars.

Comments:
1. Indirect costs at 25% as agreed with the University of Alaska Fairbanks.
2. 4% of direct cost will be spent on attending workshops and professional meetings for entire project.
3. Total project cost including 7% agency general administr tion (ADFG) will be $5.5 FY02
4.Publication cost-$4,000 to be submitted to Fisheries Oceanography and Canadian Journal of Fisheries and Aquatic Science and Journal of Geophysical Research.

FY02

Prepared:9/25/01

Project Number:
Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes.
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001- September 30, 2002

Budget Category:	Authorized FY 2003	Proposed FY 2002
Personnel		$29.1
Travel		$4.5
Contractual		$26.2
Commodities		$6.0
Equipment		$0.0
Subtotal		$65.8
Indirect		$16.5
Project Total		$82.3
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2003	Estimated		
		$16.5			

Dollar amounts are shown in thousands of dollars.

Comments:

The indirect rate is 25% TDC, as negotiated by the Exxon Valdez Oil Spill Trustee Council with the University of Alaska.

(Use this statement if there is a graduate student tuition and use proper resident or non-resident amount)

FY02

Project Number: 02649
Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes.
Name: D. H. Mann and B. Finney

FORM 4A
Non-Trustee
SUMMARY

Prepared:6/22/02

FY 02 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001- September 30, 2002

Personnel Costs:				Months	Monthly		Proposed
Name	Position Description			Budgeted	Costs	Overtime	FY 2000
Mann	PI			2.0	9.1		18.2
Finney	Co-PI			0.75	7.3		5.5
Krumhardt	Technician			1.0	5.4		5.4
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		3.8	21.8	0.0	
						Personnel Total	$29.1

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
Fbks to Anchorage	0.25	6	6	0.1	2.1
Fbks to Upper Russian Lake	0.5	2		0.5	1.0
Fbks to AGU meeting San Francisco	0.6	1	4	0.2	1.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.5

FY02

Project Number: 02649
Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes.
Name: D. H. Mann and B. Finney

FORM 4B
Personnel
& Travel
DETAIL

Prepared:6/22/01

FY 02 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001- September 30, 2002

Contractual Costs:	Proposed
Description	FY 2001
Laboratory analyses of N and C isotopes	6.0
AMS-radiocarbon dating, 20 samples @ $500/ea.	10.0
210Pb analyses, 3 @ $2000/ea.	6.0
Ski-plane charter, Kenai to Upper Russian Lake, 4 hrs	1.2
Float-plane charter, Homer to Delight and Desire lakes	3.0
Contractual Total	$26.2

Commodities Costs:	Proposed
Description	FY 2001
Material misc. cord, cable and rope for the corer and laboratory glasware for Dr. Finney's work.	1.5
Publications	4
Communications and copies	0.5
Commodities Total	$6.0

FY02

Prepared:6/22/01

Project Number:
Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes.
Name: D. H. Mann and B. Finney

FORM 4B Contractual & Commodities DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2001
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number
Description	of Units

FY02	Project Number: Project Title: Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes. Name: D. H. Mann and B. Finney	FORM 4B Equipment DETAIL
Prepared:6/22/01		