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Project No: ________________
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GEM PROPOSAL SUMMARY PAGE
(To be filled in by proposer)

Project Title: Research for nutrient-based resource management in watersheds and estuaries.

Project Period: Federal fiscal years--October 1st to September 30th--for which funding will be requested from the Trustee Council; for example "FY 04-FY 05"

Proposer(s):

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Study Location: Prince William Sound

Abstract: For a successful EVOS Gulf Ecosystem Monitoring Program (GEM), it is essential that nutrient cycling among and within South Central Alaska watersheds, estuaries, and nearshore areas be understood. Recent research has documented the importance of marine-derived nutrients as an integral component of biological productivity in salmon-bearing watersheds. Yet further research remains before informed decisions can be made about how, what, where, and when both marine- and watershed-derived nutrients should be monitored. It is also critical to establish the link between nutrient measures and production of commercially and culturally important species, like salmon, clams, and other wildlife. This proposal establishes a strategy for, and begins research on, 1) learning how to measure marine- and watershed-derived nutrients in watersheds and estuaries, 2) determining the variability of nutrient measures, and 3) relating nutrient measures to production, as a result of salmon and other marine-derived inputs to coastal watersheds. Results will guide decisions for establishing a GEM community-based nutrient monitoring program.

Funding:	EVOS Funding Requested:	FY 04	$ 153,216	
		FY 05	$ 177,003	
		FY 06	$ 152,632	TOTAL: 482,850
	Non-EVOS Funds to be Used:	FY 04	$ 120,000	
		FY 05	$ 120,000	
		FY 06	$ 20,000	TOTAL: 260,000

Date: June 16, 2004

GEM RESEARCH PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

As stated in the 2004 GEM Invitation, "Measuring marine-related phenomena in watersheds, as well as terrestrial-related phenomena in the nearshore, is fundamental to the GEM monitoring program in these two habitat types". The Invitation for watersheds specifically asks researchers to "identify and show how and where to measure the best indicators of marine-related biological production in watersheds…..". This proposal directly addresses those stated needs by first describing a strategy for long-term implementation of research and planning for a nutrient-related monitoring program, and secondly proposing initial research to support establishment of the monitoring program.

Many basic studies have established the role of nutrients, particularly C, N, and P, in trophic webs of freshwater, estuarine, and marine ecosystems. Recent research has also established that biological productivity is influenced by the upstream transport of marine-derived nutrients (MDN) in salmon carcasses (e.g., Bilby et al. 1998, Cederholm et al. 1999). However, little is yet known about 1) the relative importance of MDN to total productivity in aquatic, estuarine, or nearshore ecosystems, 2) the relative importance of watershed-derived nutrients compared to MDN-based productivity, 3) the drivers and ranges of variability in relative watershed-derived and MDN-derived nutrient contributions, and 4) how and when to best measure these productivity contributions for long-term monitoring. To answer these complex questions will require a long-term, concentrated research effort. This proposal presents a step-wise framework for that effort, and then identifies the initial steps to be funded over the next three years.

Need for a Watersheds/Nearshore Nutrient Strategy.- There are numerous possible scenarios for research to identify the appropriate watershed and estuarine nutrient variables that will ultimately be monitored under GEM. Given the preliminary state of knowledge and limited funding available, it is anticipated that resolving the final GEM monitoring variables will require a phased research program. We argue, however, that it is important to first reduce the problem to the simplest level, adding complexity in later stages. By controlling for confounding sources of variation in the simplest watersheds and estuaries, we can first learn how to measure nutrients and the relative importance of MDN. Once the methods are refined in these simpler systems, the research should be extended to larger and more complex watersheds. Furthermore, the relationships between marine-derived and watershed-derived productivity certainly varies across season, years, climate, escapement, and watershed physiography, size, and successional development, but the degree of variability has not been established. Evaluating the effects of these sampling techniques and sources of variation will require both intensive and extensive studies that will be expensive and take a number of sequential steps over time. Below we describe the Phases and steps we recommend for beginning research, expanding it into broader application, and finally implementing a monitoring program. Subsequently, in the Procedures section, we identify a specific proposal for immediate funding to address the initial steps in the first Phase.

Phase One (Years 1-3) – Learn what the key indicator variables are and how to measure them, including how to differentiate between marine-derived and watershed-derived contributions to productivity in small watersheds and estuaries. The purpose of this phase is to identify variables that can ultimately be used to monitor watershed contributions to estuaries and nearshore areas as an index of relative productivity and to learn what other variables influence the potential indicator variables. The basic approach is to initially study 2-3 small watersheds where samples of standing stock, nutrients, and MDN stable isotopic ratio composition will be related to salmon spawner biomass. During this work, details of sampling and sample processes will be refined and variability will be evaluated to determine the most cost-efficient and timely way to monitor small systems (Table 1).

Phase Two (Years 2-6) – Determine the variation of candidate indicator variables across other small watersheds having different complexity, geography, geology, presence/absence of lakes, and salmon escapement patterns. Continue original small-stream research to help establish interannual variability. Results from Phase One will be applied to monitoring nutrients and MDN in larger and more complex systems and the accuracy and variability will be re-evaluated. Parts of this phase will require new funding in subsequent years and will include a number of collaborators already working in other South Central Alaska watersheds. It will be important to focus this research on watersheds that include effective salmon enumeration projects because establishing the link between upstream movements of marine-derived nutrients and subsequent watershed and estuarine productivity is key to future GEM nutrient monitoring as well as fisheries management.

Phase Three (Years 4-8) – Emphasize integrated knowledge of the relationships of nutrient measurements, including the relative contributions from marine, watershed, and estuarine sources, with the primary drivers of productivity. Develop a model of nutrient budget and the relationship to biological drivers of production and related influential variables. This will enable the GEM monitoring program to become focused on appropriate measures that are critical abundance indices or predictors of production of commercially and culturally important species.

Phase Four (Years 4-10) – Evaluate multi-year data to begin implementing a full GEM watershed/nearshore monitoring program, with feedback loops. Once key variables are identified, and how they vary seasonally, annually, spatially, and with watershed complexity, then routine sampling can be implemented. Existing water quality monitoring programs may have information on nitrates and ammonium that would serve to establish marine linkages. Elevated nitrates and/or ammonium at certain localities and times of the year may provide an indication of levels of spawning anadromous fish. The feasibility of this concept, however, depends on successfully establishing the relationship between indicator variables and salmon escapement, as proposed in this research strategy.

Initial Research to Support the Strategy. – Eventual implementation of a GEM watershed and nearshore nutrient monitoring program requires that techniques and methods first be refined. The science of nutrient sources, pathways, and sinks, i.e., nutrient budgets, remains rudimentary in some ways, but is rapidly evolving in other areas.

Perhaps the most far-reaching connection among the GEM-defined habitats, in terms of distance, is the role that anadromous Pacific salmon play in transporting nutrients acquired in marine environments (GEM offshore and ACC habitats) into freshwaters (GEM watersheds habitat) and certain coastal areas, such as mouths of streams and sites adjacent to marine beach spawning (GEM nearshore habitat) (e.g., Kline 1991). In some systems salmon may provide the major source of nitrogen and, by extension, other essential nutrients (Kline et al. 1990, Kline 1991, Kline et al. 1993, Kline et al. 1997, Kline 2003). Salmon spawning and juvenile rearing ecosystems may thus be subject to production fluctuations occurring in distant marine habitats causing marine subsidies to these freshwaters to vary concomitantly (e.g., Hare et al. 1999, Finney et al. 2000). Pacific salmon may not be the only conveyer of marine-derived nutrients (MDN) into freshwaters. Although poorly documented, but nonetheless probably also an important transporter of MDN into freshwaters, are runs, occasionally large, of anadromous osmerids, most notably eulachon. Because salmon may spawn inter-tidally (Groot and Margolis 1991) and because salmon carcasses may wash downstream and accumulate in marine environments near mouths of spawning streams (Brickell and Goering 1970), salmon may play a significant role transporting material from the offshore and ACC to the nearshore GEM habitats as well as to freshwaters.

Assessing nutrient cycling in and among marine, watershed, and estuarine systems.- Because freshwater and marine habitats are geographically separated, the pools of elements comprising them have separate histories leading to separate stable isotope signatures that can be exploited as tracers when they are brought together. Ideally, there should be just two pools for a given element, each with a distinctive signature. When more than two pools are brought together, there can be ambiguity, e.g. three pools, each with distinctive signatures (see Figure 1 in Fry and Sherr 1984). In some of these cases, a second isotope signature will resolve the problem. In the salmon migration context, the macronutrient nitrogen is the most useful tracer. Carbon and sulfur stable isotope abundance, when used in conjunction with nitrogen, may also be useful, especially for elucidating different pathways by which salmon-borne nutrients enter terrestrial and freshwater food webs.

The sample types can reflect those taxa of greater interest to management, harvested fishes in particular. Because fishes may be several food chain steps removed from salmon nutrient linking processes, lower trophic levels should also be sampled. Low trophic level biota that grow attached to substrates, periphyton, confer the advantage of a spatial context in moving waters. The U.S. Environmental Protection Agency recommended sampling device is the Wildco Periphyton Sampler (WPS). The WPS can be securely deployed in streams, as well as lentic water bodies, for specified time periods enabling both temporal control and consistency in substrate. Periphyton grows rather well on glass microscope slides such as used in the as Wildco Periphyton Sampler, producing substantial material for analysis, in proportionate response to localized effects of marine nutrients (Mathisen 1972, Kline unpublished).

Nutrient pathways.- Stable Isotope Analysis (SIA) methods can delineate the pathways of marine derived nitrogen (MDN) from salmon to freshwater biota and terrestrial ecosystem components (Kline et al. 1993). The direct pathway (DP) is where salmon components (inorganic marine-derived nutrients) are utilized when salmon eggs and carcasses are fed upon directly by consumers (e.g., Bilby et al. 1998). In the re-mineralization pathway (RP), salmon nutrients return to an inorganic state (inorganic marine-derived nutrients) and therefore must be taken up by primary producers. The RP results from decomposition of the carcasses as well as through excrement. These pathways are critical as to which tracers are appropriate because during re-mineralization the geochemical cycles of the elements de-couple. Macromolecules are broken down so that organic tracers no longer can be used. Each of the elements mixes with existing pools. Other than loss to air via de-nitrification, salmon nitrogen re-mineralizes to nitrate via ammonium (Brickell and Goering 1970, Richey et al. 1975). Plant and animal species may vary in the ratio of marine to non-marine isotopes (C, N, S) among watersheds due to the relative magnitude of terrestrial or atmospheric inputs, which is in turn related to the species composition and plant species abundance. For example, the relative importance of atmospheric nitrogen is proportional to the activity of nitrogen-fixing plant species such as alders.

Salmon carbon is re-mineralized to carbon dioxide, which rapidly equilibrates with the CO_2 in the atmosphere. Organic sulfur re-mineralizes to sulfate when the environment is oxidizing but to sulfide in a reducing environment. Whereas the isotopic composition of sulfate derived from salmon should be conserved, reduction to sulfide could significantly alter the ^{34}S content of the salmon-derived sulfur pool. Reduction to sulfide will result in a very large isotopic fractionation that will mask any marine sulfur signature. Reduction to sulfide is a process common to the benthos, particularly in the intertidal, because of low oxygen. Nevertheless, both carbon and sulfur stable isotope are likely to be good tracers of the DP, particularly when used in combination to produce dual-isotope plots (Peterson and Howarth 1987, Kline et al. 1993). Dual isotope plots of nitrogen and carbon have been shown to be useful for distinguishing between DP and RP, Kline et al. 1993 (Figure 1). Using three stable isotope ratios, $^{15}N/^{14}N$, $^{13}C/^{12}C$, and $^{34}S/^{32}S$, will enable resolving the relative roles of more possible sources than by using only one or two ratios, because isotope mixing models can identify up to n+1 sources when n = number of isotope ratio groups (e.g., carbon stable isotope ratio, $^{13}C/^{12}C$, is one isotope ratio group; Phillips 2001).

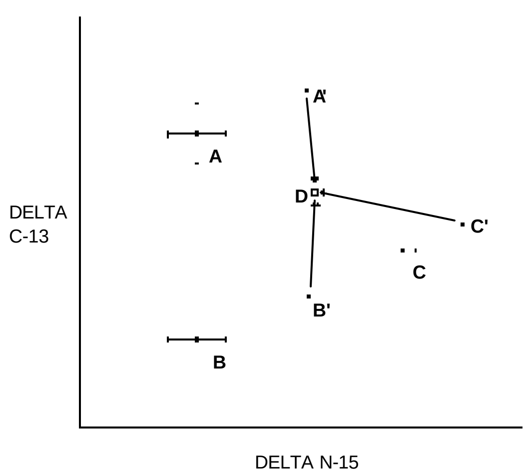

Figure 1. Dual isotope mixing model from Kline (1991). A, B, and C are possible organic material sources for consumer D. A and B are littoral and pelagic primary producers, respectively, while C is adult salmon (or components such as eggs). Multiple feeding steps are assumed between A and A' and B and B' whereas only one feed step is assumed between C and C'. A', B' and C' were estimated based on trophic

isotopic enrichment dependent on length of food chain from sources A, B and C. Once the values of A, B, and C and the number of feeding steps determined, then their relative contributions to measurement D can be made (Kline et al. 1990, 1993, Kline 2003).

The principal advantage to stable sulfur isotopes is there is virtually no isotopic fractionation within food webs. Thus data can be pooled from across a range of trophic levels (unpubl deltaS34 data from Kvichak). "Food chain length" on the other hand is a major consideration when modeling nitrogen and carbon stable isotopes. Trophic level assumptions can have a profound effect on MDN determination (Kline 2003, Figure 2). However, food webs are reconstructed as a product of nitrogen and carbon stable isotope data modeling, a very useful product. The variability in length of food chains among salmon freshwater habitats (e.g., Kline 2003) may be a very significant factor regulating productivity (Stockner 1987).

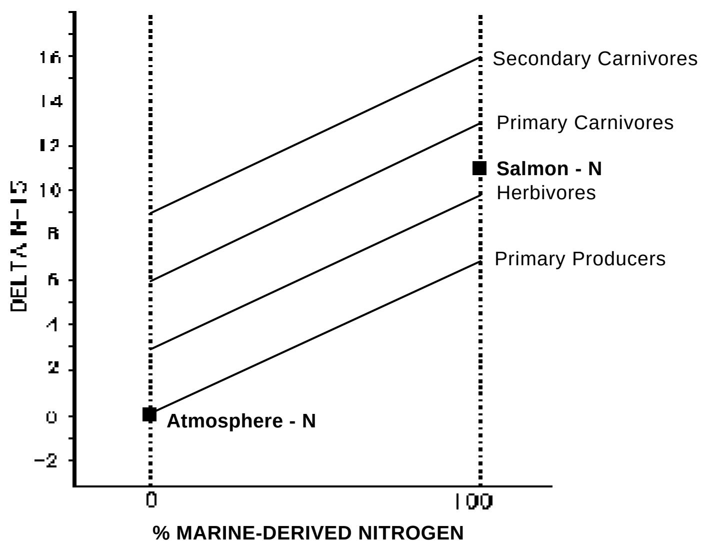

Figure 2. The isotope mixing model from Kline (1991).

There is good potential for using $\delta^{34}S$ (the ratio of $^{34}S/^{32}S$ expressed in conventional delta notation) as an additional tracer of marine-derived nutrients (Kline 1991). About 4.2 % of sulfur consists of the isotope ^{34}S, whereas 95.0 % is ^{32}S, 0.8% is ^{33}S, and 0.02% is ^{36}S. $\delta^{34}S$ differences exist between freshwater and marine systems (Peterson and Howarth 1987). There is virtually no fractionation of $\delta^{34}S$ in food webs making it a very conservative tracer (Fry 1988). SO_4^{-2} may have a role in controlling N_2 fixation (Howarth and Cole 1985), thus S and N biogeochemical cycles may interact. Very little SO_4^{-2} was precipitated during a pilot study at Iliamna Lake, suggesting that even minor input could be significant (Kline 1991). An alternative (to salmon) S source could be vulcogenic. SO_4^{-2} increased 157 times from the pre-eruptive level in Spirit Lake subsequent to the 1980 eruption of Mt. St. Helens (Wissmar et al 1982). The natural distribution of Pacific salmon (Groot, and Margolis 1991) overlaps the northern portion of the Pacific "ring of fire" distribution of volcanoes.

Downstream flow of nutrients depends on salmon escapement.- While recognition of the importance of MDN to the freshwater system has increased dramatically in recent years, little similar attention has been paid to the flow of nutrients downstream from watersheds to estuaries and the nearshore marine environment. Some research has indicated that salmon survival at the early marine stage may be critical to total productivity (e.g., Holtby et al. 1990, Pearcy 1992), but very little is known about the relative importance of nutrients and organic materials being washed downstream in the flow of rivers, or how those nutrients are translated into salmon growth and survival. Importantly, there is no documentation of the relative contributions of carcass-derived versus watershed-derived nutrients in the contributions of river discharges to estuaries. If reduced escapements have limited the contributions of MDN to watersheds, then it follows that downstream transport of nutrients could also be curtailed, to the detriment of estuarine and nearshore production and related salmon growth and survival.

The downstream flow of certain organic chemicals, such as nitrite, nitrate, and ammonia, may be directly related to the number of spawners upstream of the sampling point (Brickell and Goering 1970). Such variables may hold promise as surrogates for expensive salmon escapement estimation techniques. However, practical application of the techniques for estimating escapement from water chemistry will require extensive evaluation and refinement. Dissolved nutrients can currently be sampled periodically by hand with samples returned to a lab for analysis. Ideally, however, a method for continuous, automated sampling of a variable that reliably reflects escapement could be developed. Before significant progress can be made in this area, however, refined techniques for assessing the downstream transport of nutrients, and the relationship to salmon biomass moving upstream, are required.

B. Relevance to GEM Program Goals and Scientific Priorities

The state of the science supporting the GEM Program Document and the GEM Science Plan recognizes that "Ocean and coastal currents… ..influence biological production in coastal watersheds by controlling availability and long-term average rate of delivery of marine nutrients and carbon to watershed flora and fauna and by controlling availability of nutrients and food in the marine habitats frequented by watershed species." However, little is known about the fundamental mechanics of the nutrient pathways, relative importance of ecosystem components and vectors of nutrient flow, or the degree to which each component varies over time or space. Improved knowledge of these intricacies will greatly aid in the development of a GEM watershed and nearshore nutrient monitoring protocol.

We have designed research that, by collaborating with several existing studies, will leverage the EVOS funding into an effective research project that will meet the stated objectives. We will conduct research on 1) available approaches to measuring marine-related responses of biological production, such as marine isotopes of the elements carbon, nitrogen and sulfur, 2) the degree to which such isotopic elements would be useful as indicators of marine linkages and their possible variation in various types of watersheds, 3) possible proxy indicators of isotopes, such as nitrates and ammonium, as well as other possible suitable proxies for marine-related indicators, 4) the effects of essential auxiliary information, such as escapement estimates of anadromous species and seasonal runoff, to determine how they influence isotopic measurements and their utility as bio-indicators, 5) the variability of marine-related indicators in bodily tissues among species within watersheds 6) which species or species guilds are best suited to measuring marine linkages and 7) the variability in suitable species among contrasting types of watersheds. Lastly, we will make recommendations for a) continued research to support monitoring decision-making and b) creating a GEM marine nutrient-related monitoring program that utilizes an existing water quality sampling program.

This research is expected to significantly advance the science of marine-derived nutrient cycles in watersheds and estuaries as recommended by Cederholm et al. (1999), Gende et al. (2002), Knudsen (2002), and Knudsen et al. (2003). In addition to setting the stage for a GEM monitoring program, this research will begin the process of collecting sufficient data essential for exploring the MDN and salmon production link (Knudsen and Kline 2003). Advancements in the salmon-nutrient link science will benefit state, federal, and native fisheries managers, as well as subsistence, commercial, and recreational harvesters.

II. PROJECT DESIGN

A. Objectives

We propose to invoke a three- year program to identify, evaluate, and implement statistically rigorous sampling strategies for detecting marine signals from plants and animals in watersheds and nearby nearshore areas. We will establish the degree of annual variation in levels of carbon, nitrogen and sulfur isotopes common in the marine environment, as measured in the tissues of plants and animals in watersheds. We will also explore the possible utility of standing stock and nutrient measurements as indicator variables to relate to marine contributions.

The general research hypothesis is that **biological productivity and abundance of plants and animals in watersheds and nearshore areas are dependent on available nutrients that are variably controlled by geophysical, chemical, and biological processes, including nutrients supplied through salmon carcasses**. There are numerous specific hypotheses that could be tested and evaluated to address the overall hypothesis. In the context of the GEM Invitation for Proposals, however, we present the following objectives and their associated primary, testable hypotheses:

Objective 1. Learn which measures of biological productivity or nutrients are useful as indicator variables of the broader array of watershed and estuarine productivity variables, and how those measures vary in time and space.
H1a: Nutrients and isotopic ratios measured at key points in watersheds and estuaries vary with season and with each other.
H1b: Biologically available N, C, and P; 15N/14N, 13C/12C, and 34S/32S ratios, and salmon escapement (all corrected for stream discharge) are all correlated with each other.
H1c: The relative contributions of locally derived, watershed-derived, and carcass-derived production are detectable in estuarine biota.
H1d: All test species are equally useful as indicators of marine-derived nutrient contribution to ecosystems.
H1e: There is a relationship between single, monthly water nutrient samples and continuously recorded nutrient variables.

Objective 2. Determine how biological productivity of stream, riparian, and estuarine systems varies with the total watershed-derived and marine-derived nutrients supplied to each habitat type.
H2a: The standing stock or growth rates of juvenile fish, riparian vegetation, macroalgae, periphyton and estuarine invertebrates depend on different availability of C, N, and P, varying salmon escapements, or differing 15N/14N, 13C/12C, and 34S/32S ratios.

Objective 3. Determine the relative contribution of watershed-derived and marine-derived nutrients to the total productivity and how the relative contributions depend on watershed characteristics and the extent of salmon escapement.
H3a: Biologically available N, C, and P (or their relative proportions) depend on the biomass delivered in salmon escapement (corrected for stream discharge).
H3b: The 15N/14N, 13C/12C, and 34S/32S ratios in juvenile fish, periphyton, and invertebrates, depend on salmon escapement (corrected for stream discharge).
H3c: There is a relationship between continuously recorded nutrient variables and the ratio of MDN in monthly periphyton samples throughout a stream course.
H3d: There is a relationship between continuously recorded nutrient variables and salmon escapement patterns.

B. Procedural and Scientific Methods

Experimental design.- Extensive experience suggests that sampling design is critical for successfully employing SIA techniques to assess MDN (Kline 1991, Kline et al. 1990, Kline et al. 1993, Kline et al. 1997, Kline 2003). Design elements include the time and place as well as the specific organisms to be sampled for SIA. Included within an effective sampling design would be controls, the watersheds upstream of salmon (or other) influence(s) (e.g., Kline et al. 1990). Sampling will address temporal and spatial isotopic variability as well as trophic and pathway isotope effects. Temporal variability will be addressed by sampling at various times in relation to salmon migration pattern. Spatial variability considerations include species composition of potential MDN contributors (salmon, eulachon, birds) as well as potential resident and transient MDN benefactor species (because these are not the same in every watershed), spawning density (Kline et al. 1993), and effects due to differences in geographical settings (e.g., Kline 2003). Therefore two proximal watersheds will be compared. Using multiple SIA ($\delta^{15}N$, $\delta^{13}C$, and $\delta^{34}S$) will address pathways, whereas dual $\delta^{13}C$ and $\delta^{15}N$ SIA will address trophic effects as discussed above. To meet these requirements, material to be collected will include several types of organisms over space and time. We will also assess certain nutrient and biomass variables in relation to salmon escapement.

To help leverage GEM funding into a more effective project, the experimental design will be integrated with three existing projects.

Principal Investigators	Project Title	Funding Source
M.A. Bishop and S. P. Powers	Trophic dynamics of intertidal soft-sediment communities: interaction between bottom-up & top-down processes	GEM
M.A. Bishop and S. P. Powers	Ecology of the Copper River Delta: fish and invertebrate collections	OSRI

M.A. Bishop, S.P. Powers and G.H. Reeves	Estuaries as essential fish habitat for salmonids: Assessing residence time and habitat use of coho and sockeye salmon in Alaska estuaries	NPRB

None of these projects are assessing MDN but they will all benefit from it. The nutrient and organism data being collected in these projects will complement SIA while the sampling logistics will significantly reduce SIA sampling costs in this proposal. The combination of SIA data with those being collected by the other projects will provide a synergistic effect not otherwise possible. These other projects, however, are not sampling the middle reaches of the CRD watersheds. Therefore, we will collect additional samples to supplement those from the other projects so as to have an upstream-downstream sample continuum for each major stream. Supplemental sampling and analyses will be made for the same suite of nutrients of these other projects. The resulting nutrient data set will therefore be comparable to that of earlier studies (e.g., Brickell and Goering 1970).

The NPRB-funded salmon residence project will furnish 120 (60 juvenile sockeye, 60 juvenile coho) salmon samples per year for which residence time will be determined using otolith microchemistry. We will conduct SIA on the same fish. Integrating MDN and residence time aspects has not previously been attempted. The NPRB project will also supply 30 adult coho and 30 adult sockeye. We will conduct SIA on these to establish the MDN signature for all 3 isotopes. Recent data suggest that stable isotope signatures of marine organic materials vary in time, thus it is inappropriate to use published values (Schell 2001, Kline unpublished data).

Field and Lab Procedures.- Most of the hypotheses under the three objectives presented above can be met through a systematic sampling scheme on the same two experimental watersheds and their estuaries. The watersheds include two being sampled for the OSRI and NPRB research; the variables to be measured and the total numbers of samples of each type at each location are listed below.

Stream	**Hartney Creek**	**Alaganik Slough**	Total samples
Stable isotope analysis			
Salmon C, N, S	60	60	120
Peri C, N, S	42	42	84
Inv C, N, S	35	35	70
Juvenile Halibut	35	35	70
MDN sources (adult fish)	30	30	60
Biomass sampling			
Riparian vegetation	15	15	75
Macroalgae	15	15	75
Benthic invertebrates	15	15	75
Periphyton	15	15	75
Water nutrient sampling			
P, Nitrate, Tot N, NH4, TOC, DOC, DIC	84	84	168

Because there likely is a seasonal difference in relative proportions of watershed-derived, salmon-derived, and/or estuarine production and density/biomass among various estuarine species (see Goering et al. 1990), we will sample monthly in April-October, 2004-2005. At least two years of sampling are essential for initially examining interannual variation and/or for replication.

Samples will be collected at each stream, partly according to the OSRI and NPRB protocols (Bishop and Powers 2002, Bishop et al. 2002), from six stations ranging along the stream course, including one near the stream "mouth" and one in the estuary. The upper stations in a given watershed are salmon-free, so will serve as controls in that watershed.

Primary producers. – Periphyton will be collected on standardized periphyton collectors from the sample reaches in the three watersheds. Because periphyton is expected to show the greatest sensitivity to temporal and spatial variation, we will use standardized techniques (Mathisen 1972, Kline 1991) to compare relative productivity response among streams, reaches, and seasons. These samples will be used to assess C, N, and S stable isotopes and to estimate the monthly growth of periphyton as an index of productivity. Algal samples collected during the study described in Bishop and Powers (2002) will be used to compare biomass between watersheds having different salmon escapement, C,N, and P signals, and varying isotopic ratios.

Primary consumers. – We will collect invertebrate primary consumers with standardized estuarine 15-cm benthic core samplers at each stream mouth, following the methods of Bishop and Powers (2002). The density and biomass of organisms by major taxa will be estimated for productivity estimates. Ideally, for consistency, we will analyze MDN ratios in the same primary consumers at all sites. However, invertebrate consumer diversity and abundance will vary among sites. Therefore, we will analyze MDN in benthic invertebrates (such as copepods, mysids, and bivalve mollusks) as found at each site. We will conduct MDN analysis on 70 individuals per year.

Secondary consumers.- Juvenile fishes show the most rapid response to changing isotope signature of prey (Hesslein et al. 1993, Kline 1999, Kline and Willette 2002). Downstream migrating juvenile coho and sockeye salmon will be collected in each study stream, using a screw trap or fyke net as described in Bishop et al. (2002). They will be subjected to SIA to determine their uptake of MDN, relative to other nutrient sources. Age, condition factor, and growth estimates will be related to the relative MDN ratios. These sampled fish will also be studied for freshwater and estuarine residence time (Bishop et al. 2002) and their MDN ratios will be related to residence time. Juvenile halibut will be collected from the estuarine sampling stations each month (up to 70 samples per year) for SIA analysis. Detection of seasonal changes via SIA should help to resolve input timing effects of MDN.

MDN sources (adult salmon).– Adult salmon carcasses will be collected from the spawning areas of each watershed. At least ten individuals of each spawning species, up to 30 for each watershed, will be collected for SIA to estimate MDN baseline.

Water nutrient measures.- Water nutrient variables (Table 3) will be measured monthly at each sampling location, following the Methods described in Bishop and Powers (2002).

Additionally, we will deploy a continuous water sampling recorder in the mid-reach of each study watershed. The continuous data will be related first to the spot data to determine whether spot data sufficiently represents nutrient variations. Secondly, we will relate the continuous data to salmon escapement patterns to elucidate the possibility of using nutrient data for monitoring salmon escapement.

Adult salmon enumeration.- Alaska Department of Fish and Game currently conducts spawner surveys on the study streams. However, the accuracy of those surveys are insufficient to estimate the biomass of escapement (the primary independent variable in this research). Therefore, we will work cooperatively with ADF&G to design and implement salmon escapement enumeration most appropriate for each stream. Standard techniques, such as weirs and/or mark and recapture experiments, will be implemented on each of the study streams. The population estimates will be multiplied by the average fish weight to obtain the total biomass reaching the stream. Relative distribution of spawners will be used to apportion the total biomass upstream of specific sampling locations.

Stable Isotope Analysis Procedures.- Samples will be frozen (-20 ° C) until freeze-dried. Freeze-dried samples will be ground to a fine powder with a dental amalgamator. Powdered samples will be sent to the University of Waterloo for analysis (Dr. Robert J. Drimmie). A single triplex mass spectrometric analysis will generate the $\delta^{34}S/\delta^{33}S$, $\delta^{15}N/\delta^{14}N$, and $\delta^{13}C^{/12}C$ and $^{15}N/^{14}N$ ratios expressed in standard delta units, $\delta^{34}S$, $\delta^{13}C$ and $\delta^{15}N$, respectively, and %S, %C, and %N. The delta notation used to express stable isotope ratios is reported as the per mil (‰) deviation relative to an international standard, air for nitrogen, and Vienna Peedee belemnite (VPDB) for carbon. By definition, the isotope standards have delta values of zero, i.e. $\delta^{15}N = 0$ ‰ for atmospheric N_2. The %C and %N data are used to calculate C/N atom ratios. Data used for analysis consists of mean $\delta^{13}C$, $\delta^{15}N$, and C/N of the duplicate (for halibut, possibly more for copepods according to individual size) determinations. The C/N atom ratio is used for lipid normalization (McConnaughey and McRoy 1979). Mass spectrometric analysis quality assurance protocol consists of running laboratory standards before and after groups of five "unknowns" and duplicate analyses of each sample when ever possible. Samples are run again when duplicate analyses differ by more than 0.6 ‰.

Isotope mixing models.- Isotope mixing models, which explicitly address the pathway, DP versus RP, and trophic level issues, will be used to interpret stable isotope data enabling assessment of percent of salmon-derived nutrients within a given biological sample (Kline 1991). These models are shown graphically in Figures 1 and 2. Generic isotopic mixing models available as Microscoft Excel spreadsheets: http://www.epa.gov/wed/pages/models/isoconc/isoconc1_01.xls and http://www.epa.gov/wed/pages/models/isotopes/isoerror1_04.xls, will be adopted for computational purposes. These computational spreadsheets incorporate effects of differing elemental composition among the alternate sources being modeled and assessment of data variability (Philips 2001, Philips and Greg 2001, Phillips and Koch 2002, Phillips and Greg 2003). Accordingly, there are specific data requirements that need to be met by the sampling design. Requirements include adequate sampling in order to reduce standard errors, not only of the samples for which one wants to estimate MDN, but also samples of the major nutrient sources (i.e., salmon etc.).

C. Data Analysis and Statistical Methods

Each testable hypothesis can be stated as a statistical model. We summarize our proposed analysis by indicating which statistical model will be used to evaluate the data under each hypothesis.

Hypotheses	Statistical model	Data required
H1a	ANOVA	Monthly nutrient samples, periphyton SIA data
H1b	Correlation	N, C, and P; SIA ratios, and salmon escapement
H1c	Chi-square	SIA ratio data from all estuarine samples
H1d	ANOVA	SIA data, by species, month, and location
H1e	Regression	Monthly nutrient samples and corresponding data from continuously collected nutrient data.
H2a	MANOVA	Macroalgae, periphyton, riparian vegetation, standing stock, fish condition factors, nutrient data, SIA data, and salmon escapement
H3a	ANOVA	Monthly nutrient data and salmon escapement
H3b	ANOVA	SIA data and salmon escapement
H3c	Regression	Continuously recorded nutrient data and SIA data
H3d	Regression	Continuously recorded nutrient data and salmon escapement

All statistical significance will be determined at $P = 0.05$. Additionally, variation within and among SIA and nutrient samples, and among variables, will be evaluated by comparisons of coefficients of variation to determine which variables will be candidates for future GEM watershed and nearshore nutrient monitoring. Power analysis will be conducted on all data to determine the level of observations required to detect differences at given alpha levels. This information will guide future sampling for refining GEM monitoring variables.

D. Description of Study Area

All sampling will be conducted in Hartney Creek and Alaganik Slough, and their respective estuaries, near Cordova, Alaska. Both watersheds are accessible by road but work will require hiking and/or boats to access sample sites. The approximate Northwest corner of the rectangular study area is at 60.4978-145.9297 and the southeast corner is 60.2689-145.0556.

E. Coordination and Collaboration with Other Efforts

The proposed GEM project funding will be used for stable isotope sample field, preparation, and lab processing and scientific analysis of that data by T. Kline. By collaborating with three other previously funded projects, as listed above, we will obtain most of the other variables listed in the objectives. Salmon enumeration will be conducted in cooperation with ADF&G staff in Cordova. Ongoing GEM Nearshore Habitat research will benefit from the outcomes of this research because we will link nutrient flow from watersheds into the nearshore areas.

The specific hypotheses tested in this proposed research will compliment ongoing research in several other South Central watersheds, such as the Kenai River watershed studies, led by Dr, Asit Muzumder, and the Kenai Peninsula Lowland Studies, led by Dr. Coowe Walker. Unique advancements proposed here include 1) tracking MDN and other nutrients flowing from headwaters into and including estuaries, 2) differentiating among watershed derived, marine-derived, and estuarine-generated production in nearshore organisms, 3) using the $\delta^{34}S/\delta^{33}S$ stable isotope ratios as a third MDN indicator, 4) directly connecting salmon escapements to MDN and other nutrient variables, and 5) relationship of MDN signals in juvenile salmonids to their residence time. The results of our in-depth research on small streams should help to steer developing research in the other, more complex systems.

III. SCHEDULE

A. Project Milestones

Objective 1. Collect field samples for monthly and continuous nutrient data, SIA, standing stock, and salmon escapement.
To be met by November 2005
Complete lab processing of all SIA samples.
To be met by March 2006
Complete statistical comparison of all productivity and nutrient variables.
To be met by June 2006

Objective 2. Complete collection of salmon escapement data on the two study streams
To be met by January 2006
Analyze the relationships among variables.
To be met by March 2006.

Objective 3. Complete statistical analyses of the relationships between salmon escapement and other potential GEM watershed and nearshore monitoring variables.
To be met by April 2006

B. Measurable Project Tasks

FY 04, 1st quarter (October 1, 2003-December 31, 2003)
October: Project funding approved by Trustee Council
FY 04, 2nd quarter (January 1, 2004-March 31, 2004)
January 12-16 (tentative): Annual GEM Workshop
March 31: Purchase and prepare all equipment
FY 04, 3rd quarter (April 1, 2004-June 30, 2004)
April 15: Begin monthly nutrient sampling and establish continuous monitoring sites
Begin SIA sample processing
FY 04, 4th quarter (July 1, 2004-September 30, 2004)
September 1: Continue field sampling
FY 05, 1st quarter (October 1, 2004-December 31, 2004)
October 31: Finish first season of field sampling
FY 05, 2nd quarter (January 1, 2005-March 31, 2005)
(dates not yet known) Annual GEM Workshop

FY 05, 3rd quarter (April 1, 2005-June 30, 2005)
April 15 Begin second year field sampling
FY 05 4th quarter (July 1, 2005 -September 30, 2005)
September 1: Continue field sampling
FY 06, 1st quarter (October 1, 2005-December 31, 2005)
October 31: Finish second season of field sampling
FY 06, 2nd quarter (January 1, 2006-March 31, 2006)
(dates not yet known) Annual GEM Workshop
FY 06, 3rd quarter (April 1, 2006-June 30, 2006)
April 15: Complete all SIA sample processing
June 30: Complete all statistical analysis
FY 06 4th quarter (July 1, 2005 -September 30, 2005)
September 1: Submit final report (which will consist of draft manuscript for publication) to Trustee Council Office

IV. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

During the course of this project, efforts wil be made through traditional ecological knowledge (TEK) to develop an understanding of the historic degree of salmon escapement, so that we may generalize about expectations of nutrient flow and productivity expectations under possibly different nutrient inputs to the systems. When the research is completed, we will provide posters at local public forums, as well as publications in the popular and scientific literature.

B. Resource Management Applications

This proposal is directly addresses the GEM Invitation proposals and meets the GEM goal to “solve”, as defined in the GEM Program Document as development of tools, technologies and information that can help resource managers and regulators improve management of marine resources and address problems that may arise from human activities. This initial research sets the stage for 1) establishing appropriate variables GEM monitoring of watershed and nearshore nutrients, and 2) begins important research to establish the relationships between salmon escapement levels, nutrient measures that will ultimately help to define expectations for maximizing future salmon production. This latter element is critical to ADF&G, USFWS, Native Organizations, and all salmon harvesters, because of their interests in sustainable and productive salmon fisheries (see Knudsen 2002, Knudsen and Kline 2002).

V. PUBLICATIONS AND REPORTS

All results will be reported in annual and final reports to the Trustee Council. We will also publish results in the scientific literature.

VI. PROFESSIONAL CONFERENCES

We are requesting funding to support travel for T. Kline to travel to professional conferences (in addition to the annual GEM workshop), in years two and three. The venues are yet to be determined, but will likely be at the national or international level, given the innovative nature of the proposed research.

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Education:
Bachelor of Science, Fisheries Science, University of Massachusetts, Amherst - 1974
Master of Science, Fisheries Science, Louisiana State University, Baton Rouge - 1976
Doctor of Philosophy, Wildlife and Fisheries Science, Louisiana State University, Baton Rouge - 1990

Relevant Research Experience:

Dr. Knudsen has 16 years of fisheries research experience at LSU and with the USGS in Anchorage, as well as over 12 years experience with restoration and management of Pacific salmon stocks, primarily in the Puget Sound and coastal Washington areas. He became Fisheries Research Team Leader at the Alaska Biological Science Center in 1994 where he specialized in Pacific salmon ecology. In 1998, he became one of two Branch Chiefs; he supervises fourteen senior scientists engaged in a wide diversity of fish and wildlife research in Alaska.

Dr Knudsen's current research projects include: 1) Investigations to advance biologically based salmon stock assessment methods, 2) Determining the scale at which stock discrimination is biologically important in Pacific salmon management, 3) Integrated marine science of Glacier Bay, Alaska, with particular emphasis on testing hypotheses about the effectiveness of marine reserves on fisheries populations.4) Southwest Alaska rainbow trout movement patterns and population structure, and 5) Biological colonization of streams recently uncovered during glacial recession in Glacier Bay, Alaska.

Affiliations:
Current Past President of the Western Division of the American Fisheries Society
Member, EVOS STAC Habitat Subcommittee

Peer-reviewed publications

Meka, J., E. E. Knudsen, D.C. Douglas, and R.E. Benter. In Press. Variable migratory patterns of different rainbow trout life history types in a southwest Alaska watershed. Transactions of the American Fisheries Society.

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Two-Page Curriculum Vitae **THOMAS CLAYTON KLINE, JR.** January, 2003

Education

1991	Ph.D. in Oceanography, University of Alaska, Fairbanks AK 99775
1983	M.S. in Fisheries, University of Washington, Seattle WA 98195
1979	B.S. in Fisheries, University of Washington, Seattle WA 98195
1976	B.S. in Oceanography, University of Washington, Seattle WA 98195
1972-74	Coursework at Sophia University, Tokyo

Research Accomplishments

- Provided the first direct evidence of the role of salmon carcass-derived nutrients in freshwater ecosystems
- Developed a stable isotope technique for quantifying the role of salmon-derived nutrients in freshwater ecosystems
- Developed a stable isotope technique for monitoring fish migration on the North Slope of Alaska
- Developed a stable isotope technique that provided the first line of evidence that carbon derived in the Gulf of Alaska plays a significant role in Prince William Sound food webs
- Determined that there can be large inter-annual variation in pelagic stable isotopic signatures

Professional Experience

1994-2003	Research Scientist, Prince William Sound Science Center
1995-2003	Director andDiving Safety Officer, Prince William Sound Science Center Scientific Diving Program
1992-93	Instructor, University of Alaska Fairbanks
1991-94	Postdoctoral Fellow, University of Alaska Fairbanks
1985-91	Research Assistant, University of Alaska Fairbanks
1984-85	Teaching Assistant, University of Washington
1977-83	Research Assistant, University of Washington

Five Project-Related Research Papers

2002. Kline, T.C., Jr. Implications of Trophic Level when Assessing the Role of Salmon-Derived Nutrients for Lacustrine Juvenile Sockeye Salmon Ecology using the Natural Abundance of $^{15}N/^{14}N$. *In:* J. Stockner (ed.). Restoring Nutrients to Salmonid Ecosystems. American Fisheries Society, Bethesda. IN PRESS

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1991. Kline, T.C., Jr. The significance of marine-derived biogenic nitrogen in anadromous Pacific salmon freshwater food webs. Ph.D. Thesis, University of Alaska Fairbanks, Fairbanks, Alaska, 114pp.

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Five Other Research Papers

2002. Kline, T.C. Jr. and T.M. Willette. Pacific salmon (*Oncorhynchus*) early marine feeding patterns based on $^{15}N/^{14}N$ and $^{13}C/^{12}C$ in Prince William Sound, Alaska. Can. J. Fish. Aquat. Sci. 59: 1626–1638.

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1998. Kline, T.C., Jr., William J. Wilson, and John J. Goering. Natural isotope indicators of fish migration at Prudhoe Bay, Alaska. Can. J. Fish. Aquat. Sci. 55:1494-1502.

Recent Collaborators

Kelley, J., Coyle, K., Cooney, R., Hopcroft, R., McRoy, C., Paul, A., Norcross, B., Stokesbury, K., Wang, J., Weingartner, T., Whitledge, T. (Univ. Alaska Fairbanks); Vaughan, S., Patrick, V., Thomas, G. (P.W.S. Science Center); Willette, M., Schmidt, D (Alaska Dept. Fish and Game); Falkenberg, C. (Univ. Maryland); Mooers, C., (Univ. Miami); Eslinger, D., Mason, D. (NOAA); Bishop, M. (U.S. Forest Service); Cheng, L. (Univ. Calif. San Diego); Oakey, T., Pauly, D. (Univ. British Columbia)

Graduate and Post-Graduate Advisors

Chew, K. (M.S., Univ. Washington), Goering, J. (Ph. D., Univ. Alaska Fairbanks), Kelley, J. (Post-doctoral, Univ. Alaska Fairbanks)

CURRENT AND PENDING SUPPORT FORM

The following information must be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: E. Eric Knudsen	Other agencies to which this proposal has been/will be submitted: NA

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: I have no current support for research of this type

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Months of Your Time Committed to the Project: FY 05 FY 06 Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Months of Your Time Committed to the Project: FY FY 05 FY 06 Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Months of Your Time Committed to the Project: FY FY 06 Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Months of Your Time Committed to the Project: FY FY 05 FY 06 Sumr:

*If this project has previously been funded by another entity, please list and furnish information for immediately preceding funding period.

Budget Justification

All requested funding will be passed through USGS to the Prince William Sound Science Center. USGS, Alaska Science Center will contribute up to $20,000 of funding to the project to support salmon enumeration. Data collected during the OSRI-, NPRB- and GEM-funded projects will also contribute to this proposed research, up to and estimated $100,000 per year for FY 04 and 05.

Of the funds transferred to PWSSC, they allocation is as follows.

FY 04

Personnel $57,209.40 –Supports T. Kline and a technician
Travel $888.0 – Supports T. Kline to travel to EVOS workshop
Contractual $33,572.00 – First batch of stable isotope lab processing
Commodities $19,890.00 – Periphyton samples, microscope, continuous water quality samplers, lab supplies, field sampling gear
Equipment $0.00

FY 05

Personnel $95,832.90 - Supports T. Kline and a technician
Travel $4,001.30 - Supports T. Kline to travel to EVOS workshop and to one professional meeting
Contractual $13,140.00 - Second batch of stable isotope lab processing
Commodities $14,890.00 – periphyton collectors**,** lab supplies, field sampling gear
Equipment $0.00

FY 06

Personnel $68,171.10 - Supports T. Kline and a technician
Travel $4,100.90 - Supports T. Kline to travel to EVOS workshop and to one professional meeting
Contractual $32,987.00 – Last batch of stable isotope lab processing
Commodities $5,000 – Lab and computer supplies
Equipment $0.00

PWSSC charges 26% overhead on all other direct charges.

Data Management and Quality Assurance /Quality Control Statement

The characteristics of metadata management have been entered to Metalite at http://edcnts11.cr.usgs.gov/metalite/download.html under the name Knudsen-Kline. All data collected in the field will be reviewed by the field technicians as soon as it is collected. Principal Investigators will also review the data as soon as it is recovered. Double copies of field data will be made and stored as soon as possible.

The variables to be collected are:

Stream	**Hartney Creek**	**Alaganik Slough**	Total samples
Stable isotope analysis			
Salmon C, N, S	60	60	120
Peri C, N, S	42	42	84
Inv C, N, S	35	35	70
Juvenile Halibut	35	35	70
MDN sources (adult fish)	30	30	60
Biomass sampling			
Riparian vegetation	15	15	75
Macroalgae	15	15	75
Benthic invertebrates	15	15	75
Periphyton	15	15	75
Water nutrient sampling			
P, Nitrate, Tot N, NH4, TOC, DOC, DIC	84	84	168

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

PROJECT TITLE: _ Research for nutrient-based resource management in watersheds and estuaries

Printed Name of PI: __E. Eric Knudsen________

Signature of PI: ______________________________ Date __________

Printed Name of co-PI: ____

Signature of co-PI: ______________________________ Date __________

Printed Name of co-PI: ____

Signature of co-PI: ______________________________ Date __________

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

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

GEM POSSIBLE PEER REVIEWERS FORM

Provide the names and contact information for 3 persons qualified to review your proposal, and identify each persons' area(s) of professional expertise from the classification list available at www.oilspill.state.ak.us/nonpdf_docs/invitation/classification_form.xls. These persons must not be current co-workers or collaborators of the proposer(s), major former professors of the proposer(s), or former graduate students of the proposer(s).

PROJECT TITLE: Research for nutrient-based resource management in watersheds and estuaries

1st Name: Montoya, Joseph

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Area(s) of Expertise: Stable Isotopes

2nd Name: Cederholm, Jeff

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Washington Department of Natural Resources
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Olympia, WA 98504-7014
Tel. (360) 902-1609
E-mail: jeff.cederholm@wadnr.gov

Area(s) of Expertise: Salmon and nutrient relationships

3rd Name: Fry, Brian

Contact Information:
Coastal Ecology Institute
Louisiana State University
219 Coastal Studies Building, Baton Rouge, LA 70805-7503
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Fax. 225 578-6326
E-mail: bfry@lsu.edu

Area(s) of Expertise: Stable Isotopes

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Budget Category:	Proposed FY 04	Proposed FY 05	Proposed FY 06		TOTAL PROPOSED
Personnel	$0.0	$0.0	$0.0		$0.0
Travel	$0.0	$0.0	$0.0		$0.0
Contractual	$140,564.9	$162,387.4	$140,029.0		$442,981.3
Commodities	$0.0	$0.0	$0.0		$0.0
Equipment	$0.0	$0.0	$0.0		$0.0
Subtotal	$140,564.9	$162,387.4	$140,029.0		$442,981.3
General Administration (9% of subtotal)	$12,650.8	$14,614.9	$12,602.6		$39,868.3
Project Total	$153,215.7	$177,002.3	$152,631.6		$482,849.6

PWSSC -- Sampling during other OSRI-, NBPRB- and GEM-funded projects, that will supply data to be included as variables in the proposed research is estimated to have a value of approximately $100,000 over the first two years of this project.

USGS-ASC will contribute $20,000 per year to support salmon enumeration in the first two years and data analysis and report preparation in the third year.

FY 04-06

Date Prepared:

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency: USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Personnel Costs: Name	Description	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY 04

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency:

FORM 3B
Personnel
& Travel
DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Contractual Costs:	Contractual Sum
Description	
PWSSC - Contract for T. Kline	140,564.9
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$140,564.9

Commodities Costs:	Commodities Sum
Description	
Commodities Total	$0.0

FY 04

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency:

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY 04

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency:

FORM 3B
Equipment
DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Description	Step	Budgeted	Costs	Overtime	Sum
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY 05

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency:

FORM 3B
Personnel
& Travel
DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Contractual Costs:	Contractual
Description	Sum
4A Linkage	162,387.4
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$162,387.4

Commodities Costs:	Commodities
Description	Sum
Commodities Total	$0.0

FY 05

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency:

FORM 3B
Contractual &
Commodities
DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY 05

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency:

FORM 3B
Equipment
DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Description	Step	Budgeted	Costs	Overtime	Sum
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY 06

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency:

FORM 3B
Personnel
& Travel
DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Contractual Costs:	Contractual
Description	Sum
4A Linkage	140,029.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$140,029.0

Commodities Costs:	Commodities
Description	Sum
Commodities Total	$0.0

FY 06

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency:

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description		Number of Units	Unit Price	Equipment Sum
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
			New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY 06

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Agency:

FORM 3B
Equipment
DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Budget Category:	Proposed FY 04	Proposed FY 05	Proposed FY 06		TOTAL PROPOSED
Personnel	$57,209.4	$95,832.9	$68,171.1		$221,213.4
Travel	$888.0	$4,001.3	$4,100.9		$8,990.2
Contractual	$33,572.0	$13,140.0	$32,987.0		$79,699.0
Commodities	$19,890.0	$14,890.0	$5,000.0		$39,780.0
Equipment	$0.0	$0.0	$0.0		$0.0
Subtotal	$111,559.4	$127,864.2	$110,259.0		$349,682.6
Indirect (rate will vary by contractor)	$29,005.5	$34,523.2	$29,770.0		$93,298.7
Project Total	$140,564.9	$162,387.4	$140,029.0		$442,981.3

FY 04-06

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Personnel Costs:				Months	Monthly		Personnel
	Name	Description		Budgeted	Costs	Overtime	Sum
	T. Kline	P.I.		3.0	9914.8	0.0	29,744.4
	TBN	Tech.		6.0	4577.5	0.0	27,465.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		9.0	14492.3	0.0	
						Personnel Total	$57,209.4

Travel Costs:		Ticket	Round	Total	Daily	Travel
	Description	Price	Trips	Days	Per Diem	Sum
	EVOS review meeting	300.0	1	3	196.0	888.0
	International meeting	1300.0	0	0	196.0	0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$888.0

FY 04

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Contractual Costs:	Contractual
Description	Sum
Page charges	0.0
Photocopying	200.0
Computer lease	0.0
PWSSC network charge	1,500.0
WWW support	0.0
Stable isotope analytical (duplex)	0.0
Stable isotope analytical (triplex)	29,925.0
Stable isotope analytical (sulfate)	297.0
Freeze drier user fee	1,050.0
Shipping	100.0
Communications (fax and phone)	500.0
Contractual Total	$33,572.0

Commodities Costs:	Commodities
Description	Sum
Wildco Periphyton Collectors WPC	7,090.0
WPC replacement trays and slides	2,800.0
Lab supplies, misc.	1,000.0
Vials, chemicals, grinder blades	2,000.0
Office supplies, misc.	500.0
Computer supplies and upgrades	1,000.0
Continuous water quality sampler	5,000.0
Dyesub./photo	500.0
Commodities Total	$19,890.0

FY 04

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units
Microscope	1

FY 04

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Personnel Costs:			Months	Monthly		Personnel
Name	Description		Budgeted	Costs	Overtime	Sum
T. Kline	P.I.		3.0	10403.5	0.0	31,210.5
TBN	Tech.		12.0	5385.2	0.0	64,622.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		15.0	15788.7	0.0	
					Personnel Total	$95,832.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
EVOS review meeting	350.0	1	4	211.0	1,194.0
International meeting	1450.0	1	7	193.9	2,807.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4,001.3

FY 05

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Contractual Costs:	Contractual
Description	Sum
Page charges	0.0
Photocopying	200.0
Computer lease	0.0
PWSSC network charge	1,600.0
WWW support	0.0
Stable isotope analytical (duplex)	0.0
Stable isotope analytical (triplex)	10,089.0
Stable isotope analytical (sulfate)	297.0
Freeze drier user fee	354.0
Shipping	100.0
Communications (fax and phone)	500.0
Contractual Total	$13,140.0

Commodities Costs:	Commodities
Description	Sum
Wildco Periphyton Collectors WPC	7,090.0
WPC replacement trays and slides	2,800.0
Lab supplies, misc.	1,000.0
Vials, chemicals, grinder blades	2,000.0
Office supplies, misc.	500.0
Computer supplies and upgrades	1,000.0
Continuous water quality sampler	0.0
Dyesub./photo	500.0
Commodities Total	$14,890.0

FY 05

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	
Microscope	1	

FY 05

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 04 - FY 06

Personnel Costs:			Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Name	Description					
T. Kline	P.I.		3.0	10876.1	0.0	32,628.3
TBN	Tech.		6.0	5923.8	0.0	35,542.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		9.0	16799.9	0.0	
					Personnel Total	$68,171.1

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Description					
Collaborative workshop with pollock research group	350.0	0	0	211.0	0.0
EVOS review meeting	350.0	1	4	210.9	1,193.6
International meeting	1550.0	1	7	193.9	2,907.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4,100.9

FY 06

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

Contractual Costs:	Contractual
Description	Sum
Page charges	0.0
Photocopying	300.0
Computer lease	0.0
PWSSC network charge	1,700.0
WWW support	0.0
Stable isotope analytical (duplex)	0.0
Stable isotope analytical (triplex)	29,070.0
Stable isotope analytical (sulfate)	297.0
Freeze drier user fee	1,020.0
Shipping	100.0
Communications (fax and phone)	500.0
Contractual Total	$32,987.0

Commodities Costs:	Commodities
Description	Sum
Wildco Periphyton Collectors WPC	0.0
WPC replacement trays and slides	0.0
Lab supplies, misc.	1,000.0
Vials, chemicals, grinder blades	2,000.0
Office supplies, misc.	500.0
Computer supplies and upgrades	1,000.0
Continuous water quality sampler	0.0
Dyesub./photo	500.0
Commodities Total	$5,000.0

FY 06

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

EXXON VALDEZ **OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 04 - FY 06

New Equipment Purchases: Description		Number of Units	Unit Price	Equipment Sum
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
Indicate replacement equipment with an R.			**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	
Microscope	1	

FY 06

Project Number:
Project Title: Research for nutrient-based resource management in watersheds and estuaries
Name of Contractor: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL