GEM Proposal Summary Page

Project Title: **Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on Southern Kenai Peninsula, Alaska: Developing Monitoring Tools for Tracking MDN in Alaska Watersheds**

Project Period: November 2003 – December 2006

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Study Area: south Kenai Peninsula, below the Kenai River to Kachemak Bay.

Key words: monitoring, Kenai Peninsula, Alaska, marine derived nutrients, watersheds, streams, riparian, nearshore, salmon, nutrient subsidies, stable isotopes, fatty acids, food webs, productivity

Project Abstract: Marine derived nutrients and carbon (MDN) delivered by salmon and other anadromous fishes are considered important drivers in riverine ecosystems, providing nutrients and food to these land-based food webs. However, we know little about the relative value of MDN compared to other nutrient and carbon sources (e.g., watershed-derived) in the Gulf of Alaska region. The objectives of this study are to develop a water chemistry proxy for monitoring salmon returns, and to track and measure MDN effects in stream, riparian and nearshore environments, on the southern Kenai Peninsula. We will accomplish this by linking stream chemistry, marine isotope signatures, marine:terrestrial fatty acid ratios, and key animal and plant community density, growth, and lipid measures along a gradient from river mouth to headwaters in key watersheds. This study will be integrated with related studies proposed in other areas of southcentral Alaska to develop a broader regional understanding and a widely-applicable long-term monitoring program for the GEM region.

EVOS funding requested: $449,800 over 3 years

Non-EVOS funding to be used:

$14,500.00 EPA watershed nutrient workshop grant

$72,500 USGS stable isotope analysis

$123,000 ADFG weir materials, installation, operational plan, data analysis

The Kachemak Bay Research Reserve will provide lab support for staging, storing and processing samples and equipment, and office support for three staff for the duration of the grant.

Research Plan

Problem addressed by proposal

Salmonid ecosystems throughout the world have experienced serious declines in productivity and diversity in recent history, due in large part to the impacts of human activities, such as over-fishing, habitat destruction and dam building (NRC 1996, Naiman and Bilby 1998). Streams on the Kenai Peninsula remain productive, yet many are subject to increasing pressure from human-induced forces such a watershed development, forestry practices and fishing, in addition to global climate change and natural variability. Marine derived nutrients (MDN), conveyed by adult salmon migrating upstream from oceans to freshwater reaches, are recognized as an ecologically important flux of energy to the productivity of many stream ecosystems, providing food and nutrients to stream and terrestrial food webs (Levy 1997, Gende et al. 2002, Stockner and Ashley 2003).

Several studies in parts of Alaska have shown that salmon derived nutrients play a crucial role in subsidizing the productivity of stream food webs, and riparian and terrestrial plants and animals (Kline et al. 1997, Willson et al. 1998, Wipfli et al. 1998, 2003, Chaloner et al. 2002a, 2002b). Yet, the role of MDN subsidies in freshwater and terrestrial ecosystems has not been studied at the watershed scale. The Kenai Peninsula, supports several ecologically and economically important anadromous fish streams, including the Kenai River on the northern part of the Peninsula and the Anchor River to the south, and is a logical choice for extending knowledge of regional patterns, while providing an excellent opportunity to explore MDN relationships at the watershed scale. The goal of our proposed research is to examine in detail terrestrial and MDN sources to stream, riparian, and nearshore environments on the southern Kenai Peninsula. The streams on the south Peninsula have several distinctive characteristics which set them apart from other streams in southcentral Alaska that could be significant in developing our understanding of the effects of MDN subsidies for the GEM region, especially when combined with proposed research in the Kenai River watershed on the northern Kenai Peninsula, and other systems throughout the region (Asit Mazumder project lead). The Kenai River watershed is a large system supported by glacially fed lakes and is quite different from the smaller, non-glacial, non-lake, peat wetland supported streams typical of the southern Peninsula. The knowledge gained from this study will contribute to a broader regional understanding on the role of MDN in southcentral Alaska by comparing and contrasting this study with those in the Kenai River and other systems. This knowledge will also be useful for developing fisheries and land management strategies, especially in the Cook Inlet region, where the Alaska Department of Fish and Game Sport Fish Division is reviewing current fisheries management practices and is considering using the Anchor River as an indicator watershed (Szarzi, pers. comm.).

Relevance to the GEM program goals and scientific priorities

This project directly addresses the watershed concept described in the GEM Working Draft Science Plan for fiscal years 2003-2007. This concept, which is intended to guide the research and monitoring projects funded through GEM, states that GEM projects should focus on understanding how natural escapement variability of anadromous species affect nutrients and productivity in watersheds, and how watershed-derived nutrients influence nearshore environments. We will specifically address several of the identified watershed research needs including:

1. Determining whether stream nutrients information derived from existing water quality monitoring programs (specifically ammonium [NH_4^+] and soluble reactive phosphorus [SRP]) can be used as suitable proxies for monitoring salmon escapement levels.
2. Understand annual and spatial variation in levels of MDN in key indicator species of riverine food webs through stable isotope and fatty acid analyses.
3. Assess the proportion of riverine food web productivity resulting from MDN subsidies.
4. Understand the transfer of nutrients from watersheds to nearshore environments, and the role of MDN in these environments.

Our study will provide critical and management-relevant information to help build the GEM long-term monitoring watershed program, and will be especially useful in conjunction with other proposed MDN watershed research in the Kenai River and Prince William Sound. The proposed projects will help build our understanding on the utility of nutrient proxies, stable isotopes, and fatty acid ratio-based indicators of MDN, variability of MDN in food web components, and the extent to which MDN subsidizes food web productivity at both watershed and regional scales.

Project Objectives

Conservation of wild salmonid populations has received intense attention during the last ten or so years, principally as a result of dramatic declines and extinctions within the native Pacific Northwest populations. The ecological coupling of freshwater, terrestrial, and marine ecosystems through spawning salmon migrations is not well understood and the long-term effects of salmon declines not known. Improvements in existing monitoring programs to assess salmon populations and implementation of management practices strongly rooted in scientific understanding (i.e. harvest, recruitment, etc.) are critical to preserving remaining salmon stocks and to the ecological integrity of coastal ecosystems. In particular, the development of new and inexpensive alternatives for monitoring salmon escapement have become a high priority.

The influx of spawning salmon into freshwater ecosystems results in a pulse of MDN through excretion and decomposition. Brickell and Goering (1970) showed a close association between ammonium concentrations and the numbers of spawning salmon upstream in freshwater systems, and it is likely that a method could be developed to use levels of MDN as a surrogate for measuring salmon escapement (Knudsen, pers. comm., Wipfli et al. in prep. Mauger pers comm.) This would provide us with an important tool for assessing escapement at various locations along a river network where traditional, expensive fish enumeration methods, such as weirs, sonar counters, and towers, are not available.

Studies in southeastern Alaska have demonstrated that MDN are incorporated into multiple trophic levels in stream-riparian ecosystems (Chaloner et al. 2002), influence the productivity of multiple trophic levels in streams (Wipfli et al. 1998, 1999), and contribute to the growth of resident and anadromous salmon (Wipfli et al. 2003). Stable isotope approaches have provided some of the strongest evidence for incorporation of MDN in freshwater food web components because marine carbon, nitrogen, and sulfur are isotopically heavier relative to terrestrial and freshwater sources. The large isotopic disparities among these nutrient pools provides a novel means of tracing the contribution of MDN entering freshwater ecosystems through salmon spawning returns (Kline et al. 1990, Chaloner et al. 2002). Specifically, stable carbon and nitrogen isotopes represent a powerful approach for resolving source (i.e. food sources) and process (i.e. trophic status) information in the reconstruction of food webs (Peterson and Fry 1987). In principle, this works because carbon and nitrogen isotopes are subject to fractionation along trophic pathways. Fractionation for the latter is the most dramatic, whereby consumer organisms preferentially retain the heavier nitrogen isotope (^{15}N), resulting in an approximate 3-5 per mil (relative to δ -notation) enrichment at each step along the food chain. Consistent nitrogen isotopic enrichment across trophic levels indicates position within the food web. Carbon isotope fractionation, however, is much more subtle, ranging from approximately 1-2 per mil at each consumer step. The relatively minor enrichment along trophic pathways is useful for evaluating carbon sources in food webs. In fact, several studies have illustrated the effectiveness of using such approaches to quantify the extent of MDN incorporation into freshwater food webs (Kline et al. 1990, Bilby et al. 1996, Johnston et al. 1997, Chaloner et al. 2002). We will further exploit the stable isotope-based approach for evaluating MDN subsidies to freshwater and riparian food webs, but extend analyses to capture temporal variability and patterns at watershed (i.e. along river corridors) and regional scales.

The utility of sulfur isotopes in food web studies has received much less attention, although sulfur has been used to understand food web relations in salt marsh ecosystems (Kwak and Zedler 1997). Sulfur isotopes also exhibit a large disparity between marine and freshwater nutrient pools. In particular, sulfur isotopes are unique in that the original signature is largely conserved across consumer trophic levels (i.e. little to no fractionation). The semi-conservative nature greatly adds to the resolving power of sources comprising the base of food webs, particularly when used in conjunction with stable carbon isotopes. The proposed work seeks to integrate the use of stable sulfur isotopes for two reasons. First, to our knowledge there are no data available in which the utility of stable sulfur isotopes have been explored to study interactions between MDN and freshwater and terrestrial food webs. Second, the conservative nature of sulfur isotopes will contribute considerable insight with respect to MDN cycling in riverine ecosystems.

In addition, recent experimental evidence indicates higher fatty acid levels and omega-3 fatty acids (i.e. marine signal) are expressed in stream fishes exposed to MDN (Heintz et al. in press). Increased growth rates, body size and lipid content likely lead to higher salmonid production and survival (Olsen 1998, Wipfli et al. 2003, Heintz et al. in press). Evidence also indicates that the ratio of RNA to DNA may be a valuable indicator of instantaneous growth in fishes, creating the potential to trace the allocation of energy, and hence the effects of MDN in stream food webs. Fluctuations in lipid content generally are the result of fluctuations in the amount of lipid stored as triacylglycerols. There are data that provide evidence for a direct effect of the presence of fish carcasses on the pattern of lipid storage during the year (Gardiner and Geddes 1990), however there are no data describing differences in growth throughout the year. Energy allocation strategies among juvenile salmonids are likely to depend on their developmental stage, with younger fish emphasizing energy storage, and older fish emphasizing growth (Schultz and Conover 1999). It is apparent from these, as well as other recent studies (Reimchen et al. 2003, Jauqet et al. 2003, Nakajima and Ito 2003), that understanding the relative importance of MDN, as well as increasing our understanding of the different pathways for nutrient incorporation into food webs, is crucial for improved fisheries and ecosystem management.

Studies on the effects of MDN in stream and riparian systems have not extended into nearshore ecosystems. These systems may be gaining substantial benefit from nutrient subsidies associated with congregating fish at river mouths, as well as nutrients from fish carcasses exported from upstream. The Alaska Coastal Current (ACC), which dominates the circulation along the Kenai Peninsula, receives significant amounts of freshwater from the many small watersheds that drain into the Gulf of Alaska. Because of the glacial and mountainous origin of this substantial freshwater input, the ACC is relatively nitrate poor (Wiengartner et al. 2001). This creates the potential for watersheds receiving anadromous species to be a significant nutrient source to nearshore environments as MDN are exported from watersheds.

Our goals are to examine 1) the relationship between salmon escapement levels and stream nutrient levels, 2) marine signals in biota, 3) food web responses including surrogates of productivity (fish and macroinvertebrate densities, lipid levels, resident fish survival, diet, and fitness) along a river continuum from mouth to headwaters, and 4) to examine the potential influence of watersheds receiving anadromous fishes on the nearshore environments. We will accomplish these goals by addressing the following objectives and hypotheses:

<u>Objective 1: Determine if a water chemistry proxy (e.g., NH_4^+ or SRP) can be developed as a tool for monitoring salmon and other anadromous fish runs.</u>

Hypotheses:

> $H_{1a:}$ NH_4^+ and SRP concentrations are correlated with salmon escapement levels.
>
> H_{1b}: The stable nitrogen isotopic composition of the dissolved NH_4^+ pool should strongly reflect a marine origin (salmon-derived), exhibiting elevated $\delta^{15}N$ values relative to streams and rivers that receive no MDN subsidizes.
>
> H_{1c}: The stable nitrogen isotopic composition of the dissolved NO_3^- pool will exhibit longitudinal enrichment patterns in a downstream direction as a result of nitrification (microbially-mediated conversion of NH_4^+ to NO_3^-), whereas the residual NH_4^+ pool will become more isotopically enriched from headwaters toward nearshore areas.

Rationale: Accurately estimating salmon escapements is crucial for effective fisheries management throughout Alaska. Weirs, sonar, and towers have been commonly used to detect return levels, but are often prohibitively expensive (Nicky Szarzi pers. comm.). Because of this, estimating salmon escapements is not done for most river systems in Alaska and other places, or is done at very limited scales or for only part of the season (Nicky Szarzi pers. comm.). Based on preliminary research and observations in both southeastern and southcentral Alaska, NH_4^+ and possibly SRP appear to be good possible indicators of the timing and magnitude of salmon returns. These two forms of key nutrients (N and P) naturally occur in watersheds, typically at low concentrations, but are abundant in anadromous fish tissue (or as waste products from returning fishes). Water column concentrations of these two nutrients quickly spike when salmon enter streams (Mauger pers comm., Wipfli et al. in prep). Routine water chemistry methods are available for measuring these chemical forms, and if this technique proves effective and reliable, it could easily be developed as an inexpensive and rapid tool for monitoring anadromous fish returns. Furthermore, isotopic analysis of dissolved inorganic nitrogen pools will help resolve confounding controls over available dissolved nitrate and ammonium pools, such as processes involved in nitrogen cycling (ammonification, denitrification, nitrification). Additionally, these data will provide the first insight into the microbial use of MDN in these systems, especially in the context of longitudinal patterns. Quantifying changes in process rates in response to the influx of salmon-derived nutrients would represent the first step toward understanding the temporal effects on in-stream productivity, particularly with respect to the conservation of the marine signature in freshwater and terrestrial systems (i.e. how long MDN remains after carcass decomposition is complete).

Objective 2: Document the presence of MDN from salmon in watershed components.

Hypotheses:

H_{2a}: Stream and riparian ecosystems with anadromous salmon runs have higher marine signals of C, N, and S ($\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$), than non-anadromous systems.

$H_{2b:}$ Omega-3:omega-6 fatty acid ratios are higher in biota in systems with anadromous salmon runs than in non-anadromous systems.

$H_{2c:}$ Nearshore areas adjacent to anadromous watershed systems have higher levels of nutrients (especially nitrogen) seasonally associated with the salmon runs than non-anadromous systems.

Rationale: Simply because salmon enter streams does not mean their nutrients will be sequestered by receiving food webs, although most evidence so far shows that food webs in Alaska do quickly incorporate these nutrients (Kline et al. 1990, 1997, Chaloner et al. 2002). Existing water chemistry, food web structure, and other physical, chemical, and biological properties of watersheds and ecosystems will dictate if, and the extent to which, food webs sequester marine nutrients (Wipfli et al. 1999). Additionally, in-situ nitrogen cycling may potentially confound interpretations of MDN incorporation into food web components. For instance, nitrification likely becomes an important process during periods corresponding to ammonium pulses (excretion, carcass decomposition). Nitrification results in considerable fractionation that yields isotopically lighter nitrate while leaving the residual ammonium pool progressively enriched in $\delta^{15}N$. Primary producers preferentially take up ammonium over nitrate, yet both forms of inorganic nitrogen are likely simultaneously used for in-stream production (microbial and algal uptake). The net result is that food web components may be heavily subsidized by marine-derived nitrogen; yet not reflect such subsidies in terms of $\delta^{15}N$ values. Further, in-situ nitrogen cycling may be very important at the reach scale, yet little is known about longitudinal patterns along river continuums. Supplementing a traditional stable isotope-based food web study with stable sulfur isotope analysis and information on the isotopic composition of nutrient pools will greatly enhance our ability to quantify the importance of MDN in freshwater and riparian food webs.

Objective 3: Measure the effects of MDN on the productivity and health of key food web species in stream, riparian and nearshore ecosystems along a potential MDN gradient from nearshore to headwaters.

Hypotheses:

$H_{3a:}$ Streams with anadromous salmon runs have higher macroinvertebrate and fish densities and standing stock than non-anadromous systems.

$H_{3b:}$ Fish are consuming marine-derived food (salmon eggs, tissue) in systems that contain salmon runs.

$H_{3c:}$ Fish and macroinvertebrates in streams with anadromous salmon runs have higher levels of whole-body lipids than those in systems without salmon.

$H_{3d:}$ There is a decrease in the degree of marine influence along the spatial continuum from stream mouth to headwaters.

Rationale: Simply detecting marine isotope and fatty acid signatures in food web components does not provide direct evidence for increased productivity (in the form of increased growth, production, or health of species) or other food web effects. This part of the study will complete the MDN story by tying in measures of productivity (MDN effects) with delivery of MDN (Objective 1), occurrence and cycling of MDN (Objective 2), and will show if food webs (stream, riparian, nearshore) are responding to MDN, and will show the magnitude of response.

Description of Study Area

The southern part of the Kenai Peninsula, bounded by Cook Inlet to the west and the Caribou Hills to the east has gently rolling topography, with wide river valleys and extensive peat wetland systems. Elevations range from around 950 meters to sea level (Mauger 2002). Climate in the study area is transitional between maritime and continental, in general becoming more continental towards the north. Homer, located at the southern end of the Peninsula, has an average winter (January) temperature of $-5.2\ ^{o}$ C and average summer (July) temperatures of 11.9^{o} C. The average annual precipitation in Homer is 61.7cm, with the majority of rain occurring in fall (September through November). Snowmelt and ice breakup contribute to high stream flows in spring (April-May) (Mauger 2002).

The southern Peninsula supports many wildlife species including a wide variety of seabirds, waterfowl, shorebirds, raptors, and songbirds, moose, black and brown bears, fox, lynx, coyote, and a variety of small mammals. The streams in this area support numerous small fish and salmonid species including king *(Oncorhynchus tshawytscha)*, silver *(O. kisutch),* steelhead *(O. mykiss)* and Dolly Varden *(Salvelinus malma).*

The economic base for communities on the southern Peninsula is largely composed of commercial fishing, sport fishing and tourism. Land ownership in the area includes Federal, Native Corporation, State, Borough and private holdings. Land use on the southern Kenai Peninsula has changed dramatically over the past 15 years, especially due to increased forest practices in response to the spruce bark beetle epidemic, and to increased development activities associated with a growing population. Population growth is expected to continue (KBRR and NOAA 2001).

In year one, we will be examining two watersheds on the southern Peninsula that are similar geomorphically, and with respect to human land uses and wetland extent. The treatment watershed, the North Fork and Chakok tributaries of the Anchor River, is 283 square kilometers, while the control watershed, Happy Valley Creek, is 28 square kilometers (see Table 1) (Baird and Walker, in press). In year two, we will expand the study to additional watersheds on the southern Peninsula, including the South Fork of the Anchor River. The Anchor River system supports anadromous runs of king, silver, and steelhead, as well as anadromous and resident populations of Dolly Varden. The Happy Valley System has resident Dolly Varden, but no anadromous runs due to the presence of a waterfall near the mouth of the creek.

Table 1: Characteristics of the control watershed, Happy Valley Creek, and the treatment watershed, North Fork/Chakok of Anchor River. * Information based on 70% of the total watershed for Happy Valley Creek and 56% of the total watershed for the North Fork/Chakok.

	Happy Valley	**NorthFork/Chakok**
Contain anadromous fishes	No	Yes
Stream length (km)	19	236
Watershed area (km^2)	28	283
Mean elevation (m)	92	227
Percent wetlands*	45%	46%
Percent watershed development*	1%	2-5%

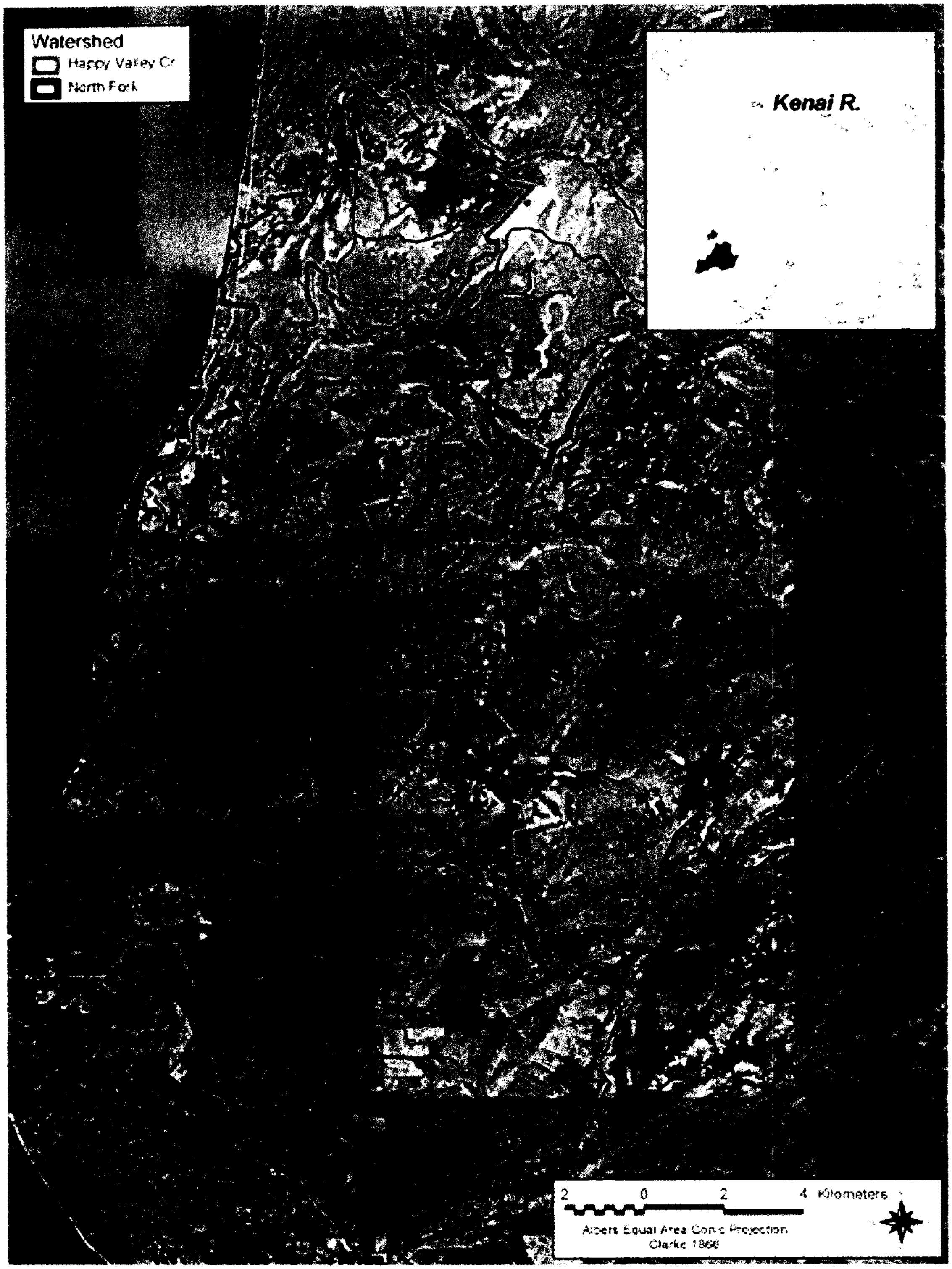

Figure 1: The treatment (North Fork and Chakok) and control (Happy Valley Creek) watersheds on the southern Kenai Peninsula.

Methods

Within each watershed, five sampling stations will be established along a river continuum extending from mouth to headwaters and representing a hypothesized MDN gradient, with three replicate samples taken at each station during each sampling event. Each station will include 200 meters of stream. We will sample four times per year, with the emphasis on sampling prior to the initiation of spawning runs in the spring (April), during the height of the combined runs in the summer, and after the runs are completed in the fall (end of September). The spring sampling will enable us to capture residual effects of MDN from the previous years' runs, and the fall sampling will enable us to examine the importance of MDN resulting from the current year, prior to overwintering. We will attempt to sample in the winter, although weather conditions may prohibit access (Sue Mauger, pers. comm.)

One sample station on the treatment watershed corresponds to an existing stream health monitoring station maintained by the Homer Soil and Water District and the Cook Inlet Keeper (Sue Mauger, pers. comm.). This program has an established monitoring station, including a stream discharge curve and is sampled monthly for various water quality parameters, including several of those that we will be measuring (Mauger 2002). Another sample station will be located just above the confluence of the mainstem and the North Fork in association with a newly established turbidity monitoring site (Sue Mauger, pers. comm.). Additional sample stations on the North Fork of the Anchor River and on the control watershed will be chosen largely on the basis of expected MDN movement into the drainage (to set up the MDN gradient), physical accessibility, and land-owner permission. Consideration for sample station locations will also be based on a watershed nutrient workshop to be convened by the Kachemak Bay Research Reserve this June. The goal of this workshop is to develop a research plan framing an investigation of nutrient sources and sinks associated with peat wetlands on the south Kenai Peninsula. Further consideration of sampling locations will come from sites already chosen by Cook Inlet Keeper to coincide with their previous and future sampling as much as possible, and by the results of annual aerial spawning site counts conducted by ADFG, Sport Fish Division.

The Anchor River has a short mainstem (approximately 2 km) near the ocean, and then divides into the North Fork and South Fork. The Alaska Department of Fish and Game operates a sonar station on the mainstem, below the divide, and a weir on the South Fork. ADFG estimates that the North Fork captures 25-40% of the salmon that enter the river (Nicky Szarzi pers. comm.). We will establish a weir on the North Fork of the Anchor River as part of a collaborative effort with the Alaska Department of Fish and Game Sport Fish Division, who will supply the materials, install the weir, train technicians to staff the weir, and supply the biometric analysis for running the weir. We will use the weir site to measure escapement through all salmon runs that begin May 15 and extend through September 15.

We will extend our knowledge of the effects of MDN into nearshore environments by examining nutrient outflow from streams. Two sampling stations will be established in the nearshore area of the control and treatment watersheds, with three replicate samples taken from each station. One station will be established near the river mouth, and the other will be established where the influence of river flow is dissipated, which we will establish by working with Dr. Scott Pegau, oceanographer with the Kachemak Bay Research Reserve.

1. Developing an MDN Proxy for Watersheds – NH_4^+ and SRP

At each stream station, a discharge curve will be developed by measuring the cross section of the stream and velocity throughout a range of flow conditions. On a monthly basis, we will collect water samples for analysis of ammonium, nitrate, total nitrogen, particulate and dissolved inorganic carbon, particulate and dissolved organic carbon, orthophosphate, soluble phosphorous and total reactive phosphorous using standard procedures (American Public Health Association 1995), and hold them on ice for transport to the laboratory. Four replicate water samples will be taken at each station. As indicated earlier, preliminary data suggest that NH_4^+ and possibly SRP may be reliable indicators and relatively inexpensive and simple proxies for estimating salmon returns (Wipfli et al. in prep, Sue Mauger, pers. comm., Eric Knudsen pers. comm.). To explore this potential, we will sample water chemistry at the weir site at monthly intervals during most of the year, and weekly intervals during salmon runs, in order to assess the baseline (non-salmon sources and prior-year residual MDN sources) and marine concentrations. Stable nitrogen isotope analysis of dissolved nitrate and ammonium will be performed on two replicate samples from each station at both sites to confirm that the inorganic nitrogen pools are salmon-derived and to evaluate longitudinal patterns in nitrogen cycling along the river continuums. We will work in collaboration with the Homer Soil and Water District and Cook Inlet Keepers stream health monitoring program to collect the water chemistry samples on the Anchor River drainage.

- Water samples will be analyzed at the Cook Inlet Keepers laboratory in Homer, AK. Stable nitrogen isotope analysis of nitrate and ammonium will be analyzed at the USGS stable isotope laboratory in Denver, Colorado.

2. MDN Occurrence in Food Webs – Isotopes and Fatty Acid Ratios

To assess the incorporation of MDN in food webs, we will collect samples of fish (Dolly Varden and sculpin; n = 10), macroinvertebrates (we will focus on abundant and widely present species such as grazing mayflies and omnivorous midges, collecting enough sample material to allow for all tissue analyses) and riparian vegetation (willow; enough sample material to allow for isotope analyses) that are resident along the entire reaches of both the control and treatment streams four times per year. Dolly Varden, sculpin, and macroinvertebrate samples will be collected as a subset of the individuals collected for density and growth measurements. Vegetation samples will be collected by picking randomly-chosen leaves. Samples will be placed on ice immediately upon collection in the field, brought to the laboratory later in the day, freeze-dried, pulverized, and portioned into subsamples for lipids (next section) and fatty acids, isotopes, and RNA/DNA subsamples. Stable isotope samples will be shipped to the USGS stable isotope laboratory in Denver, Colorado. Lipid and fatty acid samples will then be placed on liquid nitrogen until shipped to the University of Victoria for analyses. RNA/DNA and fatty acid composition samples will be shipped to the NMFS laboratory in Juneau for analyses.

3. MDN Effects on Food Webs – Density, Growth, Lipids, Diets

Densities of macroinvertebrates will be assessed in riffle habitats with a Hess sampler. We will collaborate and coordinate sampling efforts with the Cook Inlet Keeper's recently initiated volunteer citizen biomonitoring program where possible. We will work with Joel Cooper and Dale Banks, the monitoring coordinators for the Keeper to develop the degree of citizen involvement, which will be determined by the level of interest in the community.

Fish densities in pools will be assessed using baited minnow traps and a catch-per-unit-effort (CPUE). Fifty traps will be baited with salmon eggs placed in a perforated whirl-pak bag, set for one hour throughout the 200-m study reach, and the number of fish caught per trap per hour per pool area will be determined. We will also measure fish fork length and mass to calculate fish condition factor (Fulton Condition Factor $K = \text{mass}/\text{length}^3$).

Ten fish (Dolly Varden and sculpin) per site will be collected during each sampling bout for combined lipid, diet, stable isotope, RNA/DNA and fatty acid analyses. Fish samples will be handled as described above. Stomach contents will be evaluated by removing stomachs from fish at the time of collection, placed in EtOH in individual whirlpak bags, and proportion of marine, terrestrial, and freshwater content assessed based on volume. Diet analyses will indicate the amount of marine-source food the fish are consuming. Ten clam samples at each nearshore station will be collected for stable isotope analysis.

Selection of plant and animal species in this study was based on several key criteria that make them good candidates for a monitoring program: 1) sensitive to MDN enrichment, 2) wide-spread occurrence and abundance in riverine ecosystems in the GEM region, 3) ease of collecting and identifying, 4), ecologically important species in watersheds in the GEM region, 5) not considered an ecologically sensitive or economically important species, and 6) ease of getting collection permits (if needed at all). Water chemistry measures were also chosen based on their likelihood of being useful MDN proxies. We wanted to choose a suite of measures and species that have the greatest potential to serve as key indicators, to make such a monitoring program as practical, applicable, and useful as possible.

Sample analyses and PI responsibilities

Each sample will then be divided into three portions, and shipped for analysis:

- Field sample collection and laboratory preparation prior to shipping will be led by Coowe Walker.

- To USGS stable isotope laboratory in Denver, CO for analysis of $\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$ (fish, macroinvertebrates, and plant tissue) and $\delta^{15}N$ of dissolved NH_4^+ and NO_3^- (as in objective 1). This analysis will be led by Craig Stricker.
- To the University of Victoria for analysis of fatty acid ratios (omega-3:omega-6 ratios) and lipids (macroinvertebrates and fish). Fish diet samples will be sent to PNW Station, Wenatchee. These analyses, including fish condition, will be led Mark Wipfli.
- To Auke Bay Laboratory in Juneau for analysis of RNA/DNA (ratios in fish) and fatty acid allocation. This analysis will be led by Ron Heintz, who is submitting a separate companion proposal to fund this part of the study.

Modifications for Years 2-3

In years two and three, the study will be expanded to include additional watersheds on the lower Kenai Peninsula once methods of these potential proxies and measures of MDN occurrence and effects have been developed. These additional watersheds will serve as replicates to determine if techniques developed in Anchor and Happy Valley systems are applicable at larger spatial scales across a broader range of watershed conditions. Year-1 pilot study information will dictate which measures and indicators are potentially most reliable and useful, and Years-2 and 3 will provide the opportunity to test these across additional watersheds.

<u>Statistical Design and Analyses</u>

In year one, we will be contrasting two watersheds, a treatment watershed receiving salmon (Anchor River) and a control without salmon runs (Happy Valley River). We will study patterns of MDN influence from the mouth (highest density of salmon) to the headwaters (lowest density of salmon), and in the nearshore areas of these two systems. We will analyze the data using two statistical approaches: via paired t-tests (matching paired sites within each watershed based on distance from saltwater, and therefore relative MDN influence – i.e., enriched site 1 paired with control site 1) using multiple samples within each station as replicates, and via regression analyses where we will regress food web responses (e.g., invertebrate density) across the relative degree of MDN occurrence (various distances between each sampling station and the stream outlet). The slope of the regression line will indicate the degree of MDN occurrence in both watersheds. We expect to see significant differences in the MDN signal between the stream mouth and headwaters in the enriched watershed, with more influence near the mouth where the volume of salmon is relatively greater and diminishing towards the headwaters (i.e., regression slope significantly < 0). The control watershed should show no such pattern (i.e., regression slope $= 0$).

Dr. Roger Green, who is an internationally acknowledged expert in environmental statistics, has reviewed the design and will consult on analysis, database management and data retrieval, mathematical-statistical modeling, interpretation and graphical display of the results.

Coordination With Other Projects

This project has been developed as a collaborative effort between researchers, agency and citizen monitoring groups. It will not only provide valuable information towards the development of GEM's long-term watershed monitoring program, but will also directly benefit regional ADFG fisheries managers, and provide important outreach to the community through citizen involvement. Efforts are currently underway to examine terrestrial sources of nutrients into stream ecosystems. In June 2003, there will be a workshop of invited researchers and local interests convening at the Kachemak Bay Research Reserve with the purpose of developing a research plan for investigating nutrient sources, sinks and fluxes in streams associated with land uses, and in particular the extensive peat wetlands in the area. This workshop, funded by the US Environmental Protection Agency, will provide the framework for investigating terrestrially based nutrient inputs to streams.

ADFG Sport Fish managers are keenly interested in the Anchor River, which supports well-known and used recreational salmon fisheries, and one of the largest Dolly Varden fisheries in Alaska (Larson 1995). At present, ADFG operates a sonar counter on the main stem of the Anchor, plans to install a weir on the South Fork in 2004, and conducts annual aerial surveys of spawning sites. The regional sport fisheries biologist for the area estimates that the North Fork of the Anchor River supports 25-40% of the total escapement entering the Anchor River system, but so far there have not been any measurements (Nicky Szarzi pers. comm.). The establishment of a weir on the North Fork as part of this study will provide valuable information to ADFG fisheries managers (Nicky Szarzi, pers. comm., Jim Hasbrouk pers. comm.).

The Lower Kenai Watershed Health Program, Cook Inlet Keeper, and the Homer Soil and Water District have been collecting water quality data on four watersheds of the lower Kenai Peninsula, including sites on the North Fork/Chakok portions of the Anchor River. We will collaborate with Sue Mauger, stream ecologist for the Keeper to collect the water chemistry samples for this study. Cook Inlet Keeper is also in the process of building a volunteer citizen monitoring program that focuses on macroinvertebrates. We will work with the Keeper to incorporate citizen monitoring for macroinvertebrate density measurements as much as possible.

Ron Heintz is submitting a companion proposal to investigate energy allocation and fatty acid composition in order to gain a better understanding of the instantaneous effects of MDN on salmon growth and survival. If funded, we will collect, process and send a portion of the fish samples to the Auke Bay laboratory in Juneau.

Recently, several agencies and citizen groups, including the US EPA, the US Fish and Wildlife Service Kenai National Wildlife Refuge, the Kenai Peninsula Borough and the Kenai Watershed Forum have agreed to embark on developing a cumulative impacts assessment model for the Kenai Peninsula based on the ALCES® model developed for Alberta, Canada. This model provides a basic framework for long-term strategic land use planning. We are working with this consortium of partners, and plan to coordinate the results of this study into the model as appropriate.

Finally, this study will provide valuable information on watersheds of the lower Kenai Peninsula. We are planning to coordinate with other proposed MDN research in the Kenai River watershed (Asit Mazumber and Mark Johannes) and in Prince William Sound (Eric Knudsen and Tom Kline). Collectively, these studies will provide a valuable comparison of different systems, as well as different methodologies, which will benefit the development of a long-term monitoring program on the effects of MDN in the watershed environment.

Schedule

year	month	activity
2004	January/February	workshop in Homer to discuss year one of the study, include state biologists, federal biologists, volunteer citizen monitors, native Alaskans and researchers
	March	coordinate/communicate with other proposed MDN research in Kenai River and Prince William Sound. Prepare for sampling
	April-September	sampling on treatment and control watersheds Annual Report preparation
	October-December	data analysis
2005	January/February	workshop in Homer to discuss results of year one, and approach for year two. Selection of additional watersheds for sampling in year two
	March	coordinate/communicate with other proposed MDN research in Kenai River and Prince William Sound. Prepare for sampling
	April-September	Sampling on treatment and control watersheds Annual Report preparation
	October-December	data analysis
2006	January/February	workshop to discuss results of year two, and approach for year three. Review. Compare and contrast our results with other proposed efforts in Kenai River and Prince William Sound
	March	coordinate/communicate with other proposed MDN research in Kenai River and Prince William Sound. Prepare for sampling
	April-September	sampling on treatment and control watersheds Annual Report preparation
	October-December	data analysis final Report

Responsiveness to Key Trustee Council Strategies

This project is directly responsive to both of the Trustee Council strategies, as described in sections 3.3.1 and 3.3.2 of the GEM Ecosystem Monitoring and Research Program plan. The first strategy calls for incorporating community involvement and traditional knowledge. We will be working with the Cook Inlet Keeper, a local non-profit organization, to incorporate citizen volunteers into the macroinvertebrate field data collection. We will also be holding annual public workshops where active participation of community members will be encouraged. The second strategy calls for developing information that is useful for resource management applications. This project has significant potential for resource management applications by providing information that can be used to understand the effects of salmon escapement on stream nutrient budgets, food webs and salmonid growth and survival.

Expected Publications, Reports and Conference Participation

In addition to the quarterly, annual and final project reports required by the general conditions of GEM Research Program Funding, this project will result in at least one publication submitted to a peer-reviewed journal. This paper *'Presence and Effects of Marine Derived Nutrients in Stream, Riparian and Nearshore Ecosystems on the southern Kenai Peninsula, Alaska'* will likely be submitted to the Canadian Journal of Fisheries and Aquatic Sciences. The principal investigators for the project will attend the annual EVOS workshop in Anchorage.

The project will be featured on the Reserve's website: www.kbayrr.org, and will be updated quarterly. We will hold at least two public forums each year, one in Anchor Point, and one in Homer, to outreach the project locally. These presentations will include a presentation by one or more of the principal investigators, followed by an informal discussion with community members.

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Heintz, R.A., B.D. Nelson, M. Larsen, L. Holland, M.S. Wipfli, and J.P. Hudson. In revision. Effects of salmon carcasses on the lipid class and fatty acid composition of juvenile coho salmon. Transactions of the American Fisheries Society.

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Wipfli, M.S., J.P. Hudson, J.P. Caouette, N. Mitchell, J. Lessard, R.L. Heintz, D.T. Chaloner, J.L. Tank, G.A. Lamberti, and R.W. Merritt. In prep. Salmon carcasses vs. inorganic fertilizer pellets for elevating stream productivity: role of carbon and nutrients in stream food webs in southeastern Alaska. Journal of the North American Benthological Society.

Coowe Moss Walker

Resume

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EDUCATION

M.Sc. 1993. University of Virginia, Environmental Science
B.Sc. 1988. University of Maryland. Natural Resource Management. Natural Resources
A.Sc. 1983. Pennsylvania State University. Wildlife Biology

PROFESSIONAL EXPERIENCE

2001-2003 Watershed Coordinator, Kachemak Bay Research Reserve
1999-2001 Special Projects Lead, Kachemak Bay Research Reserve
1998-1999 Research Assistant, University of Maryland, College Park, MD
1992-1997 Wetlands Consultant, Moss Environmental, Gig Harbor, WA
1990-1991 Research Assistant, University of Virginia, Charlottesville, VA
1989-1990 Museum Specialist, Smithsonian Institute, Division of Birds, Washington, D.C.
1985-1987 Refuge Management Coop Student. US Fish and Wildlife Service.
1986-1988. Soils Technician. Agronomy Department. University of Maryland.
1988-1989. Boat and dive assistant, Airlie Beach, Australia.

RESEARCH INTERESTS

Developing the Reserve's watershed research program with the broad goal of understanding the patterns and processes that connect uplands, wetlands, streams and the nearshore ecosystems of the lower Cook Inlet region, and in particular to provide useful and timely information to managers and communities. Initial building of the watershed research program has involved developing wetlands functional assessments from a landscape perspective, and convening a workshop of researchers focused on framing a research plan for investigating nutrient sources and sinks connecting peat wetlands and streams on the lower Kenai Peninsula.

RELEVANT PUBLICATIONS

Kachemak Bay Research Reserve and National Oceanic and Atmospheric Administration, Coastal Services Center. 2001. Kachemak Bay ecological characterization. CD-ROM. Project Coordinator.

Walker, C. and S. Baird. In press. Wetland functions in the landscape: a tool for managers, planners and property owners in the Anchor River. CD-ROM. Kachemak Bay Research Reserve.

SCIENTISTS COLLABORATED WITH IN THE LAST FOUR YEARS

Steve Baird, Kachemak Bay Research Reserve
Mike Gracz, Alaska Natural Heritage Program
Sue Mauger, Cook Inlet Keeper
Phil North, US EPA, Kenai
Scott Pegau, Kachemak Bay Research Reserve

Mark Steven Wipfli

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EDUCATION

Ph.D.: 1992, Michigan State University, Aquatic Ecology & Environmental Toxicology
M.Sc.: 1987, University of Wisconsin – Madison, Entomology
B.Sc.: 1984, University of Wisconsin – Madison, Natural Science

PROFESSIONAL EXPERIENCE

2003: GS-0408-14, Research Aquatic Ecologist, USDA Forest Service, Wenatchee, WA
2001-2002: GS-0408-13, Research Aquatic Ecologist, USDA Forest Service, Wenatchee, WA
1997-2001: GS-0408-13, Research Aquatic Ecologist, USDA Forest Service, Juneau, AK
1996-1997: GS-0408-12, Research Aquatic Ecologist, USDA Forest Service, Juneau, AK
1994-1995: GS-0408-11, Post-Doctoral Associate, USDA Forest Service, Juneau, AK
1992-1993: GS-0408-09, Post-Doctoral Associate, USDA Forest Service, Juneau, AK
1988-1992: Ph.D. Research Assistant, Michigan State University, East Lansing, MI
1985-1987: M.Sc. Research Assistant, University of Wisconsin, Madison, WI

RESEARCH INTERESTS

Broad research interests focus around stream-riparian food webs in Alaska and the Columbia River Basin, including understanding the ecological processes that govern freshwater and riparian productivity, biodiversity and community interactions, trophic interactions, fish feeding ecology and carrying capacity, and restoration and management of freshwater and riparian ecosystems. Specific topics of research have been understanding 1) effects of land management activities, especially timber harvesting, on stream food webs, 2) role of marine nutrients and carbon (MDN) from salmon runs on stream-riparian ecosystems, and 3) contributions of terrestrial invertebrates to salmonid food webs.

FIVE MOST RELEVANT PUBLICATIONS

Wipfli, M.S., J.P. Hudson, J.P. Caouette, and D.T. Chaloner. 2003. Marine subsidies in freshwater ecosystems: salmon carcasses increase the growth rates of stream-resident salmonids. Transactions of the American Fisheries Society. 132: 371-381.

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FIVE ADDITIONAL PUBLICATIONS

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SCIENTISTS COLLABORATED WITH IN THE LAST FOUR YEARS

J. David Allan, University of Michigan, Ann Arbor, MI
Mason Bryant, PNW Research Station, U.S. Forest Service, Juneau, AK
Dominic Chaloner, University of Notre Dame, Notre Dame, IN
Robert Deal, PNW Research Station, U.S. Forest Service, Portland, OR
Toni De Santo, PNW Research Station, U.S. Forest Service, Juneau, AK
Rick Edwards, PNW Research Station, U.S. Forest Service, Juneau, AK
Scott Gende, National Park Service, Juneau, AK
Takashi Gomi, University of British Columbia, Vancouver, BC
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Ron Heintz, National Marine Fisheries Service, Juneau, AK
Paul Hennon, PNW Research Station, U.S. Forest Service, Juneau, AK
Brendan Hicks, University of Waikato, Hamilton, New Zealand
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Peggy Ostrom, Michigan State University, E. Lansing, MI
Jack Piccolo, University of Alaska Fairbanks, Fairbanks, AK
Gordon Reeves, PNW Research Station, U.S. Forest Service, Corvallis, OR
Craig Stricker, U.S. Geological Survey, Denver, CO
Jennifer Tank, University of Notre Dame, Notre Dame, IN
Jack Piccolo, University of Alaska Fairbanks, Fairbanks, AK
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Resume

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EDUCATION

2003 **Ph.D.** *Michigan State University*, East Lansing, MI. Dual Major: Limnology/Wetland Ecology and Ecology, Evolutionary Biology, and Behavior. ***Successfully defended, degree to be conferred winter 2003.***

1997 **M.S.** *Central Michigan University*, Mt. Pleasant, MI. Emphasis: Aquatic Biology.

1994 **B.S.** *Central Michigan University*, Mt. Pleasant, MI. Emphasis: Aquatic Biology.

PROFESSIONAL EXPERIENCE

2002-Present **Mendenhall Postdoctoral Fellow**. *U.S. Geological Survey*. Duties: design and implement an investigation of prairie wetlands in South Dakota; learn standard laboratory techniques for the analysis of light stable isotopes (C, H, O, N, and S) in various matrices; develop new techniques for the measurement of isotopic ratios in selected analytes (nitrate, organic-sulfur, water) using automated sample preparation and handling; develop professional scientific network.

1997-2002 **Dissertation Research**. *Michigan State University*. Objectives: quantitatively describe spatial and temporal patterns in the hydrochemistry of a Great Lakes coastal marsh; describe the spatial and temporal patterns of invertebrate assemblages; relate hydrochemical and community level changes to water level fluctuations within the context of drought and climate change predictions.

1994-1997 **Thesis Research**. *Central Michigan University*. Objectives: investigate the factors influencing transport and retention of allochthonous material in a low gradient, second order Michigan stream; quantify coarse particulate organic matter inputs.

MOST RELEVANT PUBLICATIONS

2003 **Stricker, C.A.**, M. Lang, A. Hodgson, P. Ostrom, and M.S. Wipfli. (**in prep**). Tracing marine-derived nutrients into the Chilkat River valley of southeast Alaska: a stable isotope approach.

2003 **Stricker, C.A.**, T.M. Burton, and D.G. Uzarski. (**in prep**). The influence of water level fluctuations on coastal marsh hydrochemistry: implications for drought and climate change in the Great Lakes.

2002 Burton, T.M., **C.A. Stricker**, D.G. Uzarski. 2002. Effects of plant community composition and exposure to wave action on invertebrate habitat use of Lake Huron coastal wetlands. Lakes & Reservoirs: Research and Management 7:255-269.

2001 **Stricker, C.A.**, T.M. Burton, V.J. Brady, B.J. Cardinale, and J.P. Gathman. 2001. Invertebrate communities of Great Lakes' coastal wetlands, Saginaw Bay, Lake Huron. Verh. Internat. Verein. Limnol. 27:3440-3443.

1999 Burton, T.M., D.G. Uzarski, J.P. Gathman, J.A. Genet, B.E. Keas, and **C.A. Stricker**. 1999. The development of an index of biotic integrity for Great Lakes coastal wetlands of Lake Huron. Wetlands 19(4):869-882.

ADDITIONAL PUBLICATIONS

2001 Uzarski, D.G., T.M. Burton, D.K. King, and **C.A. Stricker**. 2001. A new chamber design for measuring community metabolism in a Michigan stream. Hydrobiologia 455:137-155.

PROFESSIONAL AFFILIATIONS

American Society of Limnology and Oceanography
International Association of Theoretical & Applied Limnology
North American Benthological Society
Society of Wetland Scientists

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Stephen Hamilton, Michigan State University, Hickory Corners, MI
Craig Johnson, U.S. Geological Survey – GD, Denver, CO
Donna King, Central Michigan University, Mt. Pleasant, MI
Rich Merritt, Michigan State University, E. Lansing, MI
Nathaniel Ostrom, Michigan State University, E. Lansing, MI
Peggy Ostrom, Michigan State University, E. Lansing, MI
Robert Rye, U.S. Geological Survey - GD, Denver, CO
Donald Uzarski, Grand Valley State University, Muskegon, MI
Mark Wipfli, PNW Research Station, U.S. Forest Service, Wenatchee, WA

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

DIVISION OF SPORT FISH

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Ms. Coowe Walker
Kachemak Bay Research Reserve
2181 Kachemak Drive
Homer, AK 99603

12 June 2003

Dear Ms. Walker,

I read the draft research proposal that you intend to submit to the Gulf Ecosystem Monitoring (GEM) program entitled "Assessing the Affects of Marine Derived Nutrients to Streams, Riparian Zones and Nearshore Ecosystems on the southern Kenai Peninsula, Alaska." I want you to know that the Division of Sport Fish, Region II, supports this project.

We support this project because it will improve our assessment of chinook and coho salmon, and to some degree steelhead and Dolly Varden, in the Anchor River. This year we initiated a long-term chinook salmon assessment project on the Anchor River. We installed a partial weir and DIDSON sonar just downstream of the confluence of the North Fork and South Fork Anchor River, to determine the escapement, or number of spawning fish, that return to the river each year. We also have a netting program to collect age data. Your proposed research project would bolster our information by placing a weir on the North Fork, allowing us to better assess escapement in both forks. In addition, your project would continue weir operations in the North Fork through the coho salmon run. If this project is funded, we would likely move our weir materials into the South Fork after the chinook salmon run is completed to get a complete count of the coho salmon run to the Anchor River. We currently have no good idea of coho salmon runs to the Anchor River but are very interested in assessing coho salmon in a stream on the Lower Kenai Peninsula. Finally, this project should improve our knowledge of the links between abundance of spawning salmon and the productivity and population dynamics of fish present in the freshwater ecosystem.

I hope that your research project gets funded. We look forward to working with you and your co-investigators in assessing runs of chinook and coho salmon, and to learning the results of the nutrient dynamics of this watershed.

Please contact me if you have any questions.

Sincerely,

James J. Hasbrouck

James J. Hasbrouck
Region II Research Coordinator

Cc: Barry Stratton
Nicky Szarzi
Bob Clark

COOK INLET KEEPER

June 12, 2003

Coowe Walker
Watershed Coordinator
Kachemak Bay Research Reserve
2181 Kachemak Drive
Homer, Alaska 99603

Dear Coowe,

Cook Inlet Keeper is a member-supported nonprofit organization dedicated to protecting the vast Cook Inlet watershed and the life it sustains. To fulfill this mission, Keeper encourages citizens to take a hands-on role in collecting and disseminating reliable data on water quality in Cook Inlet.

In 1996, Keeper developed Alaska's first scientifically defensible volunteer water quality monitoring program. Keeper's efforts in Kachemak Bay have been held up as a model by the State, and have spawned monitoring in Native villages, on the Kenai River, in the Anchorage Bowl and the Mat-Su Valley and have evolved into what is now known as the Citizens' Environmental Monitoring Program (CEMP). Currently, as you know, Keeper is working to incorporate watershed-based and marine-derived nutrient sampling into the Citizens' Environmental Monitoring Program.

We would like to express our strong support for the proposal that you, Mark Wipfli and Craig Stricker are submitting to GEM to investigate the presence and effects of marine derived nutrients on the southern Kenai Peninsula. The study you propose would provide valuable information for developing long-term monitoring of the nutrient sources, sinks and fluxes of watersheds in south central Alaska.

We are especially excited about the opportunity to incorporate some of the methodology developed through your proposal into our citizen monitoring program. In addition, we appreciate the opportunity to have the Keepers' new water nutrient laboratory process samples, and to have Keeper staff involved with the data collection and macroinvertebrate analysis. This project holds great promise and we are pleased to be involved with it.

Sincerely,

Joel Cooper
Research Coordinator

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Coowe Walker
Watershed Coordinator
Kachemak Bay Research Reserve
2161 Kachemak Dr.
Homer, AK 99603

Dear Coowe,

We were pleased to support your proposal to identify the presence of marine derived nutrients and examine their effects in Happy Valley Creek and the Anchor River on the Kenai Peninsula. The work you are proposing will provide valuable insight into ecosystem level effects of supplements derived from marine sources. We are particularly happy with your approach which permits comparison with an unsupplemented stream and measurement of the relative impacts resulting from various loads of marine nutrients.

Obviously, the work we are proposing will not be possible without your efforts, but we believe that the two proposals are highly complementary. Together they should form a detailed analysis of the effects of marine nutrients on riparian foodwebs. We look forward to cooperating with you to our fullest extent. Please let us know if there is any way we can assist you.

Sincerely,

Ron Heintz

approved 3/1/04

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
	12-Sep			
Personnel	$69.0	$58.6	$60.8	$188.4
Travel	$6.8	$9.6	$5.8	$22.2
Contractual	$61.6	$65.1	$62.6	$189.3
Commodities	$17.6	$7.4	$8.1	$33.1
Equipment	$0.0	$0.0	$0.0	$0.0
Subtotal	$155.0	$140.7	$137.3	$433.0
General Administration (9% of Subtotal)	$14.0	$12.7	$12.4	$39.0
Project Total	$169.0	$153.4	$149.7	$472.0

Cost-share Funds:
In this box, identify non-EVOS funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

In year one, the salary for Craig Stricker will be covered through his post-doctoral position with the US Geological Survey. The cost of isotope analysis will also be defrayed by Dr. Stricker's lab. The in-kind contribution of funds towards the stable isotope analysis is:$72,000.

The Alaska Department of Fish and Game, Sport Fish Division will supply weir materials, supervision, operational plan for fish sampling, and data analysis for the weir on the North Fork, and will be operating sonar on the mainstem and a weir on the South Fork, enabling us to estimate escapement to the whole system and the two major tributaries. Their in-kind contribution amounts to $123,100.

The Kachemak Bay Research Reserve will supply lab support, and office support (paper, telephones, computers, field vehicles).

FY 04-06

Date Prepared: 6/11/2003

Project Number: 040726
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska:
Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Revised

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
Coowe Walker	project coordinator	HBII	3.0	5.2		15.6
Steve Baird	field staff and data analysis	RAII	1.5	4.8		7.2
Amy Alderfer	Technical supply assistant	ACIII	1.0	3.5		3.5
vacant	technician to man weir	FT III	4.9	4.0		19.6
vacant	technician to man weir	FTII	4.0	3.6		14.4
Tom Ballard	training support for weir	FBI	1.0	5.5		5.5
vacant	Statistician		1.0	3.2		3.2
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		16.4	29.8	0.0	
					Personnel Total	$69.0

Travel Costs: Description	Ticket/vehicle Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Coowe Walker RT from Homer to Anchorage	0.2	1	4	0.2	1.0
Mark Wipfli RT from Fairbanks to Homer	0.7	2	4	0.2	2.2
Craig Stricker RT from Denver to Homer	0.9	2	4	0.2	2.6
Statistician RT from Anchorage to Homer	0.2	1	4	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.8

FY 04

Project Number:
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska:
Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:		Contract Sum
Description		
Sue Mauger, Stream Ecologist, Cook Inlet Keeper- field sample collection and invertebrate identification		5.0
Cook Inlet Keeper Laboratory - water nutrient and carbon analysis	168 samples x $45/sample	7.5
University of Victoria- fatty acid/lipid analysis	240 x$35/sample	10.5
USGS Stable Isotope Laboratory in Denver, CO	806 samples and analysis by Dr. Craig Stricker	10.0
car rental for weir operation		0.9
minor repairs and maintenance for weir and vehicles		0.4
graduate research student - stipened and travel		27.3
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$61.6

Commodities Costs:	Commodity Sum
Description	
field and laboratory equipment and supplies (see budget explanation for detailed breakdown)	17.6

FY 04

Project Number:
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska:
Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

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
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
computer	3	KBRR
low temperature freezer (-70)	1	KBRR
dissecting microscopes	2	KBRR
liquid nitrogen storage tank	1	KBRR
field vehicle	1	KBRR
freeze drier	1	UAF

FY 04

Project Number:
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska: Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

FORM 3B
Equipment
DETAIL

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
Coowe Walker	project coordinator	HBIII	16D	3.5	5.4	0.0	18.9
Steve Baird	field staff and data analysis	RAIII	16B	2.0	5.0	0.0	10.0
Amy Alderfer	Technical supply assistant	ACIII	10C	1.0	3.7	0.0	3.7
vacant	technician to man weir	FT III	12A	2.5	4.0	0.0	10.0
vacant	technician to man weir	FTII	11A	2.0	3.6	0.0	7.2
Tom Ballard	training support for weir	FBI	14B	1.0	5.6	0.0	5.6
vacant	Statistician			1.0	3.2		3.2
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		13.0	30.5	0.0	
						Personnel Total	$58.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Coowe Walker RT from Homer to Anchorage	0.2	2	8	0.2	2.0
Mark Wipfli RT from Fairbanks to Homer	0.7	2	4	0.2	2.2
Craig Stricker RT from Denver to Homer	0.9	2	4	0.2	2.6
Mark Wipfli RT from Fairbanks to Anchorage	0.5	1	4	0.2	1.3
Craig Stricker RT from Denver to Anchorage	0.7	1	4	0.2	1.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$9.6

FY 05

Project Number:
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska:
Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:		Contract Sum
Description		
Sue Mauger, Stream Ecologist, Cook Inlet Keeper- field sample collection and invertebrate identification		4.0
Cook Inlet Keeper Laboratory - water nutrient and carbon analysis	200 samples x $45/sample	9.0
University of Victoria- fatty acid/lipid analysis	300 samples x $35/sample	10.5
USGS Stable Isotope Laboratory in Denver, CO	1000 samples and analysis by Dr. Craig Stricker	10.0
car rental for weir operation		0.9
minor repairs and maintenance for weir and vehicles		0.4
graduate research student - stipened and travel		30.3
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$65.1

Commodities Costs:	Commodity Sum
Description	
field and laboratory supplies (see budget explanation for detailed breakdown)	7.4
Commodities Total	$7.4

FY 05

Project Number:
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska: Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

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
computer	3	KBRR
low temperature freezer (-70)	1	KBRR
dissecting microscopes	2	KBRR
liquid nitrogen storage tank	1	KBRR
field vehicle	1	KBRR

FY 05

Project Number:
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska: Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

FORM 3B
Equipment
DETAIL

***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
Coowe Walker	project coordinator	HBII	16D	3.5	5.6	0.0	19.6
Steve Baird	field staff and data analysis	RAII	16B	2.0	5.2	0.0	10.4
Amy Alderfer	Technical supply assistant	ACIII	10C	1.0	3.8	0.0	3.8
vacant	technician to man weir	FTIII	12A	2.5	4.2	0.0	10.5
vacant	technician to man weir	FTII	11A	2.0	3.7	0.0	7.4
Tom Ballard	training support for weir	FBI	14B	1.0	5.9	0.0	5.9
vacant	Statisitician			1.0	3.2		3.2
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		13.0	31.6	0.0	
						Personnel Total	$60.8

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Coowe Walker RT from Homer to Anchorage	0.2	1	4	0.2	1.0
Mark Wipfli RT from Fairbanks to Anchorage/Homer	0.7	2	4	0.2	2.2
Craig Stricker RT from Denver to Anchorage/Homer	0.9	2	4	0.2	2.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.8

FY 06

Project Number:
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska:
Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:		Contract Sum
Description		
Sue Mauger, Stream Ecologist, Cook Inlet Keeper- field sample collection and invertebrate identification		3.5
Cook Inlet Keeper Laboratory - water nutrient and carbon analysis	200 samples x $45/sample	9.0
University of Victoria- fatty acid/lipid analysis	300 samples x $35/sample	10.5
USGS Stable Isotope Laboratory in Denver, CO	1000samples and analysis by Dr. Craig Stricker	10.0
car rental for weir operation		0.9
minor repairs and maintenance for weir and vehicles		0.4
graduate research student - stipened and travel		28.3
	Contractual Total	$62.6

Commodities Costs:	Commodity Sum
Description	
field and laboratory supplies (see budget explanation for detailed breakdown)	8.1
Commodities Total	$8.1

FY 06

Project Number:
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska:
Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

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
computer	3	KBRR
low temperature freezer (-70)	1	KBRR
dissecting microscopes	2	KBRR
liquid nitrogen storage tank	1	KBRR
field vehicle	1	KBRR

FY 06

Project Number:
Presence and Effects of Marine Derived Nutrients (MDN) in Stream, Riparian and Nearshore Ecosystems on the Southern Kenai Peninsula, Alaska: Developing Monitoring Tools for tracking MDN in Alaska Watersheds
Agency: Kachemak Bay Research Reserve/ADFG Sport Fish Division

FORM 3B
Equipment
DETAIL

Budget Justification

FY04. Requested funds $169,000

Personnel salaries. Three months of salary are requested for Walker in year 1 to cover project coordination, field sampling, laboratory preparation, data analysis and project outreach. One and a half months of salary are requested for Baird to assist with field sampling, laboratory preparation, data analysis and project outreach. One month of salary is requested for Alderfer to cover supply inventory, purchases and shipping. Four and nine-tenths months salary are requested for a lead field technician to operate the weir. Four months salary is requested for the assistant weir technician and one month of salary is requested for Ballard to train and supervise the weir technicians. Partial month salary is requested for a sport fish statistician to assist with operational planning.

Travel. Travel is requested each year for Walker, Stricker and Wipfli to attend the EVOS conference in Anchorage. Travel is also requested for Stricker and Wipfli to visit the field sites twice a year, and for a statistician to visit Homer once.

Contractual. Funds are requested for stable isotope analysis to be led by Stricker at the USGS stable isotope lab in Denver. The standard costs of analyzing C, N and S isotopes on biological samples is $150-$190 per sample. Stricker will be donating time to the project, and much of the sample analyses, however we are requesting $10,000 in funds to defray the cost of the stable isotope analysis. Funds are requested for Cook Inlet Keeper Stream Ecologist, Sue Mauger to assist with field sampling and macroinvertebrate identification. Funds are requested for water nutrient analysis to be performed at the Cook Inlet Keeper laboratory. Funds are requested for fatty acid/lipid analysis to be performed at the University of Victoria. Funds are also requested for shipping samples to the Denver stable isotope lab and the University of Victoria laboratory. Shipping costs to the Auke Bay laboratory will be covered by the companion proposal submitted by Ron Heintz. Funds are requested for car rental and minor repairs and maintenance associated with the weir operation. Funds are requested for a graduate research student stipend and travel. The student will be a lead in field sampling and lab processing for the food web response portion of the project.

Commodities. Funds are requested in year one for general field and laboratory supplies and equipment. The cost for these supplies is based on known costs associated with operating a weir on the Anchor River, the number of scheduled field visits, the number of samples to be collected, the cost of field and laboratory equipment and accessories that are essential for carrying out the objectives of this study including equipment for sampling macroinvertebrates and fish, measuring stream flow, pulverizing and shipping samples.

* Walker revised

Itemized Commodity Funds Requested-FY04

Item	Number of Units	Cost per unit ($)	Total ($)
water bottles	126	2	252
sample containers	1000	0.5	500
general supplies (markers, field notebooks, coolers, dry ice, paper)			200
gas for field transportation			1944
groceries, protective clothing, camping equipment			2600
minor repairs and maintenance of field equipment			1430
field phone			464
freeze drier flasks	5	$250	1250
Hess sampler	1	550	550
Minnow traps	100	10	1000
Liquid N shipper	1	1400	1400
Price AA current meter	1	770	770
Pygmy current meter	1	618	2600
Topset wading rod	1	412	412
Equipment case	1	100	100
Headset	1	62	62
Aquatic digitizer	1	945	945
Tagline	1	500	500
stopwatch	1	59	59
Wig-L-Bug pulverizer	1	535	535
		Total	$17,573

Equipment. There are no funds requested for equipment in FY04 for this project.

FY05: Requested funds $147,300.

Personnel salaries. In years two and three, additional sampling effort will be required and accompanying additional staff time. Three and one-half months of salary are requested for Walker in year two to cover project coordination, field sampling and data analysis. Two months of salary are requested for Baird to cover field sampling and data analysis. One months of salary is requested for Alderfer to cover supply inventory, purchases and shipping. Two and one-half months salary is requested for a lead field technician to operate the weir. Two months salary is requested for the assistant weir technician and one month of salary is requested for Ballard to train and supervise the weir technicians. Partial month funding has been requested for a Division of Sport Fish statistician to assist with operational planning. Salaries have been adjusted to account for 4% cost increase.

Travel. Travel is requested each year for Walker to attend the EVOS general conference and watershed conferences to be held in Anchorage. Travel is also requested for Stricker and Wipfli to attend the EVOS conference and visit the field sites twice a year.

Contractual. Funds are again requested to defray the cost of the stable isotope analysis. Funds are requested for Cook Inlet Keeper Stream Ecologist, Sue Mauger to assist with field sampling and macroinvertebrate identification, and for an additional field technician. Funds are requested for water nutrient analysis to be performed at the Cook Inlet Keeper Laboratory. Funds are requested for fatty acid/lipid analysis to be performed at the University of Victoria. Funds are also requested for shipping samples to the Denver stable isotope lab and the University of Victoria laboratory. Shipping costs, if any, to the Auke Bay laboratory will be covered by the companion proposal submitted by Ron Heintz. Car rental and minor repairs and maintenance funds for the weir operation are again requested. Funds are requested for a graduate research student's stipend and travel. The student will continue leading the field sampling and lab processing for the food web response portion of the project.

Commodities. Funds are requested in year two for general field and laboratory supplies associated with operating a weir on the Anchor River, the number of scheduled field visits, and the number of samples to be collected.

Itemized Commodity Funds Requested-FY05

Item	Number of Units	Cost per unit ($)	Total ($)
water bottles	126	2	252
sample containers	1000	0.5	500
general supplies (markers, field notebooks, coolers, dry ice, paper)			200
gas for field transportation			1944
groceries, protective clothing, camping equipment			2600
minor repairs and maintenance of field equipment			1430
field phone			464
		Total	$7390

Equipment. There are no funds requested for equipment in year two.

FY06: Requested funds $149,700.

Personnel. Three and one-half months of salary are requested for Walker in year three to cover project coordination, field sampling and data analysis. Two months of salary are requested for Baird to cover field sampling and data analysis. One month of salary is requested for Alderfer to cover supply inventory, purchases and shipping. Two and one-half months salary is requested for a lead field technician to operate the weir. Two months salary is requested for the assistant weir technician and one month of salary is requested for Ballard to train and supervise the weir technicians. Partial month funding is requested for a Division of Sport Fish statistician to assist with operational planning. Salaries in year three reflect a 4% cost increase.

Travel. Travel is requested each year for Walker to attend the EVOS conference in Anchorage. Travel is also requested for Stricker and Wipfli to attend the EVOS conference and visit the field sites once a year.

Contractual. Funds are again requested to defray the cost of the stable isotope analysis. Funds are requested for Cook Inlet Keeper Stream Ecologist, Sue Mauger to assist with field sampling and macroinvertebrate identification, and for an additional field technician. Funds are requested for water nutrient analysis to be performed at the Cook Inlet Keeper Laboratory. Funds are requested for fatty acid/lipid analysis to be performed at the University of Victoria. Funds are also requested for shipping samples to the Denver stable isotope lab and the University of Victoria laboratory. Shipping costs, if any, to the Auke Bay laboratory will be covered by the companion proposal submitted by Ron Heintz. Car rental and minor repairs and maintenance funds are requested for the operation of the weir. Funds are requested for a graduate research student's stipend and travel. The student will continue leading the field sampling and lab processing for the food web response portion of the project.

Commodities. Funds are requested in year three for general field and laboratory supplies associated with operating a weir on the Anchor River, the number of scheduled field visits, and the number of samples to be collected.

Itemized Commodity Funds Requested-FY06

Item	Number of Units	Cost per unit ($)	Total ($)
water bottles	126	2	252
sample containers	1000	0.5	500
general supplies (markers, field notebooks, coolers, dry ice, paper)			200
gas for field transportation			1944
groceries, protective clothing, camping equipment			2600
minor repairs and maintenance of field equipment			1430
field phone			464
		Total	$7390

Equipment. There are no funds requested for equipment in year three.