KACHEMAK BAY RESEARCH RESERVE

A Unit of the National Estuarine Research Reserve System

Project Number: EVOS GEM Project Number: 040726

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.

Principal Investigators:
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Time Period Covered by Report: October 2005 – August 2006
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1. Work Performed

During this fiscal year, we completed analysis of several data sets from our year two (2005) field season, used that information to plan our second year of investigation (2006 field season) and carried out our final rounds of field sampling (still ongoing).

Results from year one indicated the following responses to MDN in stream food webs: 1) Stream invertebrates, fish *(Dolly Varden)* and vegetation (*Equisetum*) in the North Fork had higher levels of marine derived nitrogen (δN^{15}) compared to the same taxa in Happy Valley; 2) No obvious pulse of MDN was observed post-spawning, perhaps due to bear predation, the relative low density of fish, or the effects of the underlying nutrient rich geology; 3) Longitudinal enrichment was noted in both systems and likely indicates increased trophic complexity with stream size regardless of spawning salmon presence. Results from year one also indicated that the development of a nutrient proxy for salmon escapement might be problematic.

Our strategy for year two of the study (2005) was to explore the effects of underlying geology on stream food web response to MDN. Our approach was to link stream chemistry, marine isotope signatures, and lipid and fatty acid measures along a three-site gradient from headwaters to river mouth in three streams (two with salmon, one without) in each of three regions that differed in expected nutrient concentrations and potential limitation due to underlying geology (granitic vs. sedimentary). Our main hypotheses were that (1) stable isotope and fatty acid signatures would reflect increasing MDN presence and effects along a gradient from headwaters to stream mouth in salmon-bearing streams and (2) that this effect will be greater in granitic watersheds (Cooper Landing and Seldovia areas) with low ambient nutrient concentrations than in sedimentary watersheds (Homer area).

Results from year two of the study indicated that the response to MDN inputs did indeed vary depending on underlying geology. Prior to salmon runs, P concentrations were generally below detection limits in granitic streams (Cooper Landing and Seldovia areas), suggesting P limitation. Sedimentary streams (Homer area) had higher pre-salmon P concentrations, suggesting P was not limited. NH_4^+ and PO_4^{-3} spiked in most streams during salmon spawning and returned to pre-spawn levels by October. NH_4^+ in Homer salmon streams did not increase above levels in the salmon-free reference, suggesting rapid N uptake in these N-limited sedimentary streams.

Macroinvertebrates and *Equisetum* from salmon streams generally (but not always) showed (1) enriched $\delta^{15}N$ during salmon spawning, (2) $\delta^{15}N$ enrichment in a downstream direction, and (3) enriched $\delta^{15}N$ relative to salmon-free reference streams. Higher ω3:ω6 fatty acid ratios in Dolly Varden provided evidence of direct incorporation of MDN into stream food webs. When normalized for Dolly Varden size, ω3:ω6 fatty acid ratios appear to increase in a downstream direction. Dolly Varden ω3:ω6 fatty acid ratios correlated with body size in the Anchor River ($r^2 = 0.21$) but not in Happy Creek. This suggests that larger fish incorporated more MDN. Preliminary conclusions from the 2005 data are (1) Nutrient data suggest N limitation at sites with sedimentary geology (i.e., Homer area). (2) Nutrient profiles suggest rapid N uptake in Homer streams. (3) ω3:ω6 fatty acids appear to be a reliable indicator of MDN influence in Dolly Varden. (4) $\delta^{15}N$ was highly variable, likely due to spatial variation in N sources and cycling, and may not be a reliable predictor of MDN inputs at the watershed scale.
Results from the nutrient proxy investigations indicate promise for development of a nutrient proxy for salmon escapement, especially using PO_4^{-3} in nitrogen limited streams. High underlying P levels in the Anchor, and presumably Deshka, based on the similar underlying sedimentary geology, may lead to nitrogen limitation of primary producers which, in turn, could lead to rapid nitrogen uptake. PO_4^{-3} has potential for development of a nutrient proxy in these systems for two reasons: (1) N is probably in biological demand because of the high ambient P levels, (2) P, despite being non-limiting, is still in lower abundance than N (i.e., it has less background noise to overcome).

For year three of the project (2006), we are focusing on enhancing our understanding of fish as integrators of MDN, and further development of a nutrient proxy for salmon escapement. In addition to sampling Dolly Varden, we are also sampling juvenile coho because they are more ubiquitous in salmon bearing streams than Dolly Varden, and therefore be a more suitable monitoring tool. An Operation Plan, detailing our 2006 field and data analysis plans was completed during the spring of 2006, and was included as an attachment with the third quarter progress report.

Food web sampling and analysis. The objective for this component of the project is to use stable isotopes, lipid and fatty acid analysis as possible means for understanding how MDN subsidize stream food webs in the continuum from headwaters to stream mouth. The isotope analysis indicates the presence and magnitude of marine derived nutrients; the lipid and fatty acid analyses reveal the fitness effects of MDN.

Sampling. Our goal for year three is to sample streams with a range of salmon densities so that we can assess the relationship between MDN concentrations, which is related to the number of returning salmon, and the following juvenile fish responses: growth (length and weight); lipid levels; ω3:ω6 fatty acids; and $\delta^{15}N$, $\delta^{13}C$. The 2006 field work is being conducted in association with salmon enumeration projects on fourteen streams throughout south central Alaska (Figure 1). The streams were selected as sample sites to obtain a range of salmon return densities, and ease of access. Salmon densities were estimated by dividing the salmon returns, (from enumeration projects) by stream length, calculated from USGS maps. Each stream is being sampled twice – once before the salmon (Chinook, sockeye and/or pink, but not coho) runs begin and once two-three weeks after peak spawning. We are not attempting to sample post-coho runs because they enter the systems too late in the year to sample an MDN response in juvenile fish. Both juvenile Dolly Varden and coho salmon will be collected at each site. We have completed the first round of sampling, and are currently in the process of completing the second, and final, round of sampling.

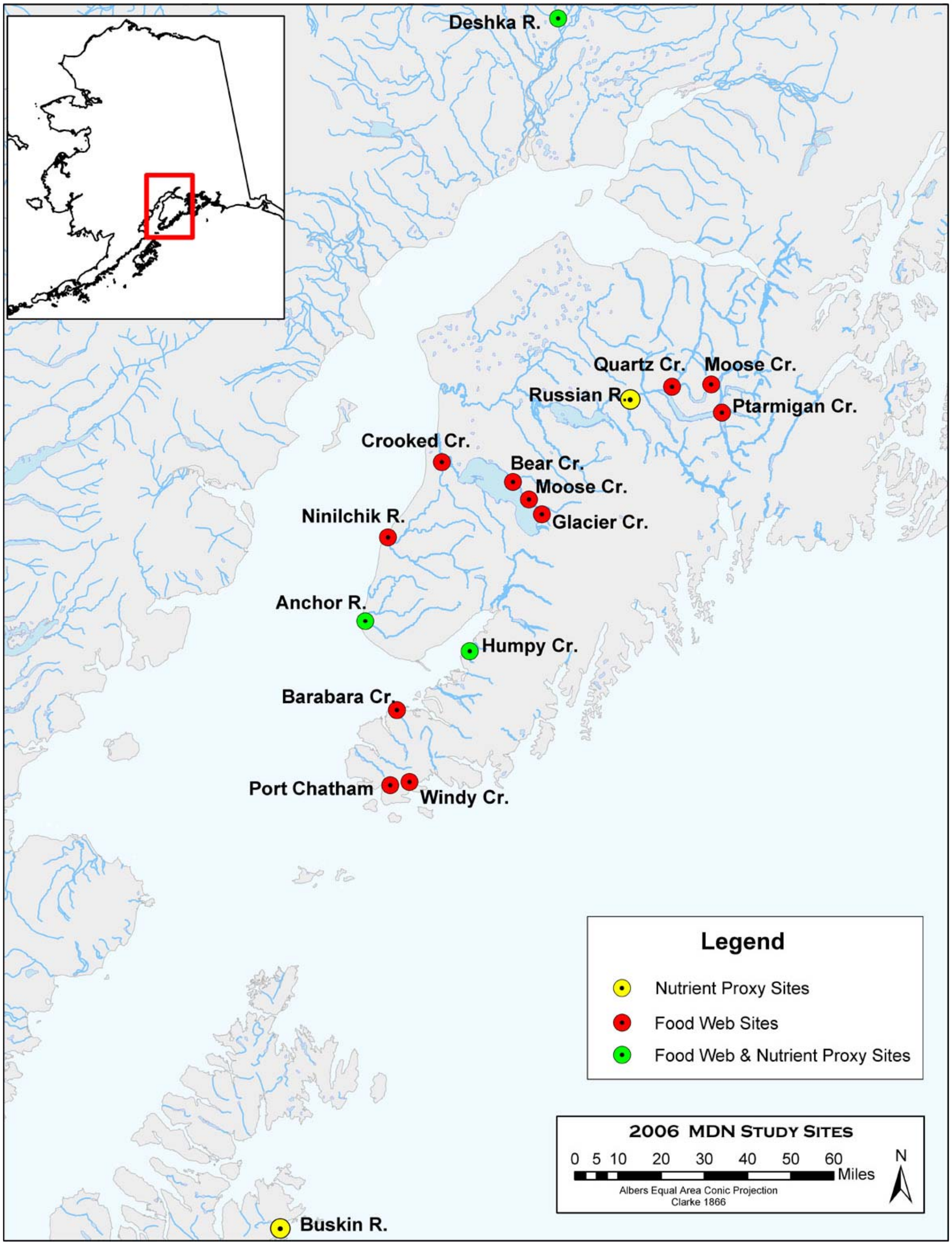

Figure 1. Map illustrating study sites for food-web and nutrient proxy responses to MDN.

Water chemistry nutrient proxy. We are further investigating the potential for developing a water chemistry proxy for salmon escapement levels by comparing the numbers of returning salmon with the concentration of ammonium, nitrate and soluble reactive phosphorous. Water chemistry samples have been collected weekly at six five with salmon enumeration projects (Figure 1). The Anchor River is located on the southern Kenai Peninsula. The Russian River is a tributary of the Kenai River that drains central and northern portions of the Kenai Peninsula. The Buskin River is centrally located in the urban area of Kodiak Island. The Deshka River is a tributary to the Susitna River draining the west side of northern Cook Inlet. Humpy Creek is located on the south side of Kachemak Bay at the southern end of the Kenai Peninsula.

2. Future Work.

We have respectfully requested a six month extension for our project based on the following reasons (copy of request letter is attached with this report):

1) Our project design is based on measuring food web responses to marine-derived inputs from returning adult salmon before the salmon runs begin and after adults have decomposed post-spawning. Over the previous two years of the study, we recognized the need to continue sampling through October in order to capture the greatest pulse of marine-derived nutrients. We would like to be consistent with these previous years in our data collection during this third year.
2) Once samples are collected, it takes several months for the samples to be prepared and analyzed. An extension would allow us to incorporate results from this third year sampling efforts in our final report.

3. Coordination/Collaboration.

This project was developed as a collaborative effort between researchers, agency and citizen monitoring groups, with the purpose of providing valuable information towards the development of GEM's long-term watershed monitoring program, and for the benefit of regional ADF&G managers, and local coastal communities. Sport Fish personnel are assisting with water chemistry sample collection at five salmon enumeration projects around the state. ADF&G Commercial Fish biologists have assisted with the set-up of a video monitoring station on the south side of Kachemak Bay, and are also providing fish count data for two salmon bearing streams on the outer coast of the peninsula. As part of these collaborative efforts, we have engaged in several meetings with ADF&G managers to discuss the project. Additional collaborations are discussed in more detail in the FY06 quarterly progress reports for this project.

4. Community Involvement/TEK & Resource Management Applications

This project has attracted the interest of several community volunteers, who have assisted with field work.

5. Information Transfer

Posters and presentations: A presentation was given to ADF&G Division of Sport Fish Education staff on the project. Posters on the project were presented at the Marine Science Symposium, January 2006, in Anchorage. These posters have also been on display at the Alaska Islands and Oceans Visitor Center in Homer. An oral presentation was given at the Kachemak Bay Science Conference in March of 2006. Updates on the project have been given at semi-annual Lower Kenai Watershed Workgroup meetings, which include representative from various agency and non-profit groups working on the lower Kenai Peninsula.

6. Budget

There are no substantial differences between the expected and actual budget expenses. The project has had the good fortune to receive additional resources this fiscal year, including the use of an ADCP Acoustic Doppler Current Profiler (valued at $55,000) , and the assistance of ADF&G field technicians from five salmon enumeration projects in collecting weekly water chemistry samples at no cost to the project.

Signature of PI:

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Project Web Site Address:
http://www.habitat.adfg.state.ak.us/geninfo/kbrr/research/watershed.html