



Indicators supporting Freshwater Vital Signs for the Arctic Network of Parks

Results and experiences from the 2005 and 2006 field initiatives for rivers and streams



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Photo: G. Burkart (2005)

Partners – Streams Component



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Objectives of the Freshwater Initiative

- Objective 1: Understand the patterns and long-term trends in the physical, chemical, and biological characteristics of streams, lakes, and surrounding watersheds
- Objective 2: Understand how landscape components interact at various spatial and temporal scales to affect freshwater ecosystems

Phase 2 Report (2006)



Across from the Igning River, 2005

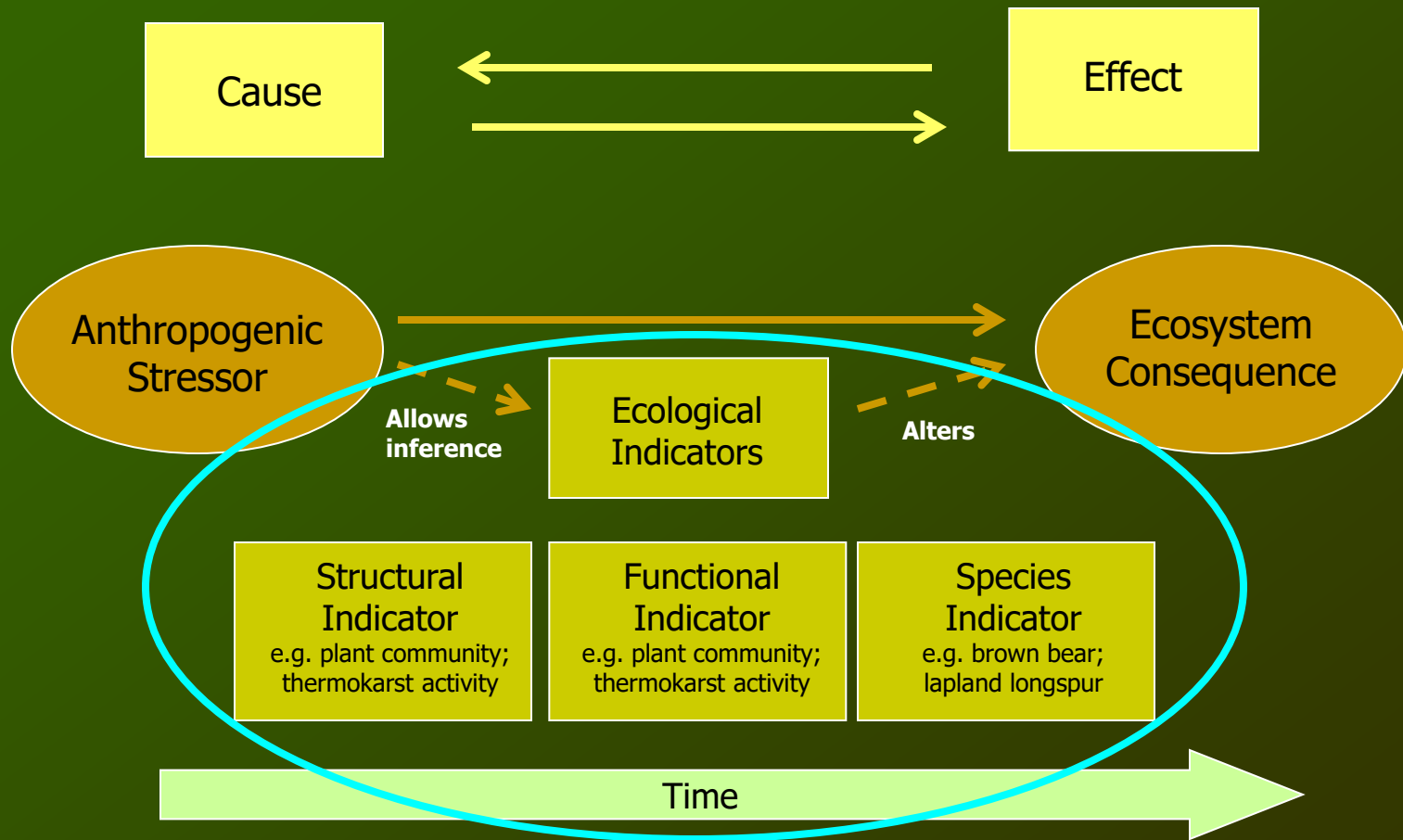
Primary Stream Vital Signs



Ultramafic site (SUM01), Feniak Lake

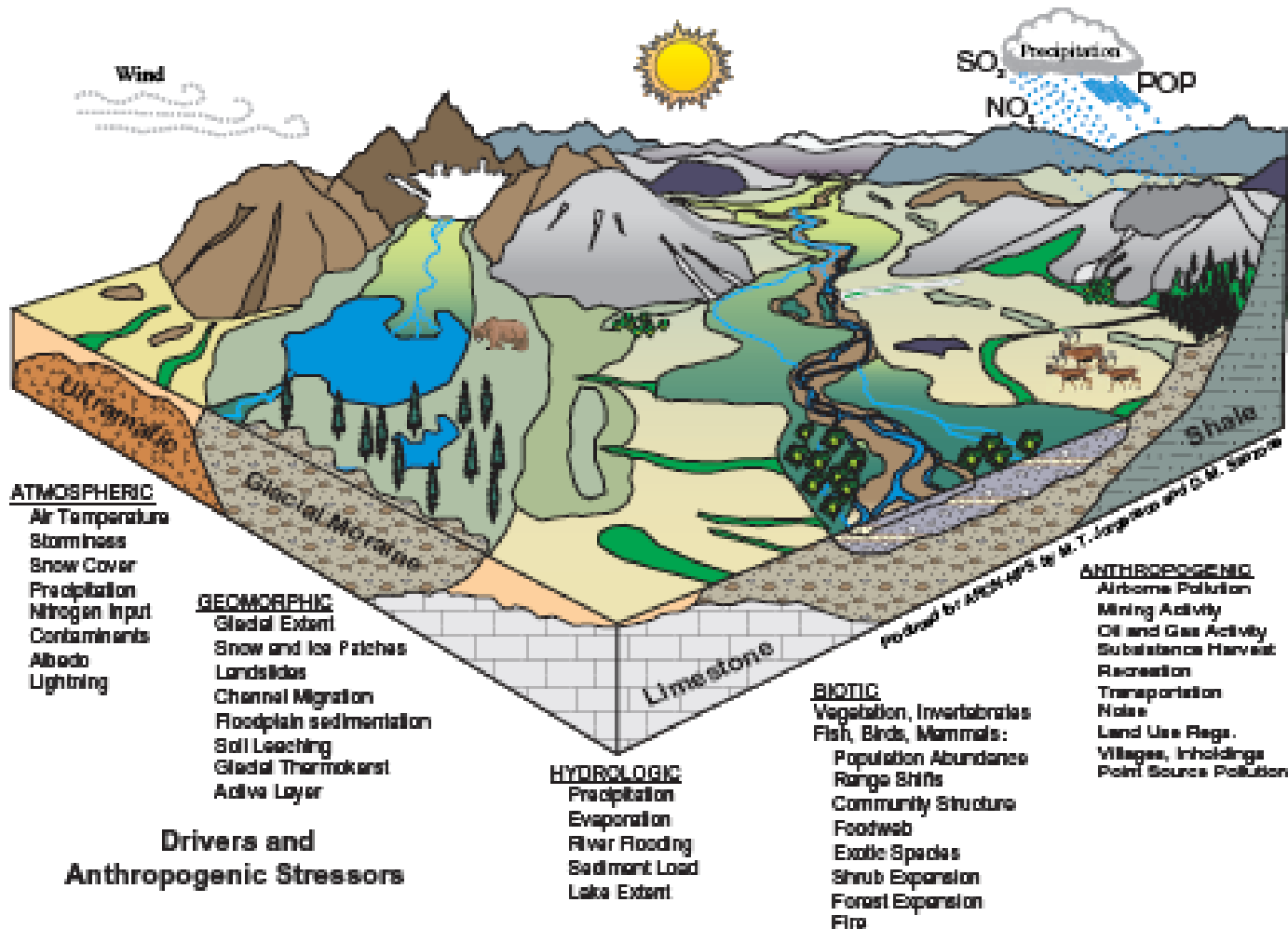
- Stream Communities and Ecosystems – biodiversity and biogeochemistry
- Aquatic Invertebrates
- Fish Assemblages
- Rare and Unique Species and Systems
- Surface Water Dynamics and Distribution

The NPS Monitoring Framework



Phase 2 Report (2006) after Noon (2003)

The Landscape Template



Baseline Survey Data Collection

Stream Metrics

Physical

GPS locations
Photo
Documentation
Flow regime
Substrate

Chemical

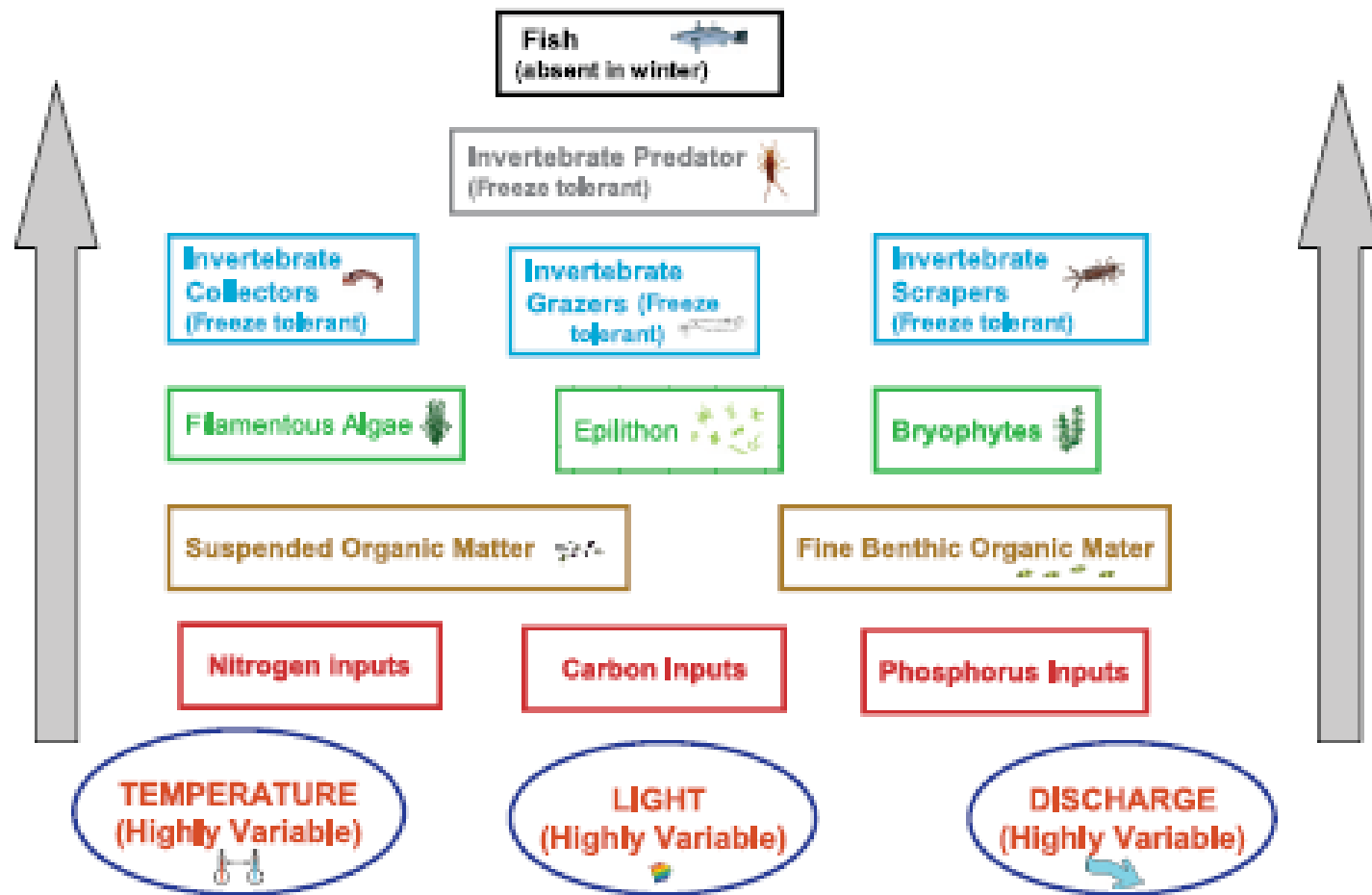
EC (κ)
pH
T °C
DO
Base Cations
Heavy Metals
Nutrients
TPN/TPC
TDP/TDN
Nitrate

Biological

Epilithic Biofilm
CHLa
TC/TN
Algal specimen
Macrophytes &
Bryophytes
Macroinvertebrates
isotopes
biomass
Dominant Vegetation
isotopes

Easy collection – No analysis
Easy collection – Routine analysis
Easy collection – Specialist analysis

Components of Stream Ecosystems

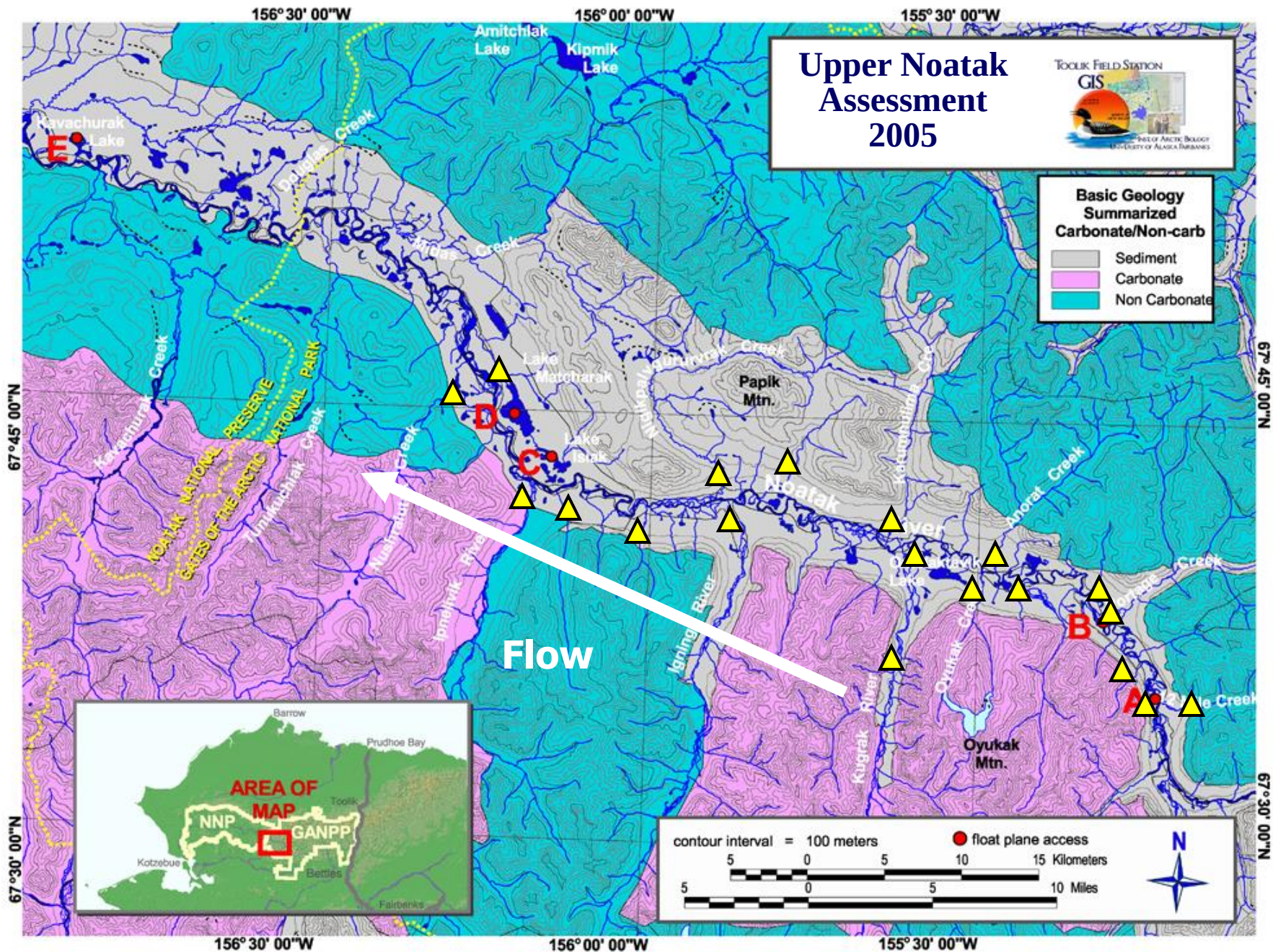


2005 Field Workplan

- River float access
- Upper Noatak in GAAT
- Major river confluences (diverse, high-order)
- Influences of carbonate/non-carbonate lithology
- Unique habitat (Kugrak Spring)



Nushrulatak River, 2005



General Characterization

Metric	Noatak 2005		Noatak 1974 ^a	
	Mean	Range	Mean	Range
Width (m)	10	2.5 - 25	N/A	N/A
Depth (cm)	24	13 - 40	N/A	N/A
D ₅₀ (mm)	54	22.6 - 90	N/A	N/A
Temp. (°C)	12.2	7.2 - 20.2	N/A	N/A
pH	8.3	7.7 - 8.6	7.4	7.0 - 7.5
DO (mg/L)	10.2	7.6 - 13.3	6.8	5.7 - 7.5
*EC (μS/cm)	416	77 - 811	199	44 - 623

***Significant differences between carbonate and non-carbonate sites (t-test, p=0.009)**

**^a Young, S.B. 1974 The environment of the Noatak River basin, Alaska,
Contrib. Cent. North. Stud. 1**

Nutrient Chemistry

Metric	Noatak 2005		North Slope	
	Mean	Range	Mean	Range
*Nitrate (μM)	*7.1	3.7-9.9	3.0 ^a	0.98-6.43 ^a
**TDN (μM)	**10.7	5.1-24.5	N/A	N/A
TDP [SRP] (μM)	0.07	0.01-0.44	[0.04] ^a	[0.025-0.058] ^a
Benthic TN (mg/L)	3.1	0.8-19.2	N/A	N/A
Benthic TC (mg/L)	10.8	1.9-14.6	N/A	N/A
Sestonic TN (mg/L)	0.06	0.01-0.33	N/A	N/A
Sestonic TC (mg/L)	0.65	0.1-2.9	N/A	N/A
CHLa ($\mu\text{g}/\text{cm}^2$)	0.04	0.00-0.3	0.28 ^b	0.08-0.69 ^b

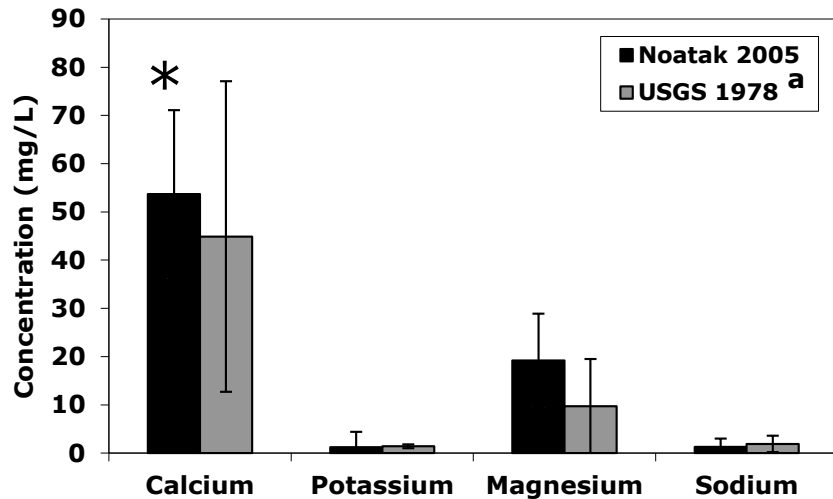
***Significant differences between carbonate and non-carbonate sites (t-test, $p=0.014$)**

****Significant differences (Mann-Whitney, $p=0.008$)**

^aLTER Toolik Lake Research Station SRP data (2000-2004)

^bLTER Toolik Lake Research Station data (June/July 2004)

Base Cations



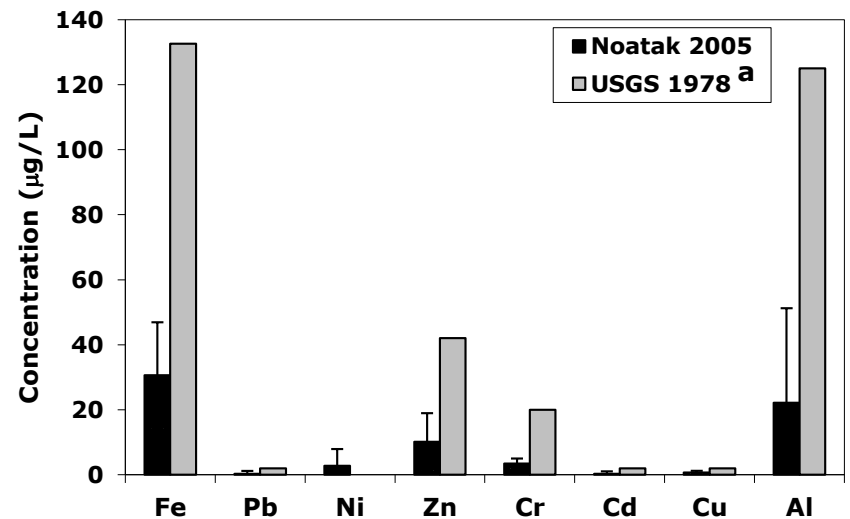
*** Calcium was the only significant difference between carbonate and non-carbonate sites (2-sample t-test, $p=0.009$)**

^aUSGS Water Quality Database

Geochemistry

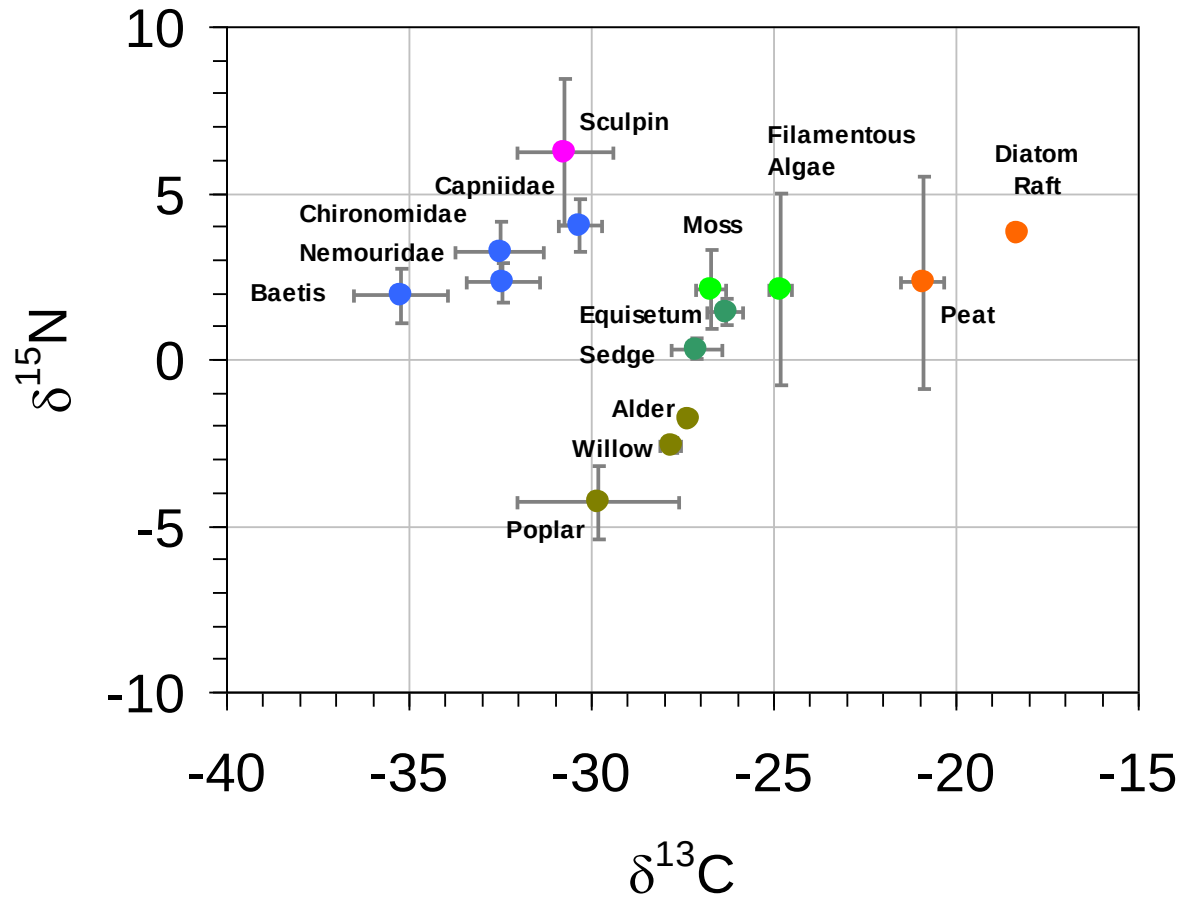
(Comparisons to early USGS data)

Heavy Metals



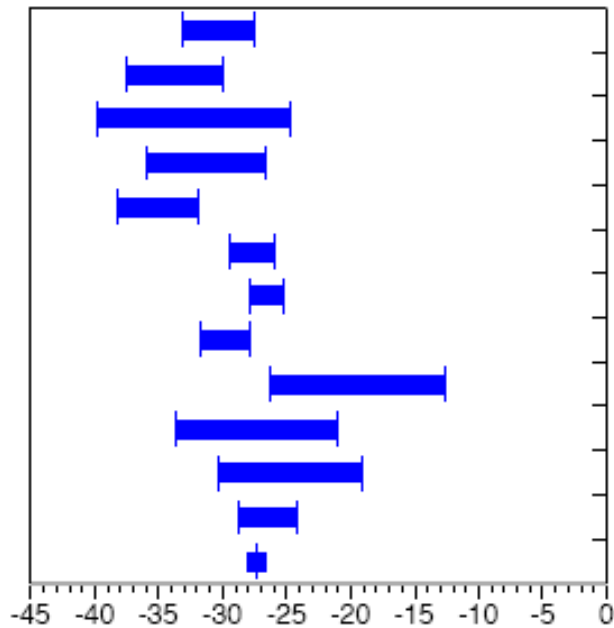
Stable Isotope Bi-plot

Trophic interaction



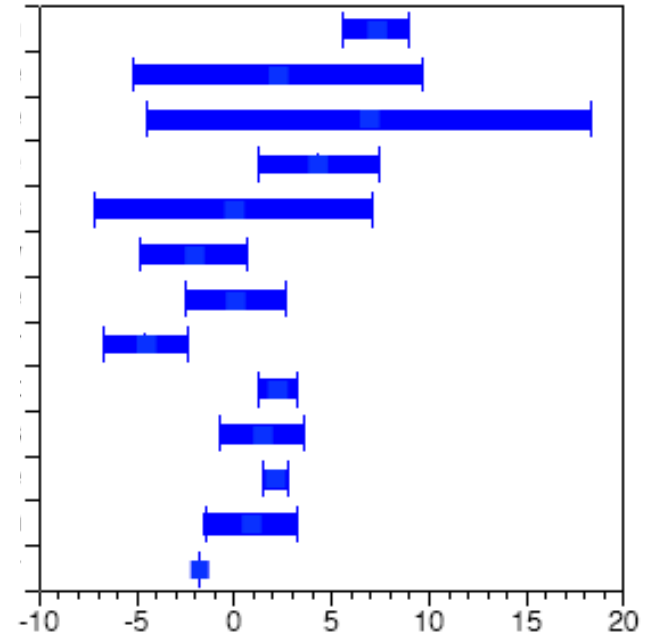
Food Source

Isotopic Composition Ranges



$\delta^{13}\text{C} \text{ ‰}$

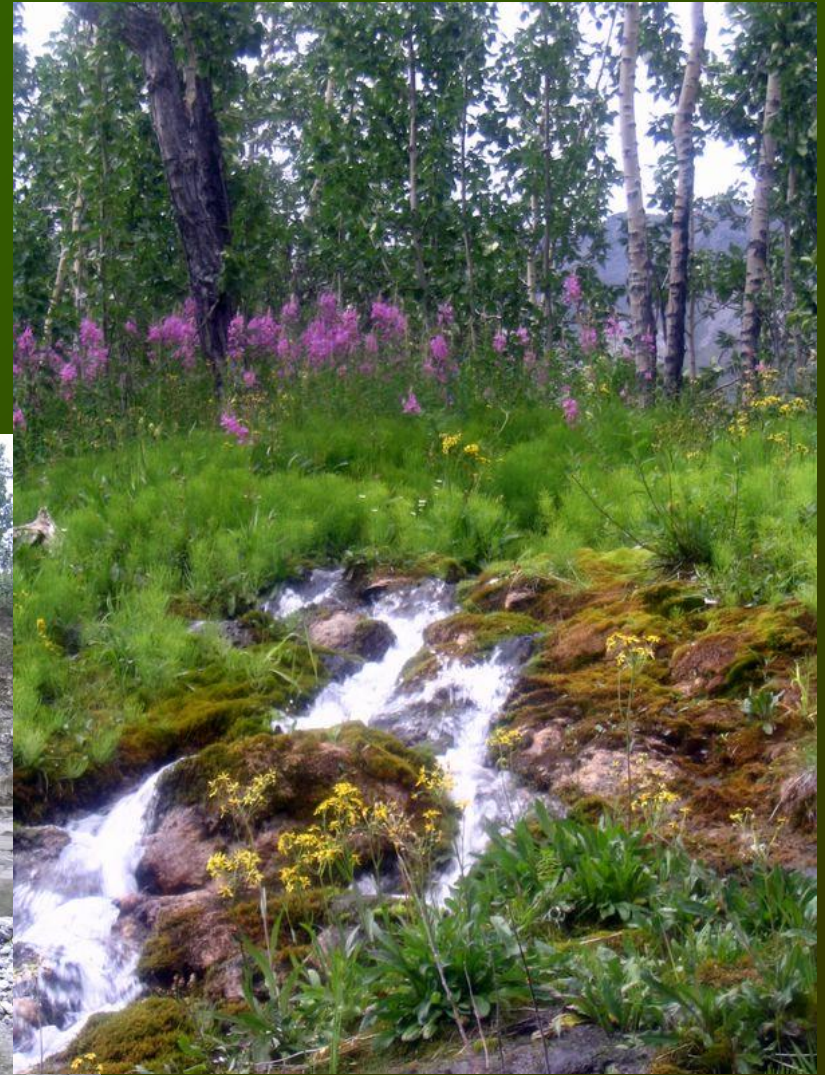
Sculpin
Nemouridae
Chironomidae
Capniidae
Baetidae
Willow
Sedge
Poplar
Peat
Moss
Filamentous Algae
Equisetum
Alder



$\delta^{15}\text{N} \text{ ‰}$

Special Ecosystems

Kugrak Spring



Conclusions

- In general, we observed low diversity and low productivity across stream sites (except Kugrak Spring).
- Few differences attributable to carbonate vs. non-carbonate landscapes.
- Large differences in $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ across stream sites.
- Ecologically sensitive area: Kugrak Spring
 - High biological diversity, but few surprises
 - Productive system, but few geochemical differences
- Float-sampling major tributary mouths has operational limitations
 - Time and effort limitations
 - Valley bottom “re-setting” of stream characteristics?

Feniak Lake

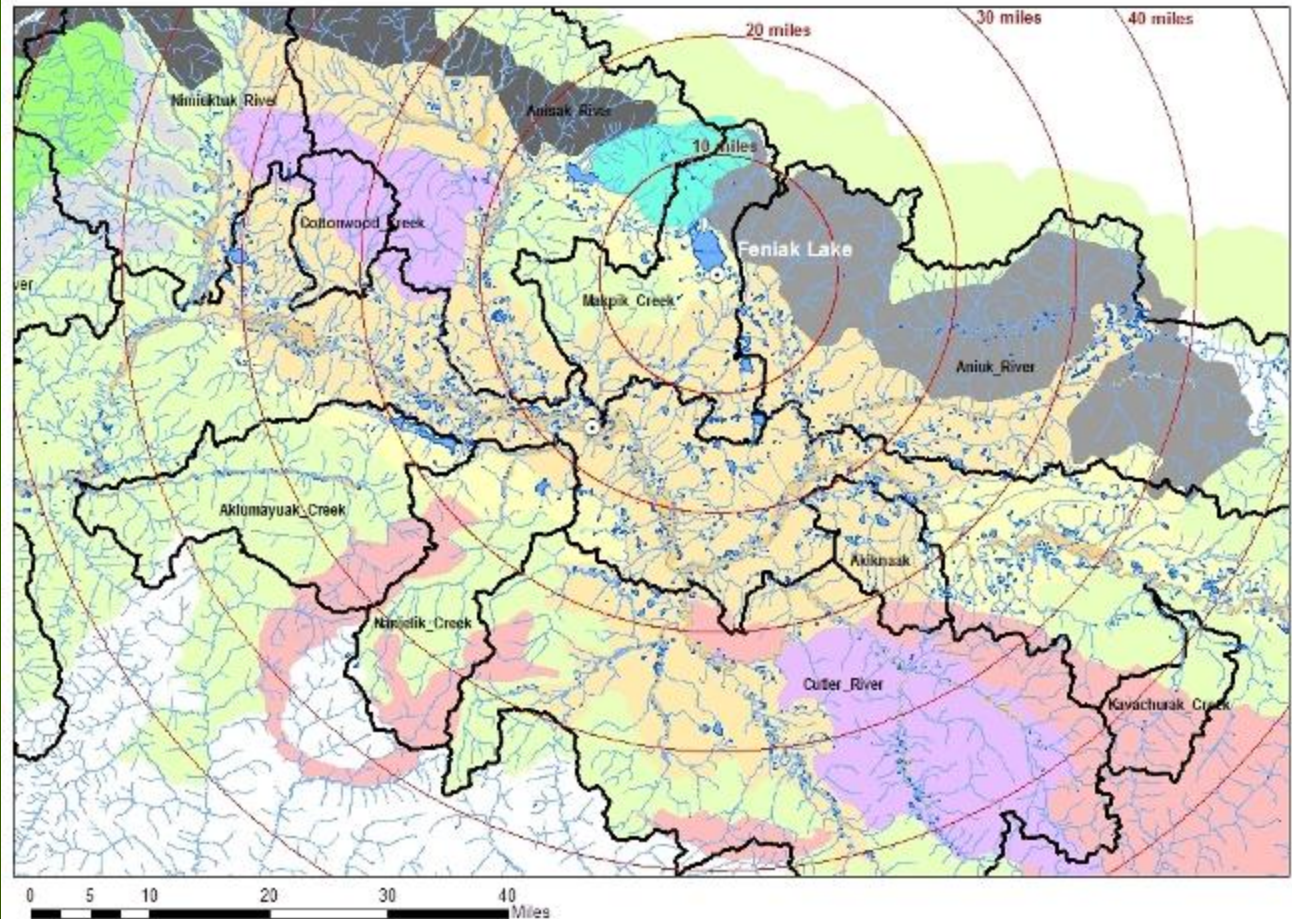
Site of 1973 and 2006 Base Camps



Photo: Steve Young (1973)

Study Site 2006: Feniak Lake

EcoSubSections: Lithology by Watershed



Ultramafic

Quaternary, glacial deposits

Quaternary non-carbonate, glacio-lacustrine

Sedimentary, non-carbonate

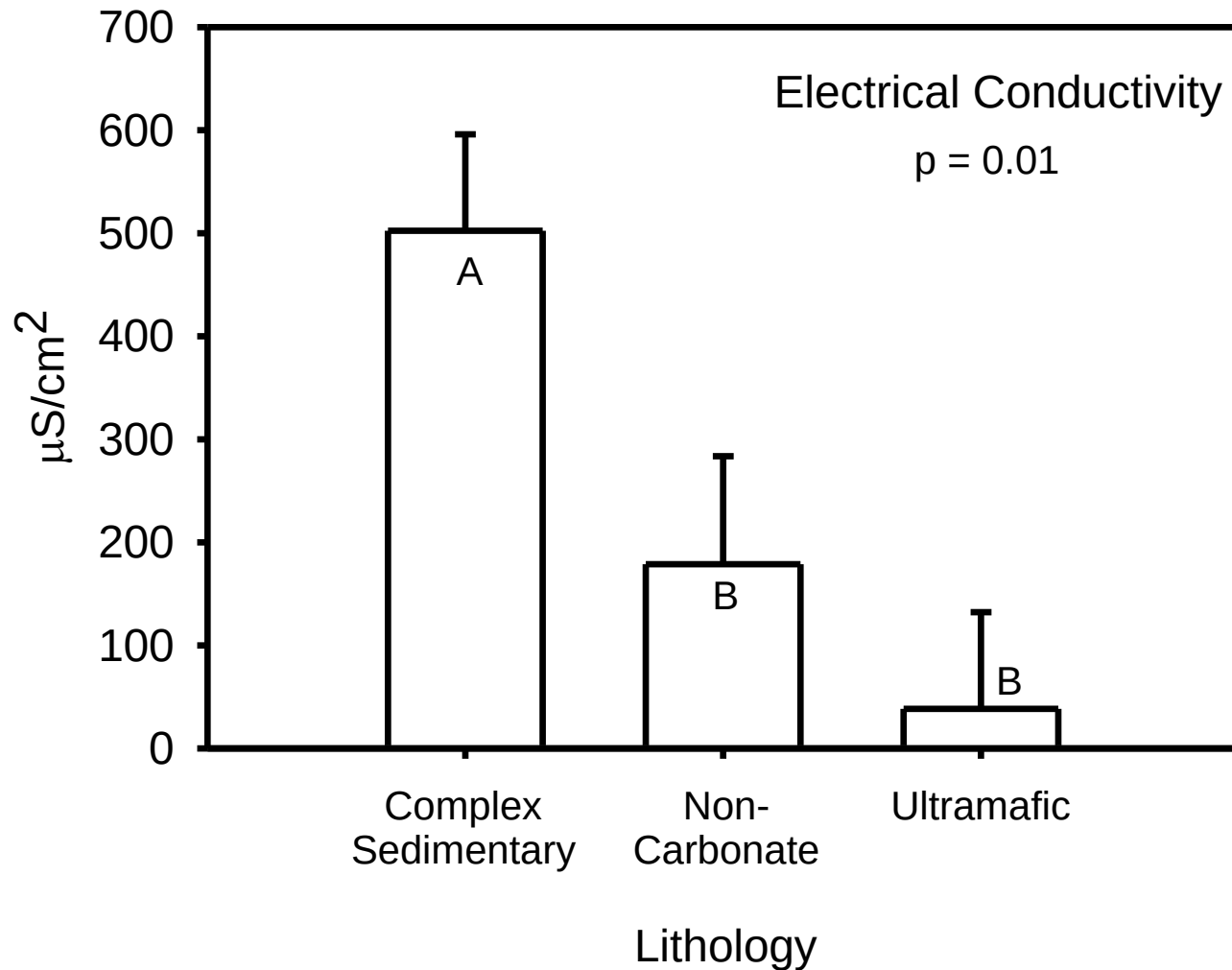
Complex sedimentary mix

2006 Field Workplan

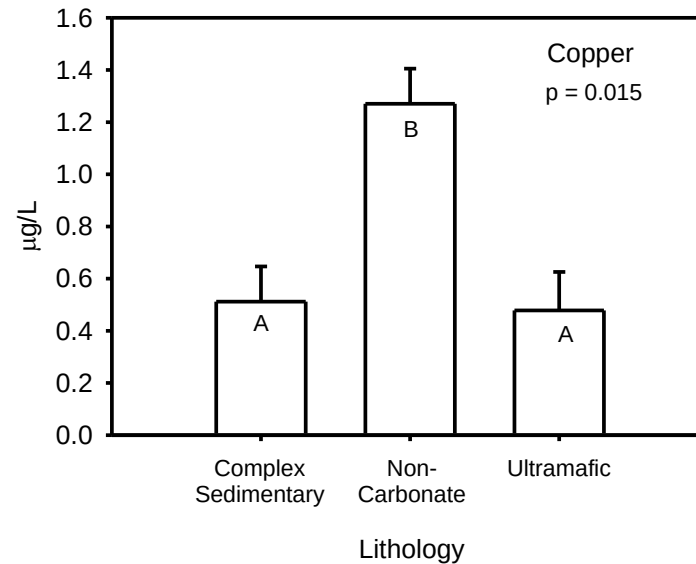
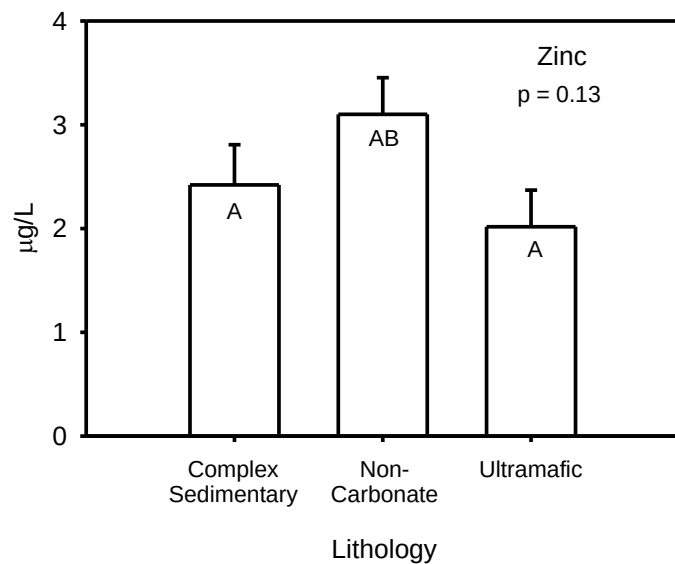
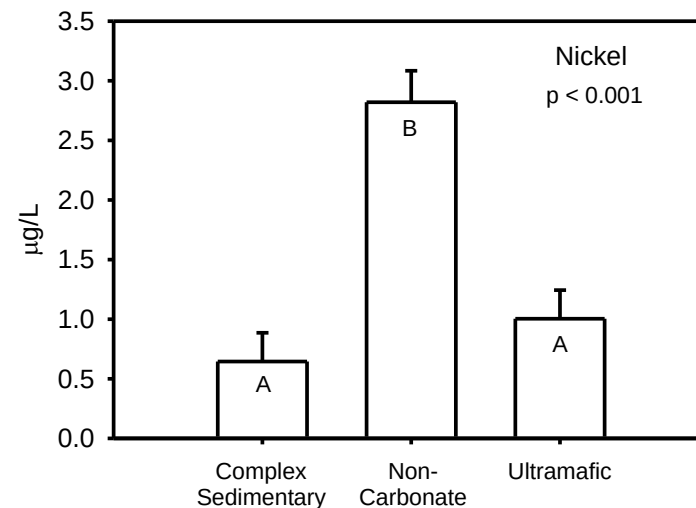
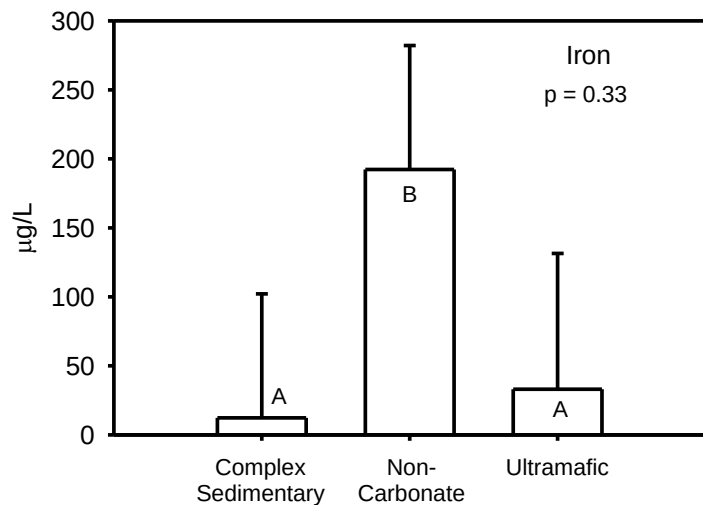
- Feniak Lake area in upper NOAT
- Across landscape contrasts (ultramafic, mixed, and non-carbonate lithology)
- Within site homogeneity (uniform lithology, low-order)
- Fixed camp, helicopter support



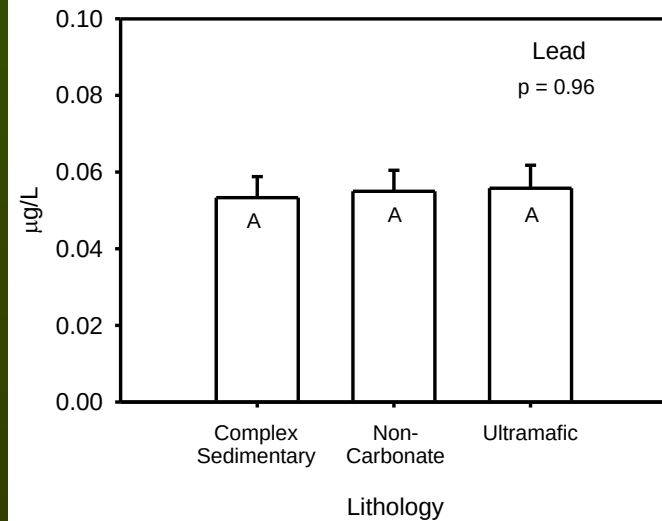
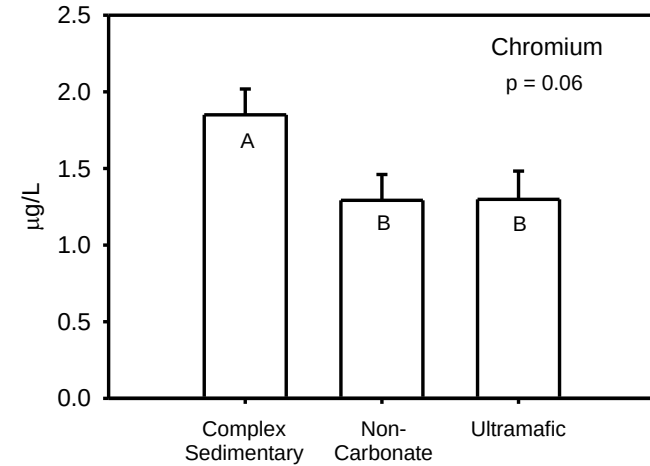
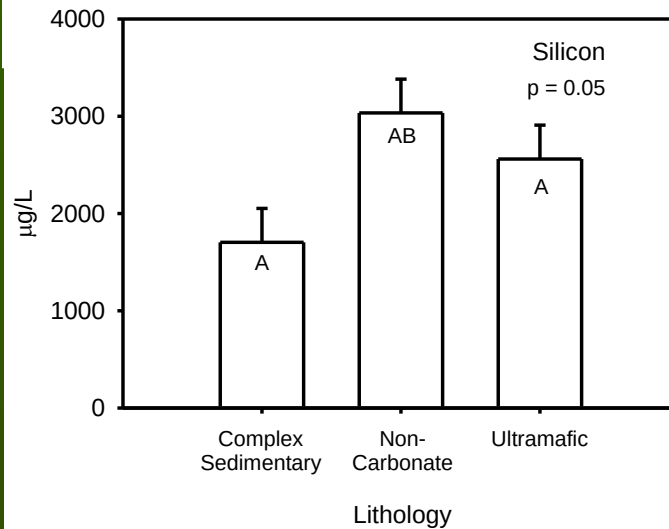
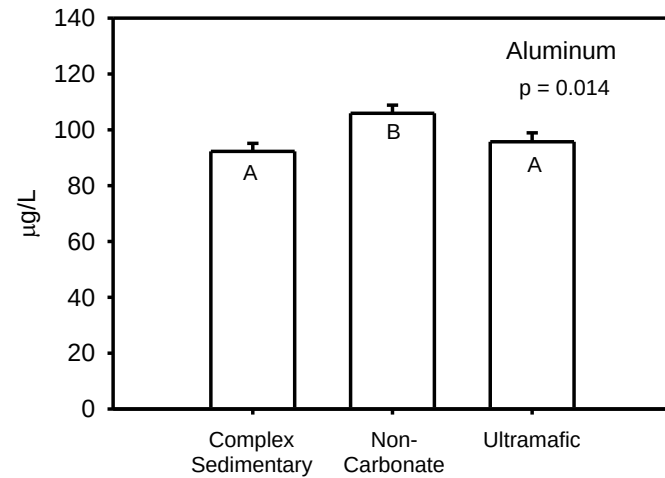
Basic Characteristics



Geochemistry

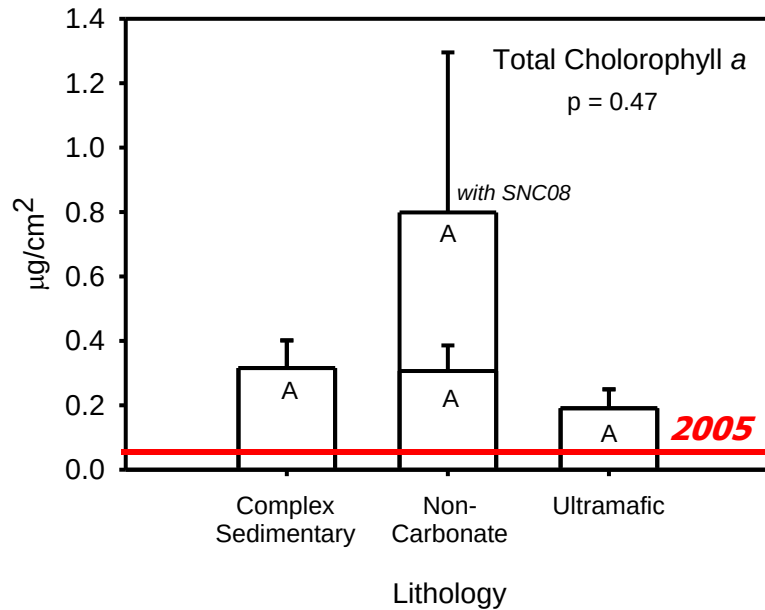


Geochemistry

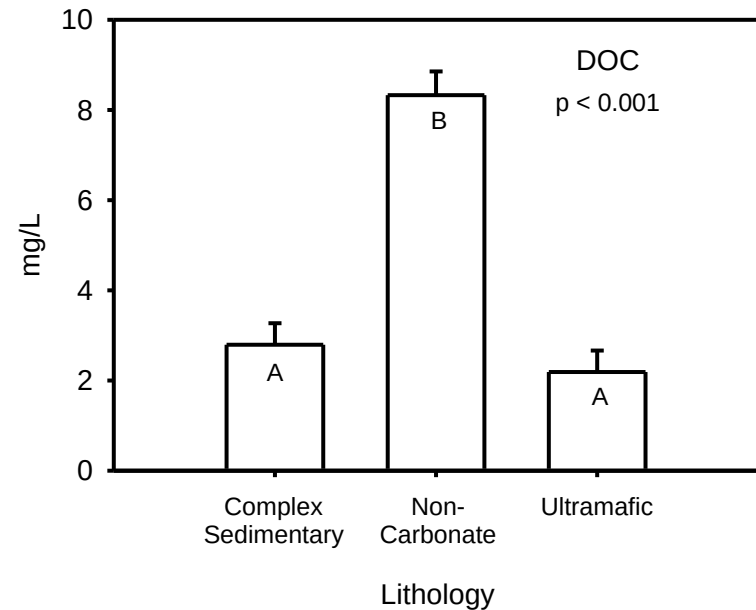


Cadmium undetectable everywhere

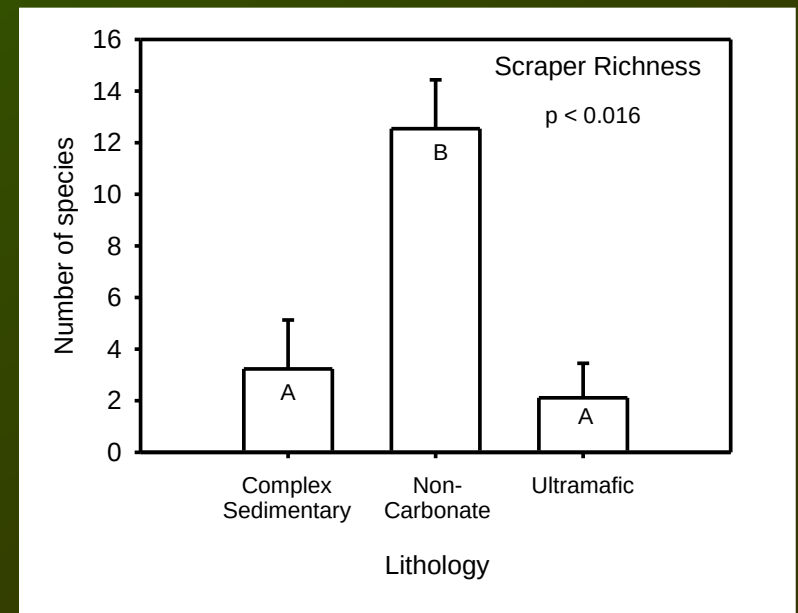
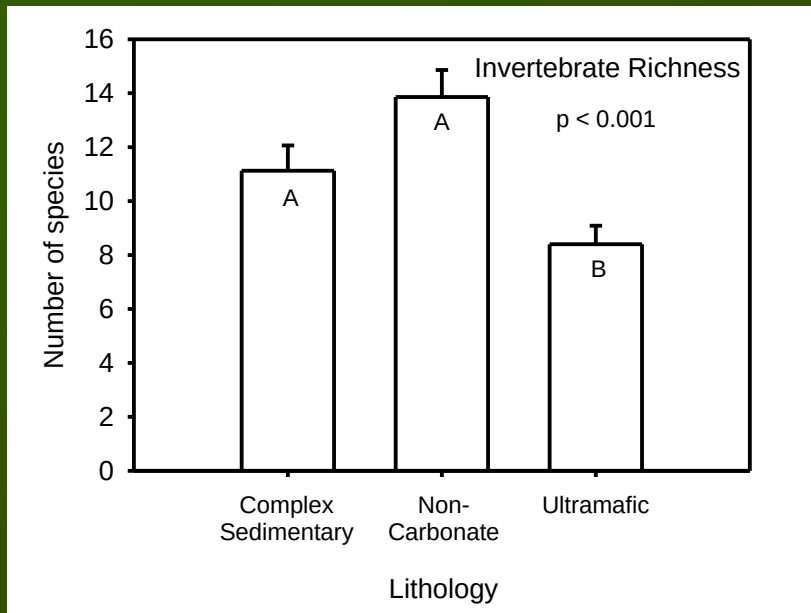
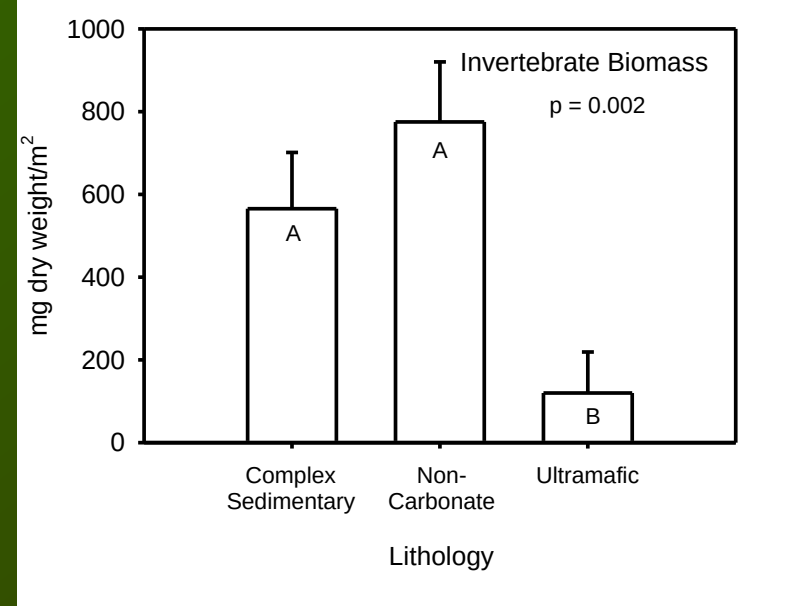
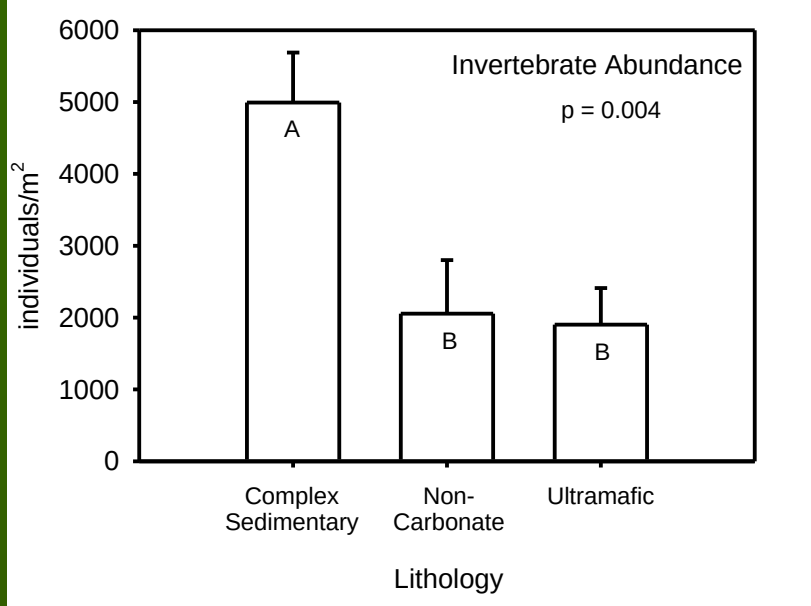
Chlorophyll (Primary Producers)



Organic Production



Invertebrates (Secondary Producers)



Key Findings for Vital Signs

- After ~35 years the state of stream resources in upper Noatak River basin is still superb
- Many (but not all) of these headwater systems are notably unproductive (ultra-oligotrophic) even by Alaska standards.
- There are, however, strong correlations among lithology, terrestrial communities and stream characteristics
- These correlations can be used to help design efficient monitoring programs



Camp 4, 2005

Immediate Plans

- Draft protocols for the Freshwater Vital Signs (2007)
- Develop plans to complete baseline sampling of the lower Noatak River (2008)?

What to monitor – Easy

How often to monitor – Relatively easy

Where to monitor – Hard



Acknowledgements



The 2005 Field Team

The 2006 Field Team

