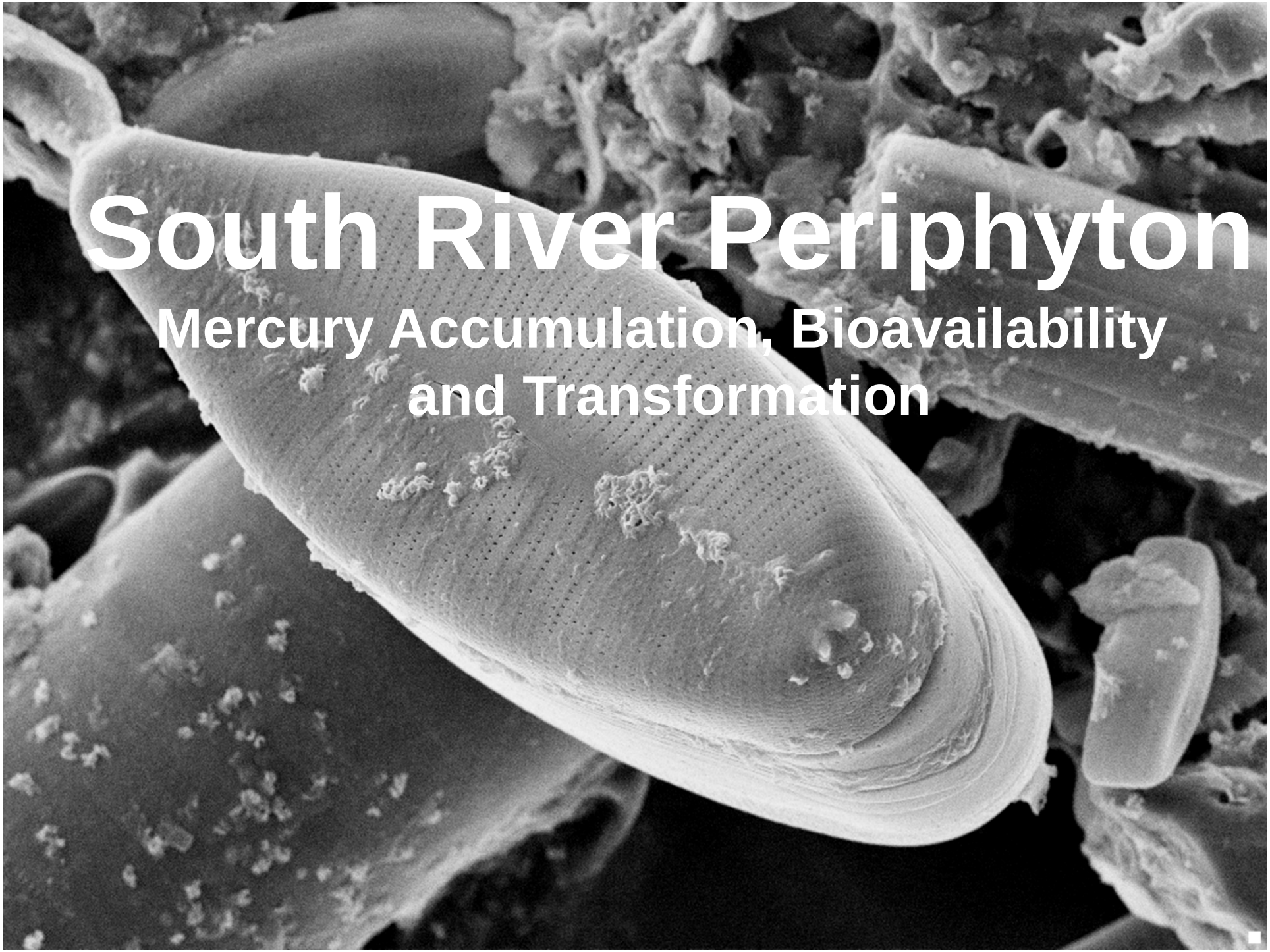


South River Periphyton

Mercury Accumulation, Bioavailability and Transformation

Conceptual Context

Biogeochemically Dynamic/Important Component

Adsorption
Coprecipitation

Bioaccumulation
Physical Inclusion

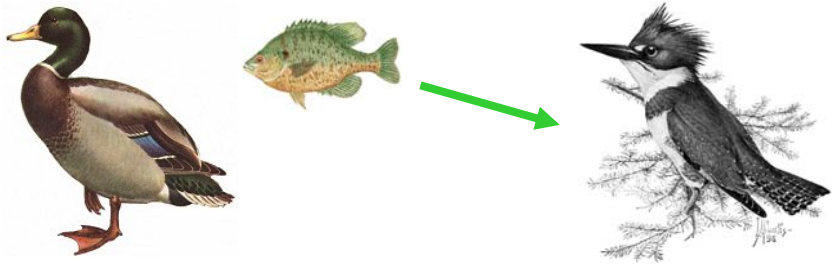
"Periphyton"
Biomonitoring

"Surface Coatings"
Metal Prospecting

Trophic Uptake
and Availability

Hg methylation by
sulfur-reducing
bacteria in microlayer
and deep anoxic layer;
heterocysts of BG Algae

Trophic Transfer
& Magnification



Tiered Study - Hg Accumulation and Trophic Transfer

1. Define the Mercury in Site Periphyton
   - How high are periphyton mercury concentrations?
   - How high relative to other components, e.g, fish, clams?
   - How are periphyton mercury concentrations distributed in the study area?
   - Do organic carbon, Mn, and Fe correlate with mercury concentration?

2. Quantify Methylmercury in Periphyton
   - Previously sampled locations in study area

3. Define Mercury within Trophic Web
   - Periphyton, grazers, grazer consumers, predators (fish, birds)
   - Subset of locations
   - N isotopes for quantifying trophic position
   - Regression models predicting mercury from trophic status

4. Manipulative Experiment Quantifying Bioavailability
   - *In situ* or in laboratory grazer uptake kinetics
   - Support eventual trophic model

Mercury in Site Periphyton

<u>JUNE PERIPHYTON STUDY (based on Corbicula Study)</u>

- Define total Hg concentration in periphyton
- Test for significant difference from reference region
    - Dunnett's Test
- Correlation Analysis of [Hg] versus
    - river km, organic carbon, Fe and Mn

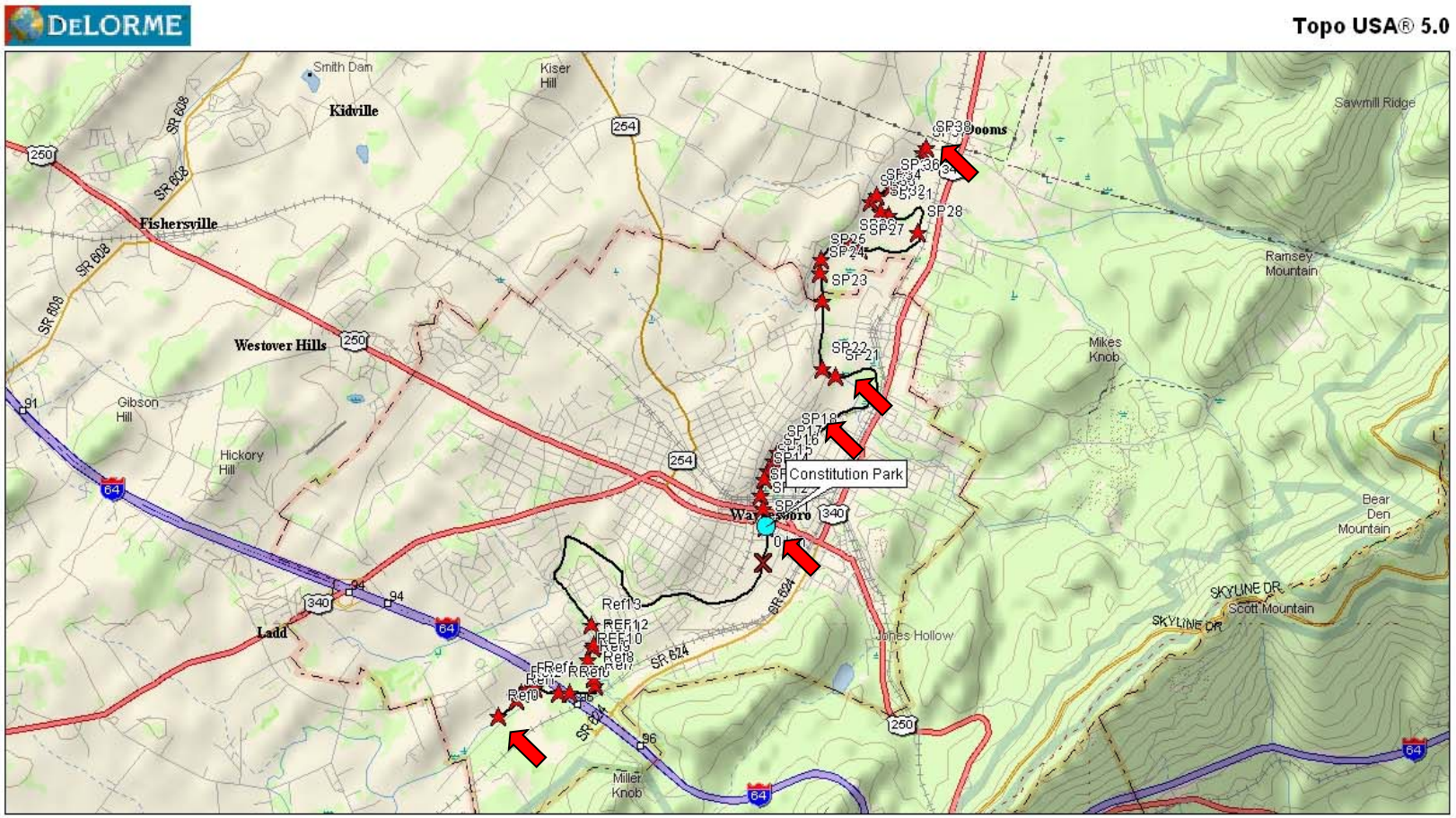
42 samples plus QC/QA Samples

- **Hg (total amt/g dry wgt)**
- **C (amt of organic matter)**
- **C/N isotopes (trophic position)**
- **Fe & Mn (amt of adsorption to oxides)**

Subsets for exploring composition of "periphyton"

- **SEM/EDAX visual & elemental characterization**

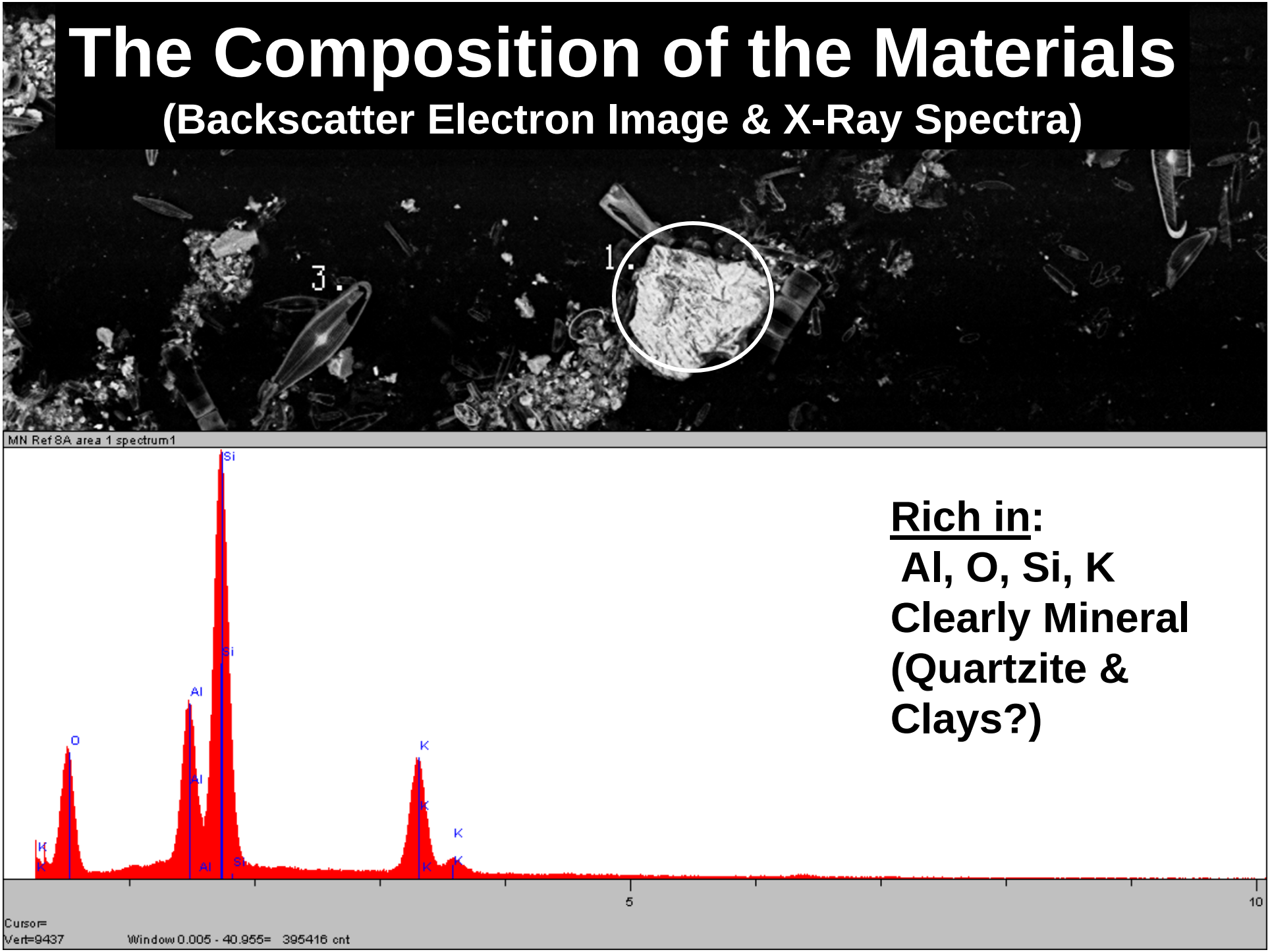
Define & Test [Hg] Difference



Qualitative Examination of “Periphyton”

The Composition of the Materials

(Backscatter Electron Image & X-Ray Spectra)



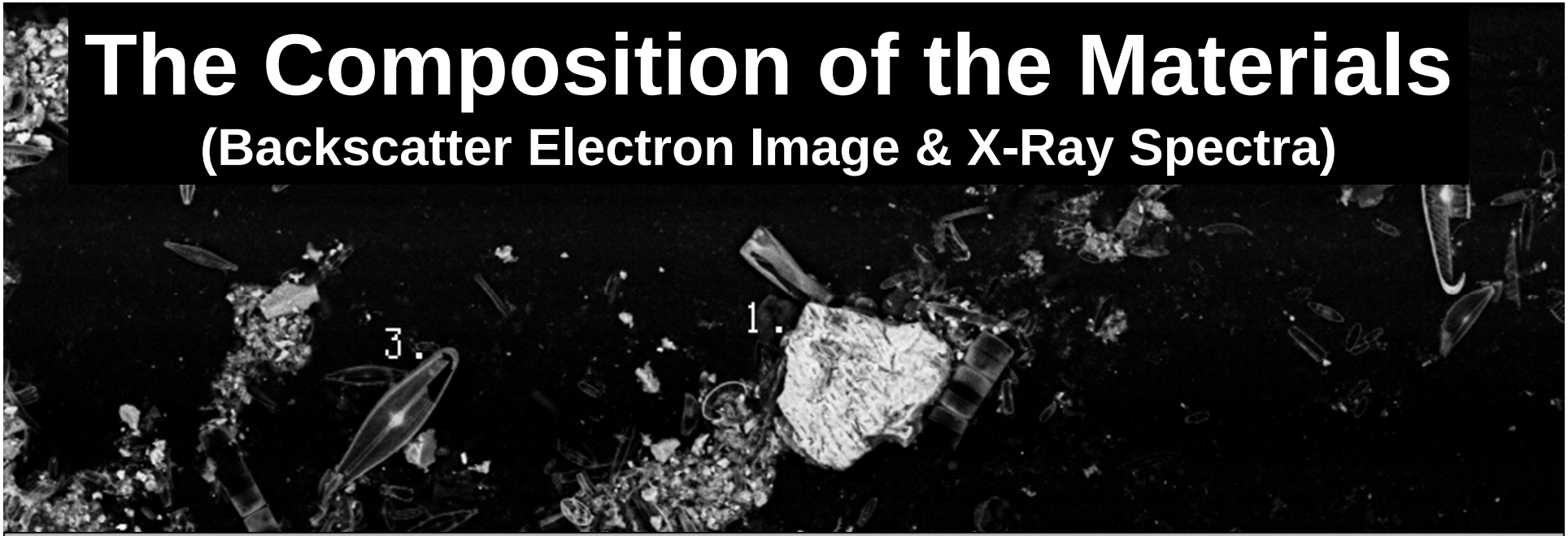
<u>Rich in</u>:

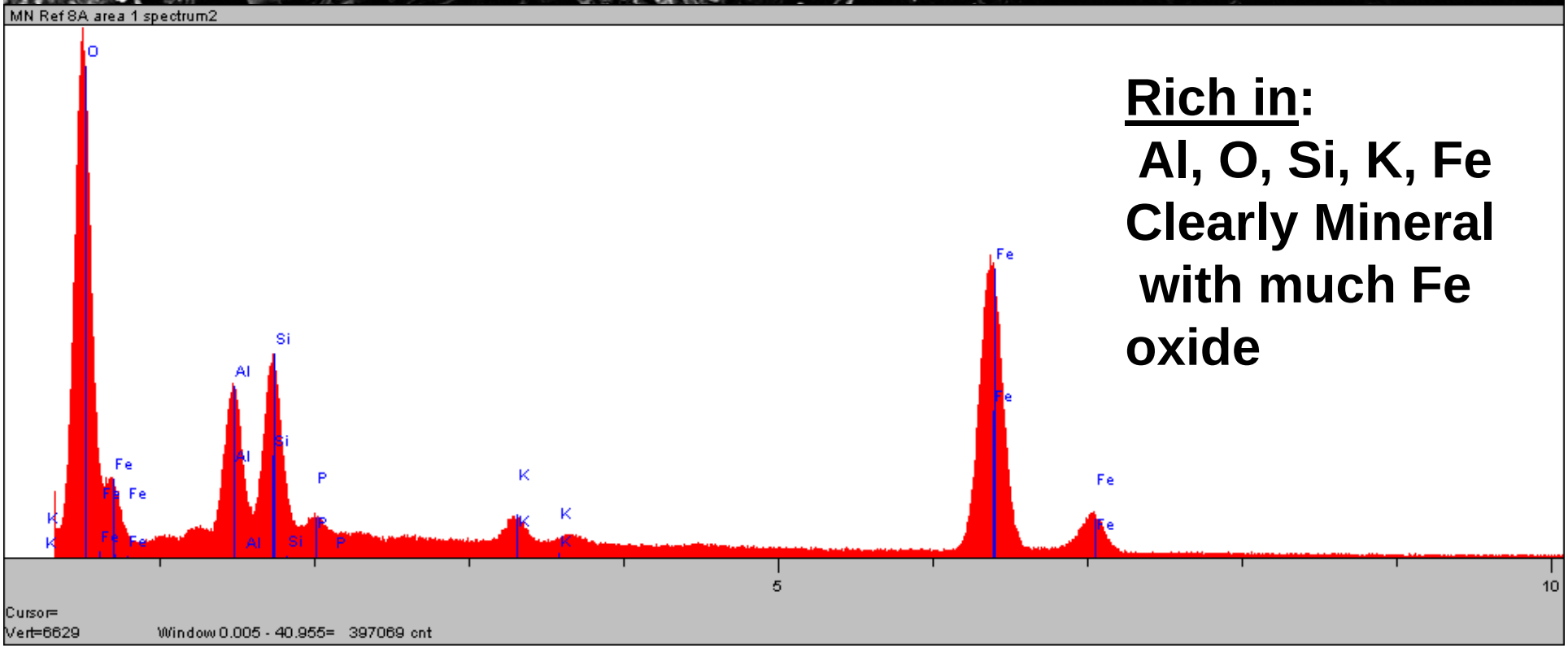
Al, O, Si, K

Clearly Mineral (Quartzite & Clays?)

The Composition of the Materials

(Backscatter Electron Image & X-Ray Spectra)





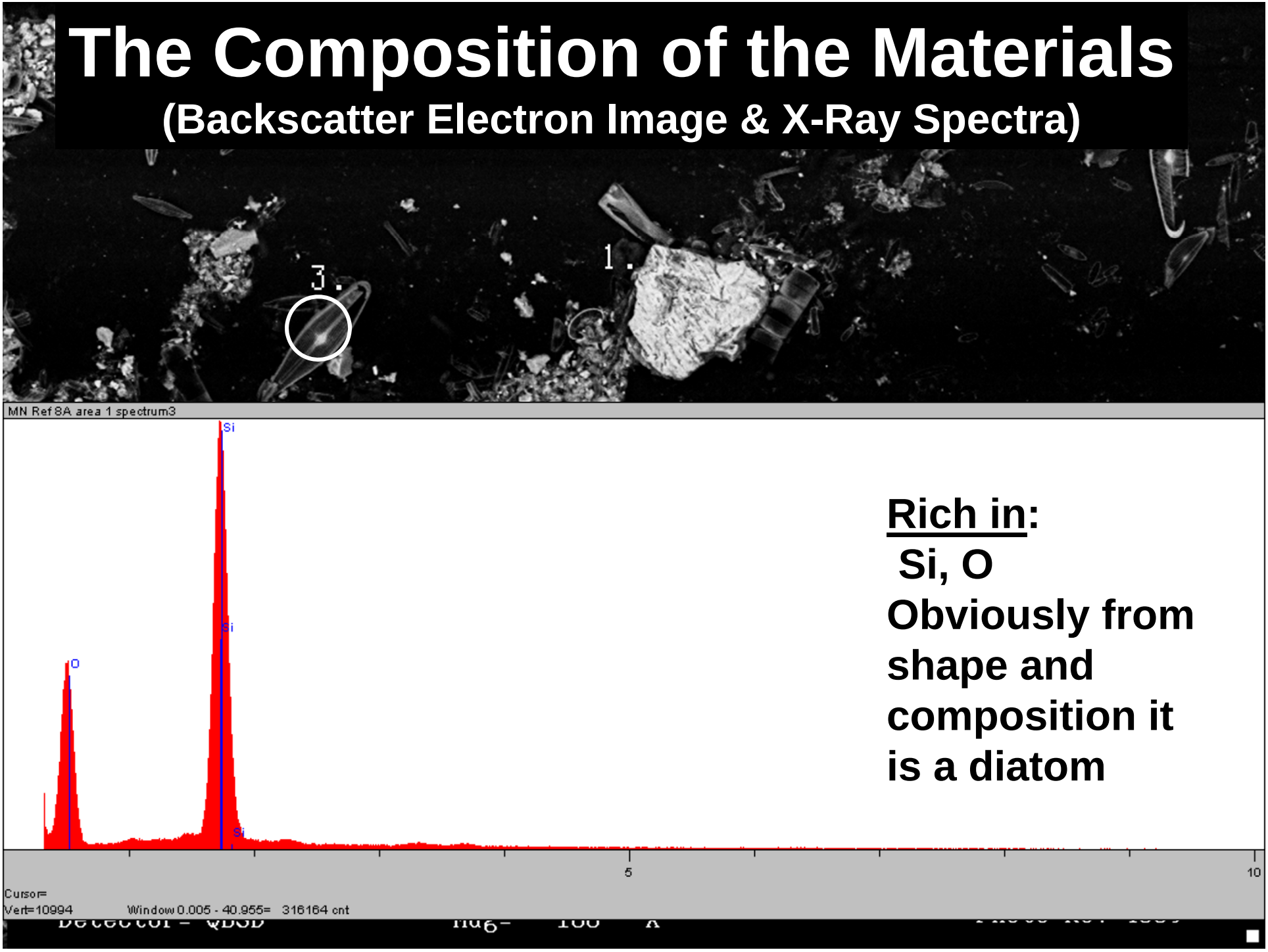
<u>Rich in</u>:

Al, O, Si, K, Fe

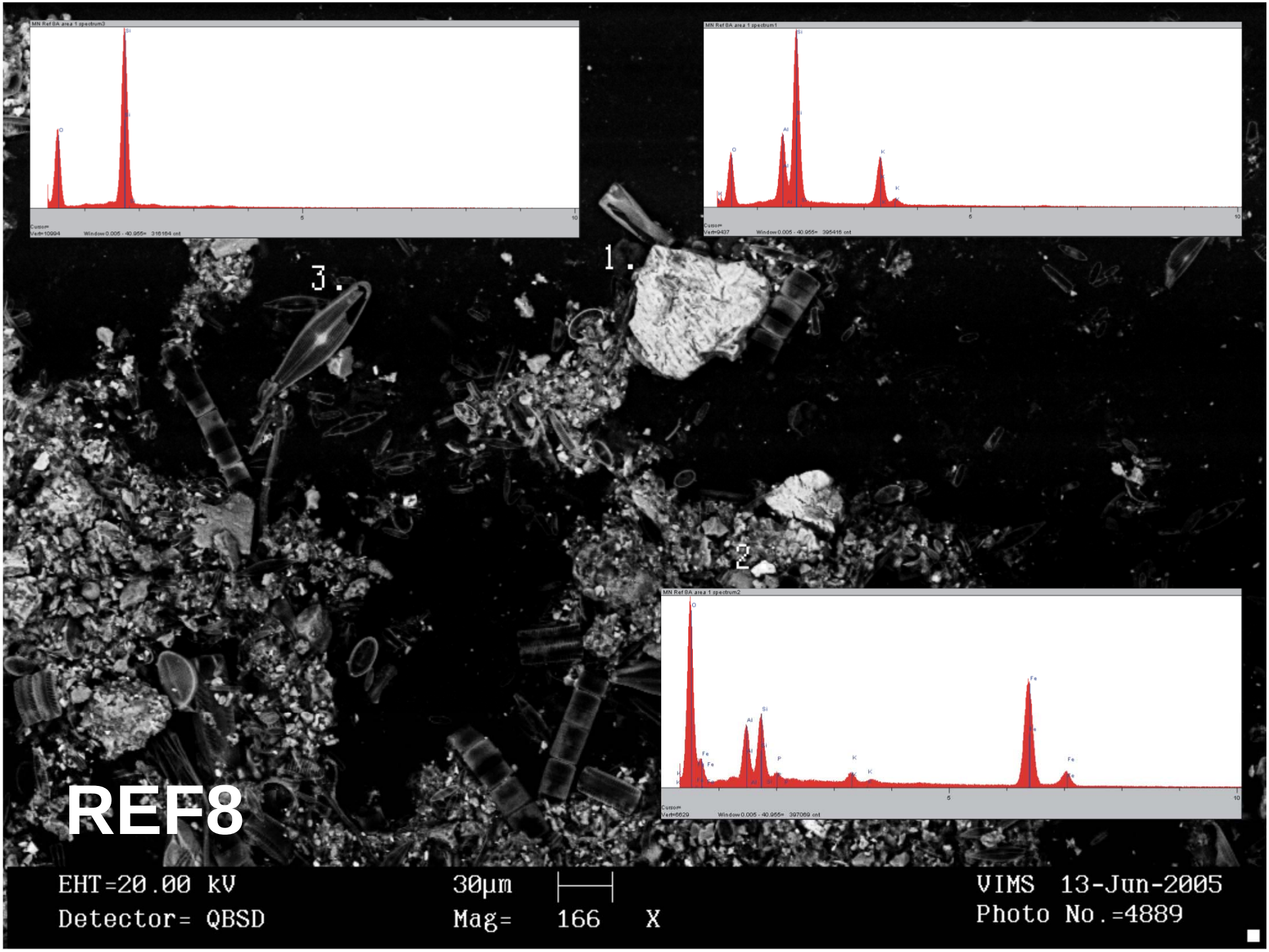
Clearly Mineral with much Fe oxide

The Composition of the Materials

(Backscatter Electron Image & X-Ray Spectra)



<u>Rich in</u>:
Si, O
Obviously from shape and composition it is a diatom


MN Ref 8A area 1 spectrum3
MN Ref 8A area 1 spectrum1
MN Ref 8A area 1 spectrum2
3.
1.
2
REF8
EHT=20.00 kV
Detector= QBSD
30µm
Mag= 166 X
VIMS 13-Jun-2005
Photo No.=4889

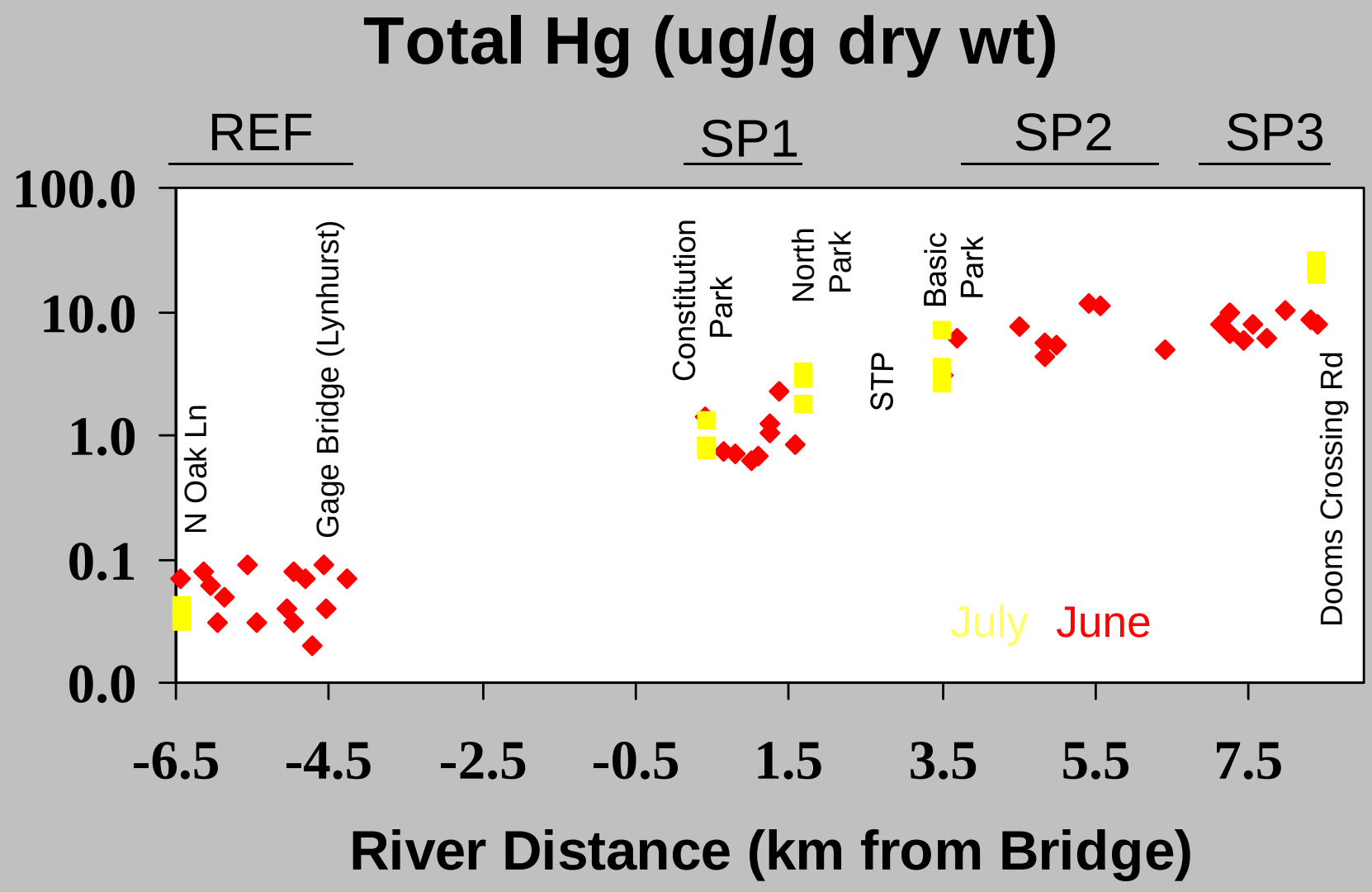
Conclusion - SEM/EDAX Analysis

Extremely Heterogeneous

<u>4-F</u>: Fines Flora Fauna Flocs

Predictions about trophic transfer and transport/transformations must take this into consideration

Mercury Spatial Distribution



Dunnett's & SNK Tests

Intensive June Sampling

Dunnett's Test (ln Total Hg Concentration)

Means of each site significantly different from that of REF

SNK Test

REF SP1 SP2 SP3

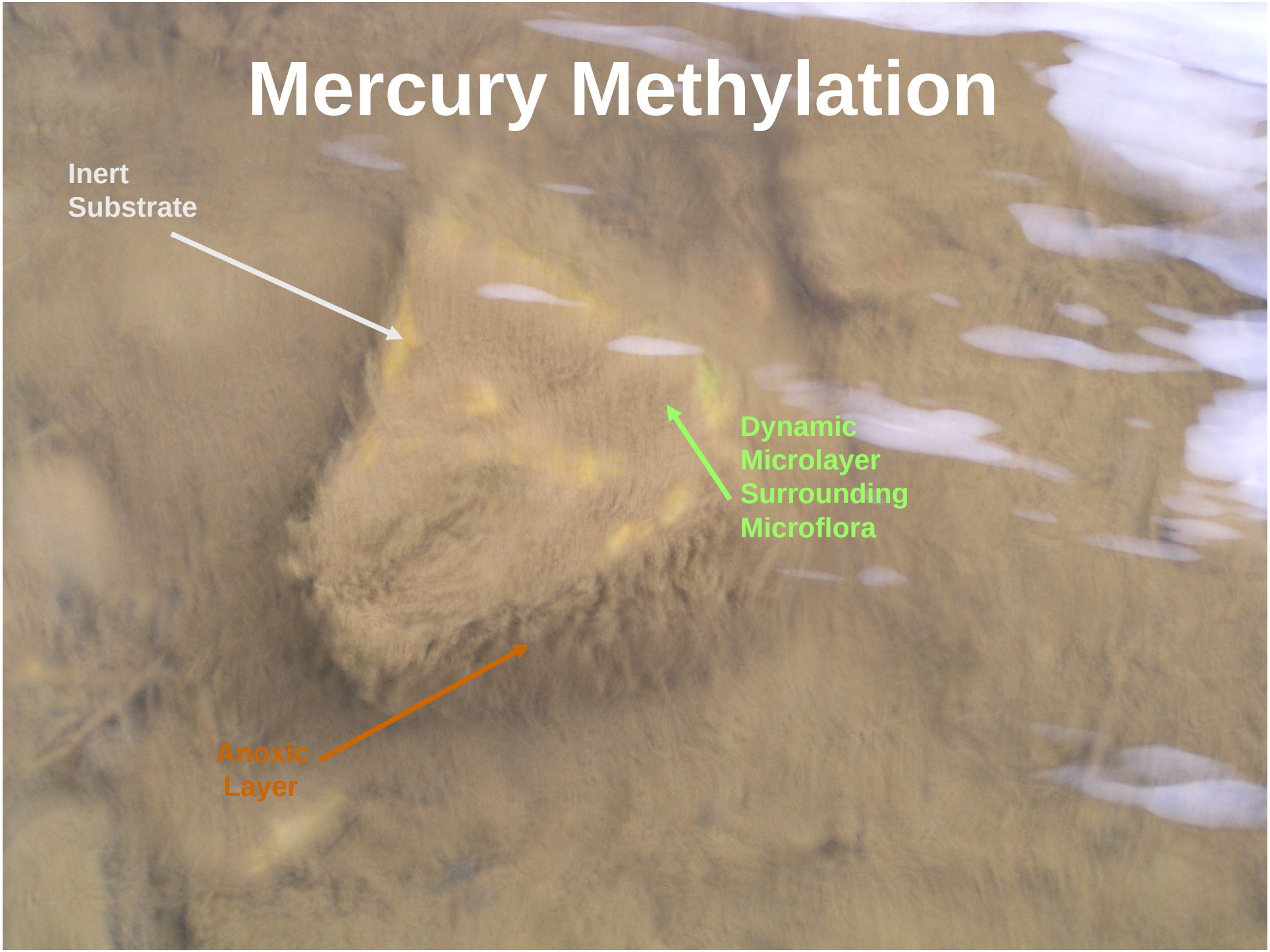
July Sampling

Dunnett's Test (ln Total Hg Concentration)

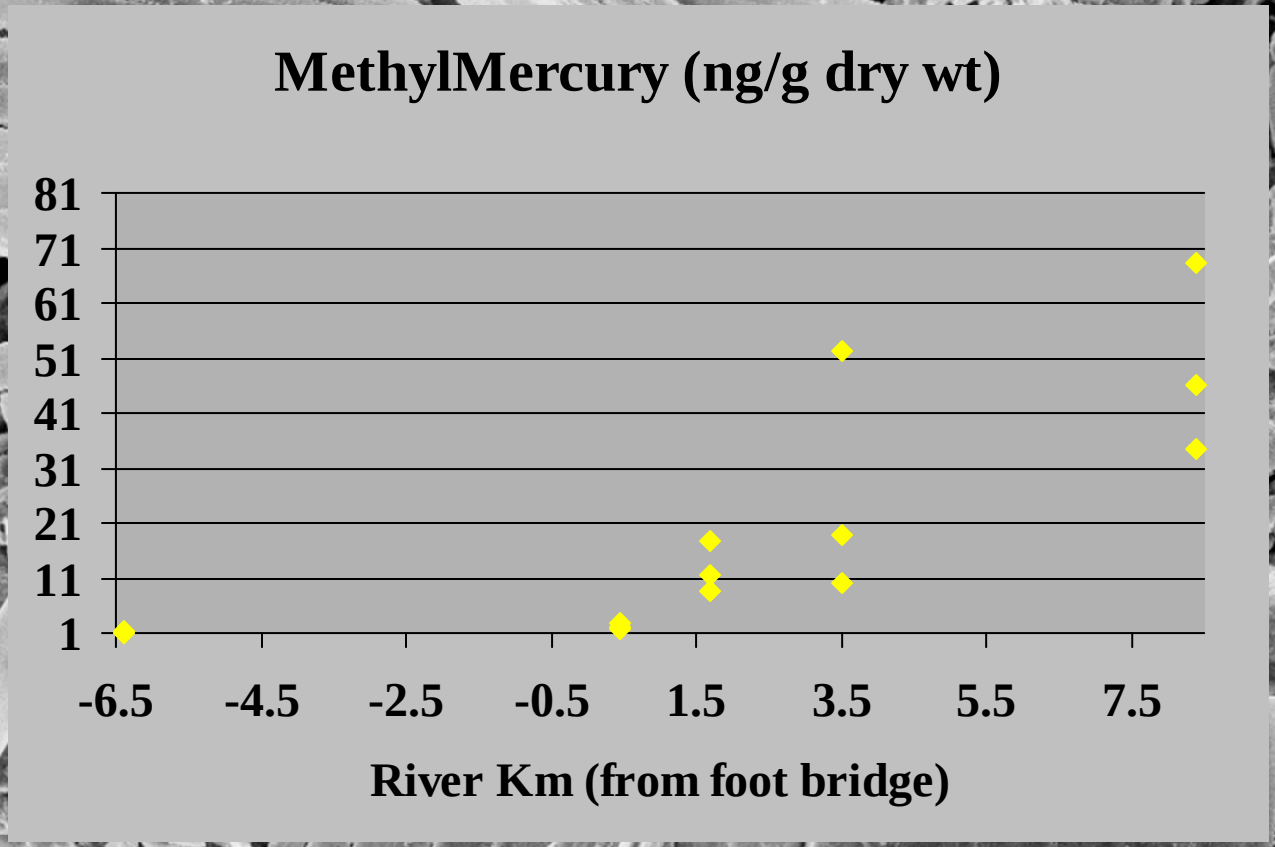
Mean of each site significantly different from that of REF0

SNK Test

REF0 SP1-1 SP2-1 NORTH PARK SP3-8


Mercury Methylation
Inert
Substrate
Dynamic
Microlayer
Surrounding
Microflora
Anoxic
Layer

MethylHg in Periphyton



Correlated (Kendall Tau b) -
STRONG: River km (+, 0.015) Total Hg (+, <.0001)
MODERATE: $\delta^{15}N$ (+, 0.033) Organic Carbon (+, 0.015)

Concentrations and Correlations

Intensive June Sampling

High Total Hg at downstream sites

River Km vs ‰ ^{15}N (+, <.0001), Total Hg (+, <.0001)

O. Carbon vs ‰ ^{15}N (+, .0026)

Total Hg vs Fe (+, 0.017), ‰ ^{15}N (+, <.0001)

July Sampling (+ mHg and Area)

High methylmercury at downstream sites

River Km vs Total Hg (+, <.0001), mHg (+, <.0001),
‰ ^{15}N (+, .026), O. Carbon (+, .043)

MethylHg vs Total Hg (+, <.0001),
O. carbon (+, .015), ‰ ^{15}N (+, 0.033)

Both total and methyl Hg increase downstream

‰ ^{15}N increases after the STP

Covariates such as OC, Fe, Mn have modest influence on Hg

Trophic Transfer

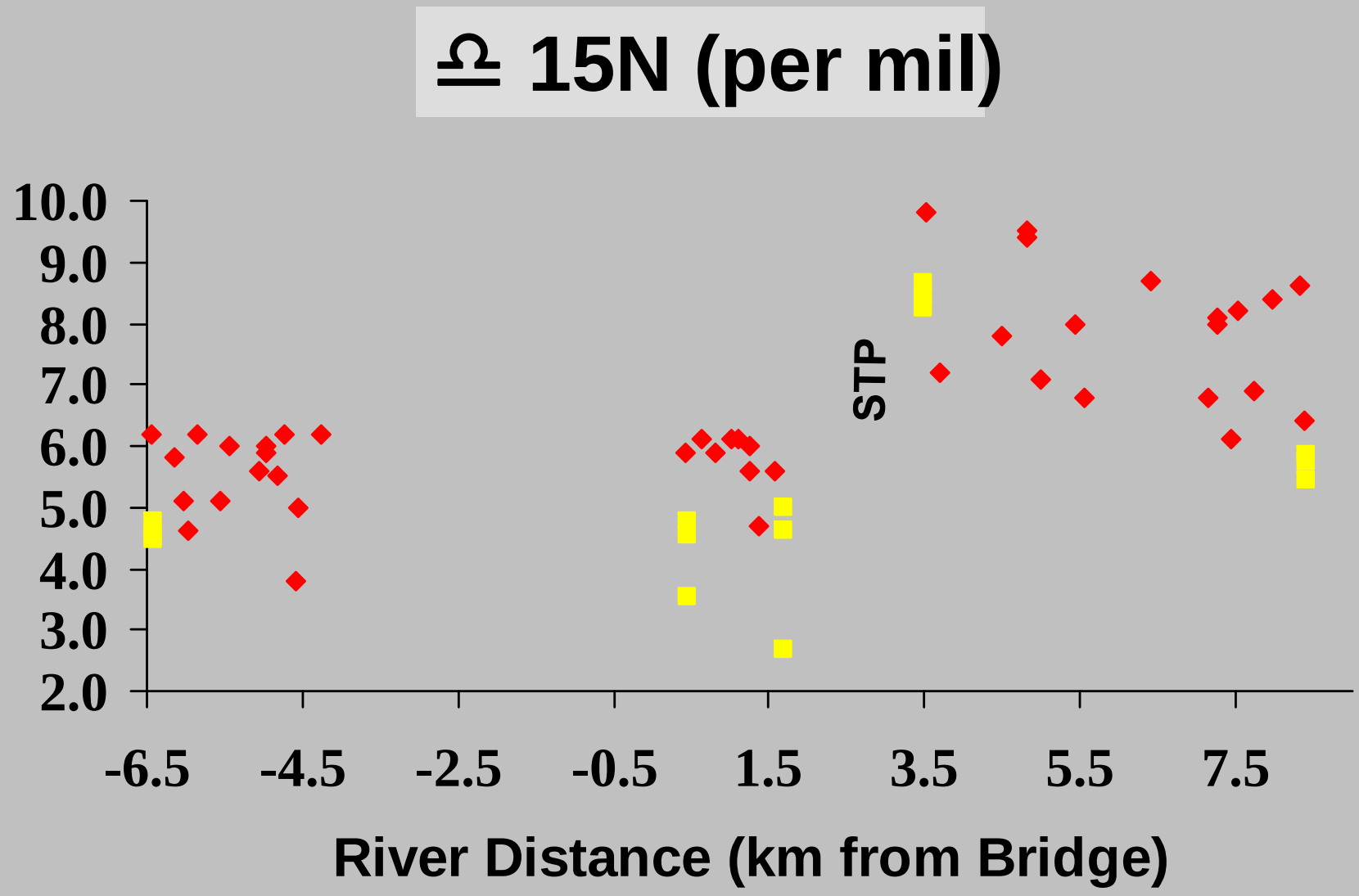
In situ regression via Isotopic Discrimination Technique

Isotopic discrimination tends to reduce the amount of lighter isotopes (^{12}C, ^{14}N, or ^{32}S) in organisms relative to the heavier isotopes (^{13}C, ^{15}N, or ^{34}S)

Nitrogen isotopes work best for trophic position

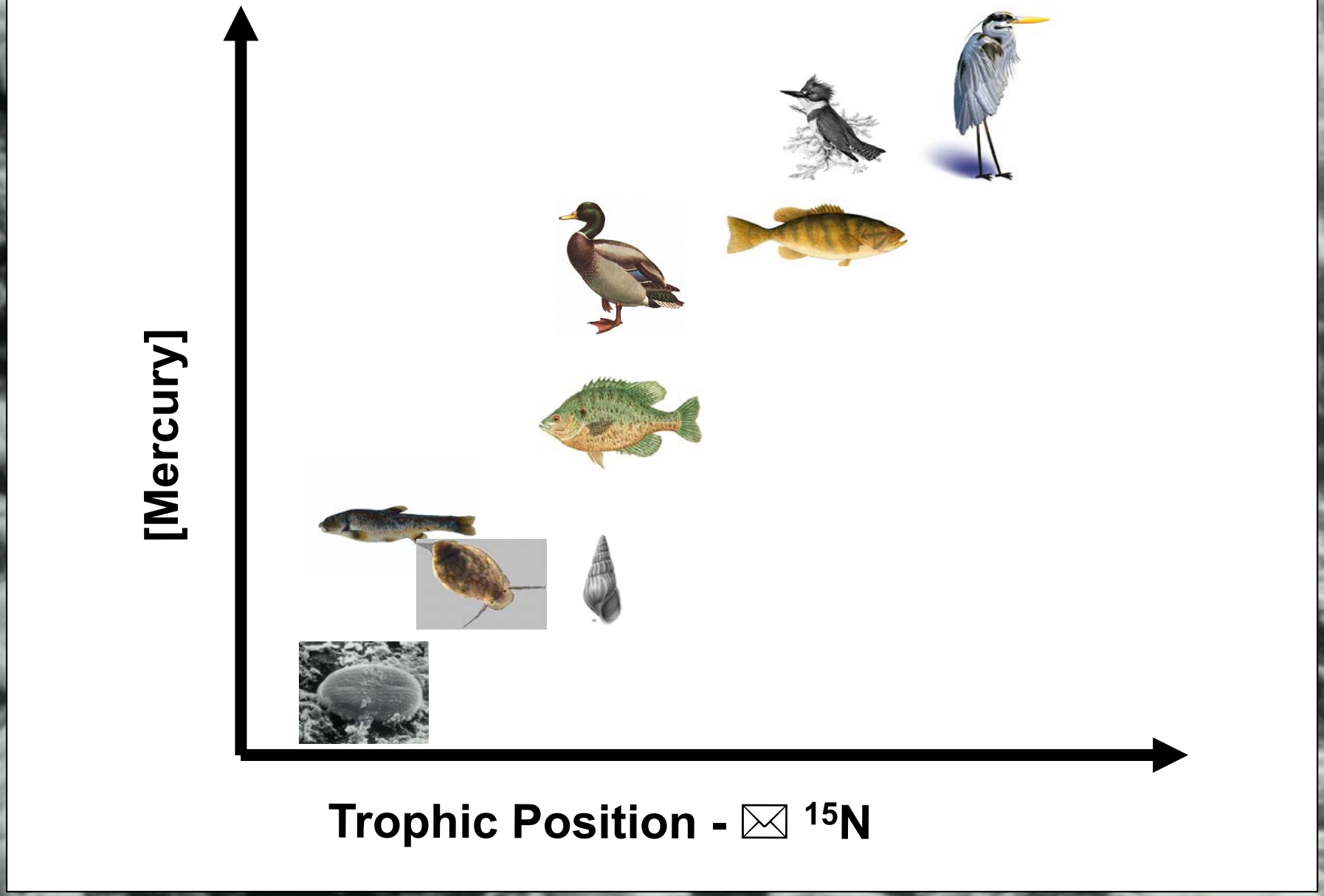
$$\delta^{15}N = 1{,}000\left[\frac{(^{15}N_{sample})/(^{14}N_{sample})}{(^{15}N_{air})/(^{14}N_{air})} - 1\right]$$

Trophic Status - Baseline



Trophic Analysis

Trophic Structure - N Isotopes



Proposed Periphyton Program

YEAR 1

-How much mercury is present in periphyton/surface coatings?
-What is the nature of the periphyton/surface coatings?
-How is the periphyton mercury spatially distributed?
-Preliminary N isotope samples to design sampling program
-How much methylmercury is associated with periphyton?

YEAR 2

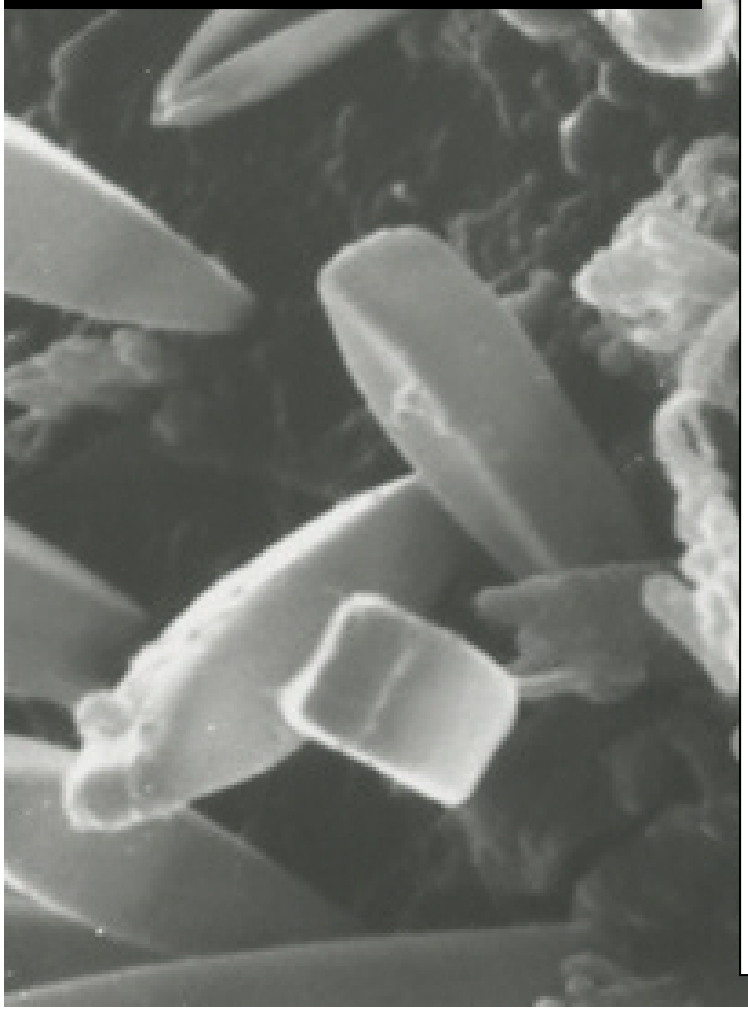
-What is the trophic status of selected biota?
- Regression model of mercury concentration vs trophic status

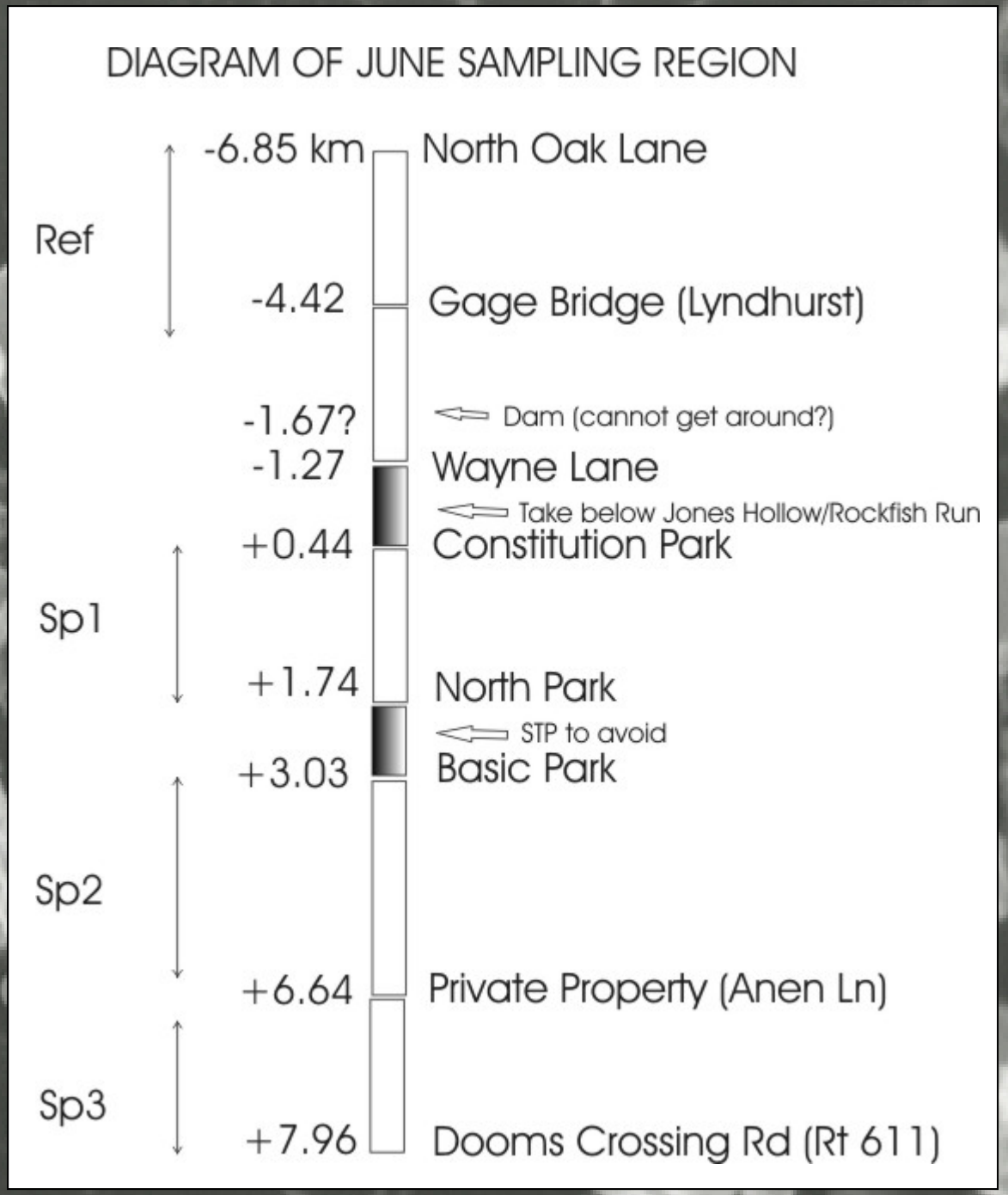
YEAR 3

-Quantitative model of periphyton mercury uptake by grazers
-Potential additional trophic transfer to grazer consumer


QUESTIONS?

Spatial Distribution of Hg





Define & Test [Hg] Difference

SP3 (N=8)