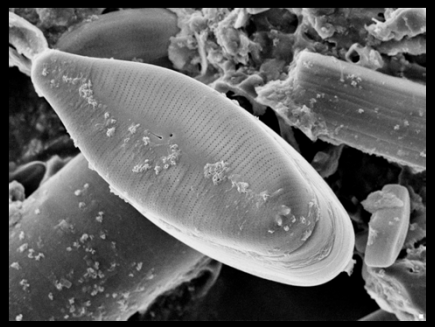
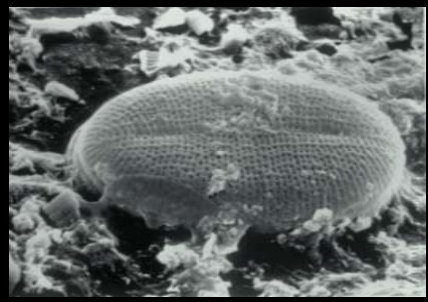
Biomagnification Models:
Aquatic & Floodplain

Prof. Mike Newman
in collaboration with several South River Research Teams





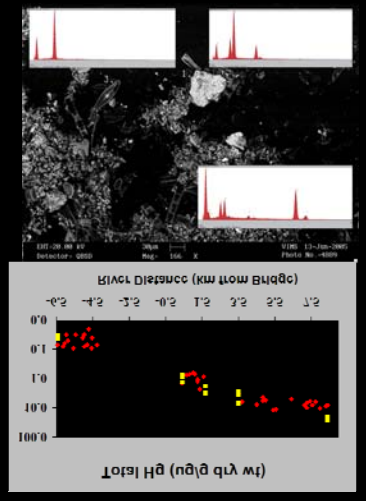
Initial Conceptual Context

Periphyton Survey to Resolve a Key Information Gap

Adsorption
Coprecipitation

Bioaccumulation
Physical Inclusion

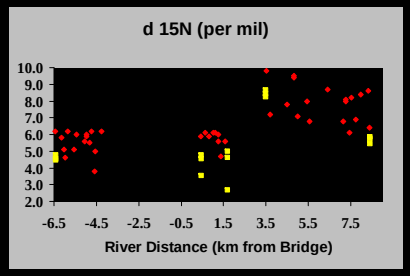
"Periphyton"
"Surface Coatings"
Biomonitoring

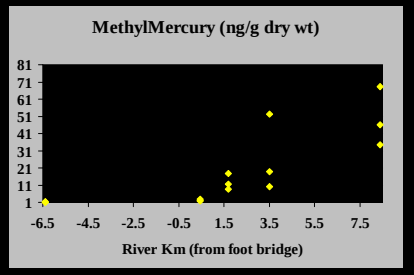


Trophic Uptake
and Availability

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

Trophic Transfer & Magnification
Primarily in Aquatic Receptors





Initial Conceptual Context

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Trophic Uptake
and Availability

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

- THg quantified
- <0.1 to 25 µg/g dw
- Significant trend
- Correlations:
  Strong Correl.
  Riv. Km (+)
  ≙ ^{15}N (+)
  Moderate Correl.
  Fe(+)

Trophic Transfer & Magnification
Primarily in Aquatic Receptors

- Defined N (and C) Isotopic Signatures
- Identified changes along river segment
- Preliminary data for gastropods
- Future directions

- [mHg] quantified
- Circa 1 to 50 ng/g dw
- Correlations:
  Strong Correl:
  Riv. km (+), T. Hg (+)
  Moderate Correl:
  ≙ ^{15}N (+), OC (+)
- Flux Estimates?

Periphyton [Hg] & Trophic Transfer

Trophic Uptake and Availability

Trophic Transfer & Magnification Primarily in Aquatic Receptors

ORIGINAL YEAR 2 GOALS

Define Mercury within Aquatic Trophic Web

- Periphyton, grazers, grazer consumers, predators (fish, birds)
- Subset of locations
- N isotopes for quantifying trophic position
- C isotopes for (perhaps) identifying major sources of C
- Regression models predicting mercury from trophic status

REVISED YEAR 2 GOALS

Define Mercury in Aquatic/Floodplain Webs

- Model mercury biomagnification for 3 sites using $\delta^{15}N$.
- Model the ratio of methylmercury to total mercury using $\delta^{15}N$.
- Attempt to understand trophic behavior (i.e., terrestrial versus aquatic sources of C) for selected endpoint species within the watershed using tissue $\delta^{13}C$ and $\delta^{15}N$ signatures.

Trophic Transfer

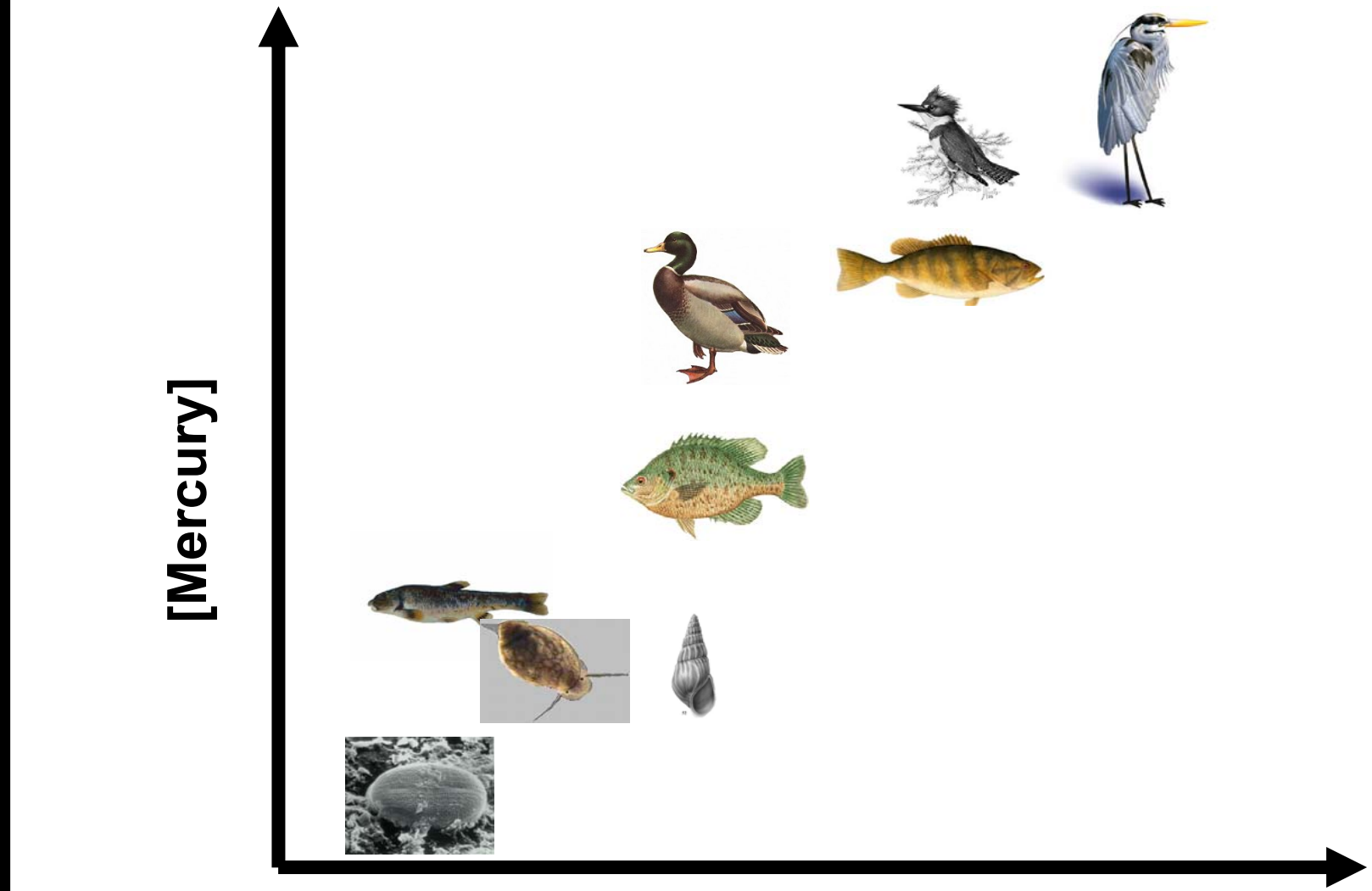
In situ regression via Isotopic Discrimination Technique

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)

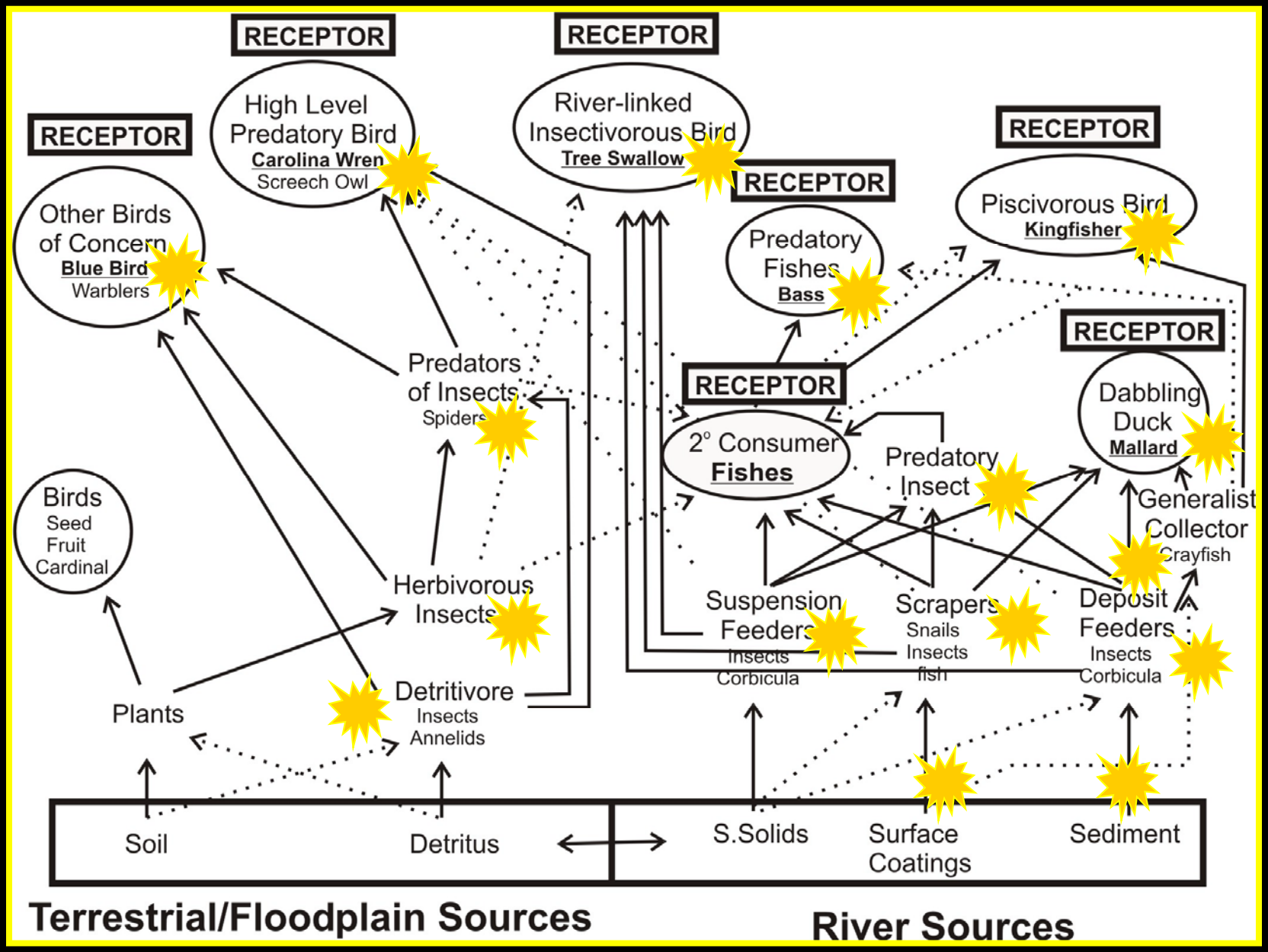
Nitrogen isotopes work best for trophic position

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

Trophic Structure - N Isotopes



Year 2 - Trophic Models



Specifics of Summer Sampling

Central theme is to coordinate sampling with avian and Eco Study (invertebrates & fish) for tissue analyses.

Initial sites were selected near (but discussions continue)

- Constitution Park (likely drop)
- *Dooms Crossing Road
- *Crimora (Forestry Facility)
- Grottoes near Grand Caverns bridge (likely add)

Also want to take advantage of past fish samples (subset of):

- 1BSTH02510 Waynesboro City Park North of DuPont Footbridge
- 1BSTH023.73 Waynesboro near 2nd St Bridge
- *1BSTH020.44 Dooms near Rt 611 bridge (above dam)
- *1BSTH014.49 Crimora at CDF Forestry Center
- *1BSTH004.21 Grottoes near Grand Caverns bridge

Specifics Summer Sampling

Table 1. Samples from 2006 Avian and Eco Studies for Each of Three Sites

Component	Number of Samples and Sample Type
Birds	
Mallard	3 blood, 3 feather
King Fisher	3 blood, 3 feather
Tree Swallow	3 blood, 3 feather, 3 prey samples taken from adults
Carolina Wren	3 blood, 3 feather, 3 prey samples taken from adults
Screech Owl	3 blood, 3 feather
Bluebird	3 blood, 3 feather, 3 prey samples taken from adults
Other	6 blood, 6 feather
Fish	
Bass	3 muscle
2^0 Consumers	15 muscle (5 species)
Aquatic Invertebrates	
Suspension Feeder	
Insect	3 samples
Corbicula	3 samples
Scraper	
Snail	3 samples
Insect	3 samples
Fish	3 samples
Deposit Feeder	
Insect	3 samples
(Corbicula)	- (already taken above)
Predatory Insect	3 samples
Crayfish	3 samples
Periphyton	
Eco Study	3 samples
VIMS Collected	3 samples
Sediments	
VIMS Collected	3 samples
TOTAL PER SITE	108

Specifics of Summer Sampling

Statistical Fitting of Data to Biomagnification Models:

A separate model will be generated for each site and slopes compared to assess whether a more general model can be generated that includes all sites. Data pairs (total mercury concentration vs ✉ ^{15}N) will be fit to the model,

$$[Hg]_i = a + b(\delta^{15} N_i)$$

or, if plots of mercury concentration vs ✉ ^{15}N suggest a power relationship.

$$[Hg]_i = e^{a + b\delta^{15} N_i}$$

QUESTIONS?

Mercury Spatial Distribution