

Trophic Transfer Models for South River Mercury

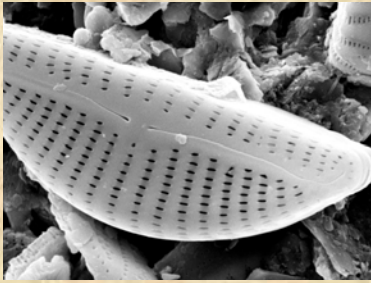
M. Newman

K. Tom

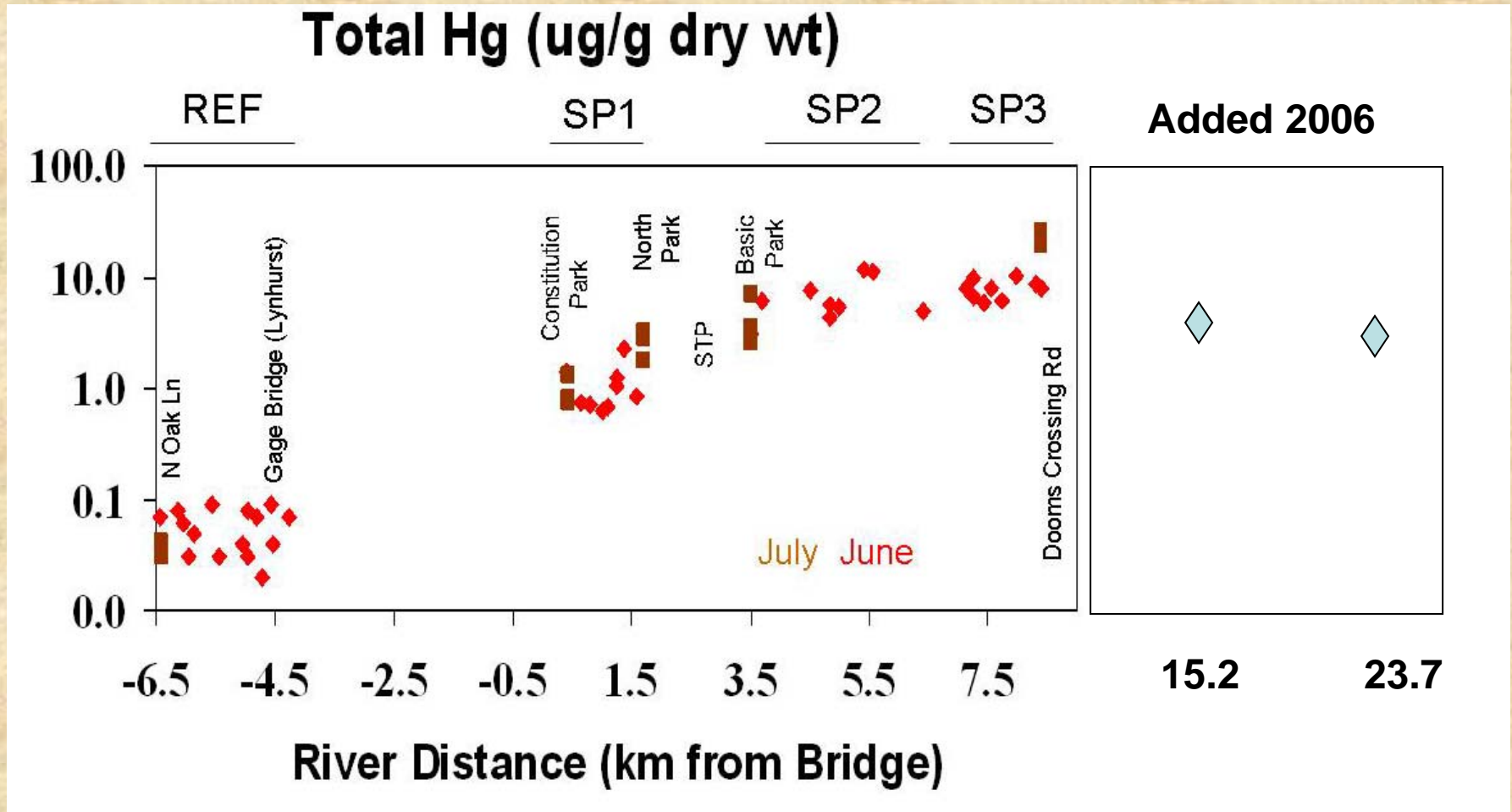
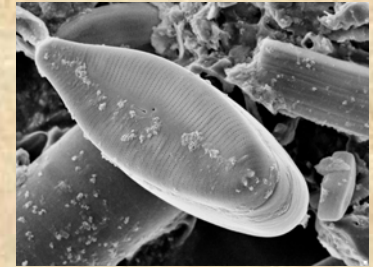
College of William & Mary - VIMS

General Objectives

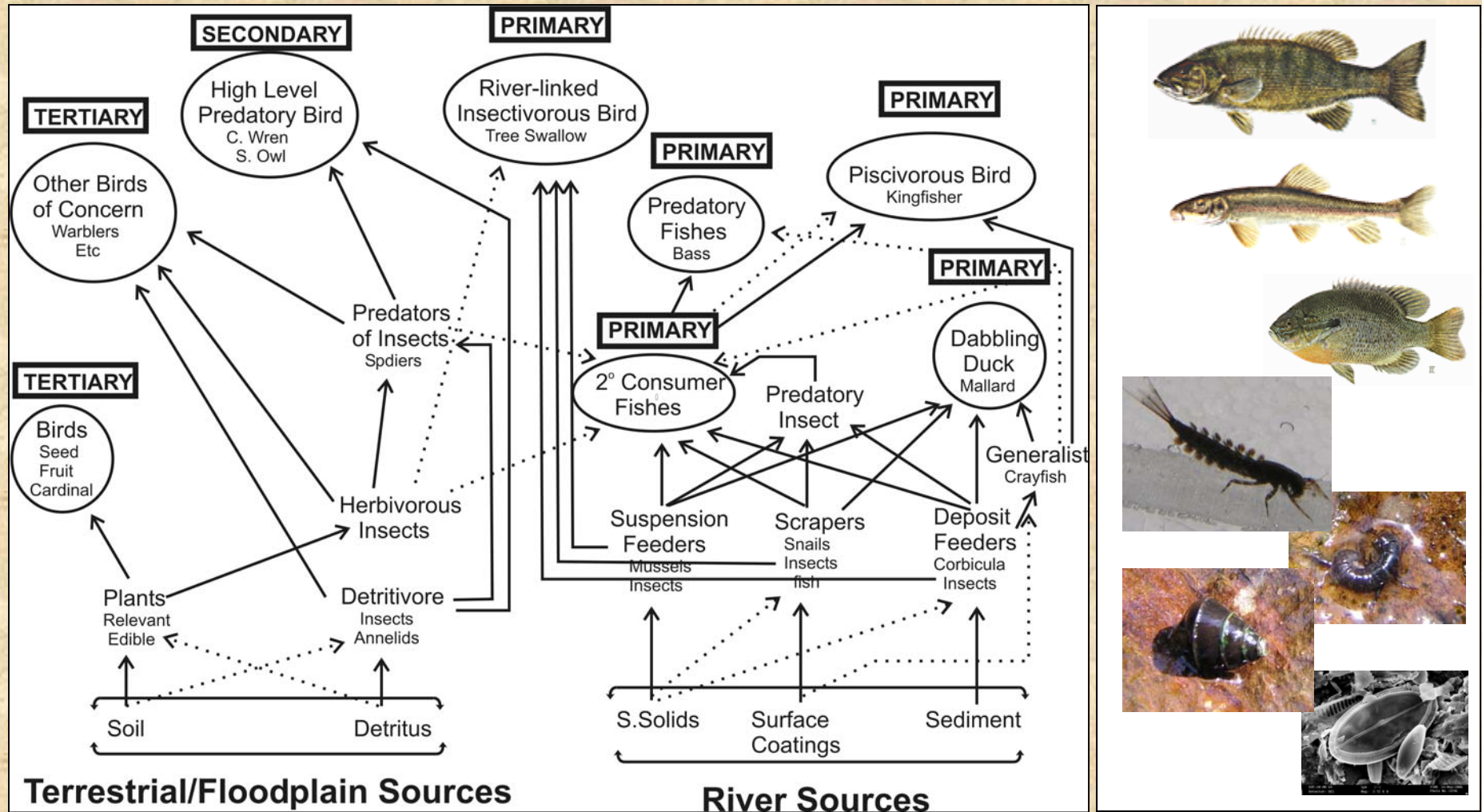
- Define Hg at base of scraper food web
 - Define general relationship for Hg in scraper trophic web members
 - Quantify trophic transfer of Hg in scraper trophic web (leading to edible fish species)
- Apply careful experimental designs (power, PPV)
 - Optimize information/unit cost
 - Enhance soundness of conclusions
 - Enhance quality of predictions/projections
 - Enhance legal defensibility



Base of Scraper Food Web

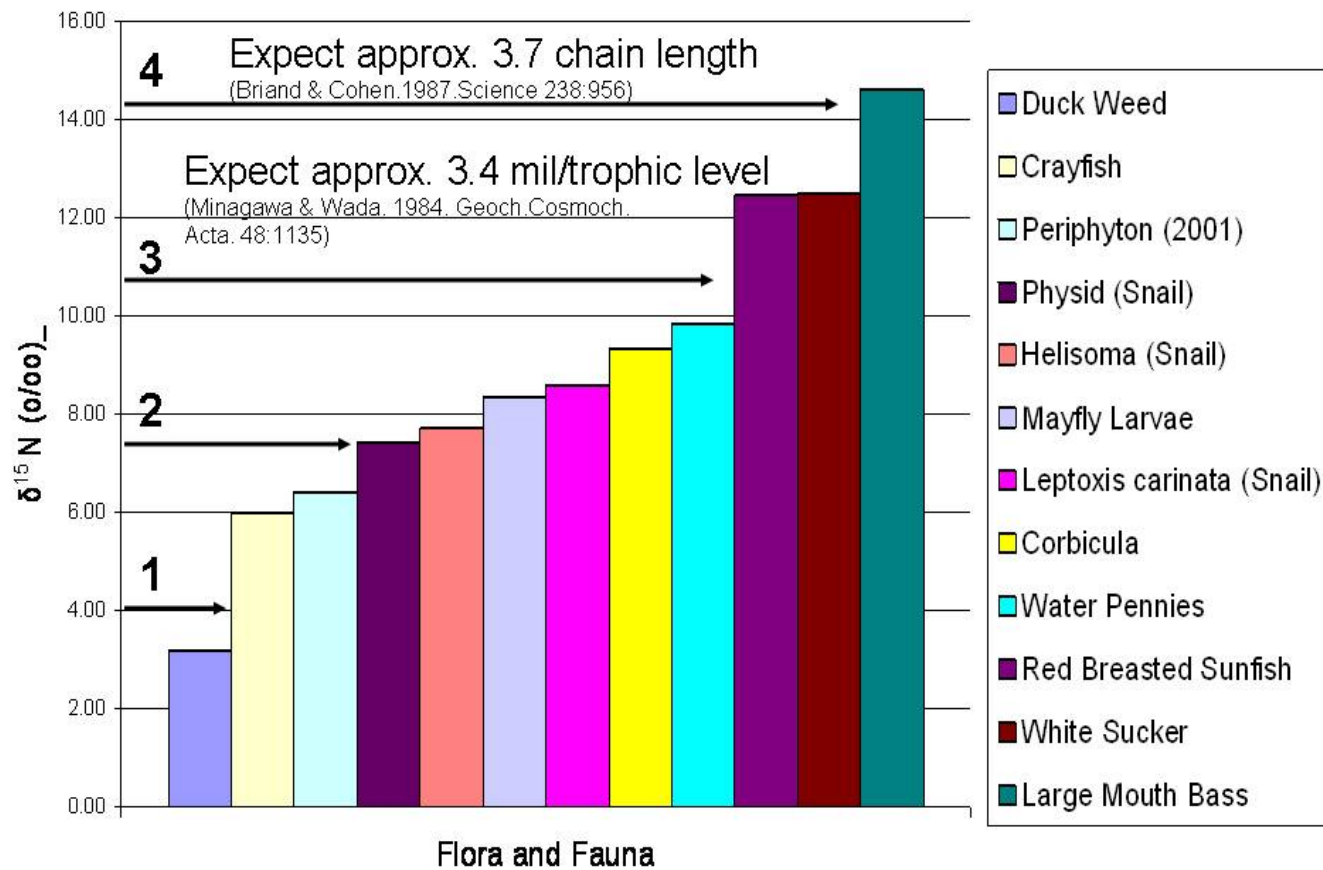


2006 Conceptual Model General Trophic Web Structure



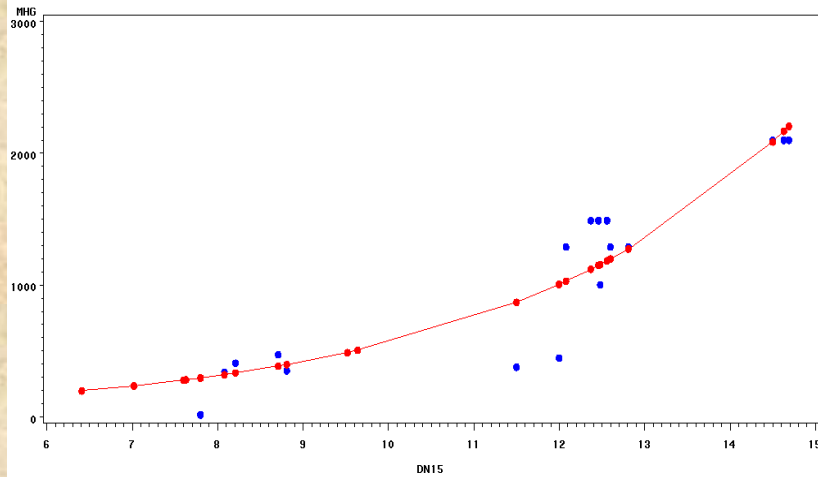
2006 Conceptual Model General Trophic Web Structure

Dooms Crossing Rd (Rt 611)

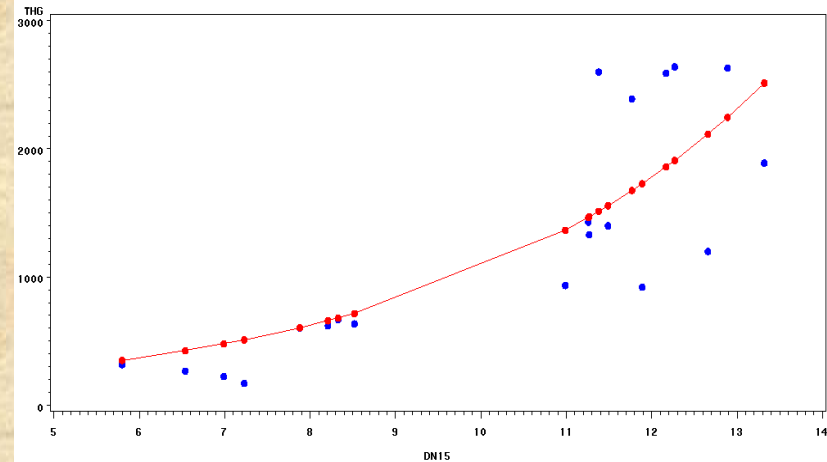


2006 Conceptual Model General Trophic Web Structure

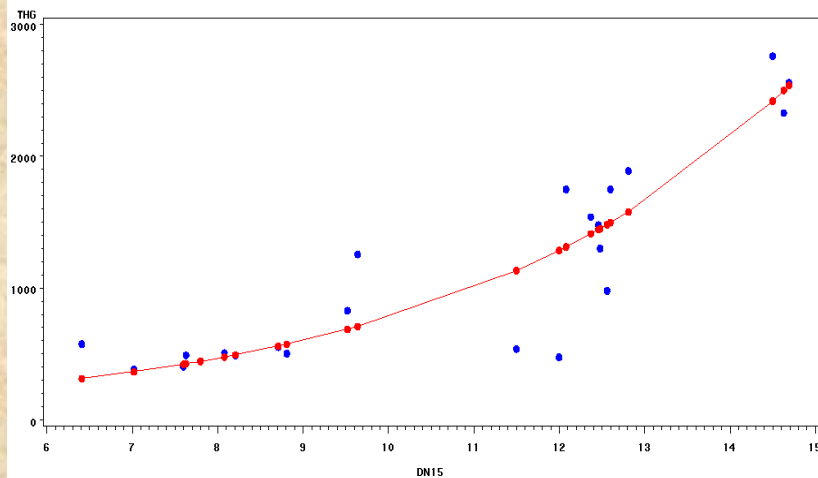
DOOMS – Methylmercury – Omitting One Point



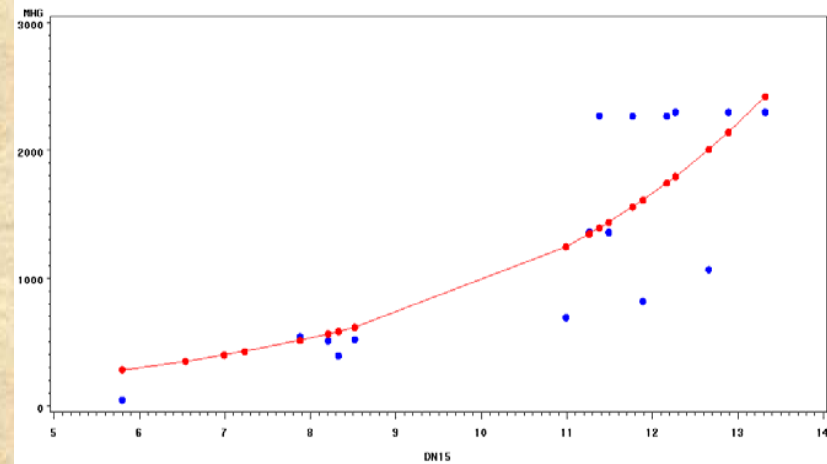
CRIMORA (AFC) – Mercury



DOOMS – Mercury – Omitting One Point

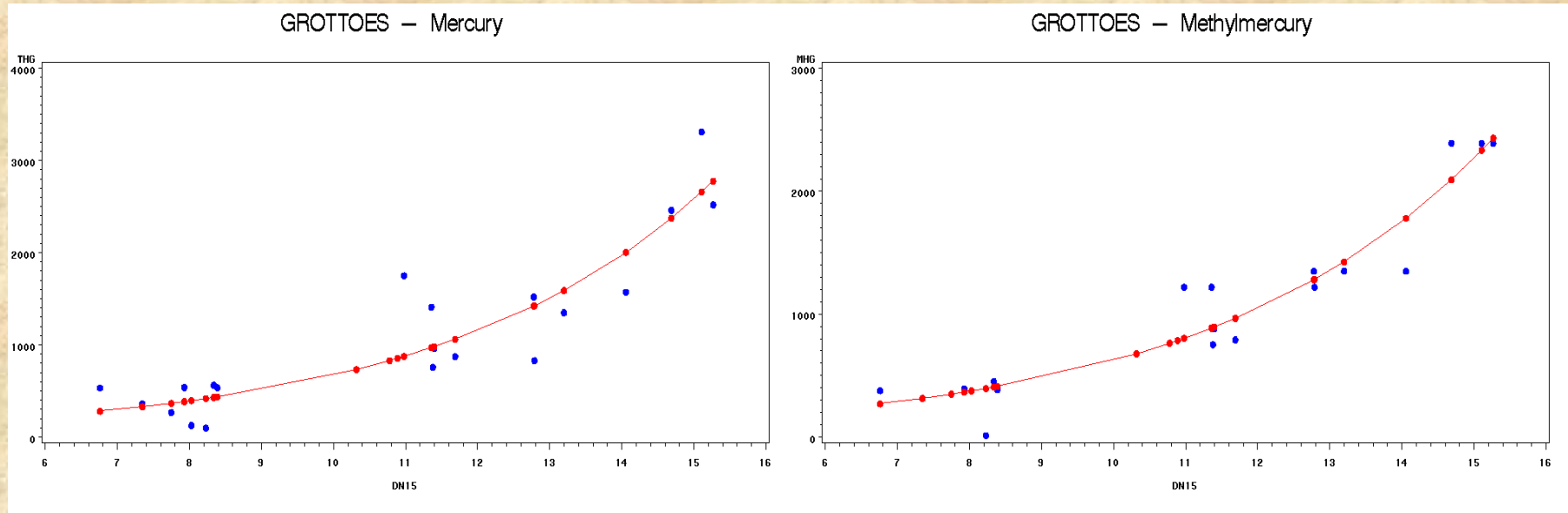


CRIMORA (AFC) – Methylmercury



2006 Conceptual Model General Trophic Web Structure

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



- Relationship emerging – three locations in high [Hg] region of river.
- Using diverse sample types from different sources and years.
- Clear trends perhaps getting clearer with distance downriver.

2006 Conceptual Model General Trophic Web Structure

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

Table 1. Preliminary Biomagnification Models for the Three Representative Sites

Site	Form	Estimate of e ^a	Estimate of b	Increase (x)
Dooms Crossing	THG	60.4751 (30.2389)	0.2545 (0.0374)	2.38 x fold
	MHG	30.4476 (16.1757)	0.2915 (0.0392)	2.70 x fold
Crimora (AFC)	THG	109.300 (96.6596)	0.2333 (0.0736)	2.21 x fold
	MHG	54.2560 (50.9751)	0.2852 (0.0774)	2.64 x fold
Grottoes (TP)	THG	52.2376 (29.5396)	0.2591 (0.0404)	2.41 x fold
	MHG	47.3793 (17.4062)	0.2579 (0.0263)	2.40 x fold

THG = total mercury in ng/g ww, MHG = methylmercury in ng/g ww. Standard error of parameter estimates are shown in brackets aside each estimate. Increase = the predicted increase expressed as a “fold increase” in concentration with a change of one trophic level at the middle of the trophic web, i.e., a $\delta^{15}N$ change from 8 to 11.4 ‰.

- **General models successfully built from preliminary data for various sources.**
- **Clear proof of concept established (consistent with substantial literature).**

2007 Trophic Transfer Modeling

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

Objectives

Generate and formally cross-validate fine-grained aquatic trophic transfer models by conducting a careful 2007 sampling (May & June) of five locations:

Constitution Park

Pool location - “Shifflett” Farm or between miles 7 and 9

Dooms Crossing (Rt 611)

Crimora (Augusta Forestry Center)

Grottoes (Town Park)

Test H (using model slopes): Downriver movement of mercury is slowed by its conversion to mHg and efficient trophic incorporation.

2007 Trophic Transfer Modeling

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

Approach

For 16 different sample/species types at each location ...

- Take 3 samples (individuals or pooled for smaller species)
- Analyze all for total Hg and one set from the triplicate for mHg also.
- Use two samples/type to generate a model for each site.
- Use remaining samples to do formal cross-validation.
- Also generate prediction residuals and compare to regression residuals for models built with all replicates.

For mHg samples (16 per site or 80 samples from biota ranging entire trophic web):

- Estimate change in % Hg that is mHg in biota of different trophic positions
- ANCOVA design

Product

Five (or one general) model(s) predicting [Hg] of any relevant aquatic species for predicting, planning, and decision making.

Test of hypothesis about Hg retention in the South River below the historic source.

Utility

- Move beyond description for better prediction of Hg changes with time, location, or management.
 - How long until the bass are lower than ...
 - How far down river until the bass are ...
 - What would happen if we altered the trophic structure of ...
 - If sediment and periphyton Hg was reduced to ...
- Capable of interpolation to other species as they become of interest.
- Explicitly define the uncertainty while doing all of the above.