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Biological Indicators Workshop
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Zooplankton communities and chemical properties of suspended particulate matter as tools for river monitoring and assessment.

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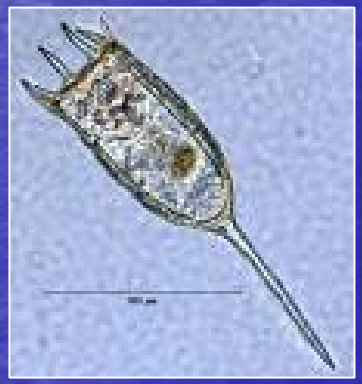
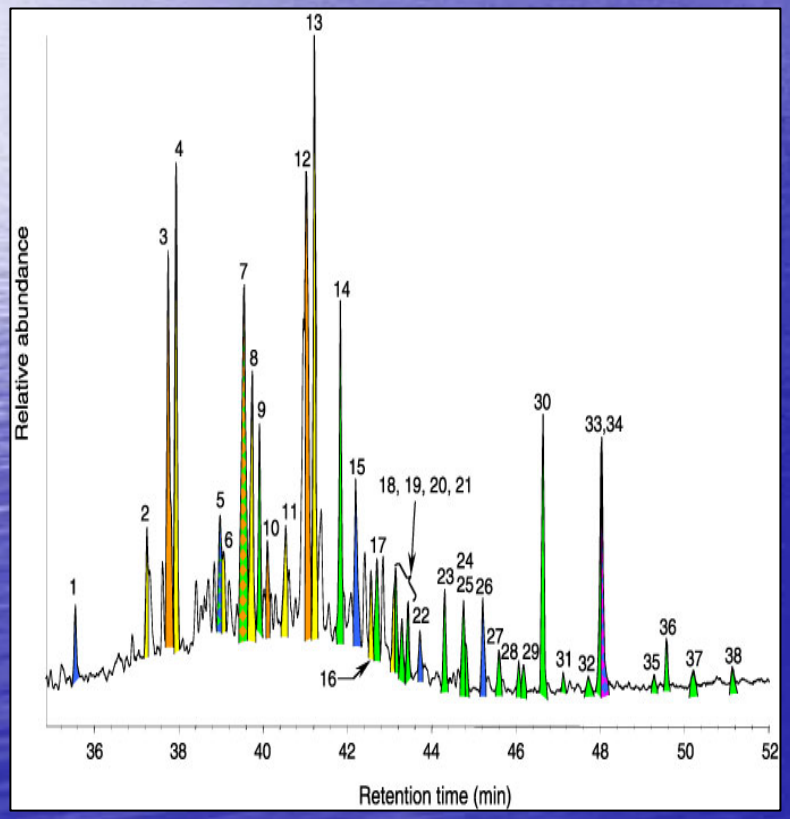
EMAP-GRE Plankton-Geochemical Indicators



Zooplankton:

- Energetic link between autochthonous & allochthonous inputs and higher trophic levels.
- Diverse group with well-defined taxonomy.
- Rapid response and sensitive to water quality (e.g., nutrients, metals, dissolved O_2).
- Widely used in lake and estuarine monitoring studies.

EMAP-GRE Plankton-Geochemical Indicators



Suspended Particulate Matter:

Living and non-living particles of terrestrial and aquatic origin.

Chemical composition offers a wealth of information about sources and within-river processes.

- Isotopes (^{13}C, ^{14}C, ^{15}N)
- Stoichiometry (nutrient, protein, lipid content)
- Biomarkers (fatty acids)

EMAP-GRE Plankton-Geochemical Indicators: Research Team and Responsibilities

Anthony Aufdenkampe	Stroud Water Research Center	Geochemistry
Paul Bukaveckas	VA Commonwealth University	CHLa & Light
John Chick	IL Natural History Survey	Zooplankton - Upper MS River
John Havel	Missouri State University	Zooplankton - MO River
Jeff Jack	University of Louisville	Zooplankton - OH River

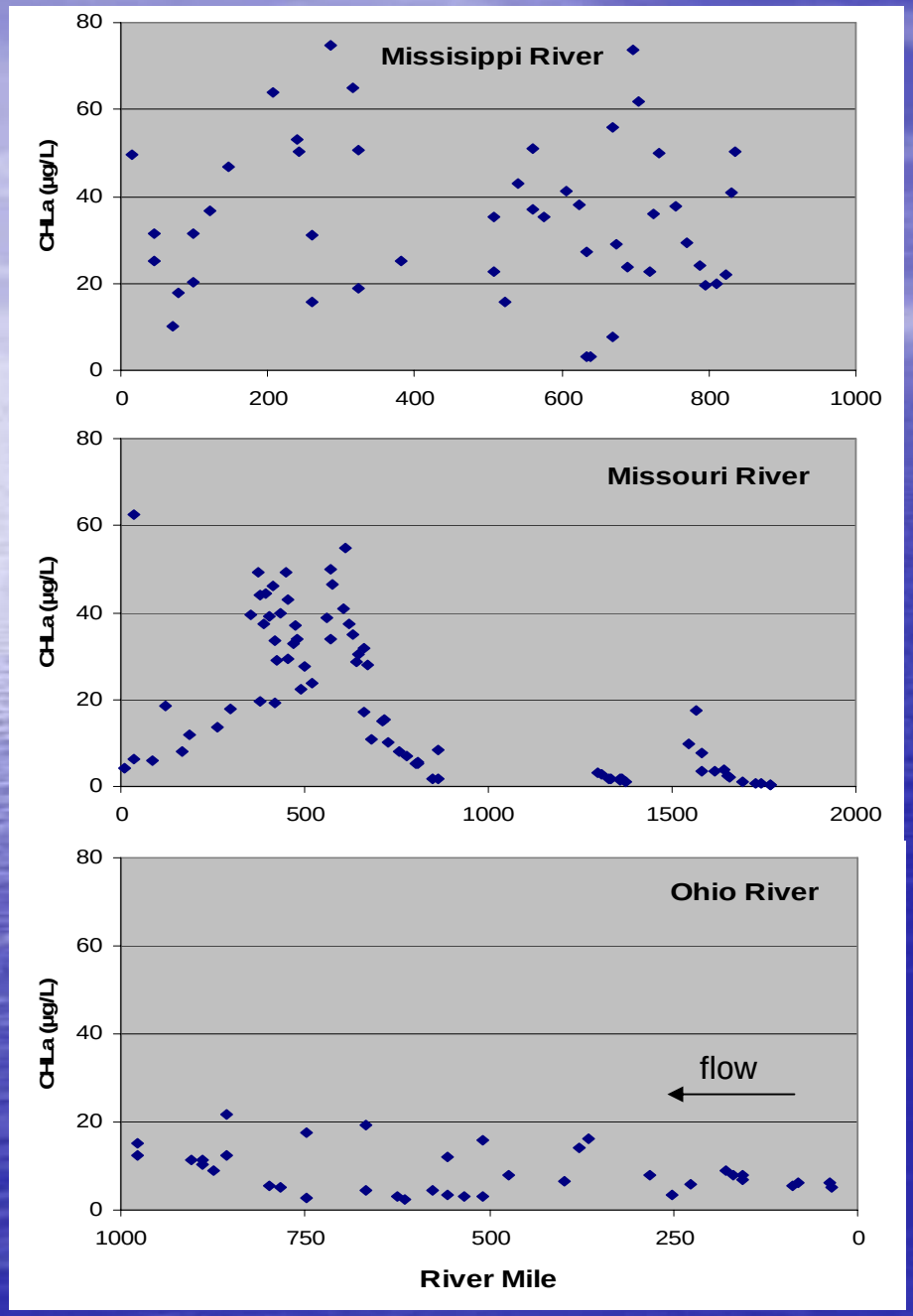
EMAP-GRE Plankton-Geochemical Indicators: Project Status

Indicator	Sample Analyses	Data to EPA
CHLa	2004-2005 completed	Yes
Geochemistry	2004 completed; 2005 in progress	No
Zooplankton - Upper MS River	2004-2005 completed	Yes
Zooplankton - MO River	2004-2005 completed	Yes
Zooplankton - OH River	2005 completed; 2004 in progress	No

Approach to Data Analyses:

1. Inter-river Variation:
   - Are metrics sensitive to hydrogeomorphic differences among the three rivers ?
2. Spatial and Temporal Variation:
   - Are metrics sensitive to localized and seasonal differences in river condition ?
3. Cross-system comparisons:
   - Do river metrics differ from those for other aquatic habitats ?

Inter-river variation: CHLa



CHLa concentrations in the Mississippi, Missouri and Ohio Rivers during 2004 EMAP sampling.

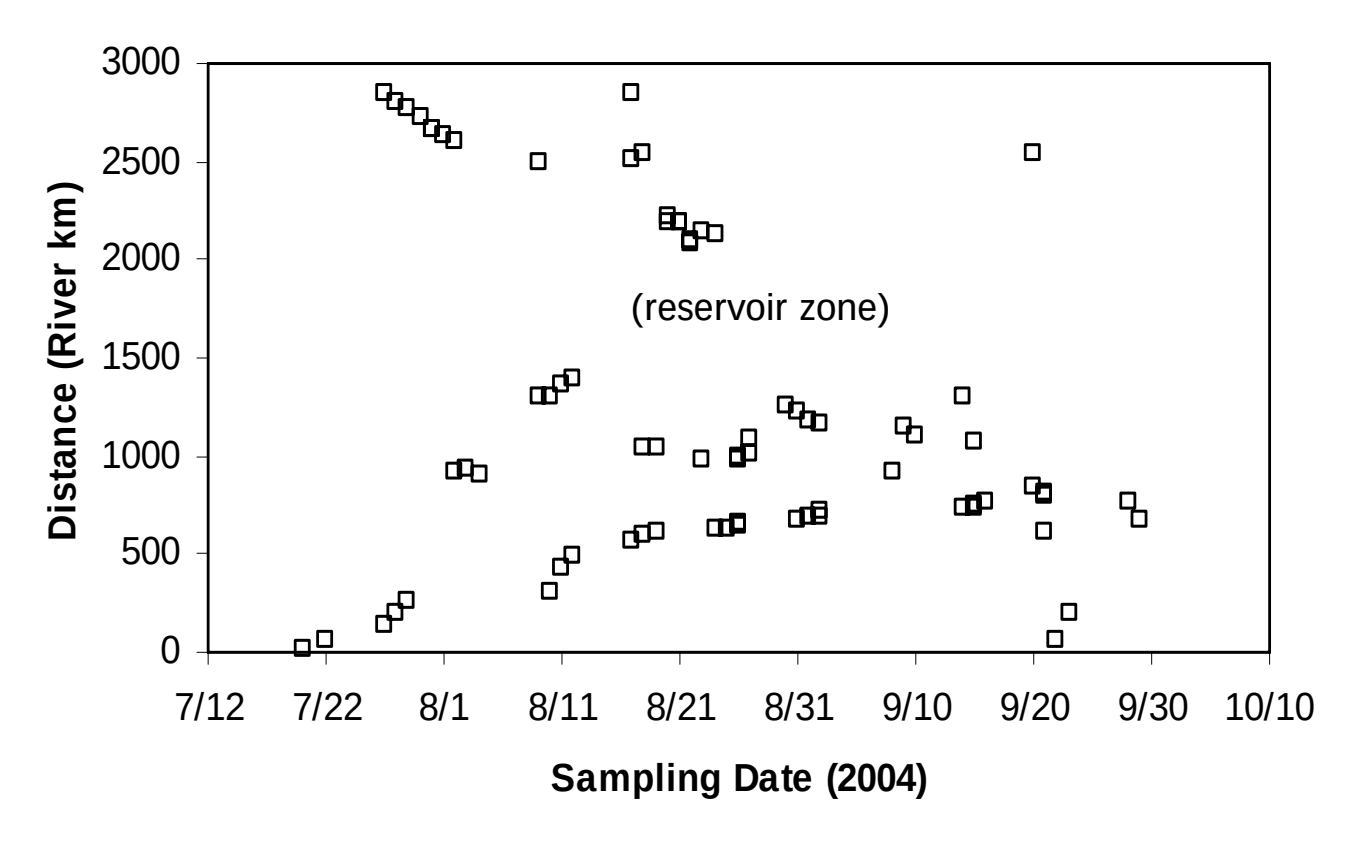
Relating CHLa to inter-river differences in hydrogeomorphology:

	OH	MO	MS
Depth (m)	6.1	2.7	3.9
Kd* (m^{-1})	2.07	5.39	3.40
PAR# (µmol photons/m^2)	200	490	273
Velocity (m/s)	0.62	1.16	0.68
PAR (dose/m)	396	558	1013
CHLa (µg/L)	8.7	20.1	34.9

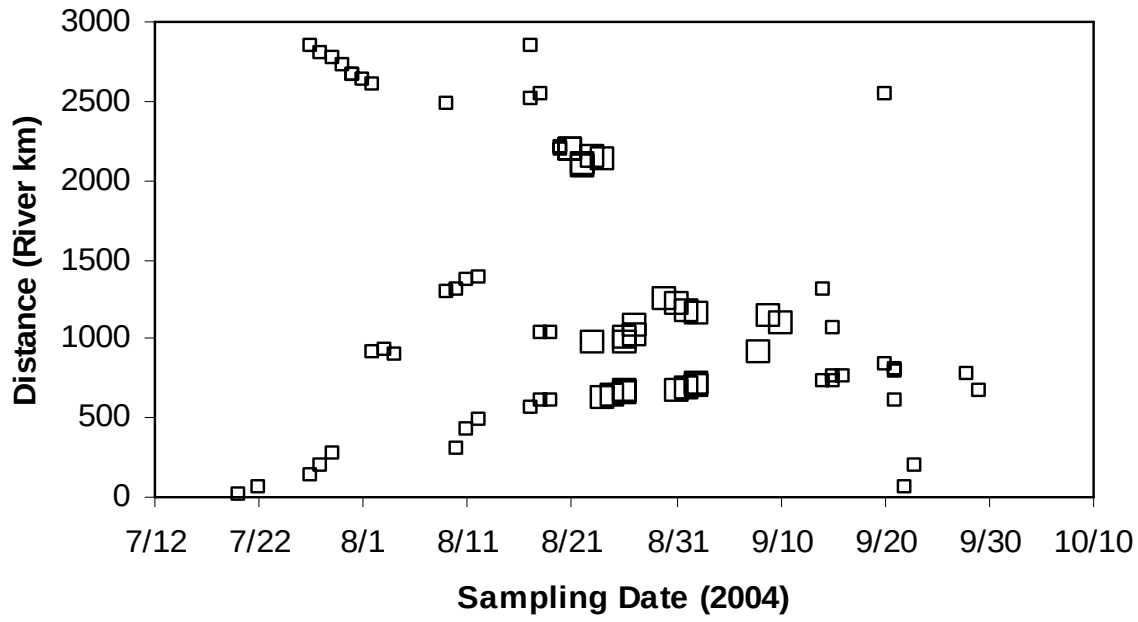
Data for 2004 EMAP sites.

*Light attenuation coefficient (Kd) inferred from measured turbidity.
#Average water column irradiance calculated from Kd and x-sec depth.

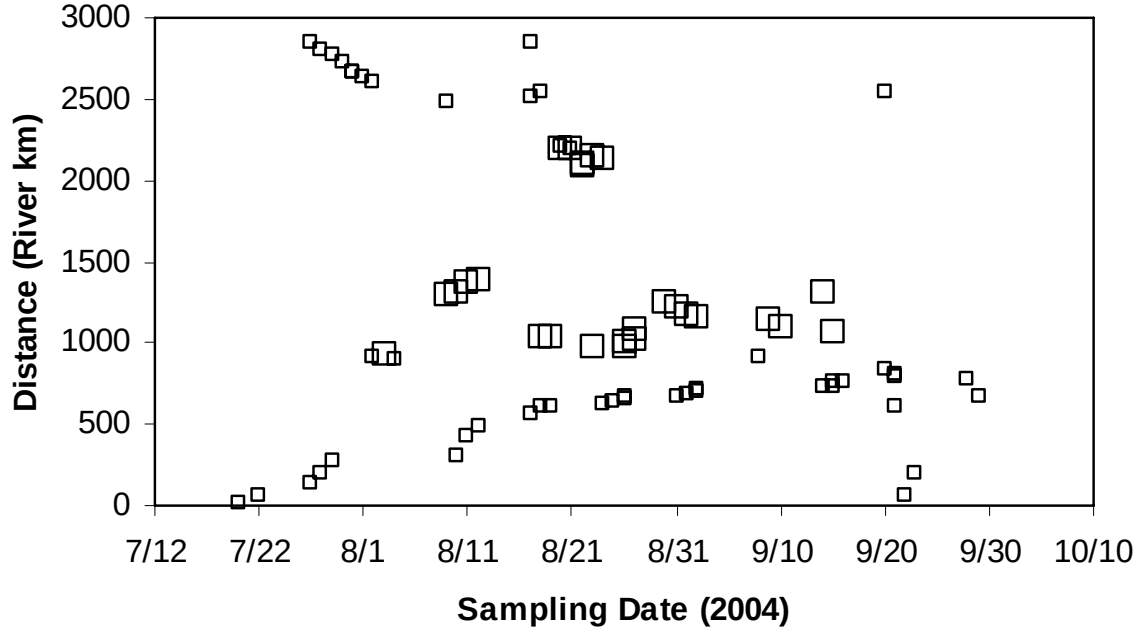
Intra-river variation: metric sensitivity to seasonal and longitudinal influences.



Example: space-time structure of EMAP 2004 MO River data.

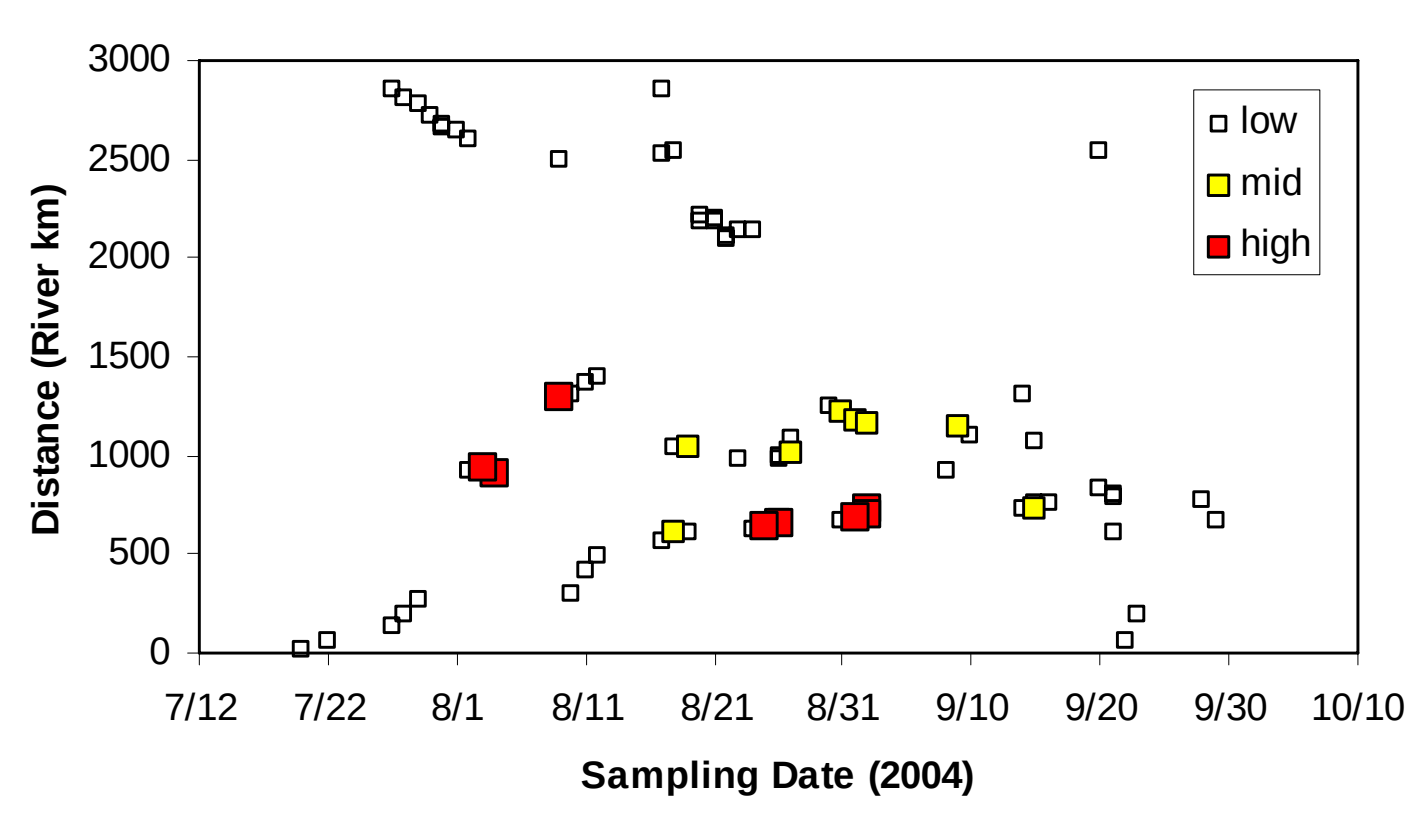


Metric sensitive to seasonal effects.



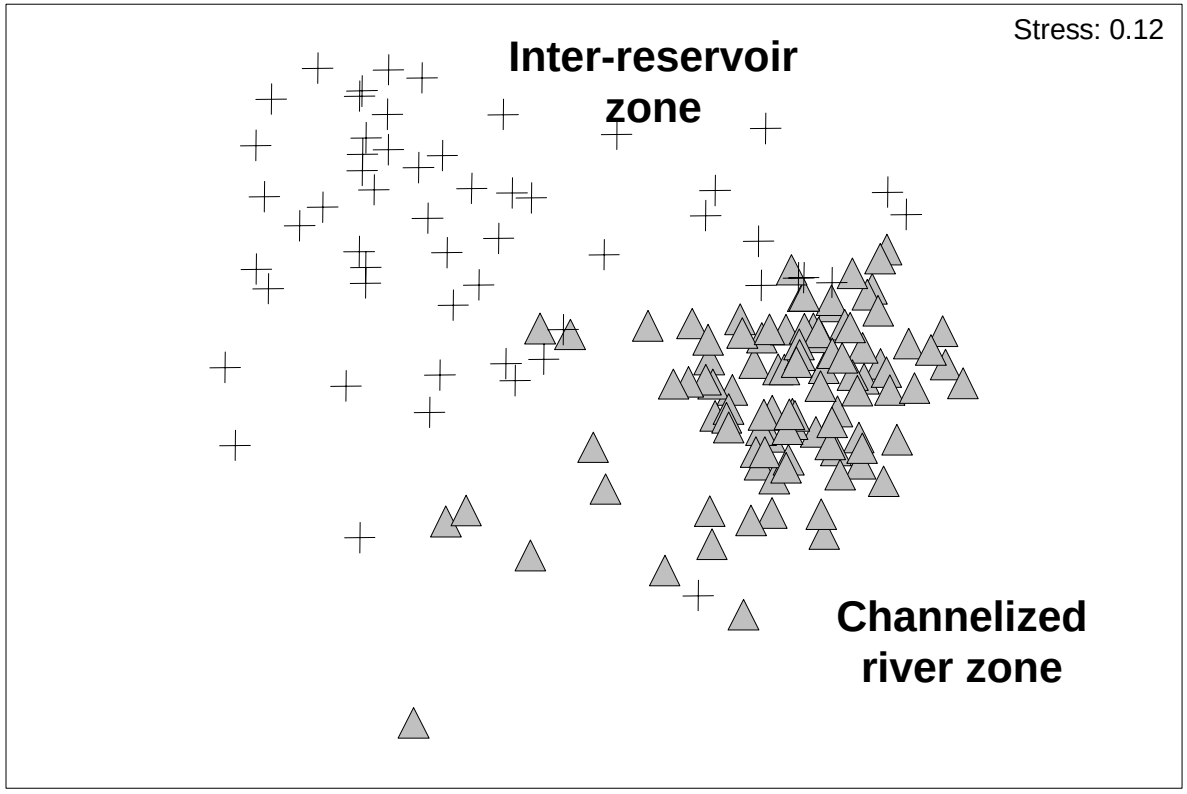
Metric sensitive to longitudinal effects.

Intra-river variation: spatial structuring of rotifer data for MO River.



‘Low’ = <500 ind/L; ‘Mid’ = 500-1000 ind/L; ‘High’ = >1000 ind/L.

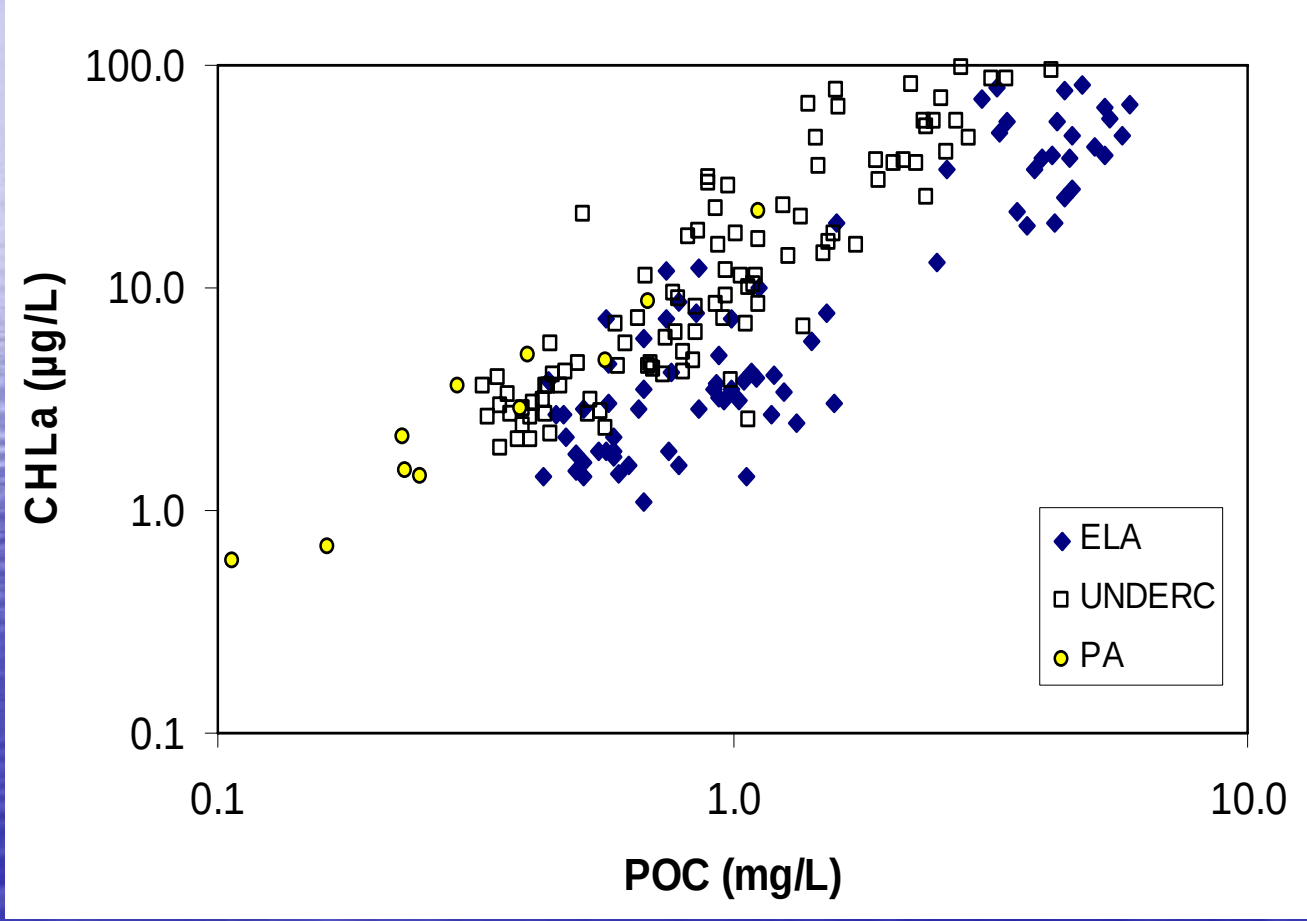
Intra-river variation in zooplankton community structure.



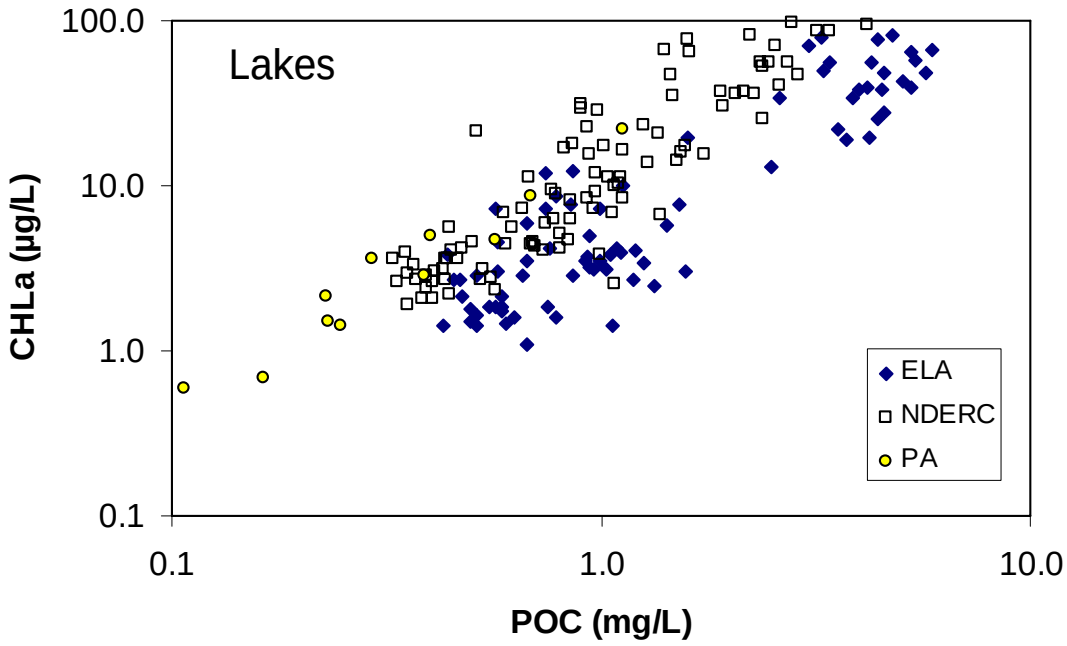
MO River 2004 and 2005 data.

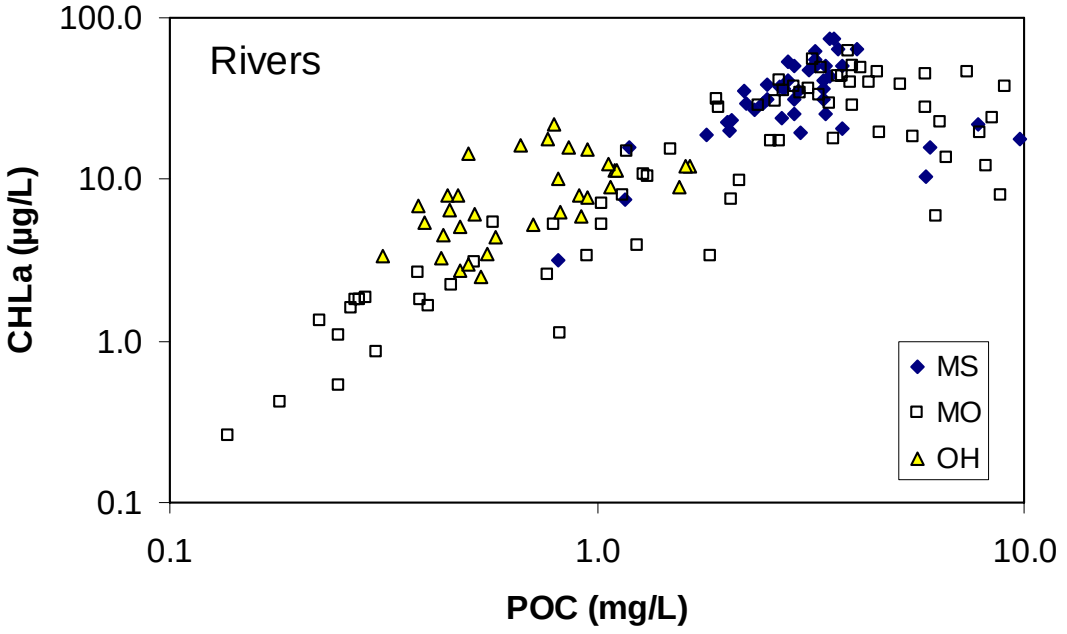
NMDS ordination: Global R=0.70; P=0.001

Cross-system comparisons: River metrics vs. other aquatic systems.



Example: seston metrics used in lake studies.

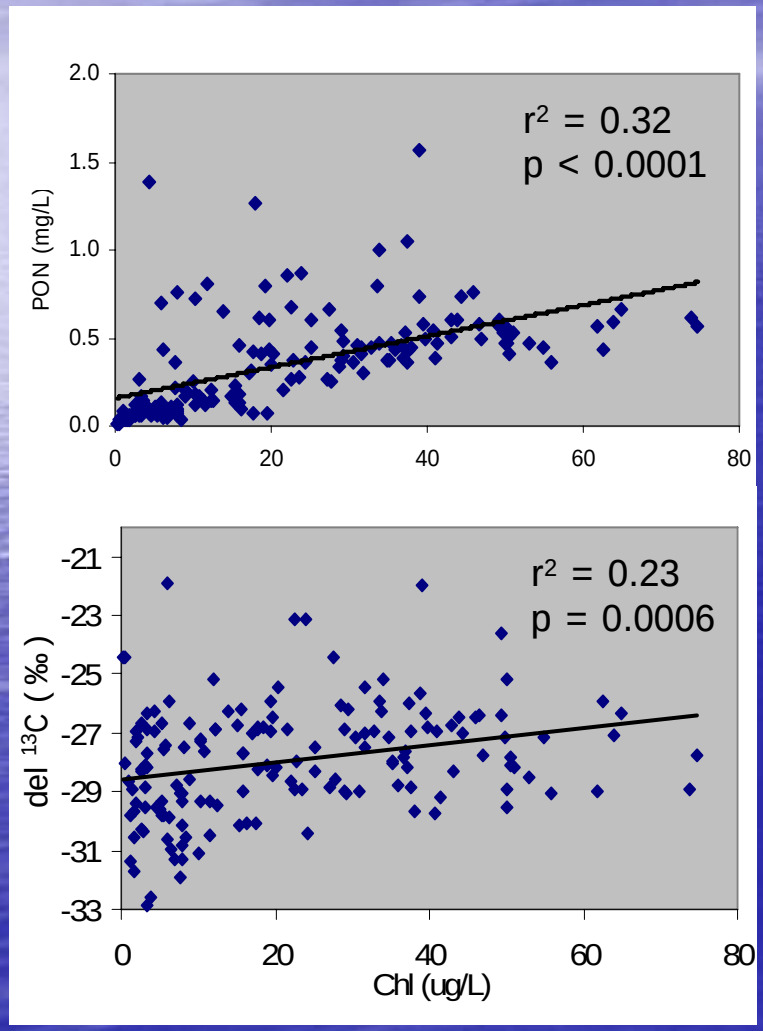




Comparison of EMAP River data vs. North temperate lakes.

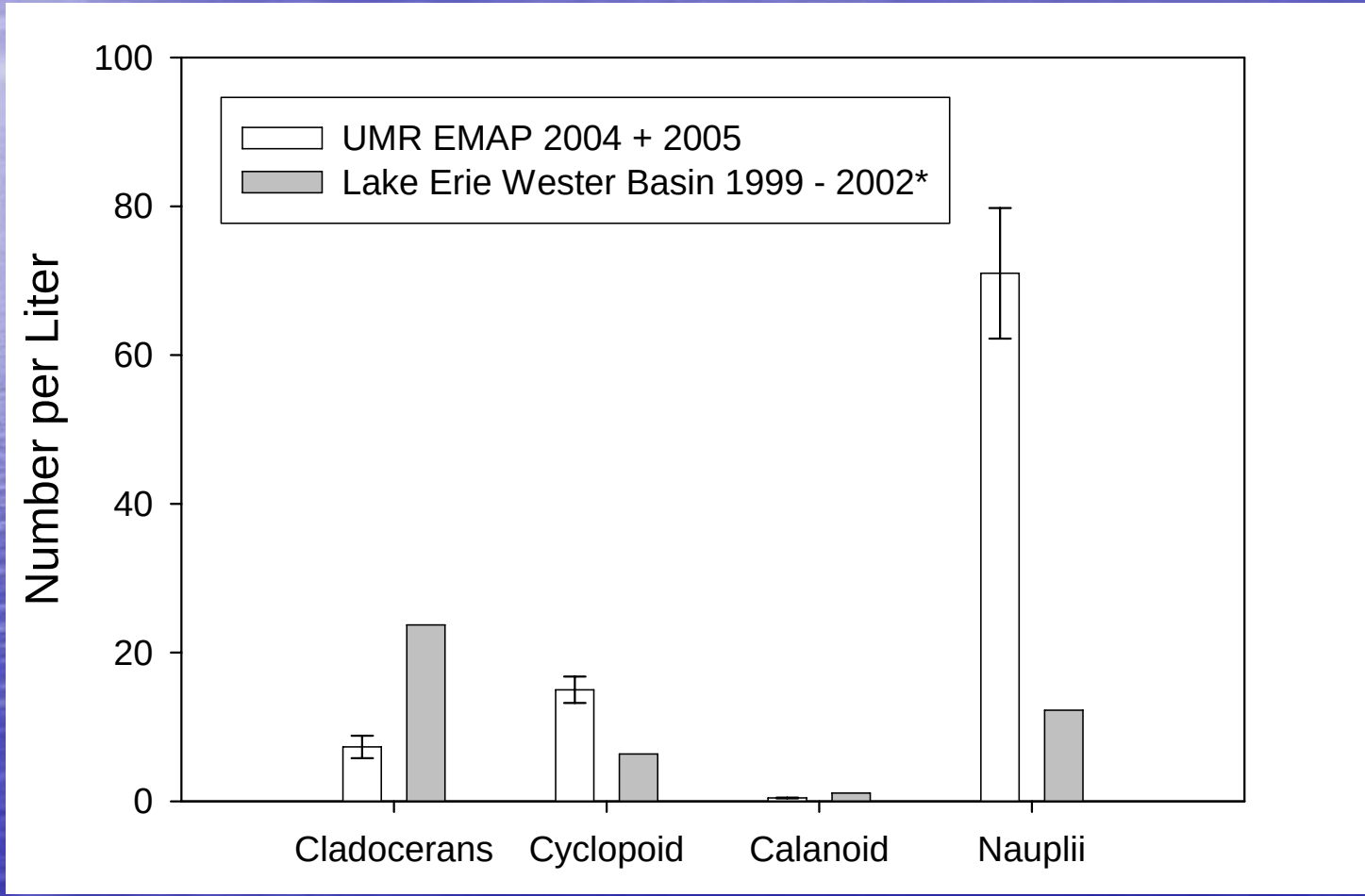
Lake data contributors:
J. Elser (ELA),
M. Pace (NDERC)
& R. Moeller (PA).

Seston Stoichiometry & Isotopic Signature



Autotrophy (CHLa) is associated with enriched N and altered C isotope composition of riverine particulate matter (EMAP 2004 data pooled for all rivers).

Lake – River Comparisons: Zooplankton

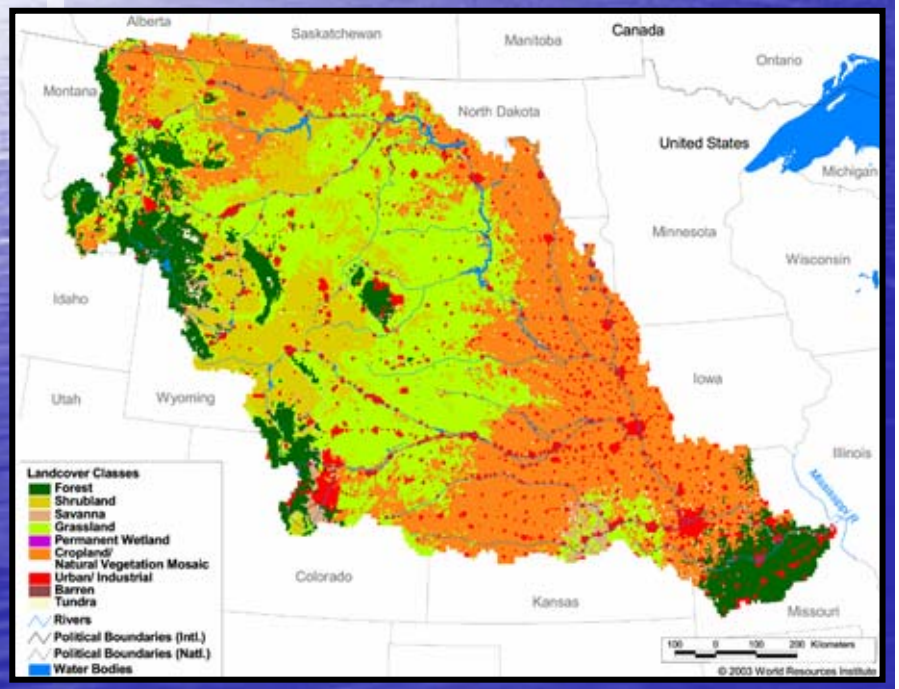


*Lake Erie data from Johnson et al. (2003) Great Lakes Fishery Commission Report.

Linking indicators to stressors:

Which metrics provide the most useful information for monitoring and assessment purposes ?

Relating zooplankton and seston metrics to landscape and physico-chemical features.



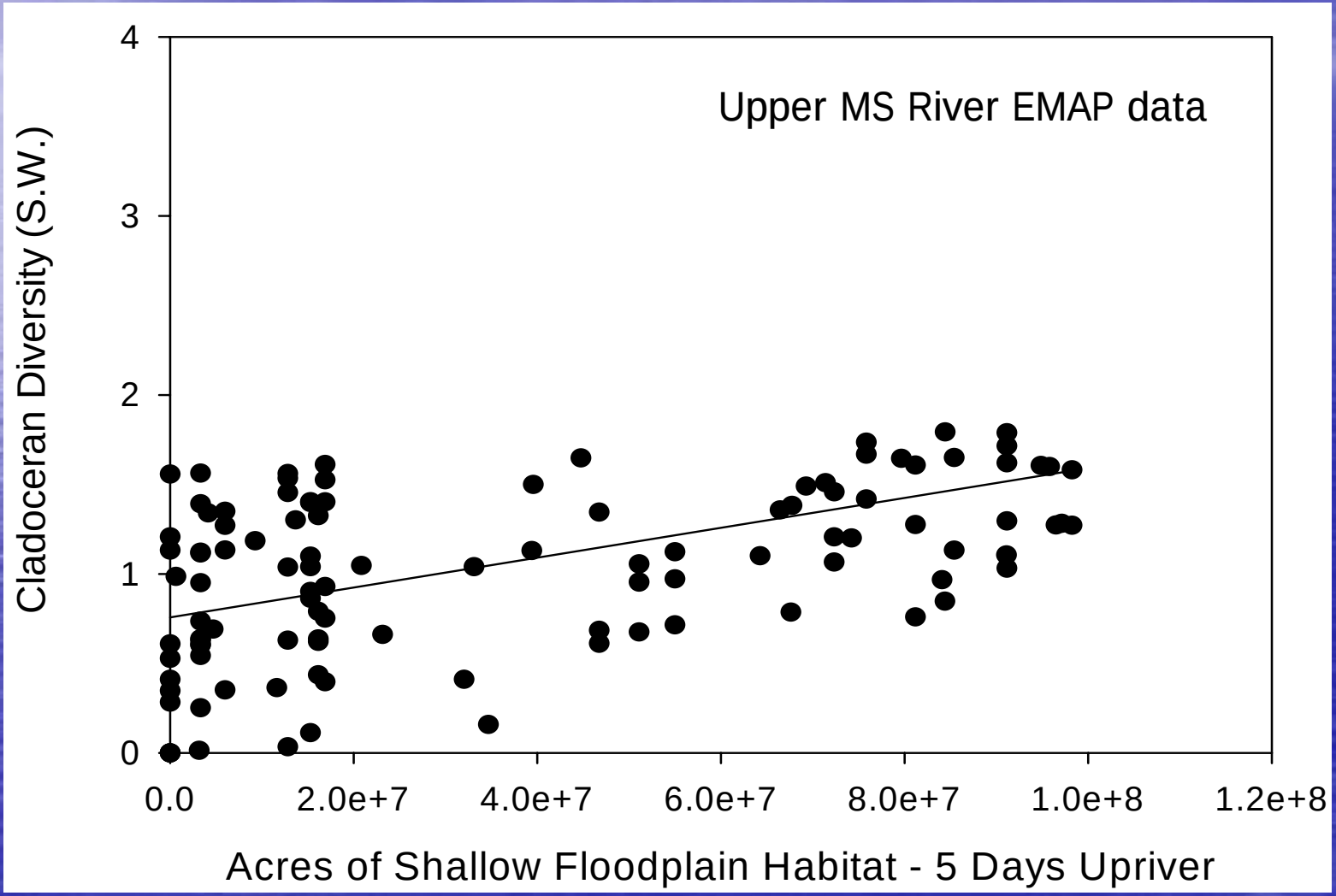
Indicator	Metric
Water quality	**dissolved oxygen**
	conductivity
	pH
	turbidity
	alkalinity
	temperature
	metals: As, Pb, Se, Cu, Al, Fe, Ni, An
	ammonia
	total phosphorus
	total nitrogen
	dissolved nitrogen
	total organic carbon
	anions: SO4, Cl
	silica
	site depth
	secchi depth
Geomarkers	% organic matter and N
	stable isotopes of C and N
Physical habitat	channel width
	large woody debris
	channel form (single, braided, anastomosing)
	channel constraint
	water residence time*
	shoreline development
	dominant land use
	substrate type
Chlorophyll	**Chlorophyll-a concentration**
Phytoplankton	species richness
	abundance
Periphyton	species richness
	abundance
Aquatic vegetation	relative density of dominant species
Fish assemblage	species richness
	abundance
Zooplankton	Species richness
	abundance
Geographic	**distance from nearest upstream reservoir**
	Floodplain connections*
	Zone
	Reach

Example: relating zooplankton metrics to landscape features.

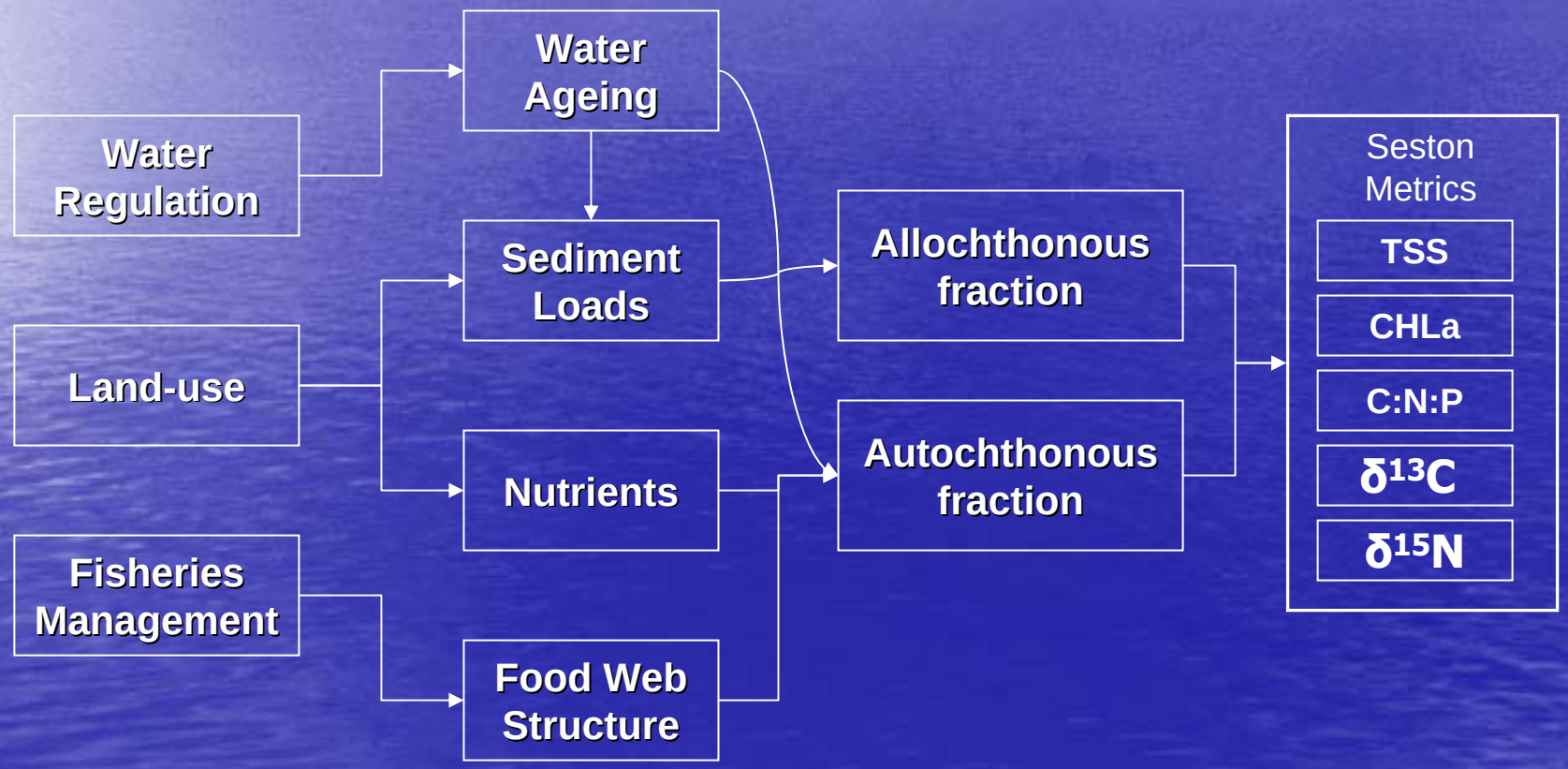
- Hydrologic data used to delineate river segments representing 5-d* transit time above each EMAP sampling location on the UpMS River.
- GIS analyses to estimate floodplain plain area in each segment.

*Transit-time reflects growth rates of common zooplankton.

Floodplain influences on zooplankton metrics:



Conceptual model linking seston metrics to anthropogenic stressors:



Thanks to:

- Alex Levchuk, INHS.
- Kim Medley, Missouri State University.
- Amy MacDonald, VCU.