Life on the Mississippi and Other Great Rivers: Conceptual Understanding Leading to Assessment Design

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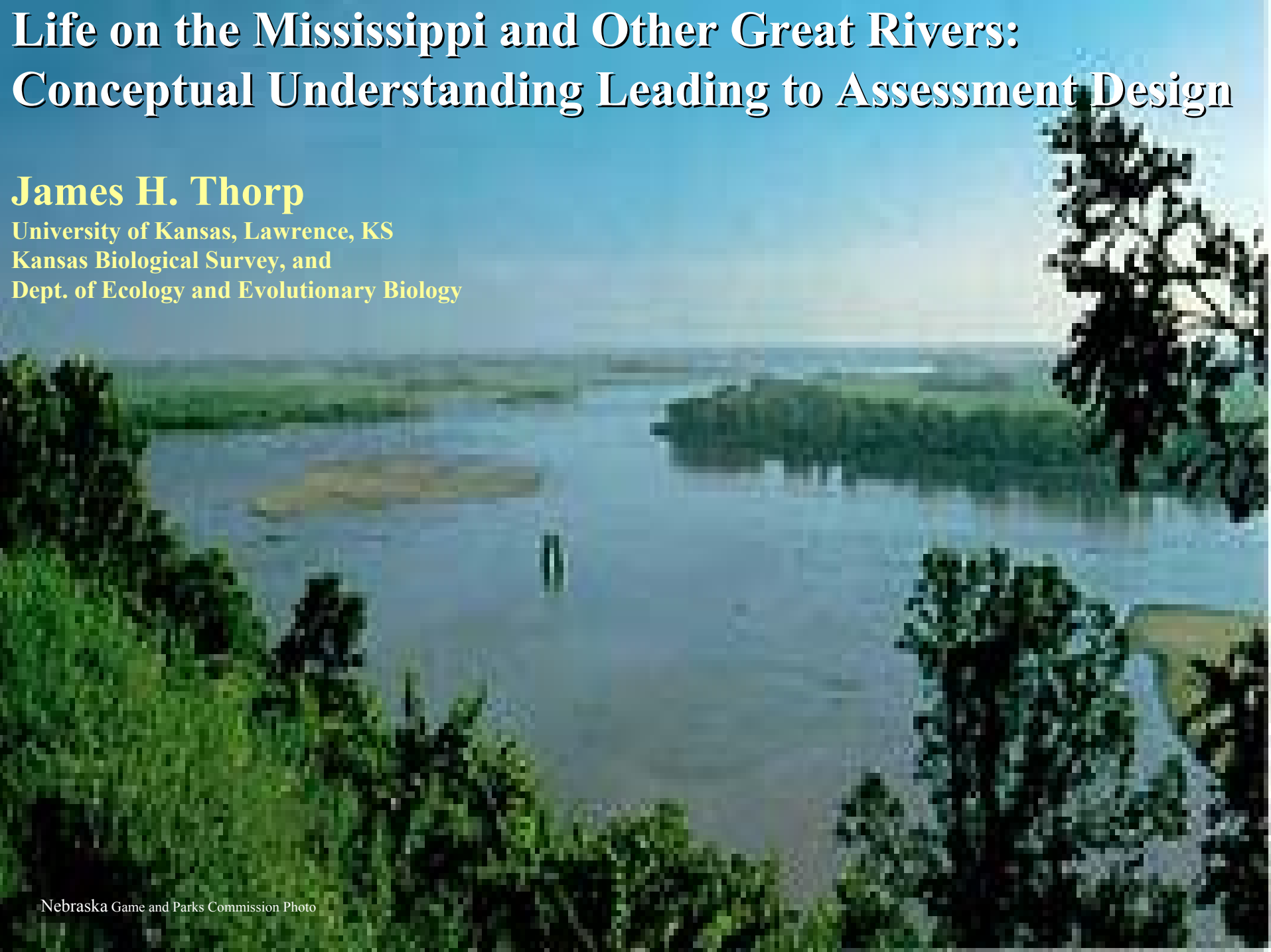


Nebraska Game and Parks Commission Photo

Environmental Monitoring and Assessment Program

A *research program* to develop *environmental tools* for monitoring and assessment

EMAP's goal:

"... to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into *assessments of ecological condition* and *forecasts of the future risks to the sustainability* of our natural resources."

Modified from the EMAP web page; italics were added by me.

My objectives today are to:

1. Define great rivers.

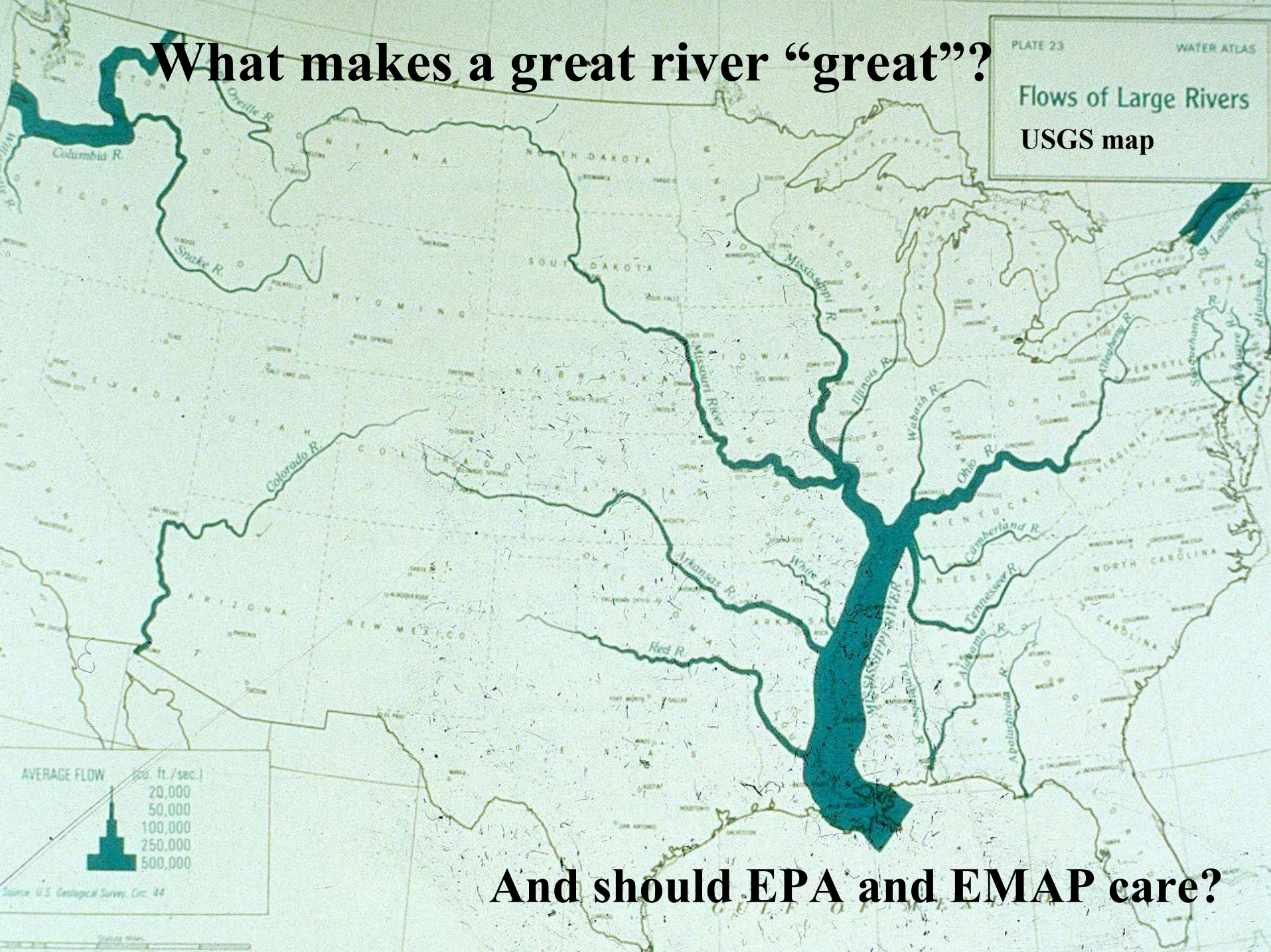
2. Evaluate importance of river size from ecological, economic, and technique perspectives.

3. Identify other important differences among and within great rivers.

4. Consider other conceptual river issues relevant to EMAP.

These perspectives are influenced by my research experience in the Mississippi, Missouri, Ohio, Tennessee, and St. Lawrence Rivers.

What makes a great river "great"?



And should EPA and EMAP care?

River Size -
A Continuous Variable With Categorical Labels

Great rivers are first and foremost "big rivers"!

Non-wadeable

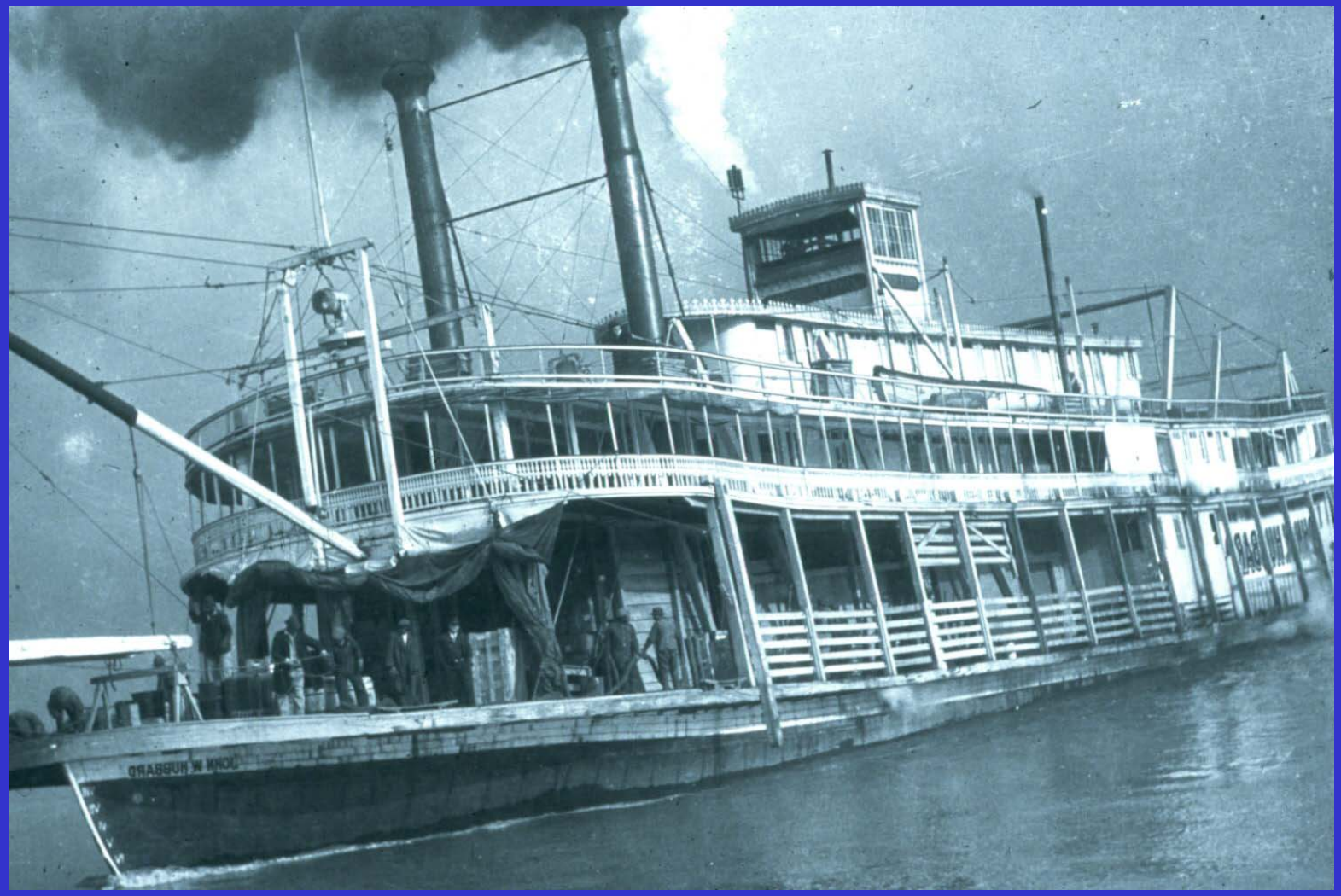
7th order or larger

High discharge

… and large enough to be intimidating!

How do large rivers differ from great rivers ?

Great rivers (in their modern, regulated state) are large enough to be commercially <u>navigable</u> through most of the year.



If river size is a continuous variable, should EPA recognize river categories?

From a practical standpoint …Yes … because important differences associated with river size are related to:

ecology/environmental biology (ecosystem integrity)
economics (sustainable use of rivers)
monitoring and assessment approaches

for example …

- what economic & ecological indicators to focus on
- how to sample these in different kinds of rivers

Ecological Justifications for Size Categories

Oregon headwater stream

Amazon tributary

Width, depth, and discharge influence ecosystem structure and functioning by affecting processes at different levels:

- Species (life history strategies, morphology, behavior)
- Community - composition (e.g., functioning feeding groups, zooplankton)
- Community/ecosystem - food webs (nutrient sources, regulation)
- Ecosystem (e.g., productivity, nutrient spiraling)

Such differences influence EMAP's choice of:

- Ecological indicators
- Spatial and temporal scales for monitoring
- Sampling devices

*** And remember, the larger the river, the greater its integrative role !**

Economic Perspectives on River Size

All sizes of rivers potentially provide humans with water, hydroelectric power, and recreational opportunities.

But, only <u>great rivers</u> can commercially support transport of coal, grain, and fertilizers…. a justification for a great river focus !

River Size: Implications for Logistics and Study Techniques

Target species change with the size and type of lotic ecosystem studied and which habitat is sampled.

Some Species in Wadeable Streams

Topeka shiner

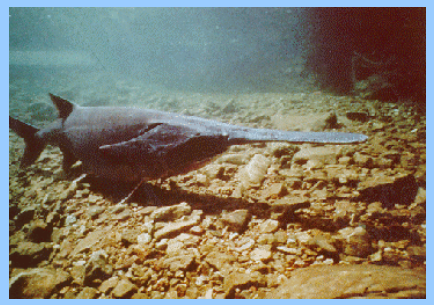
Fishfly eating a stonefly

Photo by Larry Sherpa

Crayfish

Photo by Bo DiStefano

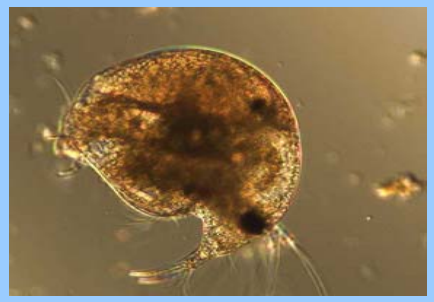
Some Species in Large and Great Rivers



Paddlefish

True midge

Photo by Dave Penrose



Bosminid water flea

River Size: Implications for Logistics and Study Techniques

Wading in streams, using a kick net, and adding chemical tracers are often not viable research and monitoring options in great rivers.

River Size: Implications for Logistics and Study Techniques

25' Boston Whaler Challenger like the one we have at KU for large-great river research

Studies in great rivers may require bigger boats with sophisticated electronics, different sampling gear, and often special techniques (e.g., in studies of effects of fish and zebra mussels, we used this 110' long x 20' wide raft and field enclosures).

Raft with submerged potamocorrals drifting down Ohio River in zooplankton experiment

Permeable potamocorrals (right) and impermeable limnocorrals (left) next to St. Lawrence River

EMAP Design Considerations for Sampling Large & Great Rivers: Between River Differences

a. channel morphology: e.g., constricted, braided, and constricted

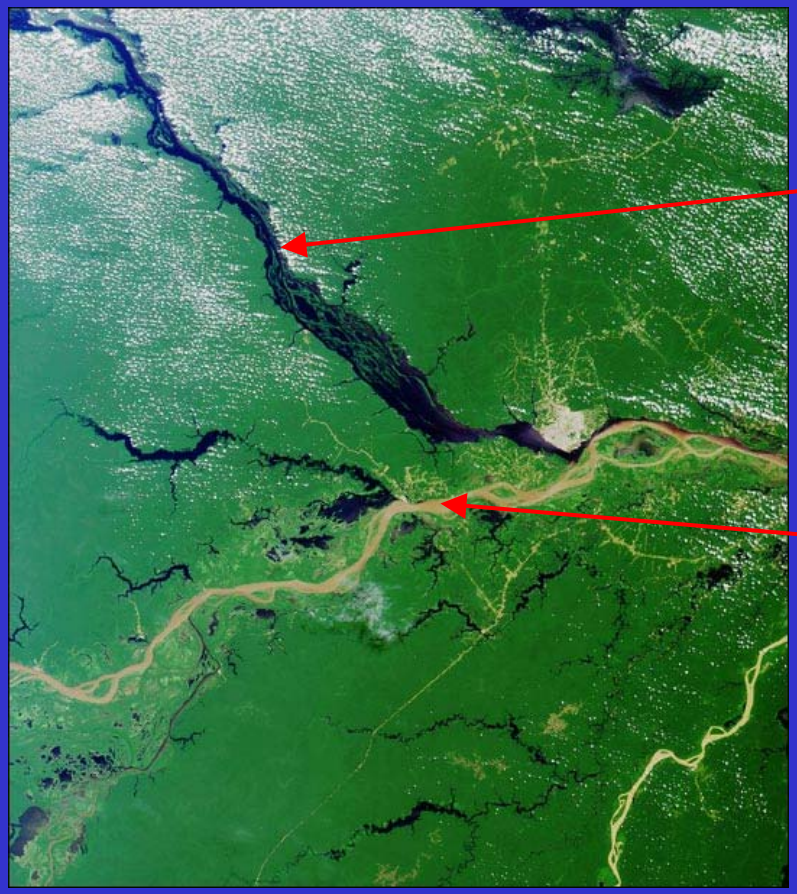
Constricted Ohio River

Braided Tagliamento River in northern Italy

Floodplain Amazon River (Landsat image)

EMAP Design Considerations for Sampling Large & Great Rivers: Among-River Differences

a. channel morphology: floodplain, braided, constricted
b. natural turbidity



Low turbidity, blackwater Rio Negro (Amazon tributary)

Non-polluted but highly turbid Rio Solimoes

EMAP Design Considerations for Sampling Large & Great Rivers: Among-River Differences

a. channel morphology: floodplain, braided, constricted
b. natural turbidity
c. annual hydrographic patterns
- timing of peak discharge
- length of high water stage
- periodicity and predictability of physical flood pulse

EMAP Design Considerations for Sampling Large & Great Rivers: Between River Differences

a. channel morphology: floodplain, braided, constricted
b. natural turbidity
c. annual hydrographic patterns
d. unique characteristics of the biotic community

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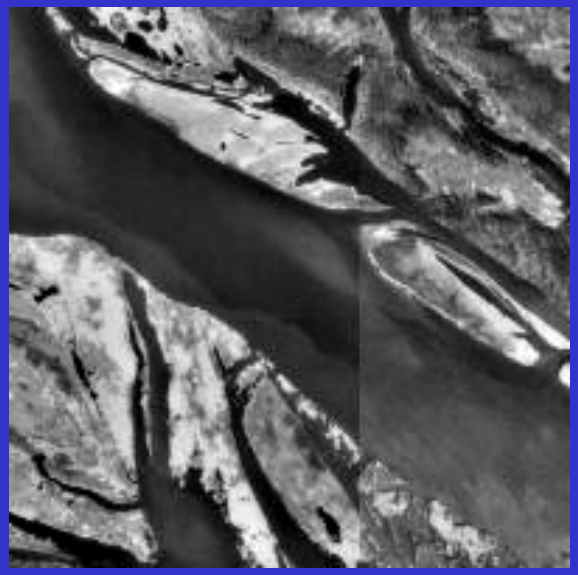
a. channel morphology: floodplain, braided, constricted
b. natural turbidity
c. annual hydrographic patterns
d. unique characteristics of the biotic community
e. temporal variations over seasons and among years
f. macrohabitats
- main channel vs slackwaters
- benthic vs planktonic

EMAP Design Considerations for Sampling Large and Great Rivers: Anthropogenic Complications



braided reach of the Missouri River

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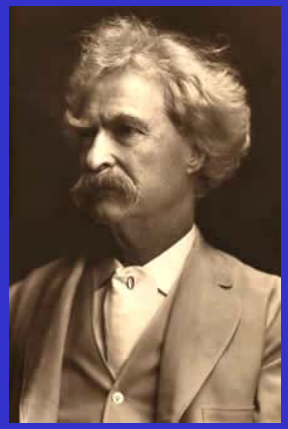
channelized reach of the Missouri River



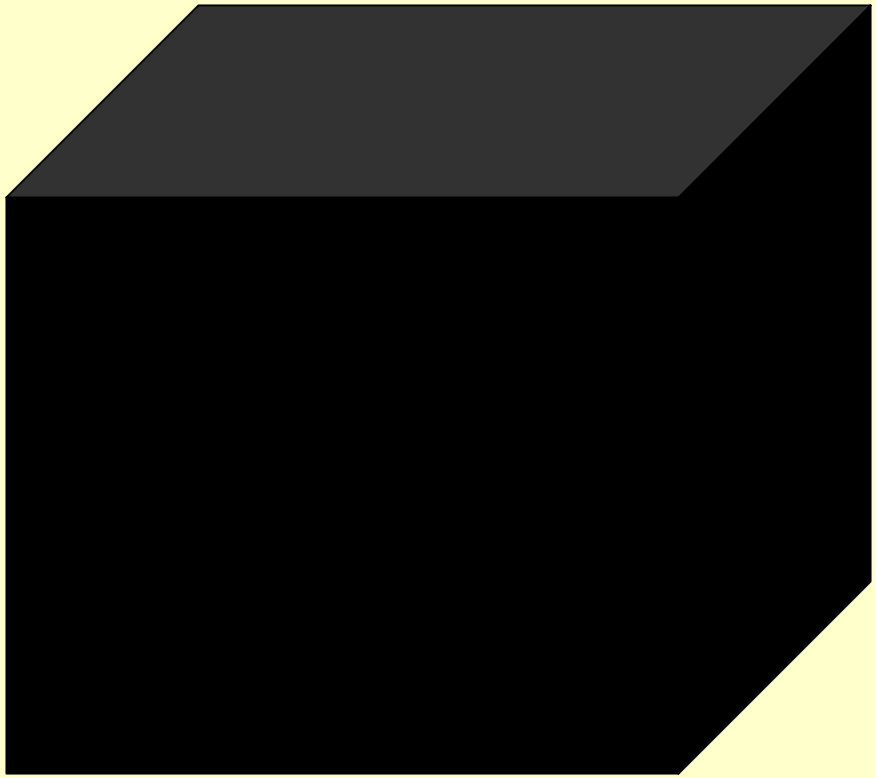
"A river without islands is like a woman without hair. She may be good and pure, but one doesn't fall in love with her very often."

Samuel L. Clemens

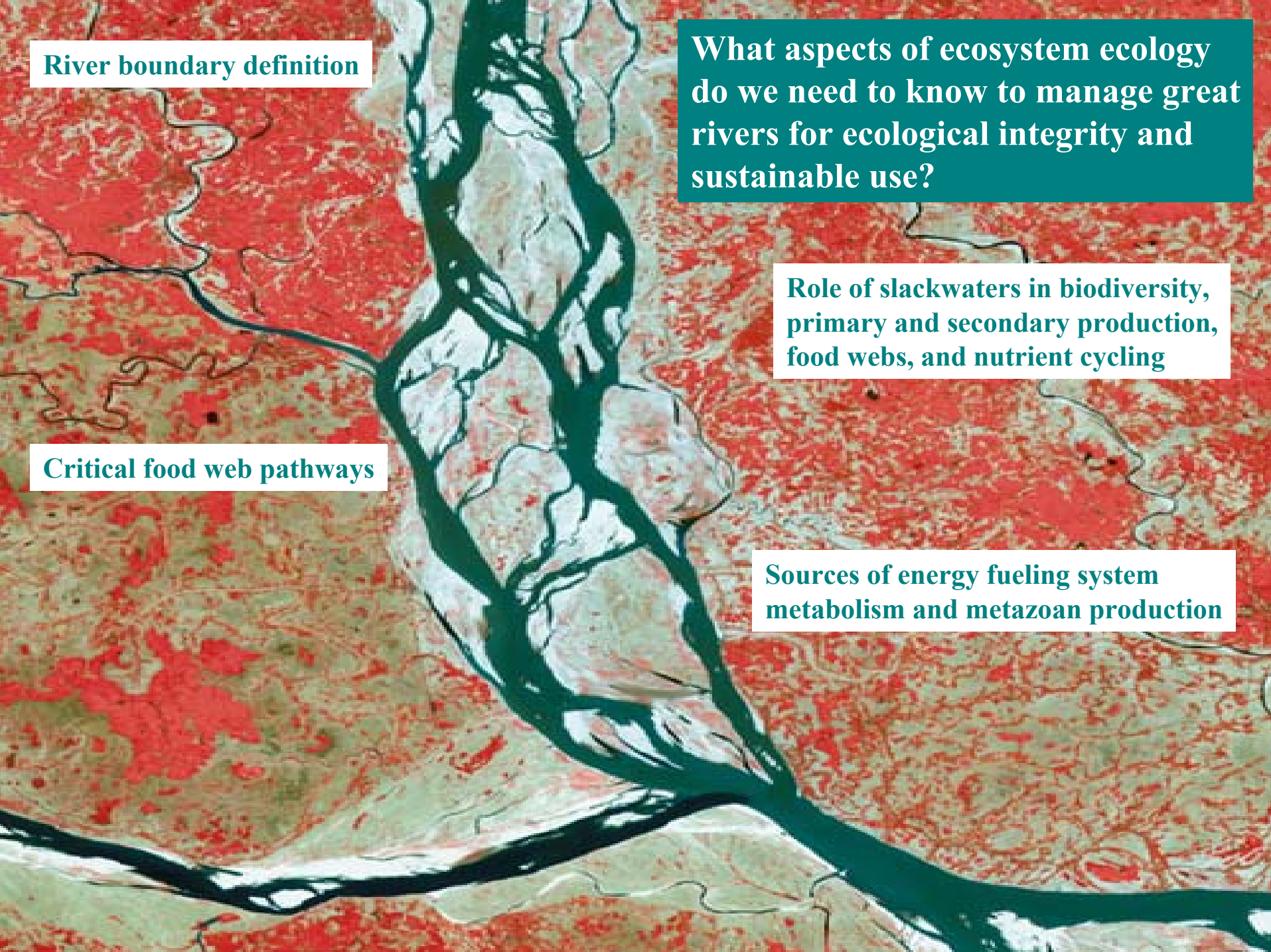
- Impoundments
  - navigation (low head)
  - reservoirs (high dams)
- Channelization

Recall the goals of EMAP: develop tools to…..

- Assess ecological condition of rivers
- Forecast future risks to sustainability



Unfortunately, from the standpoint of understanding their functional ecology, large and great river ecosystems remain …..

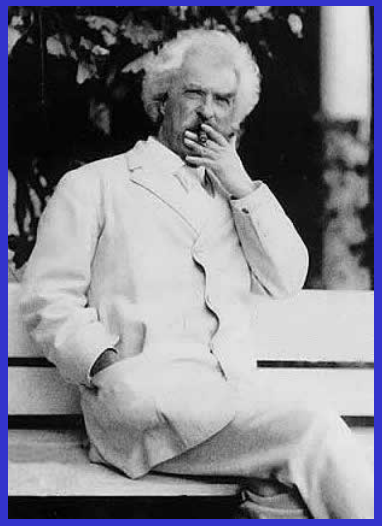

River boundary definition
What aspects of ecosystem ecology do we need to know to manage great rivers for ecological integrity and sustainable use?
Role of slackwaters in biodiversity, primary and secondary production, food webs, and nutrient cycling
Critical food web pathways
Sources of energy fueling system metabolism and metazoan production

Energy Sources Fueling System Metabolism & Metazoan Production

Critical to understand: ubiquitous influence and affected by river management

Several primary conceptual theories, including ….

- **Riverine productivity model (RCC; Vannote et al. 1980)**
- **Flood pulse concept (FPC; Junk et al. 1989)**
- **Riverine productivity model (RPM; Thorp and Delong 1994, 2002)**



Some truth and some conceptual "bull" in each of these theories.

Basing river management on any theory is risky at this point, and we certainly do not want to create any "sacred cows."

"Sacred cows make the best hamburger"
Samuel L. Clemens

Take Home Message

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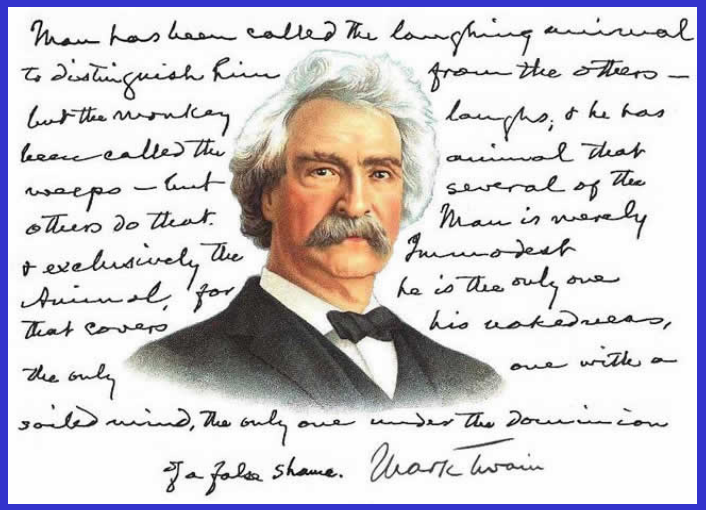
An EMAP design for great rivers cannot be developed by simply scaling up from approaches used in wadeable streams.

***Needed*: research on sustainability and workshops to define ecosystem integrity in great rivers.**

Acknowledgments

(Contributors to this talk and people who keep me honest)



There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact.

Samuel L. Clemens

This guy !

If you start to thinkin' you're a person of some influence, try orderin' somebody else's dog around.

Cowboy Wisdom
(and Mike Delong's)

“There are three kinds of lies ….. lies, damned lies, and statistics.”

Samuel L. Clemens