Response of stream ecosystem structure & function to restorations in urban watersheds

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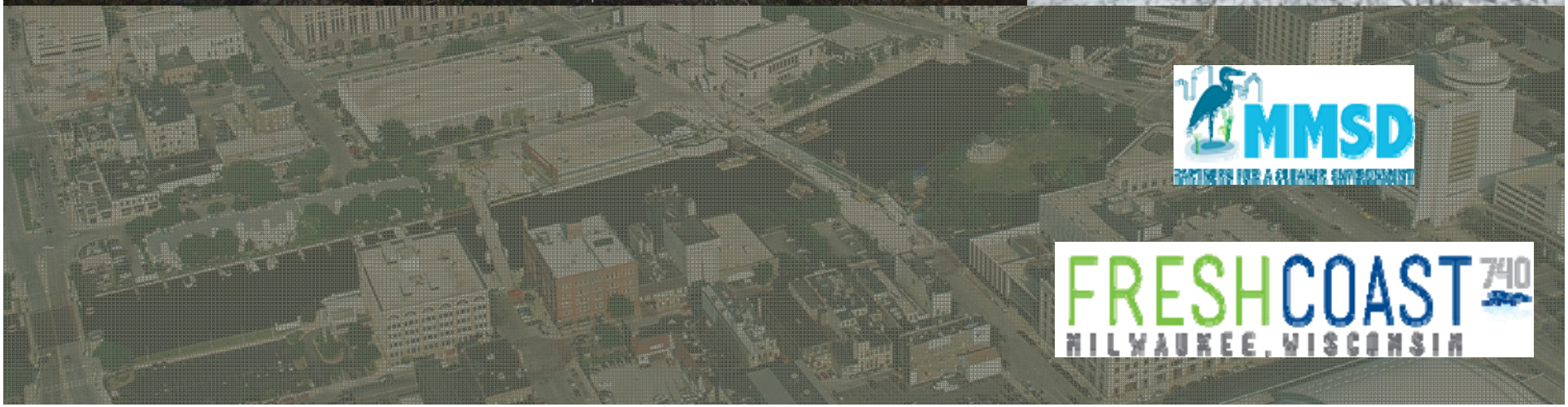

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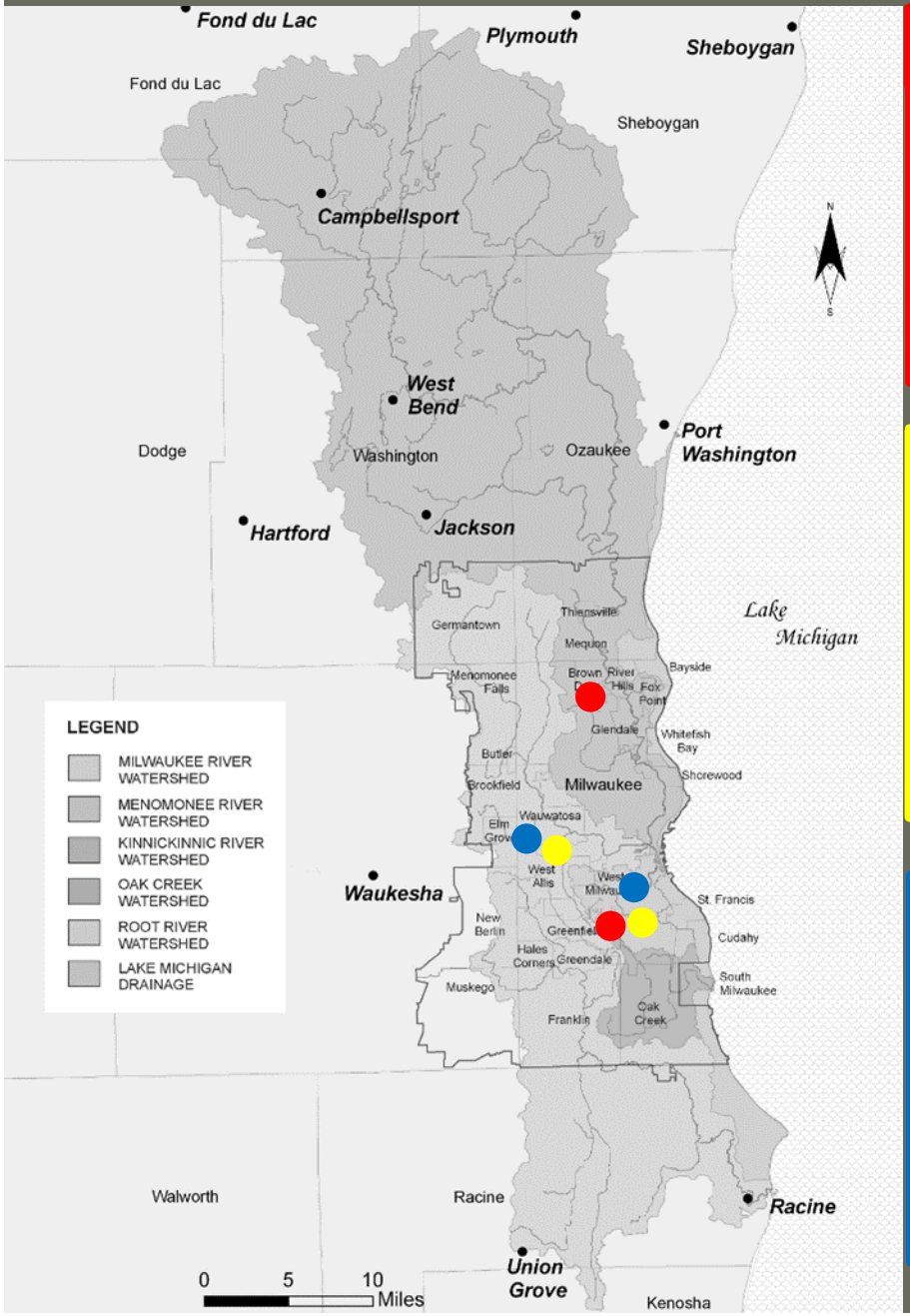
Study streams span range of discharge



Approach to assessing ecological value

• Quantified ecosystem structure & function in restored reaches & concrete channels

• Calculated *log response ratio (L)* to determine the effect of the restoration (Hedges et al., 1999)

$$L = \log (X_{treatment} / X_{control})$$

If L > 0, restoration had **positive** effect

If L < 0, restoration had **negative** effect

• Restoration improves ecological value if restored reach more similar to literature values of less impacted streams

Measures of ecosystem structure & function

Physical

- Discharge
- Travel time
- Channel geomorphology
- Sediment size

Biological

- Benthic chlorophyll-a
- Benthic organic matter

Chemical

- Stream water nutrients

Landscape

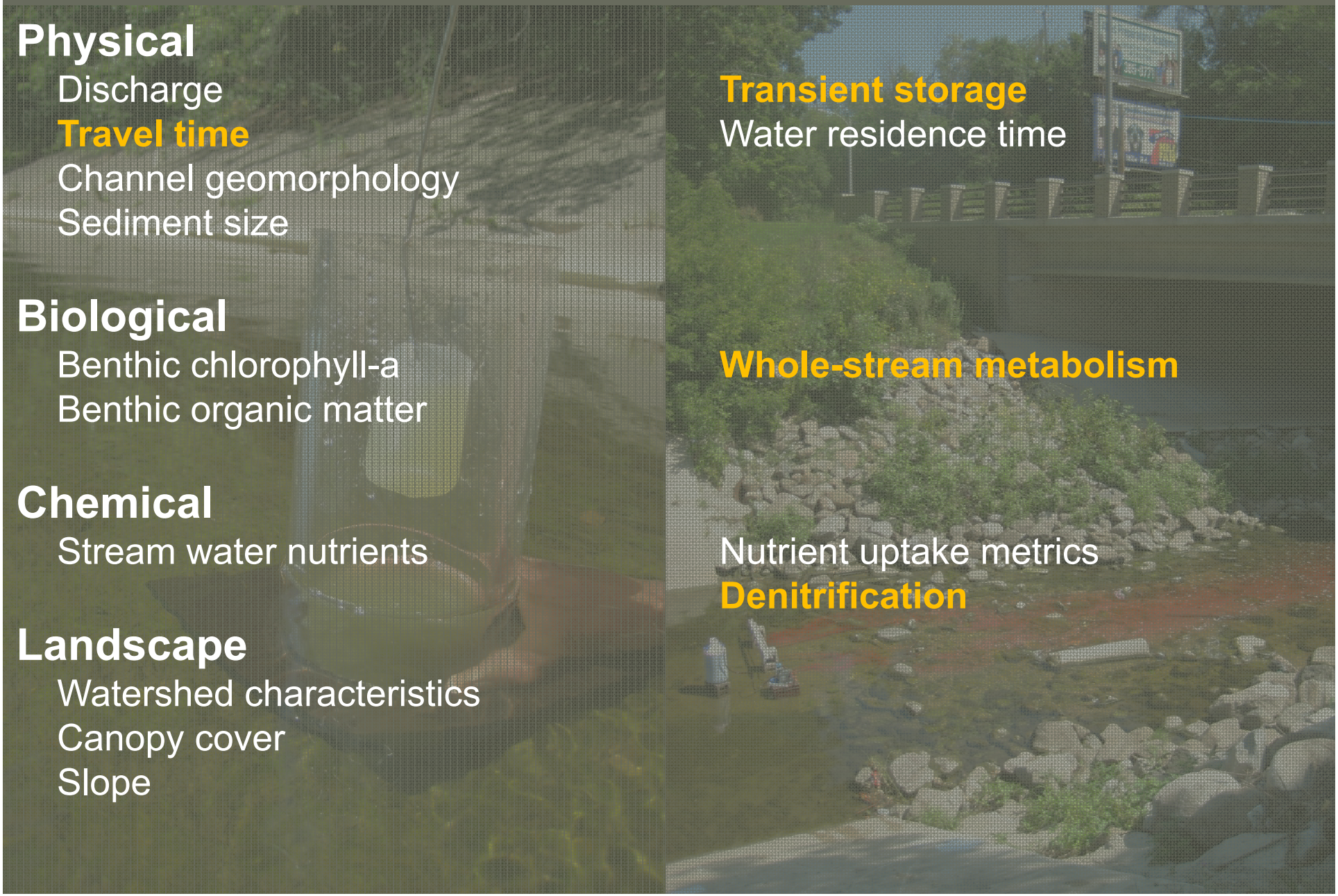
- Watershed characteristics
- Canopy cover
- Slope

- Transient storage
- Water residence time

- Whole-stream metabolism

- Nutrient uptake metrics
- Denitrification

Measures of ecosystem structure & function



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- **Travel time**
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Transient storage

Water residence time

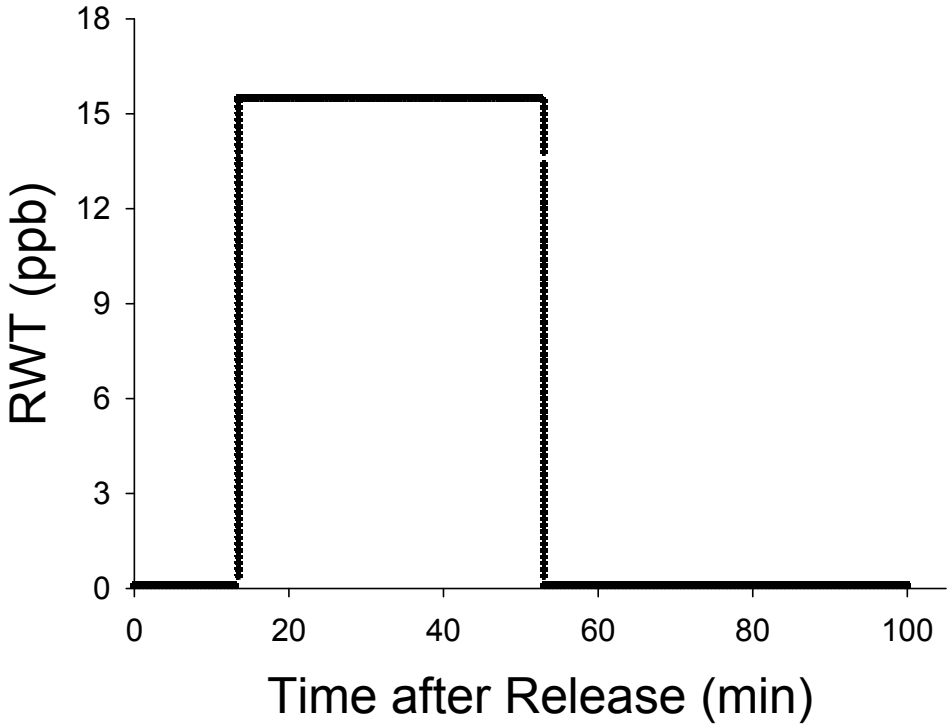
Whole-stream metabolism

Nutrient uptake metrics

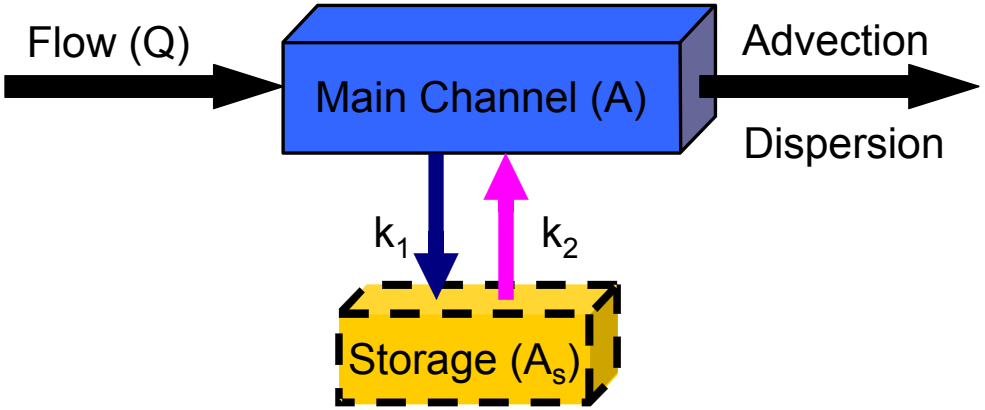
Denitrification

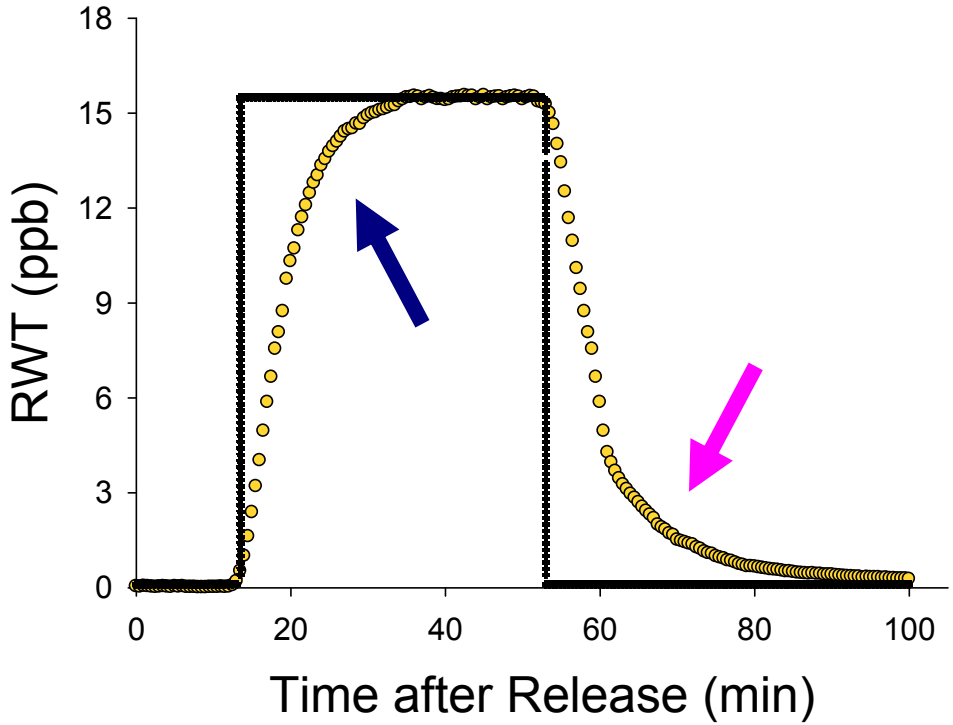
Do restorations alter hydrology?

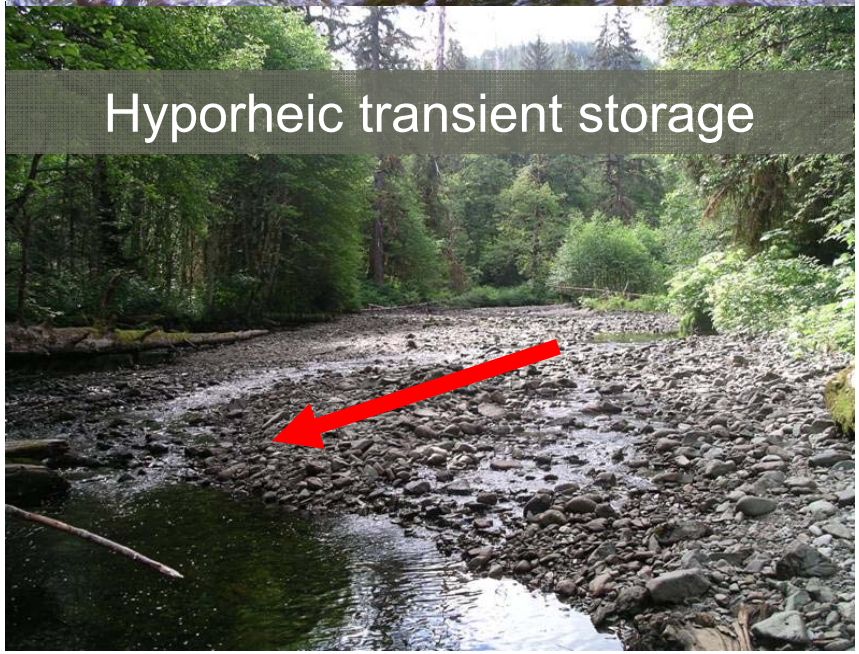
Methods: Transient storage releases & modeling



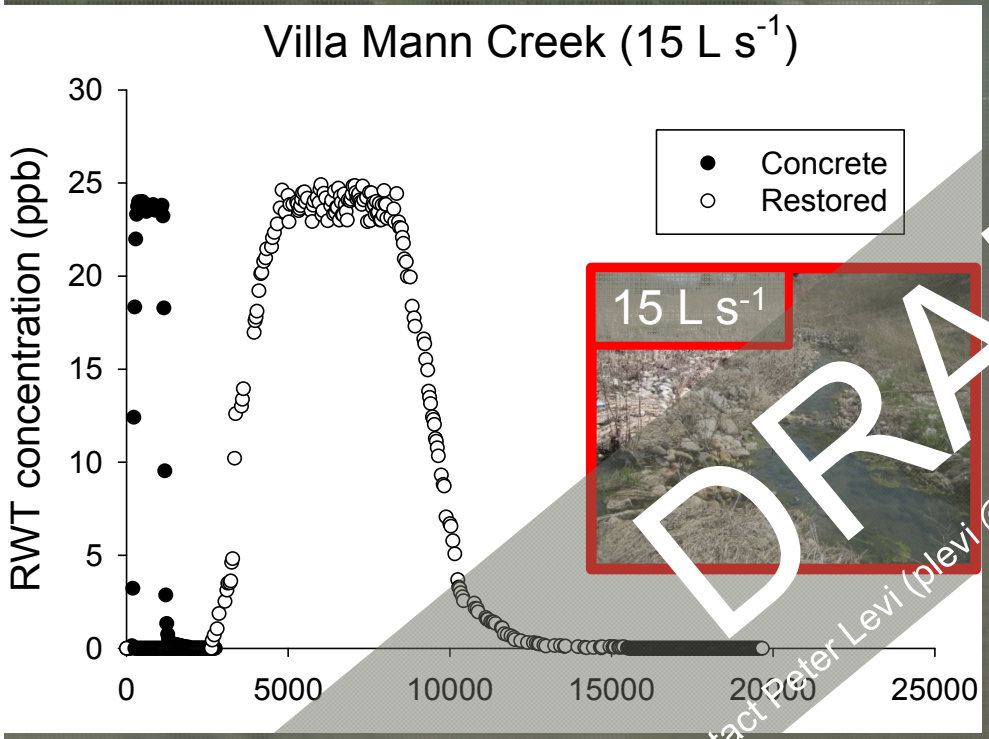
Methods: Transient storage releases & modeling







Concrete channels are pipes, restorations more natural



DRAFT

Contact Peter Levi (plevi @ wisc.edu) for most recent data)

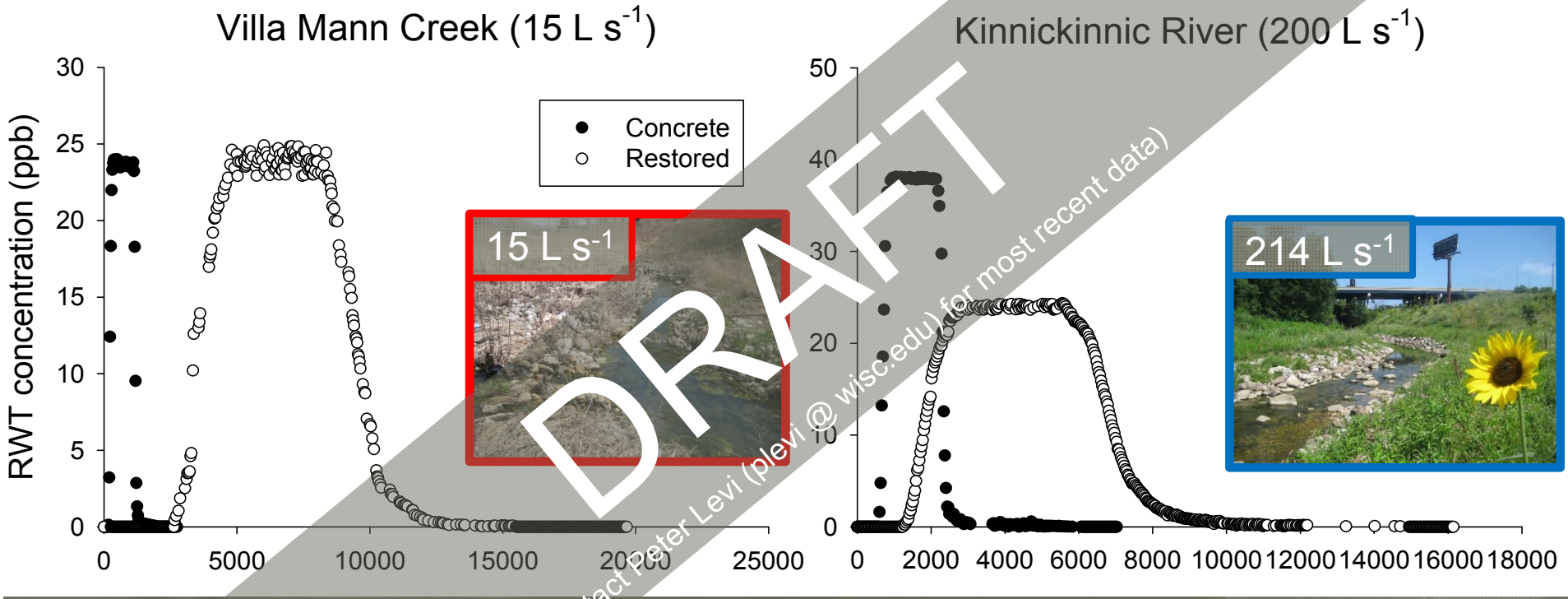
Travel time

Concrete: 3.5 min

Restored: 56.1 min

L = 1.17

Concrete channels are pipes, restorations more natural



Travel time

Concrete: 3.5 min

Restored: 56.1 min

L = 1.17

Travel time*

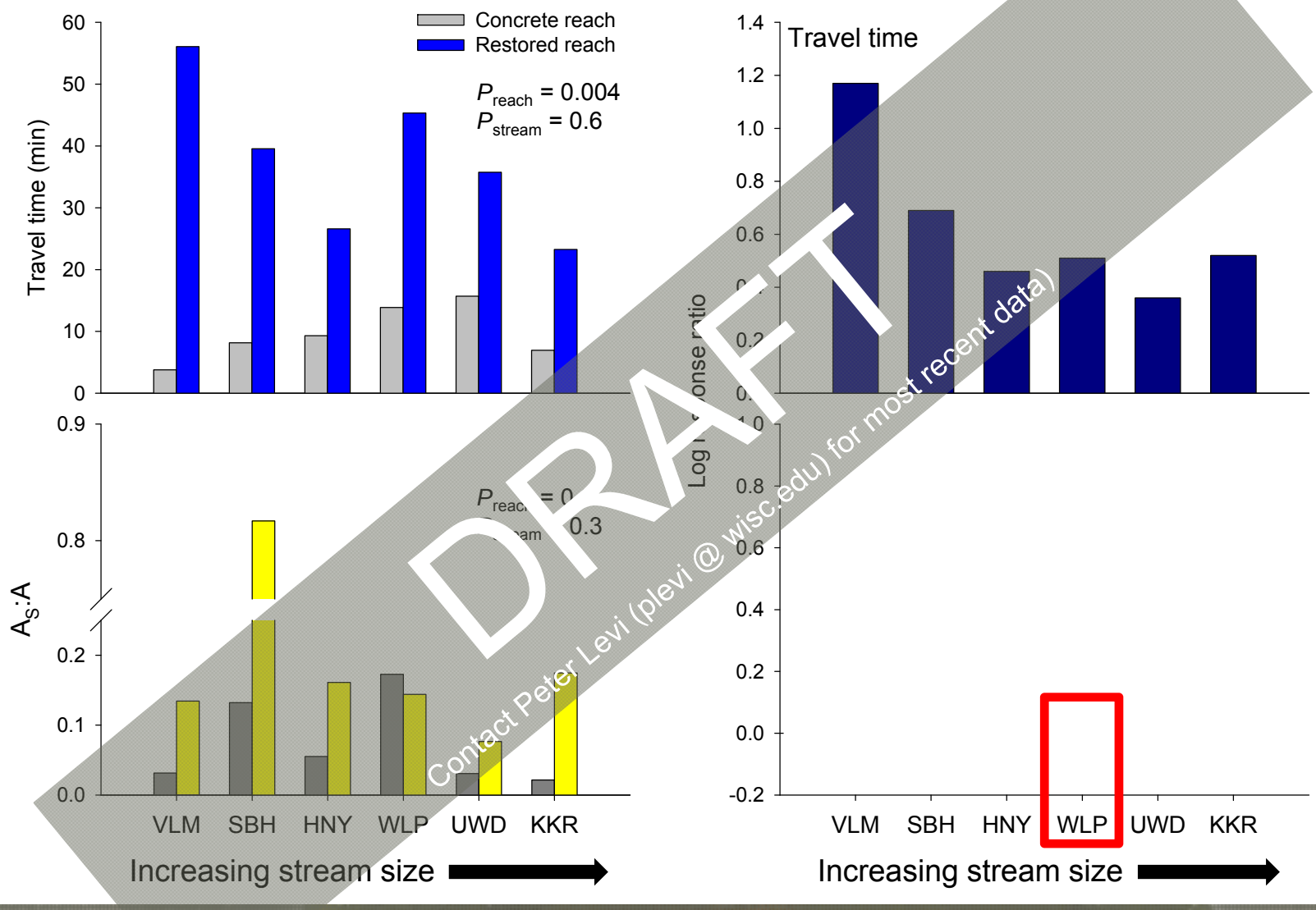
Concrete: 7.0 min

Restored: 23.2 min

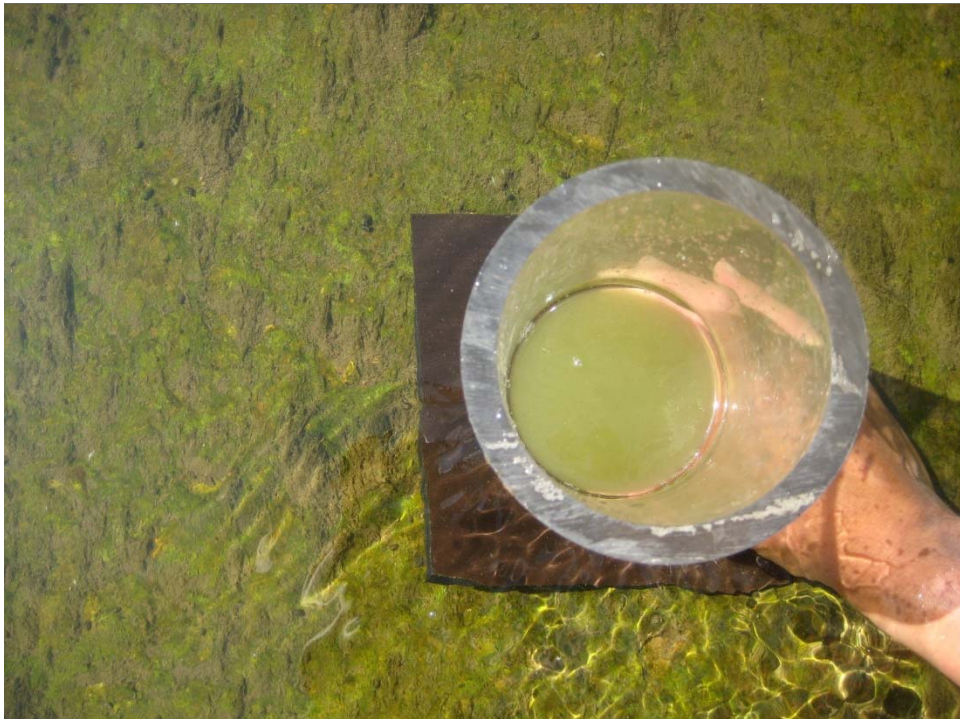
L = 0.52

*normalized for 150m reach

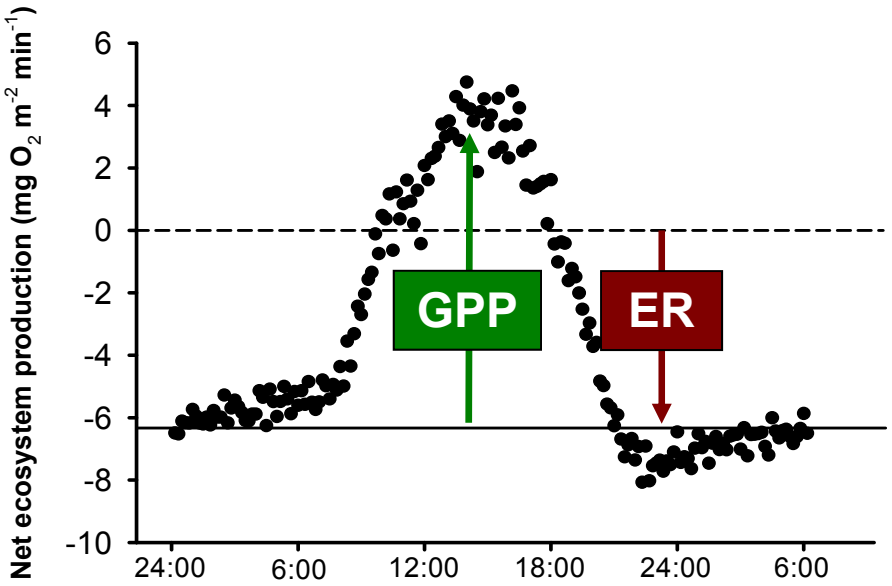
Restored reaches have long travel time, high storage



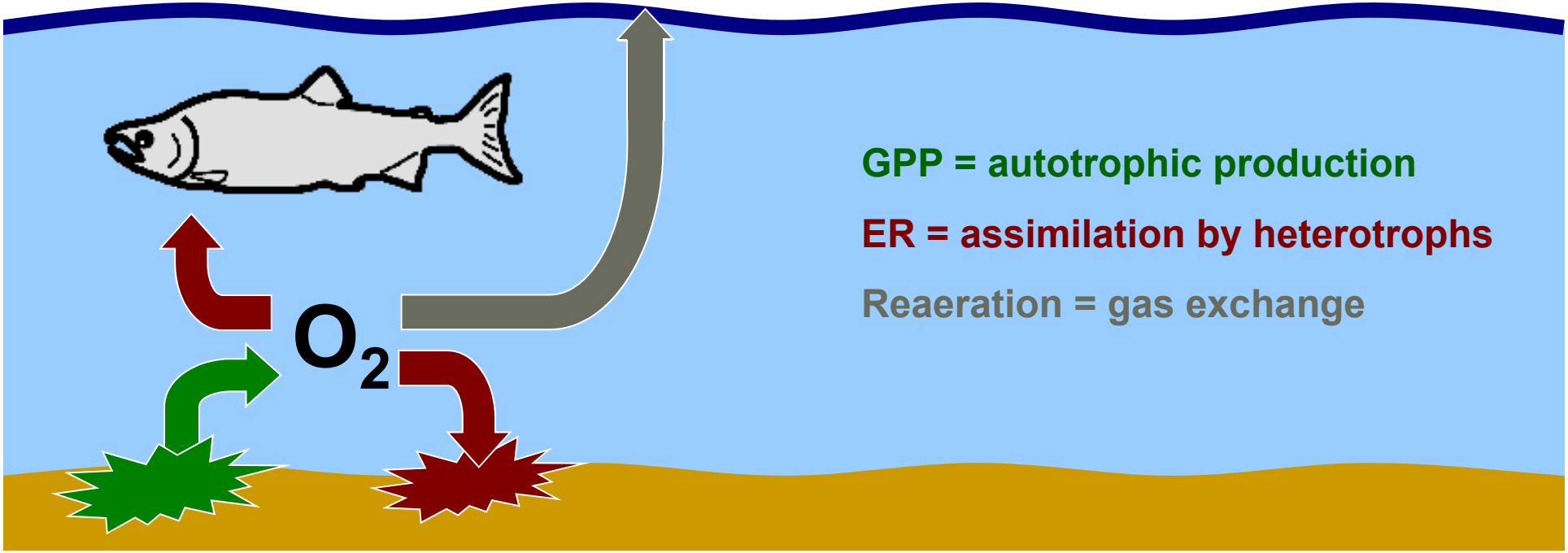
What is the biological response to restorations?



Methods: Whole stream metabolism modeling

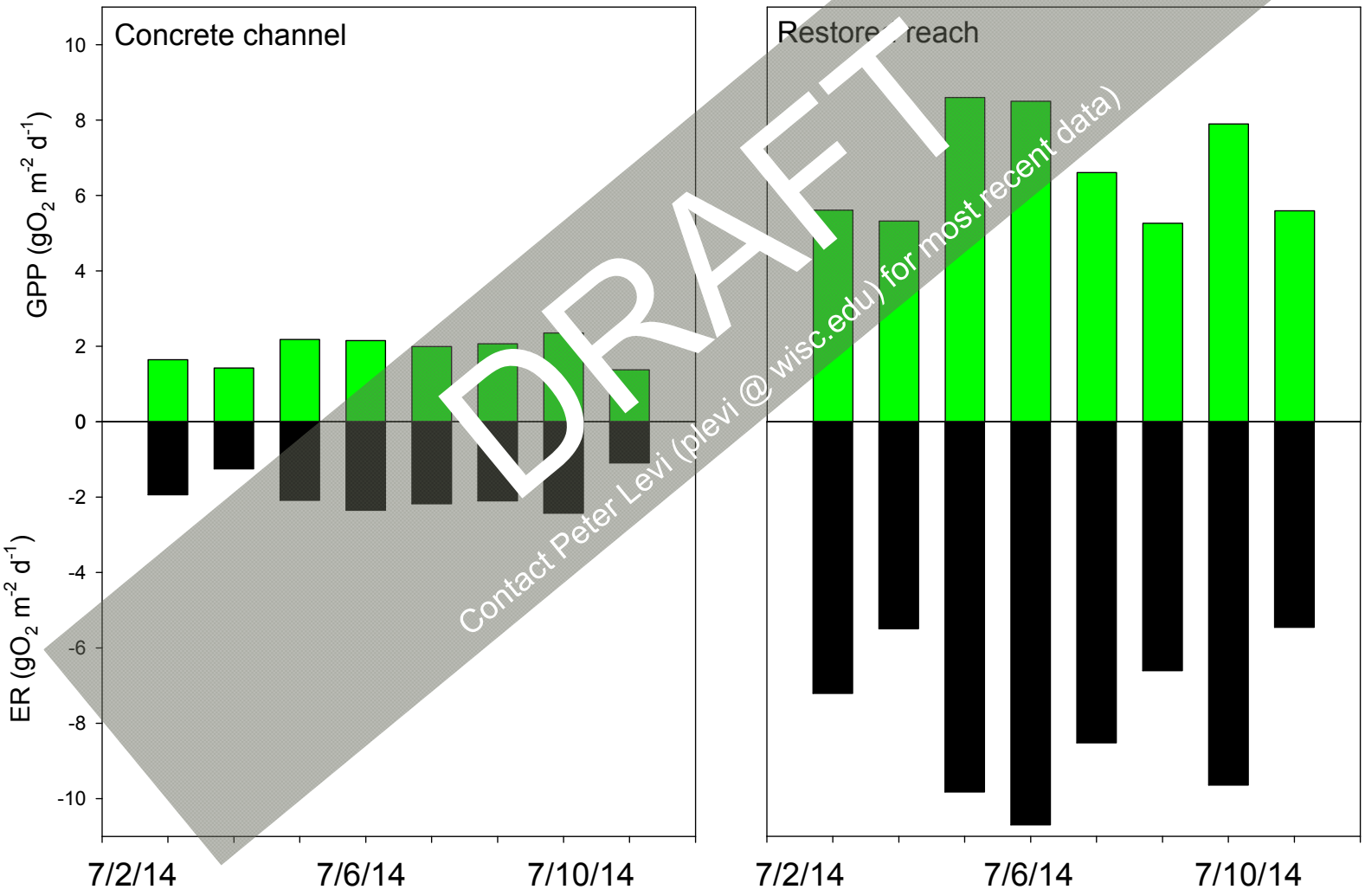


- Analyzing using both one- and two-station open channel method
- GPP, ER, & reaeration determined using day-time regression model (Kosinski 1984) and Bayesian approach (Holtgrieve et al. 2010)



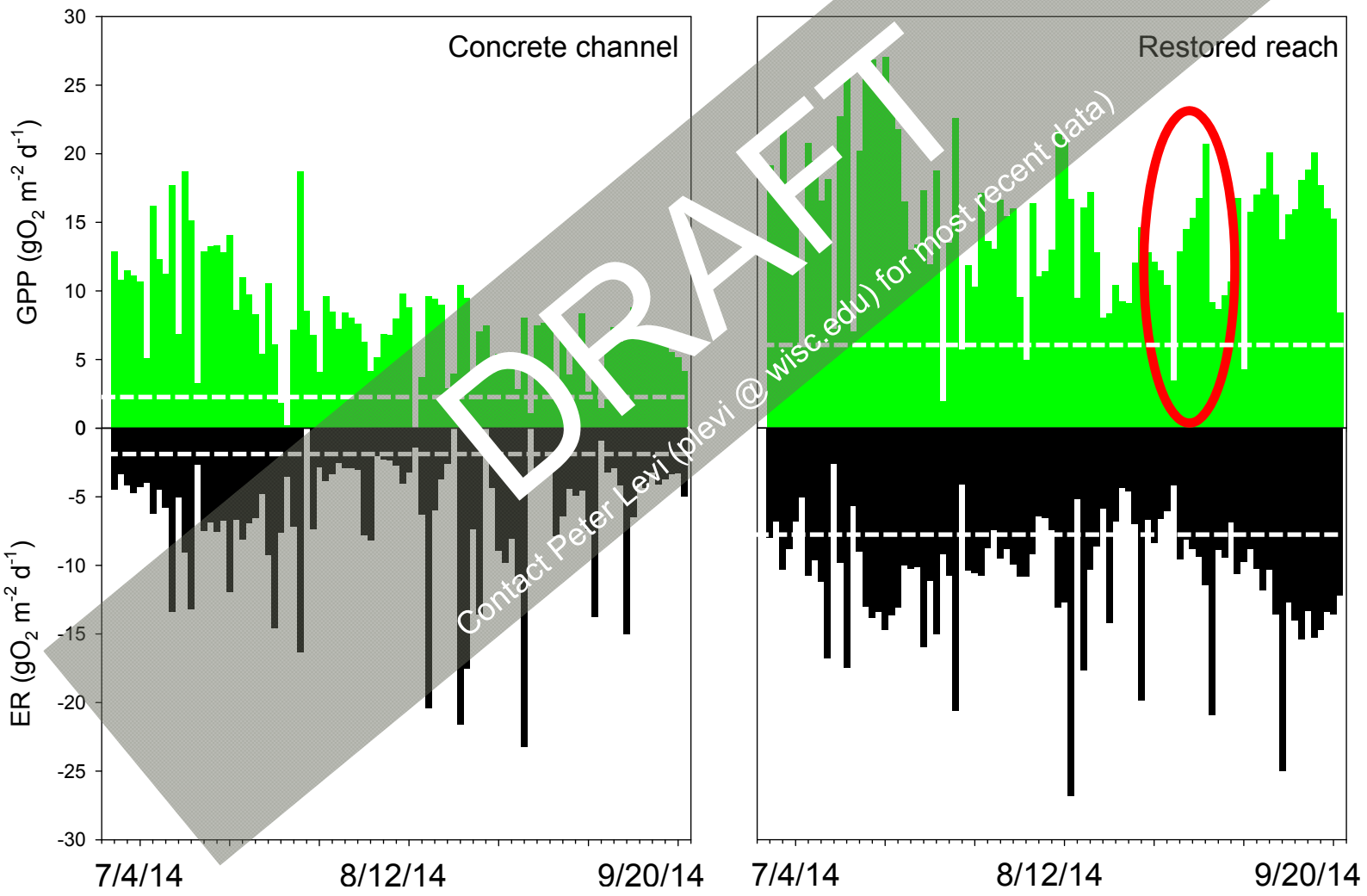
Restoration increases metabolism

- Higher GPP & ER in restored headwater relative to concrete
- Restored reach heterotrophic (GPP < ER)



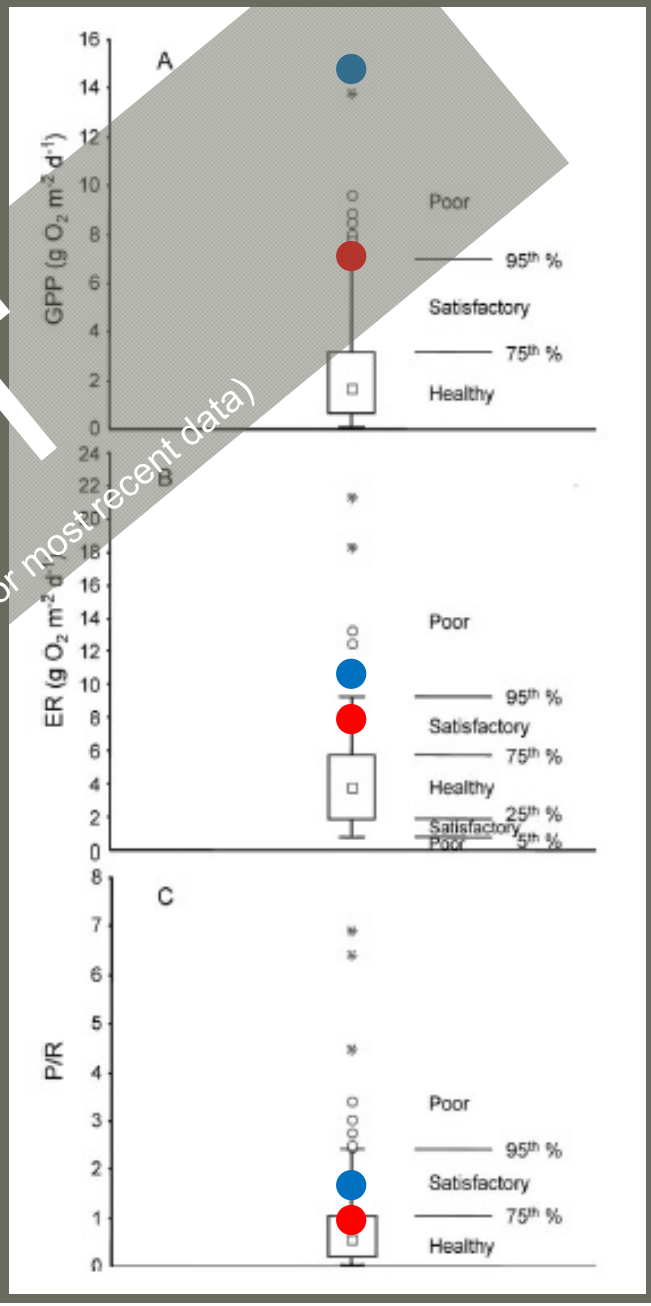
Restoration increases metabolism

- Both reaches highly autotrophic (GPP >> ER)
- High daily variation in GPP & ER related to discharge, weather



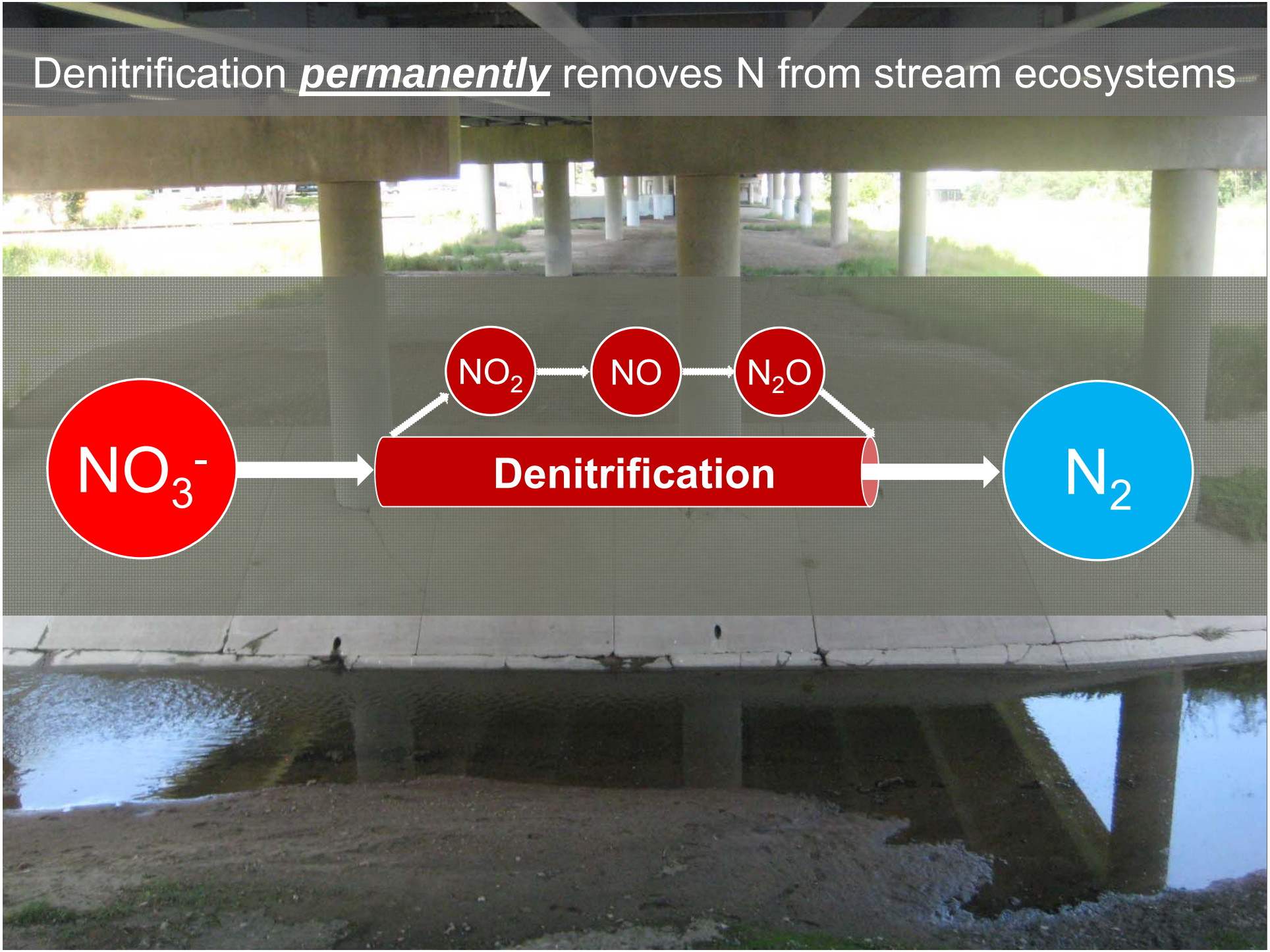
Metabolism provides pulse of ecosystem

GPP :	14.9	6.7
ER :	-10.8	-7.9
P:R :	1.38	0.85
L_{GPP} :	0.29	0.55

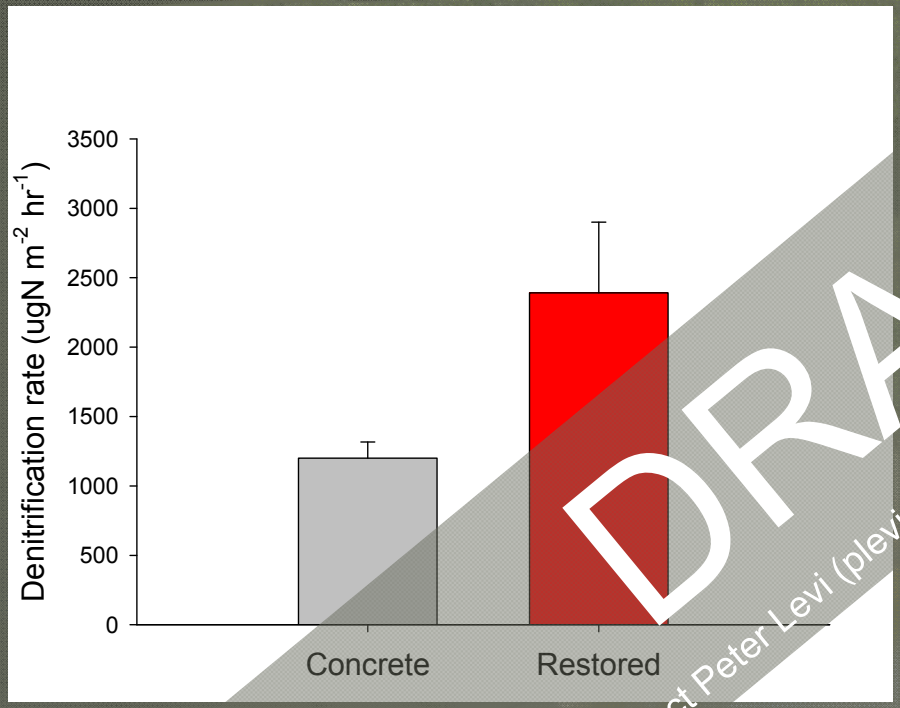


Young et al. (2008) proposed using whole-stream metabolism as indicator of ecosystem health

Denitrification ***permanently*** removes N from stream ecosystems



Denitrification *higher* in sediments of restored reach



- DENIT twice as high in restored sediments
- Suggests microbial communities differ in reaches

Do restorations improve urban stream ecosystems?

Definitely maybe…

\+ Physically: restored reaches much more natural

\- Biologically: restored & concrete reaches are both impaired

~ Chemically: denitrification increases in restored reach (n=1)

What are the ecological, economic, and social costs and benefits of urban stream restorations?

Assessing ecological, economic, & social costs & benefits

	Ecol.	Econ.	Social
Cost			
Benefits			

Thank you. Questions, comments, suggestions?

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