Applying Ecological Resilience Concepts to the Restoration and Management of the UMRS

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Acknowledgements/Contributors

Resilience Working Group

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Resilience Workshop – January 2016

- Additional Workshop attendees
  - Yao Yin (USGS)
  - Brian Ickes (USGS)
  - Jim Rogala (USGS)
  - Melinda Knutson (FWS)
  - Dru Buntin (UMRBA)
  - Kevin Stauffer (MDNR)
  - Lance Gundersen (Emory U.)
  - Allyson Quinlan (Resilience Alliance)

Partnership Meetings

UMRR LTRM Science Mtg – Feb 2016
A-team update – Feb 2016
UMRCC Annual Mtg – March 2016
UMRR CC Quarterly Mtg – May 2016
HNA-II Workshop – July 2016
UMRBA & UMRR CC Mtg – Aug 2016
A-team update – Aug 2016
HREP Workshop – Sept 2016

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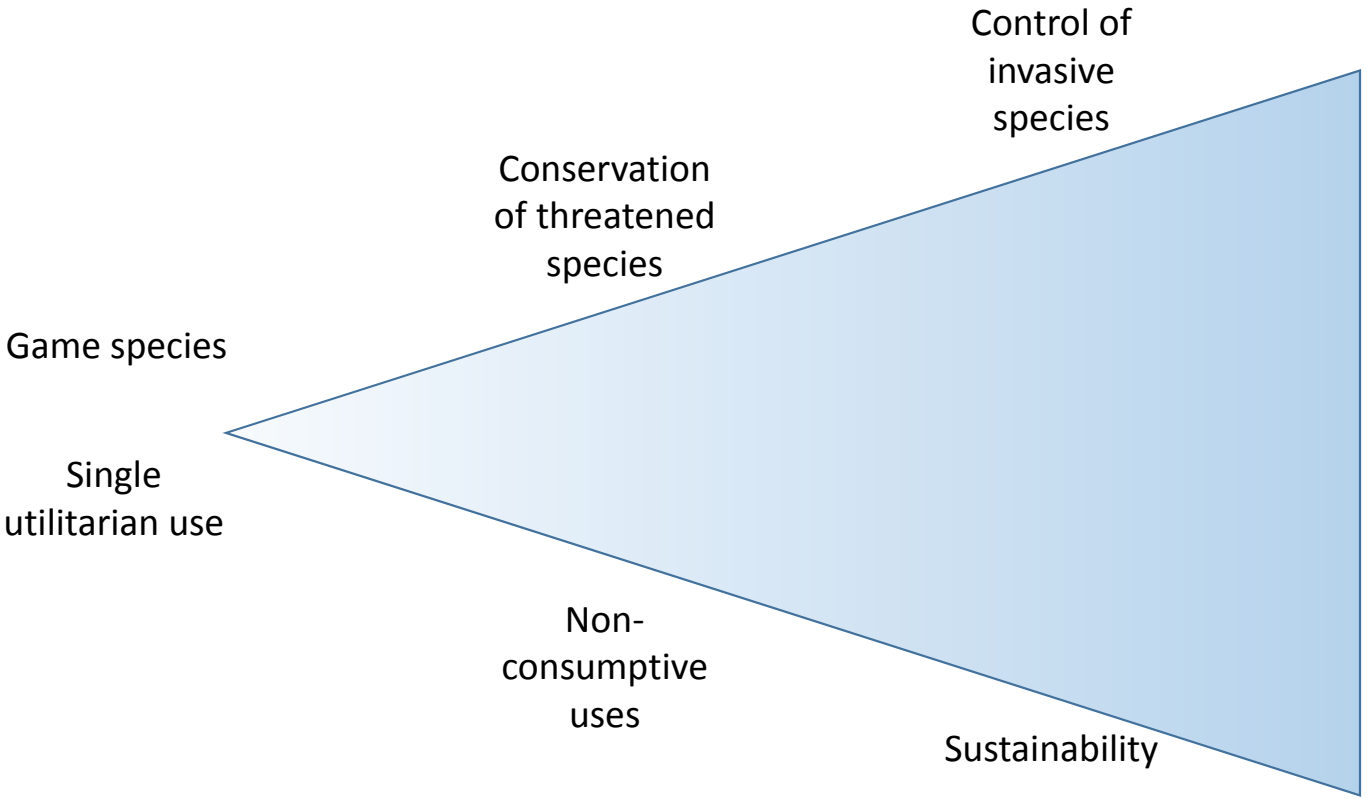
Management approaches



Aesthetics, photography and sight-seeing
Biodiversity
Bird-watching
Boating, swimming and camping
Cultural identity
Drainage
Flood risk reduction and storage
Floodplain agriculture
Hunting and trapping
Hydropower
Navigation
Nutrient and sediment processing
Recreational and commercial fishing
Water quality
Water supply

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Resilience: a definition

- "…capacity of a system to **absorb disturbance** and reorganize while undergoing change so as to **still retain essentially the same function, structure, identity and feedbacks** (Holling 1973, Walker et al. 2004)"

- In other words – the ability of the system to cope with unexpected disturbances without losing its fundamental characteristics or identity

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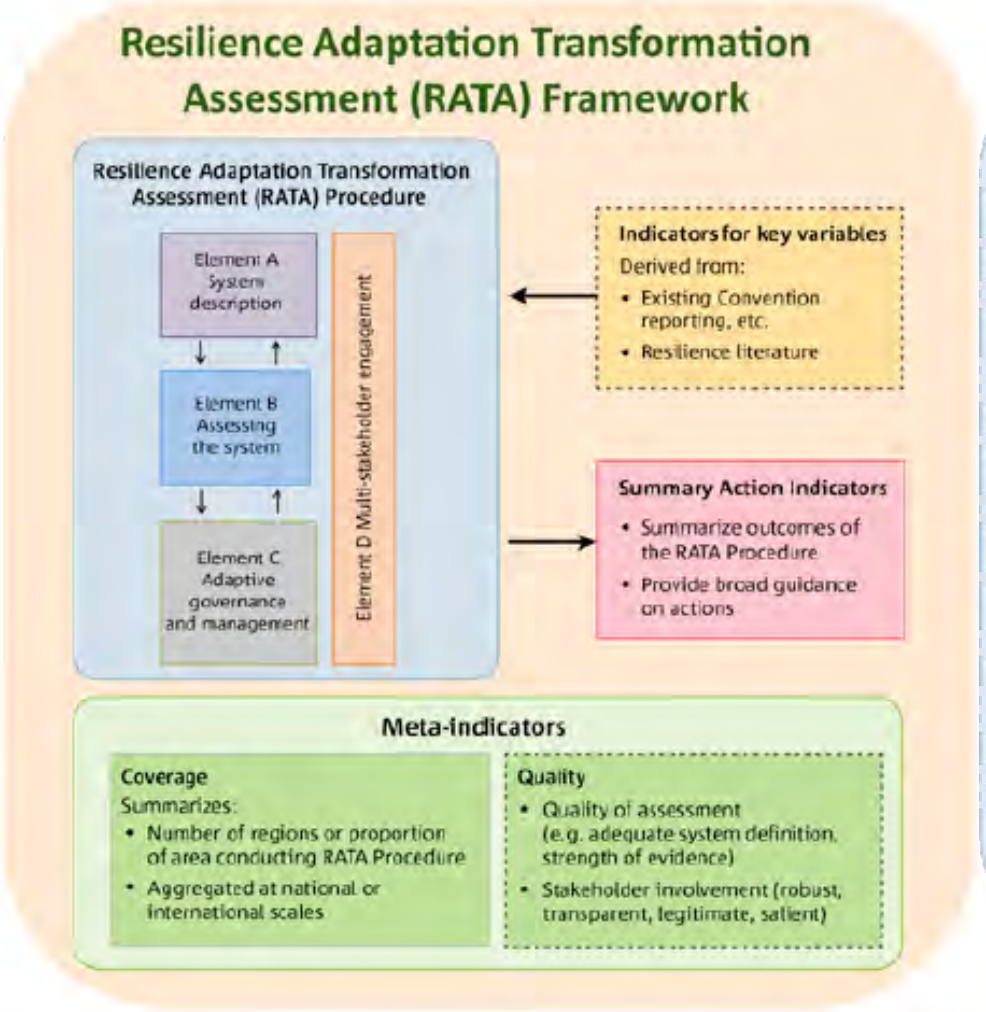
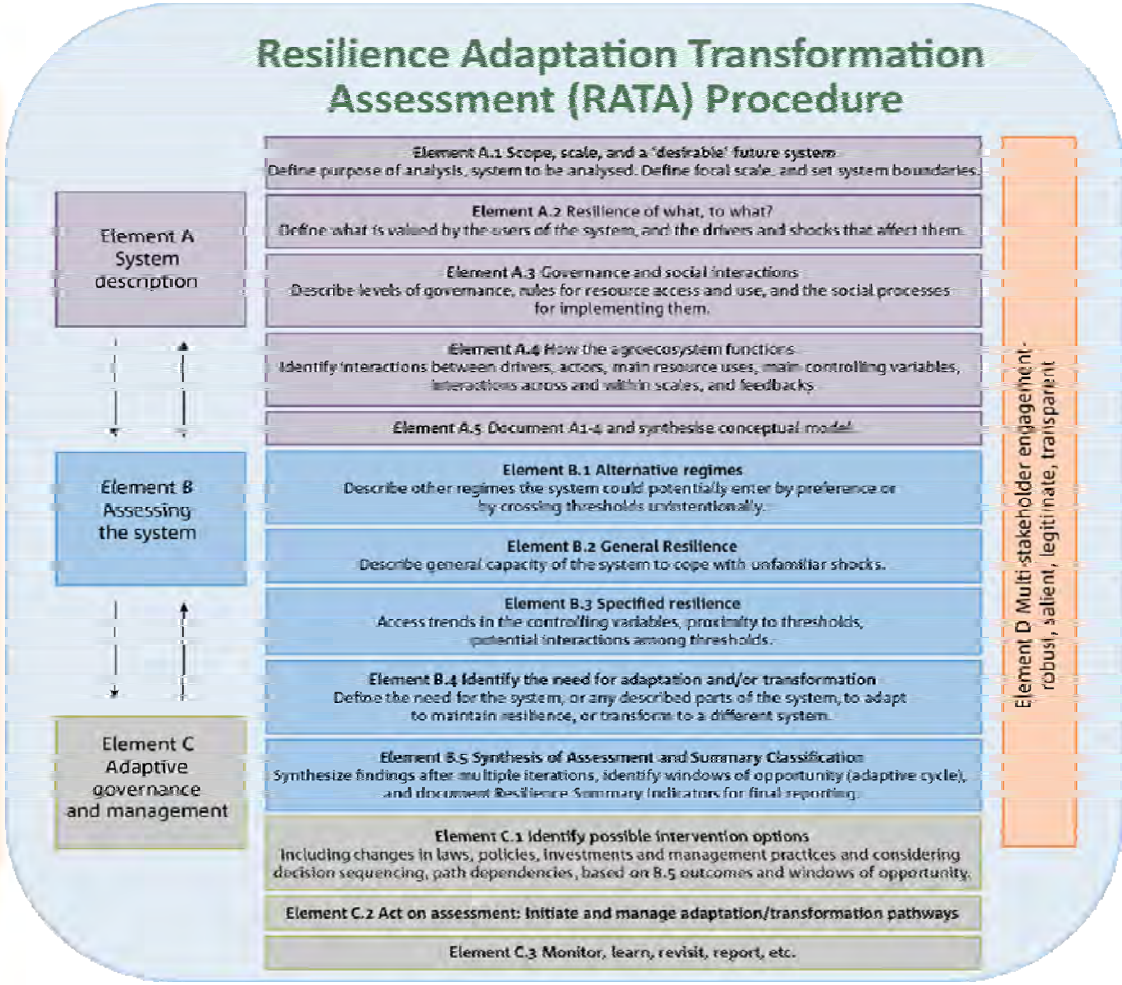
UMRS Resilience Assessment

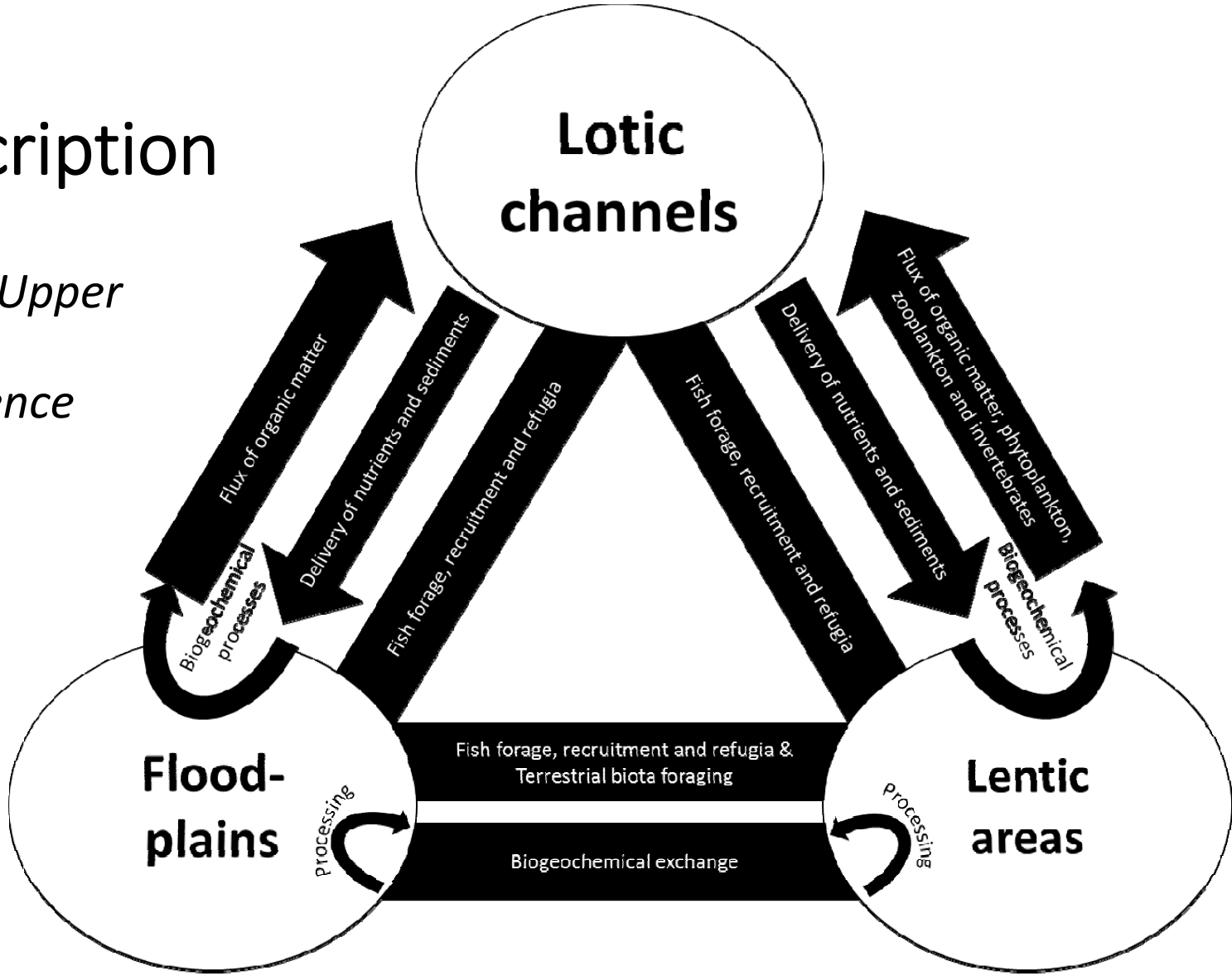




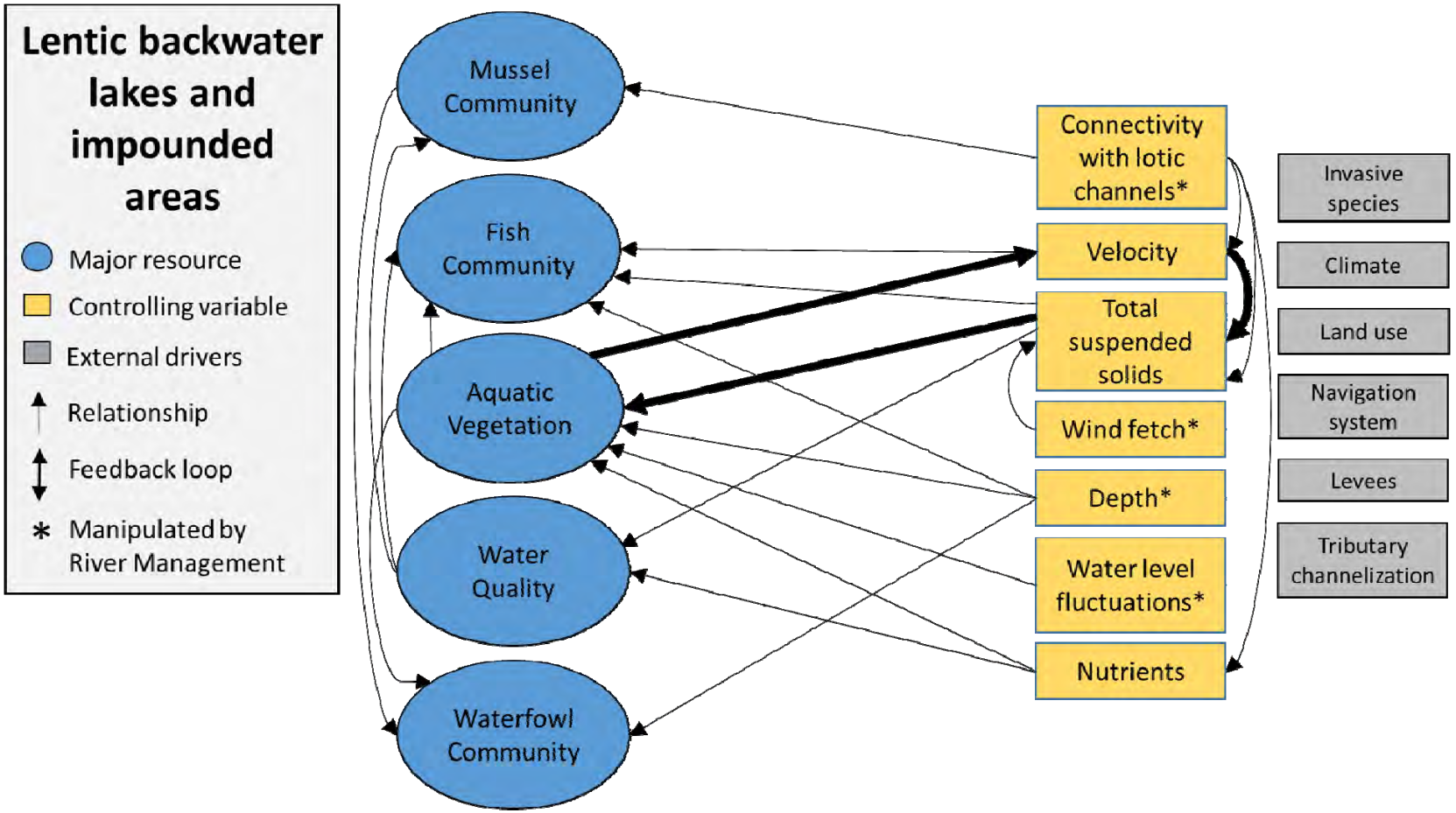
O'Connell, D., B. Walker, N. Abel, and N. Grigg. 2015.

System Description

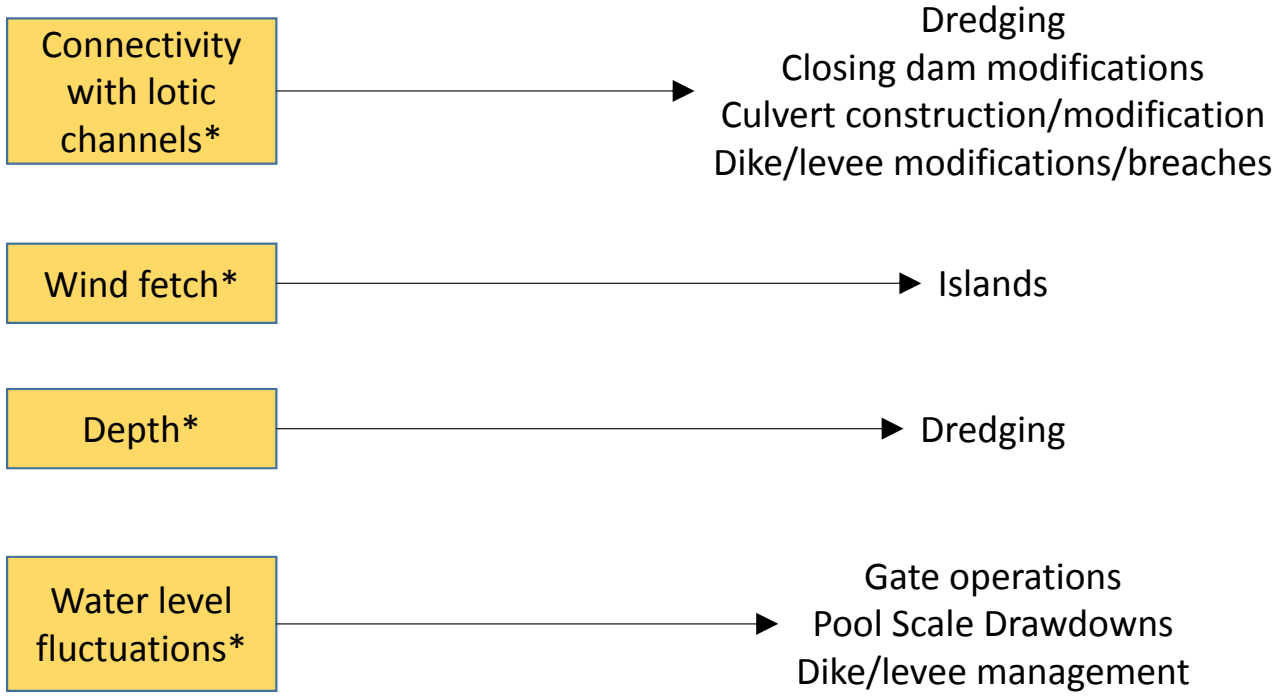
- *Developing a shared understanding of the Upper Mississippi River: the foundation of a resilience assessment*



System Description -> Assessing the system



System Description -> Assessing the system



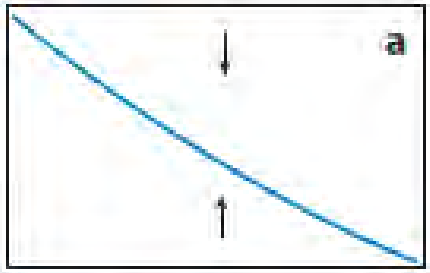
Resilience: main concepts

- Small changes in variables can lead to rapid changes in major ecosystem services when system is near a **threshold**
- Multiple possible **states** exist
- Components of the ecosystem can interact resulting in **positive or negative feedbacks**

State changes: gradual, threshold, & hysteresis

Abundant vegetation

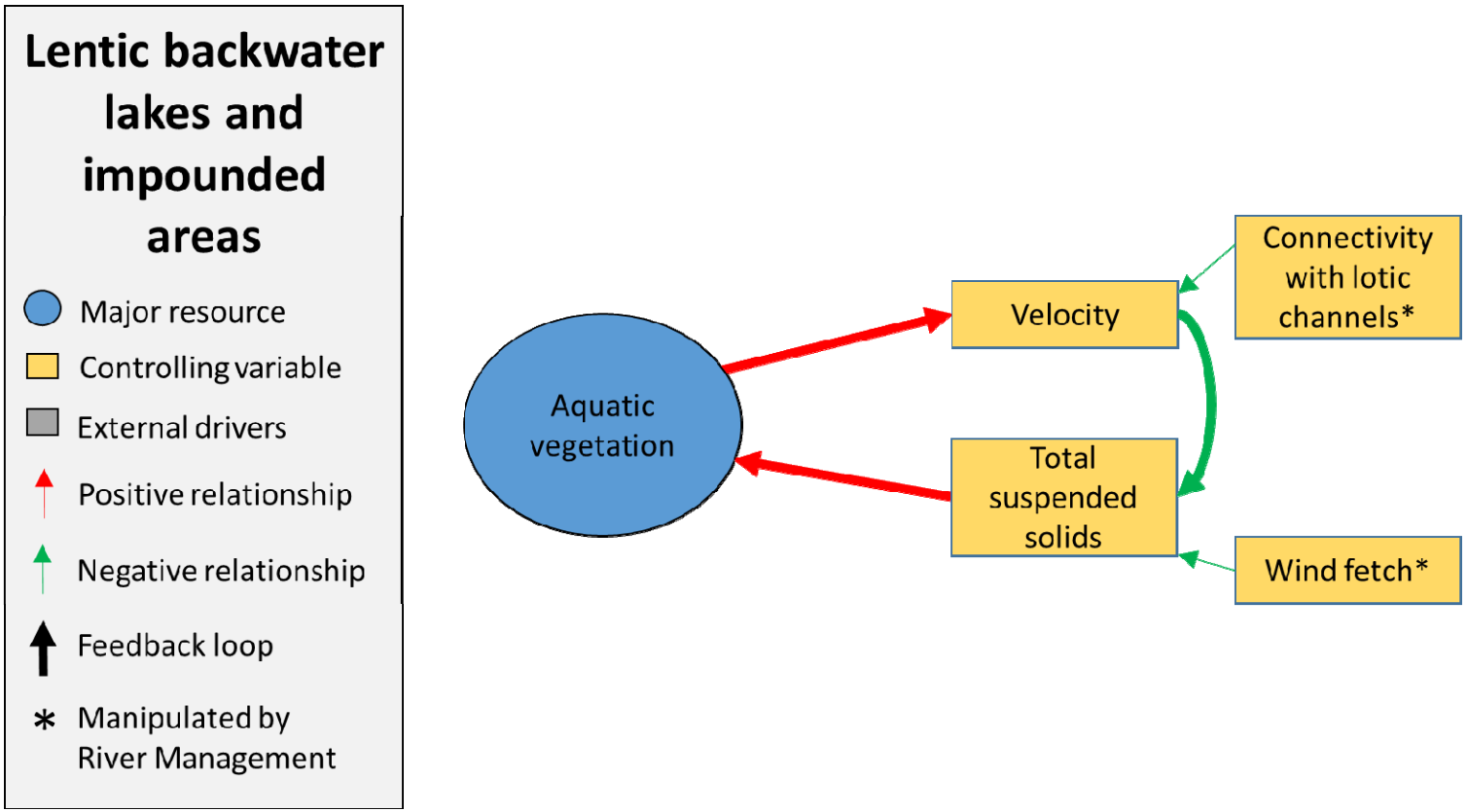
Scarce vegetation



gradual

(Scheffer et al. 2015)

Feedback example: aquatic vegetation



Alternative regimes

- Floodplain – mature forest -> young forest -> reed canarygrass / wet meadow
- Aquatic to Terrestrial transition in side channels, backwaters, and deltas
- Lentic – Abundant SAV / clear vs. scarce SAV / turbid
- Lotic – diverse native fish community vs. nonnative dominant
- Others…

What are the mechanisms driving transitions or regime changes?

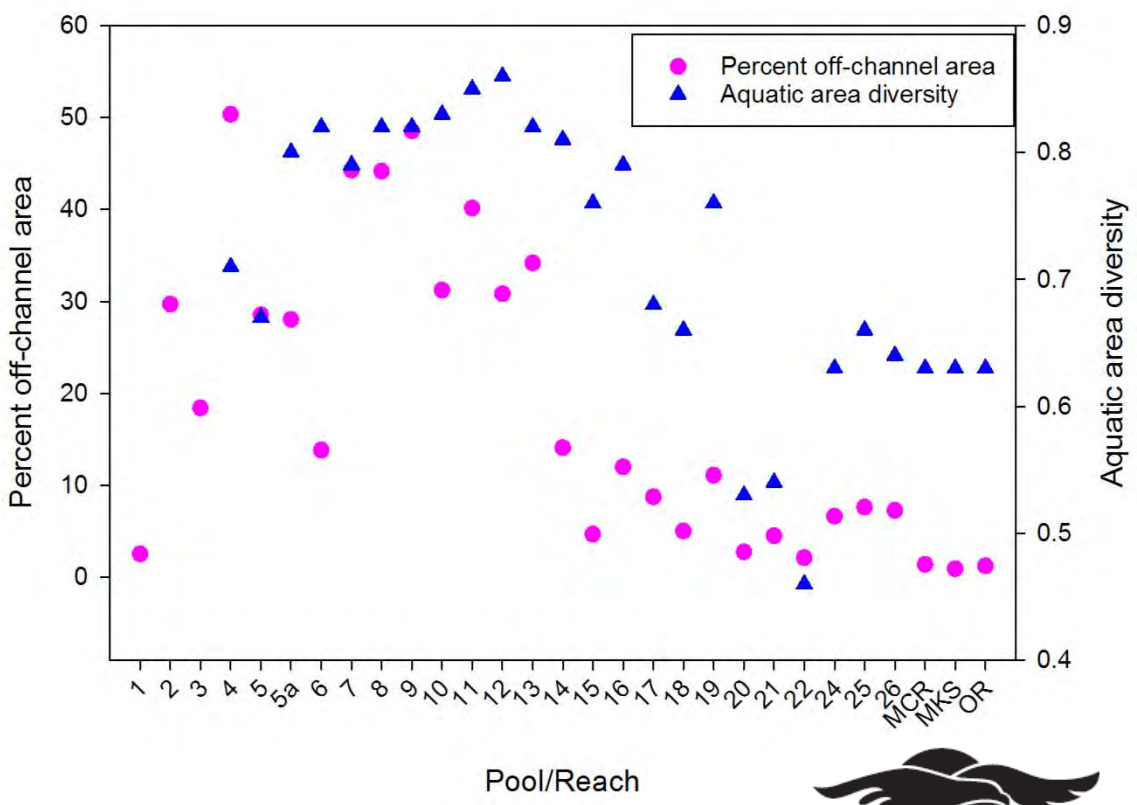
General Resilience:
Principles for Building Resilience

1. Maintain diversity and redundancy
2. Manage connectivity
3. Manage slow variables and feedbacks
4. Foster complex adaptive systems thinking
5. Encourage learning
6. Broaden participation
7. Promote polycentric governance

Biggs et al. 2015.

General Resilience

1. Maintain diversity and redundancy
   - provide options for responding to change and disturbance
     - Geomorphic diversity
     - Biodiversity
   - HREPs alter geomorphic diversity (e.g., dredging, island construction)



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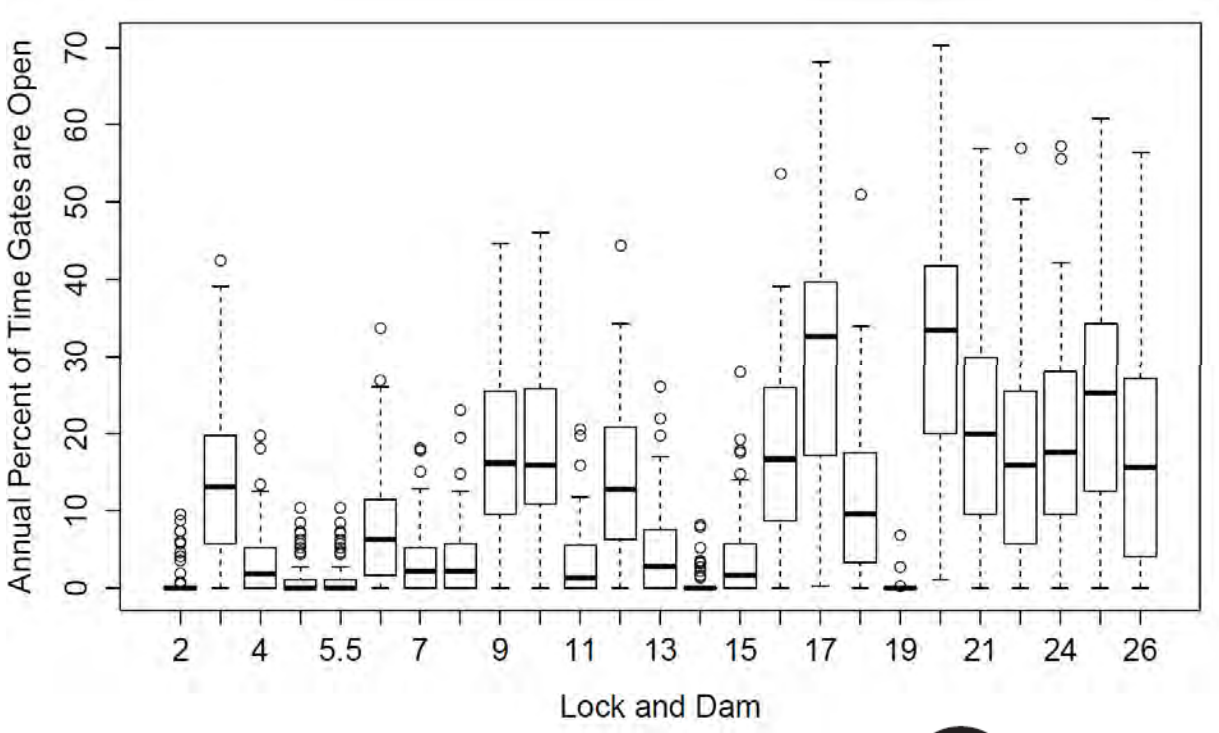
General Resilience Principle	Metric	Data needed	Project/Status (Lead)	Spatial Extent	Current
Diversity and redundancy	Aquatic area diversity	Enhanced aquatic areas	HNA II (Anderson)	System	HNA 2000
	Vegetation diversity	Land cover	HNA II (De Jager)	System	De Jager and Rhoweder 2011
	Depth distribution and diversity (aquatic)	Topobathy (applied to different discharges)	In progress (Rogala)	System	
	Elevation distribution and diversity (floodplain)	Topobathy	In progress (Rogala)	System	
	Forest species diversity, functional redundancy, and response diversity	Species distribution or abundance data	HNA II (Van Appledorn)		
	Fish species diversity, functional redundancy, and response diversity	Species distribution or abundance data	Resilience (Bouska)	LTRM + LTEF	
	Aq. veg species diversity, functional redundancy, and response diversity	Species distribution or abundance data	Resilience (Weeks)	LTRM (P4, P8 & P13)	

General Resilience

2. Manage connectivity
   - provides access to a wide range of conditions
     - Longitudinal barriers
     - Lateral (hydraulic)
   - HREPs alter connectivity
     - dredging
     - closing dam modifications
     - Culvert construction/modification
     - Dike/levee modifications/breaches



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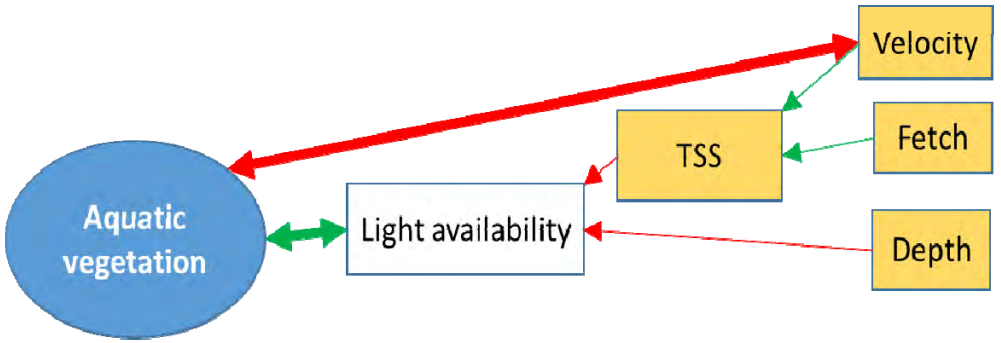
Upper Mississippi River Restoration

General Resilience Principle	Metric	Data needed	Project/Status (Lead)	Spatial Extent	Current
Connectivity	Longitudinal barriers (percent days open)	Discharge and stage data from each L&D	Completed (Bouska)	System	Wilcox et al. 2004
	Floodplain connectivity (floodplain inundation)	Water surface elevations at different discharges	HNA II (Van Appledorn)	System	De Jager and Rohweder 2015
	Lentic-lotic hydraulic connectivity (connectivity metrics)	Connectivity at low-moderate discharge	HNA II (Rogala)	System	

General Resilience

3. Manage slow variables and feedbacks
   - Determine underlying structure of system
     - Hydrology
     - Sediment and nutrient accumulation
     - Spread of invasive species
   - Provide ability to strengthen or disrupt stabilizing feedbacks



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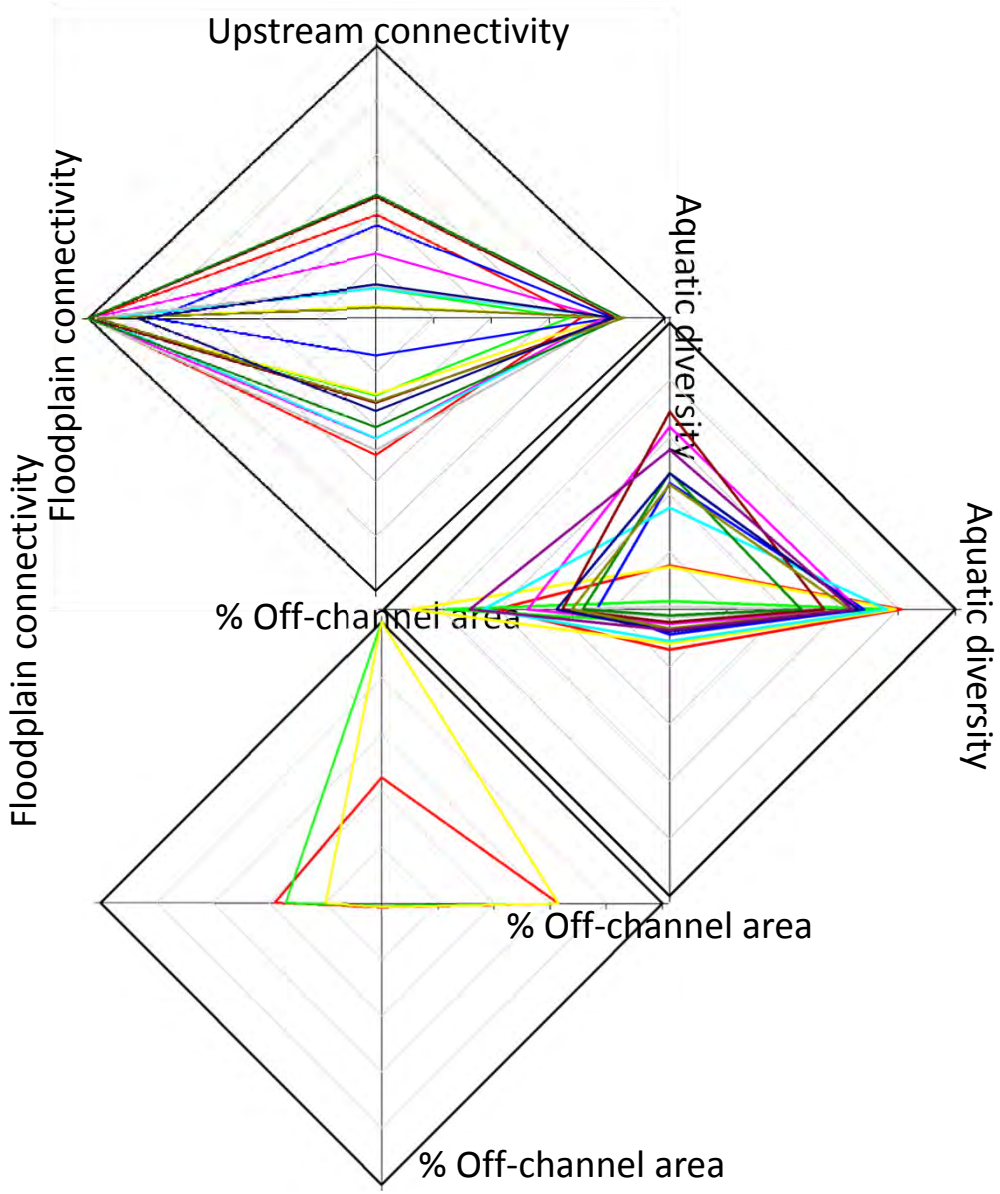
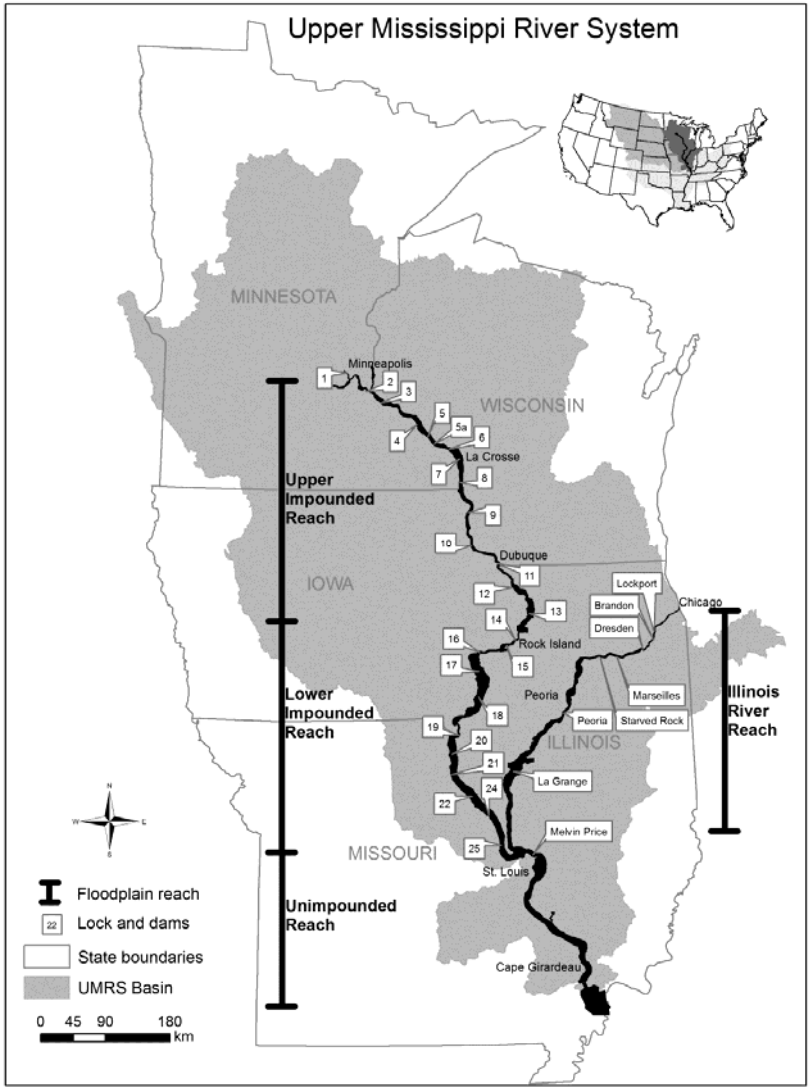
General Resilience Principle	Metric	Data needed	Project/Status (Lead)	Spatial Extent	Current
Slow variables	Flow regime (mainstem and tributaries)	USGS gages	HNA II (Rogala and Van Appledorn)	Gage locations	
	Water temperature	SRS, gages		LTRM, gage locations	
	Water surface elevation variability	Water surface elevations at different discharges		System	Rogala 1989 and 2000 (unpub)
	Floodplain inundation	Water surface elevations at different discharges	HNA II (Van Appledorn)	System	
	Sedimentation	Depth transects over time		Site-specfic transects in P4, P8 & P13	Rogala et al. 2003
	Total suspended solids	SRS – regression of TSS with catchment area	Resilience	LTRM to system extrapolation	Houser et al. 2011
	Invasive species (fish, veg, etc.)	Species distribution or abundance data			
	Catchment land use	National land use datasets	HNA II	System	
	Tributary nutrient and sediment inputs	Tributary SRS data		LTRM	Kreiling and Houser 2016
	Floodplain forest demographics	Forest species diversity, functional redundancy, and response diversity	HNA II (Van Appledorn)		
	Sediment nutrients	?			
	Soil	Forest data	HNA II (Van Appledorn)		
	Wind fetch	Wind fetch model	HNA II (Rogala)	System?	Rohweder et al. 2012


Upstream connectivity
Floodplain connectivity
Floodplain connectivity
Aquatic diversity
Aquatic diversity
% Off-channel area
% Off-channel area
% Off-channel area


Upper Mississippi River System
MINNESOTA
WISCONSIN
IOWA
ILLINOIS
MISSOURI
Minneapolis
La Crosse
Dubuque
Rock Island
Lockport
Brandon
Dresden
Chicago
Peoria
Marseilles
Peoria
Starved Rock
La Grange
Melvin Price
St. Louis
Cape Girardeau
Upper Impounded Reach
Lower Impounded Reach
Unimpounded Reach
Illinois River Reach
Floodplain reach
Lock and dams
State boundaries
UMRS Basin
0 45 90 180
km

Expected Resilience Assessment outcomes

- Publish a simple, conceptual description of the UMRS that identifies the major resources provided by the river and the primary controlling variables.
  - Combines output of the resilience workshop, subsequent discussions among partners, existing programmatic reports, and published research.
- Assess current state and resilience of system
  - Trends in controlling variables
  - Feedbacks and interactions among controlling variables
  - Proximity to thresholds of concern
  - General resilience metrics
- Describe potential impacts of our management and restoration activities on the resilience of the UMRS

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